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ON MATHEMATICS EDUCATION
AND INNOVATION

Theme:
Preparing Future Generations
Through Transdisciplinary Learning

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“Preparing Future Generations Through Transdisciplinary Learning”

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Foreword

This is with deep gratitude that I write this Foreword to the Proceedings of the 5th International Symposium on Mathematics Education Innovation (ISMEI).

SEAMEO Regional Centre for QITEP in Mathematics keeps maintaining its tradition to foster the exchange of innovative ideas and strategies for mathematics teaching and learning in modern classrooms and to encourage collaboration and partnership amongst mathematics educators. In this year’s symposium, we have been pleased to provide mathematics educators with an intriguing theme on ‘Preparing Future Generations Through Transdisciplinary Learning’.

During the symposium, all paper presenters presented their works on several topics namely innovation in assessment and evaluation, curriculum issues, distance education, innovation in teaching and learning, learning environments, online learning, and teacher education. Their contributions helped the symposium as outstanding as it was. In addition to the contributed papers, we also invited five keynote speakers to give participants new insights about mathematics education. They were Prof. Lew Hee Chan from Korean National University, Chairuti Lertwanasiriwan, Ph.D from Institute for the Promotion of Teaching Science and Technology, Thailand, Prof. Dindyal Jaguthsing from Nation Institute of Education, Singapore, Dr. Lynda Ball from University of Melbourne Australia, and Prof. Yoshisuke Kumano, Ph.D from Shizouka Univerisity, Japan.

I believe that this proceeding will be a fresh impetus to stimulate further study and research in mathematics education.

Finally, we thank all authors and participants for their willingness to share their latest research and ideas. Without their effort, the symposium would not be possible. Keep up the good work and see you in 2020.

Dr. Wahyudi
Centre Director
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Developing Learning Kit of Geometry for Vocational School Grade X Based on Multiple Intelligence Theory

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Abstract

This study aims at developing a learning kit of geometri for vocational school grade X based on multiple intelligence theory wich has valid, practical, and effective. This research was research and development using the 4D model suggest by Thiagarajan, Semmel & Semmel consisting of four stages that is define, design, development, and disseminate. The validity and practicality of the data were analyzed by converting the actual scores obtained into a five scale qualitative data. The effectivity was analyzed by determining the percentage of students completeness in a test and determining the percentage of students in each category of the questionnaires. According to the results of validation, Lesson Plan and worksheet that are developed are valid. According to the result of try- out Lesson Plan and worksheet are practical based on the result of implementation, teacher’s assessment and students’ assessment. Furthermore, Lesson Plan and worksheet effective view from the students’ achievement in spiritual attitude, social attitude, and knowledge competence. However, in terms of skill competence, Lesson Plan and worksheet is not effective yet.

Keywords: learning kit, Multiple Intelligence Theory, Geometry

Introduction

According to the Law of the Republic of Indonesia (RI Law) number 20 of 2003 article 1 paragraph 1 education is a conscious and planned effort to realize the learning atmosphere and learning process so that students actively develop the potential of themselves, society, nation and state. But in reality education in Indonesia is still not optimal. This can be seen from the UNESCO Educational for All Monitoring Report 2012 report which shows the quality of education in Indonesia is ranked 64th out of 120 countries. This means that the quality of education in Indonesia is still low.

Also included in the mathematics subject which shows achievements that have not been optimal, this is indicated by the results of TIMSS and PISA (Permendikbud No 60, 2014, p.2). Though mathematics is an important subject.
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NCTM (2000, p.5) states that in an ever-changing world those who understand and can do mathematics will have more opportunities and choices in determining their future. In line with this opinion Permendikbud number 60 (2014, p.323) states that to master and create technology in the future, it takes mastery and understanding of mathematics that is strong from an early age. Therefore it is important for vocational students especially in the technology family to master mathematics.

However, based on the results of observations conducted at State Vocational High School 1 Padaherang, it shows that students' mathematics learning achievement is less than optimal. This is shown from the completeness of students who only 20% at the end of learning and the results of the National Examination (UN) which decreased in 2012/2013. The decline in UN results for mathematics subjects can be seen in Table 1 below.

**Table 1. Mathematics National Examination (UN) Results Data**

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<th>Exam Value</th>
<th>Years 2011/2012</th>
<th>Years 2012/2013</th>
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</thead>
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<tr>
<td>Calsification</td>
<td>A</td>
<td>D</td>
</tr>
<tr>
<td>Mean</td>
<td>9,43</td>
<td>4,64</td>
</tr>
<tr>
<td>Lowest Score</td>
<td>8,50</td>
<td>3,00</td>
</tr>
<tr>
<td>Hight Score</td>
<td>10,00</td>
<td>9,25</td>
</tr>
</tbody>
</table>

Source from BSNP (2012 & 2013)

From Table 1, it can be seen that the average score of the National Examination in 2012/2013 was 4.64 which dropped drastically from the previous year's average of 9.43. From the results of the National Examination, it indicates that mathematics learning achievement has decreased.

SMK Negeri 1 Padaherang is one of the vocational schools that implement the 2013 Curriculum. Based on Permendikbud number 65 (2013, p.1) states that the learning process in educational units is organized interactively, incentive, fun, challenging, motivating students to actively participate and provide space sufficient for initiative, creativity and independence in accordance with the talents and interests, and the physical and psychological development of students. However, based on observations it appears that students are less enthusiastic in learning...
mathematics, students tend to get bored quickly. Students tend to prefer productive subjects compared to other subjects including mathematics. This is because the learning of mathematics is monotonous and still teacher-centered.

The fact is in current teaching practices, when the teacher becomes the center of teaching activities, the teacher becomes dominant, students seem to be empty glasses that must always be filled with water (Suyono & Hariyanto, 2014, p. 10). According to Yaumi (2012, p.1) a new student-centered approach is a theory and concept that has not been fully integrated in the learning implementation plan. To maximize learning, planning learning must pay attention to learning styles and multiple intelligences (Moore, 2009, p. 28). This opinion emphasizes that multiple intelligences can be empowered in planning learning to achieve the expected competencies, including in mathematics learning. In addition Hoerr (2000, p.5) states that teachers who use multiple intelligences can give students the opportunity to use the strongest intelligence to demonstrate what they are learning.

Compound intelligence is meant here is the multiple intelligences proposed by Gardner. In the first edition in his book "Frame of Mind" Gardner describes seven types of intelligence namely logical-mathematics, verbal-linguistic, visual-spatial, musical, bodily-kinesthetic, interpersonal, and intrapersonal. Then in the second edition he added two types of intelligence namely naturalist and existential (Calik & Birgili, 2012, p.2). However Connell (Yaumi, 2012, p.229) states that Gardner himself still occupies existential intelligence as a half or imperfect intelligence into an intelligence due to its physiological location in the human brain. So in this study the meaning of multiple intelligences is eight intelligences expressed by Gardner namely logical-mathematics, verbal-linguistic, visual-spatial, musical, bodily-kinesthetic, interpersonal, intrapersonal and naturalist.

The multiple intelligence potential that students have should be used as an opportunity to create interesting learning. Interesting learning requires careful planning supported by adequate learning media. However, based on the results of the interview. The teacher has not actively developed all the potential possessed by students including multiple intelligences, besides that, related to the implementation of the 2013 curriculum the teacher also still has difficulties in
developing learning tools based on the 2013 Curriculum and there is no mathematics learning device based on multiple intelligence theories developed especially at the secondary school level vocational. Therefore the development of mathematics learning devices based on multiple intelligence theories is oriented towards achieving competence according to the 2013 Curriculum can be used as a solution. Based on this, the researcher conducted a research on the development of mathematics learning devices based on multiple intelligence theories oriented to the achievement of competencies according to the 2013 curriculum of SMK students of class X semester 2.

**Research Method**

This type of research is development research. The development model used is the Thiagarajan, Semmel & Semmel model 4D, which consists of 4 stages, namely define, design, development, and disseminate (Thiagarajan, Semmel & Semmel, 1974, p.5).

**Research Procedure**

The first stage is the stage of defining this stage to establish and define the requirements for development. The defining phase consists of five stages of analysis, namely preliminary analysis, curriculum analysis, student analysis, material analysis, and analysis of the final goal. The initial analysis aims to find out and get information about the conditions and facts of the tools of mathematics learning in the field. Curriculum analysis aims to establish the competencies in which learning tools are developed. Student analysis is done to find out the characteristics of students at the level of vocational high school (SMK). These characteristics include initial abilities, background, knowledge, students' cognitive development, and the multiple intelligence potential of students. The potential of multiple intelligence students can be seen through the provision of multiple intelligence questionnaires to students who are the subject of research. Material analysis is done by identifying the material to be taught, collecting and selecting relevant material, and rearranging it systematically. Analysis of the final goal is useful to limit the researcher so as not to deviate from the initial goal of the study.
The next stage is the design stage. At this stage the design and preparation of products is carried out, namely Lesson Plan and Student Worksheet based on multiple intelligence theories. The steps at the design stage are media selection, format selection, and initial product design. The selection of media is related to the determination of the right media to present the subject matter based on material analysis, analysis of students and available facilities at school. The format selection includes the activity of determining the format for designing learning tools in the form of Lesson Plan and Student Worksheet. The initial design is the activity of designing and writing Lesson Plan and Student Worksheet so that the draft 1 Lesson Plan and Student Worksheet are obtained.

The next stage is the development stage. The development phase is divided into two activities, namely expert appraisal and development testing. Expert appraisal is a technique to validate or assess the feasibility of product design. In this activity validation was carried out by experts in their fields. The suggestions given are used to improve the learning tools that have been compiled. Development testing is the activity of testing the product design on the real target subject. There are two activities, namely limited trials to find out in terms of legibility and understanding the words or sentences used in Student Worksheet, learning achievement tests, spiritual attitude questionnaires and social attitude questionnaires. Field trials were conducted to determine the practicality and effectiveness of learning devices.

The last stage is the disseminate stage. At this stage a limited number of learning tools for teachers is disseminated. This is intended to obtain responses and feedback on the learning tools developed. If the response is good then printing in large quantities so that the learning device can be used by a wider target.

**Subjects of Testing, Time & Research Sites**

This research was conducted at SMK 1 Padaherang having its address at Pangandaran stret KM 1 Karangsari Village, Padaherang District, Pangandaran District. The subjects of limited trials in this study were 10 students of class XI TKJ C and the subject of field trials were 31 students of class X TPMP. The research was conducted in March-May 2015.
Data, Techniques and Data Collection Instruments

The data in this study consisted of quantitative data and qualitative data. Quantitative data were obtained from the results of expert validation, teacher assessment questionnaire, student response questionnaire, observation of learning achievement, achievement tests, spiritual attitude questionnaire, and social attitude questionnaire. Qualitative data is obtained from comments and suggestions about the learning tools developed, as well as the results of quantitative data conversion. Instrument for measuring validity, namely the validation sheet. Instruments for measuring practicality, namely teacher assessment questionnaires, student response questionnaires, and learning implementation observation sheets. Instruments for measuring effectiveness are achievement tests, spiritual attitude questionnaires, and social attitude questionnaires.

Validity and practicality data analysis technique is by converting the average score obtained into a five-scale qualitative form. The data conversion criteria can be seen in Table 2 below.

Table 2. Data Conversion Criteria

<table>
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<th>Interval Score</th>
<th>Category</th>
</tr>
</thead>
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<tr>
<td>( M_i + 1,5S_i &lt; X \leq M_i + 3S_i )</td>
<td>Very good</td>
</tr>
<tr>
<td>( M_i + 0,5S_i &lt; X \leq M_i + 1,5S_i )</td>
<td>Good</td>
</tr>
<tr>
<td>( M_i - 0,5S_i &lt; X \leq M_i + 0,5S_i )</td>
<td>Enough</td>
</tr>
<tr>
<td>( M_i - 1,5S_i &lt; X \leq M_i - 0,5S_i )</td>
<td>Not good</td>
</tr>
<tr>
<td>( M_i - 3S_i &lt; X \leq M_i - 1,5S_i )</td>
<td>Bad</td>
</tr>
</tbody>
</table>

Source Azwar (2013, p.163)

Information:

: average ideal score

: ideal standard deviation

: actual total score

= (ideal maximum score - ideal minimum score)

= (ideal maximum score + ideal minimum score)

Data analysis techniques for the effectiveness of learning devices in terms of achievement tests is by determining the percentage of student completeness,
while the effectiveness of learning devices in terms of spiritual attitudes and social attitudes that is by determining the percentage of students in each category.

Geometry learning devices based on multiple intelligence theories are said to be valid if the expert judgment is minimal in the good category. Multiple intelligence-based geometry learning devices are said to be practical if the results of teacher assessment and student responses are minimal in the good category and the percentage of learning achievement is at least 80% implemented. Geometry learning devices based on multiple intelligence theories are said to be effective in terms of achievement tests if at least 80% of students have reached the minimum completeness criteria, set by the school for geometry material, namely 75. For questionnaires on spiritual attitudes and social attitudes, geometry learning devices based on multiple intelligence theories said to be effective if the percentage of students who attained attitudes in the high category was at least 80%.

**Research Results and Discussion**

The description of the results of the development of the geometry learning device based on multiple intelligence theories using the Thigarajan, Semmel & Semmel 4D development model is as follows.

**Define phase**

Based on the preliminary analysis, it was obtained information that the learning tools used in SMK 1 Padaherang were the results of subject teachers' deliberations (MGMP) but only limited to the implementation plan of learning (Lesson Plan) without supported by adequate learning media, and the learning resources used by students were the mathematics books available in the school library and even then the numbers are limited. Besides that the learning tools made by the teacher have not facilitated students through students' multiple intelligences. In relation to the implementation of the 2013 Curriculum, the learning tools that are oriented towards achieving competencies according to the 2013 Curriculum are still limited and teachers are still having difficulties in developing these learning tools.
Based on these problems, the development of learning tools based on multiple intelligence theories oriented towards the achievement of competencies according to the 2013 curriculum can be used as a solution in solving these problems. Through learning tools based on multiple intelligence theories, it is expected to facilitate students in learning mathematics through the multiple intelligence potential that students have so that students can achieve the expected competencies based on 2013 curriculum.

Furthermore, the curriculum analysis, the curriculum used in SMK 1 Padaherang is the 2013 curriculum, where in the 2013 Curriculum the approach used in learning activities is a scientific approach with five main learning experiences namely observing, asking, collecting information, associating and communicating. The competencies that must be achieved by students in learning include four core competencies, namely core spiritual attitudes (KI-1), core competencies (KI-2), core knowledge competencies (KI-3), and core skills competencies (KI-4).

Based on the results of observations and interviews with teachers of mathematics subjects obtained information that learning using a scientific approach has not been implemented optimally, the teacher uses more direct learning in mathematics learning because teachers still have difficulties in developing learning tools whose activities use scientific approaches. Teachers also have difficulties in assessing each core competency in the 2013 Curriculum, especially the assessment of KI-1 spiritual attitudes and KI-2 social attitudes.

The next stage is student analysis. Based on Piaget's development stage (Riyanto, 2012, p. 124) vocational students belong to the formal period of operation or the stage of development of formal operations, this period begins at 12 years. In this period students can think symbolically and can understand something meaningfully and can understand things that are imaginative. The implication in mathematics learning students can learn if input (learning material) is in accordance with students' interests and talents.

Based on the results of observations and interviews, it shows that vocational students tend to be less enthusiastic in learning mathematics compared
to productive subjects. Students also get bored quickly when learning mathematics. This causes student achievement in learning mathematics is less optimal, this is indicated by the achievement of students who only 20% of students who can achieve KKM at the end of learning.

In the analysis phase, the material of the researcher analyzed the mathematics lesson material to be developed in accordance with the curriculum used, namely 2013 Curriculum, the material chosen was the geometry material of X grade semester 2 of SMK which included basic competencies (KD) 3.13, namely describing the concepts of distance and angle between points, lines and the field through demonstration using props and other media, and 4.13 that is using various principles of flat building and building space and in solving real problems related to distance and angle between points, lines and fields.

Next is to analyze the final goal of learning which is the basis for the preparation of learning tools in the form of Lesson Plan and Student Worksheet and is equipped with an assessment instrument in the form of learning achievement tests and attitude questionnaires. Based on the achievement of competencies in the 2013 curriculum, assessment includes cognitive aspects and affective aspects. At this stage the learning objectives are arranged from KI-1 to KI-4.

**Design phase (design)**

The design phase aims to prepare prototypes of learning device products based on multiple intelligence theories. The design stage starts with media selection. The media used in the learning process besides using public facilities such as blackboards, markers, rulers, projectors are also used by other media such as worksheets and teaching aids in the form of a cube frame. Then before the initial design stage of the learning device, the format selection for Lesson Plan and Student Worksheet is done. The Lesson Plan format is adjusted to the Lesson Plan format in the 2013 Curriculum. While the Student Worksheet format is in the form of print media and adjusts the steps for preparing Student Worksheet.

Next is the initial design stage of learning tools in the form of Lesson Plan and Student Worksheet. Lesson Plan is one form of teacher preparation before implementing learning. The learning that will be carried out is a multiple
intelligence-based learning so that the drafted Lesson Plan is adjusted to multiple intelligence-based learning. There are steps in developing a multiple intelligence based Lesson Plan, starting with reviewing the syllabus, conducting a multiple intelligence survey, selecting the type of intelligence that will be facilitated, developing learning scenarios, and selecting the media and tools used in learning.

Based on the results of the study on the material syllabus that was chosen was geometry material that is in KD 3.13 which was translated into 14 learning goals and KD 4.13 which was collapsed into 2 learning objectives. KD 3.13 and KD 4.13 are made into one Lesson Plan consisting of six meetings. Multiple intelligence surveys are conducted to see students' multiple intelligence mapping, so researchers can design mathematics learning that facilitates students through the multiple intelligences that students have. The following is the result of a multiple intelligence survey in class X TPMP.

![Figure 1. Compound intelligence survey results](image)

Based on the results of the multiple intelligence survey in Figure 1, it can be seen that the most prominent intelligence in class X TPMP is interpersonal intelligence, based on this group discussion activities were chosen to facilitate interpersonal intelligence of students, so at each learning meeting carried out with group discussion. Besides that, other faculties are also facilitated according to the material taught at each learning meeting. At each learning meeting there are at least 4 intelligences facilitated.

After conducting a multiple intelligence survey and choosing the type of intelligence that will be facilitated in learning, the next step is to develop a learning scenario. The approach used is a scientific approach in which a combination of
intelligence that will be facilitated is integrated in the learning experience in the scientific approach of observing, asking, collecting information, associating and communicating.

After developing the learning scenario the researcher designs the media and tools that will be used in learning. The media that will be used in learning is multiple intelligence-based Student Worksheet. In addition, media and other tools such as props and other tools are adapted to the needs of each meeting. The next step is the stage of writing Lesson Plan. At the writing stage Lesson Plan is used Microsoft Word 2013 in the hope of producing an attractive Lesson Plan.

In addition to Lesson Plan, there are also multiple intelligence-based Student Worksheet. The steps in compiling multiple intelligence based Student Worksheet are compiling a map of Student Worksheet needs, preparing reference books, determining Student Worksheet titles, and writing Student Worksheet. Based on the analysis of Student Worksheet needs, the number of Student Worksheet and the order of presentation of Student Worksheet on geometry material is obtained. The number and sequence of worksheets are determined by taking into account core competencies, basic competencies, and indicators of achievement of competencies that students must achieve in learning. In addition Student Worksheet is prepared by taking into account the combination of multiple intelligences that will be facilitated in learning. After that, a reference book was collected to assist researchers in writing Student Worksheet. In writing Student Worksheet used Word 2013 Microscope. In addition, Geogebra and Corel Draw X6 applications are also used. The Geogebra application is used to create geometry images while Corel Draw is used to design cover Student Worksheet.

In addition to designing and preparing Lesson Plan and worksheets based on multiple intelligence theories, it is also necessary to complete instruments that aim to measure the effectiveness of the Lesson Plan and Student Worksheet developed. The instruments designed in this study were achievement tests, spiritual attitude questionnaires, and social attitude questionnaires.

Achievement tests aim to determine the extent to which students have mastered or achieved the competence of the material that has been studied. In this
study divided into two. The first achievement test in the form of multiple choice questions is intended to measure the achievement of knowledge competencies. While the second achievement test is the test of the contest in the form of a description of the problem which is intended to measure the achievement of skills competencies. The details of the questions on each achievement test are 14 questions for multiple choice questions and 3 questions for the form of description. While for spiritual attitude questionnaires composed of 5 positive statements and 5 negative statements. For social attitude questionnaires consisting of 9 positive statements and 9 negative statements.

Before achievement tests and questionnaires are used to determine the effectiveness of the learning tools developed, it is necessary to analyze the quality of tests and questionnaires. The quality of achievement tests and questionnaires in this study were obtained from the validity and estimation of reliability. According to Reynolds, Livingstone & Wilson (2010, p.124), validity is the accuracy or accuracy of interpretation of test scores. There are two validities that are carried out in this study, namely content validity and construct validity. Based on the content validity and construct validity, it was found that achievement tests, spiritual attitude questionnaires and social attitude questionnaires were valid and feasible to use. According to Reynolds, Livingston, & Wilson (2010, p. 91), reliability is the consistency or stability of the results of the assessment. Based on the analysis, it was found that achievement tests which included multiple choice tests and skill tests, spiritual attitude questionnaires, and social attitude questionnaires were reliable and could be used in subsequent trials.

Development stage

In the development stage, the development products in the form of multiple intelligence-based learning devices that have been followed in the previous step were validated by experts to find out the validity of developed learning tools (Lesson Plan and Student Worksheet) and instruments (achievement tests, spiritual attitude questionnaires, and social questionnaires) before testing. In this study there were four validators who validated the product, two lecturers and two mathematics teachers.
Based on expert judgment, there were several suggestions and input regarding learning devices and instruments. Therefore it is necessary to revise based on advice and input from experts. The results of validation analysis of learning devices can be seen in Table 3 below.

<table>
<thead>
<tr>
<th>Developed Devices</th>
<th>Actual Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson Plan</td>
<td>3.57</td>
<td>Very Good</td>
</tr>
<tr>
<td>Student Worksheet (Content)</td>
<td>3.57</td>
<td>Very Good</td>
</tr>
<tr>
<td>Student Worksheet (Graphics)</td>
<td>3.56</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

From the results of the analysis in Table 3, the average actual score of Lesson Plan validation is 3.57, for STUDENT WORKSHEET in terms of material is 3.57, and Student Worksheet in terms of graphics is 3.56. Based on this, it can be concluded that Lesson Plan and Student Worksheet are based on multiple intelligence theories that are developed valid and feasible to be used in mathematics learning.

Furthermore, after the learning device and instrument are validated there is a limited trial. The limited trial involved 10 students of class XI TKJ C. The selection of limited trial subjects was based on the consideration that students of class XI had studied geometry so that they could provide an assessment of worksheets, achievement test questions, spiritual attitude questionnaires, and social attitude questionnaires in terms of legibility. This readability includes clarity of instructions, language, material and meaning of statements in the questionnaire. Readability test is done by filling out the readability guide questionnaire. From the results of questionnaires given to 10 students related to the legibility of worksheets, achievement tests and questionnaires found that 6 students considered the readability of the developed devices included in the excellent category, and 4 students stated that the readability of the developed devices included in the good category.
Based on the readability test, the things that are the material for improvement are the appearance of Student Worksheet that is less attractive so that it needs to be added pictures or illustrations and still found typing errors. In the attitude questionnaire there are several statements that require explanation. From the results of the readability test the researcher revised the product before field testing.

The next stage is field trials. Field trials were conducted to see and assess the practicality and effectiveness of learning devices. Practical assessment can be seen from three sources, namely from the results of the teacher assessment questionnaire, student response questionnaire, and the results of observations of learning implementation. The results of the practical analysis in terms of the teacher's assessment can be seen in Table 4 below.

<table>
<thead>
<tr>
<th>Developed Devices</th>
<th>Actual Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson Plan</td>
<td>3.57</td>
<td>Very Good</td>
</tr>
<tr>
<td>Student Worksheet</td>
<td>4</td>
<td>Very Good</td>
</tr>
<tr>
<td>Total</td>
<td>3.78</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

Based on the results of the analysis in Table 4, the total score of the Lesson Plan and student worksheet scores is 3.78, with very good categories. From these categories it can be concluded that Lesson Plan and Student Worksheet are based on multiple intelligence theories that are developed practically in terms of teacher ratings.

In addition, the practicality of the developed device was reviewed from the student response questionnaire. The questionnaire is given after students carry out mathematics learning using worksheets based on multiple intelligence theories. Based on the results of the analysis, the average student response score was 3.31 with a very good category. From these categories it can be concluded that worksheets based on multiple intelligence theory were developed practically in terms of student response questionnaires.
Learning practicality in terms of learning implementation is done by calculating the average percentage of learning implementation. The results of practical analysis in terms of the learning feasibility can be seen in Table 5 below.

<table>
<thead>
<tr>
<th>Learning</th>
<th>Percentage of completeness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>82.60%</td>
</tr>
<tr>
<td>2</td>
<td>88.46%</td>
</tr>
<tr>
<td>3</td>
<td>96.15%</td>
</tr>
<tr>
<td>4</td>
<td>100%</td>
</tr>
<tr>
<td>5</td>
<td>100%</td>
</tr>
<tr>
<td>6</td>
<td>100%</td>
</tr>
<tr>
<td>Average</td>
<td>94.53%</td>
</tr>
</tbody>
</table>

Based on the results of the analysis in Table 5, it was found that the percentage of learning implementation at each meeting > 80%. So it can be concluded that Lesson Plan based on multiple intelligence theory is developed practically in terms of the implementation of learning.

The effectiveness of geometry learning devices based on multiple intelligence theories based on achievement test results can be seen from the percentage of students' completeness on achievement tests. Achievement tests are divided into two, namely to measure knowledge competency using multiple choice tests and to measure skills competencies used a description test. The results of achievement tests can be seen in Table 6 below.

<table>
<thead>
<tr>
<th></th>
<th>Multiple Choice</th>
<th>matter of description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Score</td>
<td>88.24</td>
<td>62.90</td>
</tr>
<tr>
<td>Many Students Complete</td>
<td>28</td>
<td>9</td>
</tr>
<tr>
<td>Percentage of Completed Students</td>
<td>90.32%</td>
<td>29.03%</td>
</tr>
<tr>
<td>Many Students Are Not Completed</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>Percentage of Students Who Are Not Completed</td>
<td>9.68%</td>
<td>70.97%</td>
</tr>
</tbody>
</table>
From Table 6, it can be seen that there are 28 students who completed the multiple choice test or 90.32%. While in the description test only 9 students were completed or 29.03%. The geometry learning device is said to be effective based on achievement tests if 80% of students have achieved the criteria of minimum complete set by the school which is 75. Based on this it can be concluded that the geometry learning device is based on effective multiple intelligence theory in terms of the achievement of knowledge competencies and not yet effective in terms of achievement of skill competencies.

In addition to reviewing the results of achievement tests, the effectiveness of geometry learning devices based on multiple intelligence theories is viewed from the achievement of competencies in spiritual attitudes and social attitudes. The results of the analysis of spiritual attitudes can be seen in Table 7 below.

Table 7. Results of Spiritual Attitude Questionnaire Analysis

<table>
<thead>
<tr>
<th>Category</th>
<th>Many Of Student</th>
<th>Percentes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Hight</td>
<td>13</td>
<td>41.93%</td>
</tr>
<tr>
<td>Hight</td>
<td>12</td>
<td>38.70%</td>
</tr>
<tr>
<td>Medium</td>
<td>5</td>
<td>16.12%</td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
<td>3.22%</td>
</tr>
<tr>
<td>Very Low</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Based on Table 7 it can be seen that 41.93% of students have a very high spiritual attitude, 38.70% of students have a high spiritual attitude, 16.12% of students have a moderate spiritual attitude and 3.22% of students have a low spiritual attitude. Based on this, it can be concluded that the geometry learning device based on compound intelligence theory is effective in terms of the achievement of spiritual attitude competencies.

While the effectiveness of geometry learning devices based on multiple intelligence theories in terms of achievement of social attitude competencies is shown in Table 8 below.
**Tabel 8. Hasil Analisis Angket Sikap Sosial**

<table>
<thead>
<tr>
<th>Category</th>
<th>Many of Student</th>
<th>Percentase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>3</td>
<td>9.67%</td>
</tr>
<tr>
<td>High</td>
<td>23</td>
<td>74.19%</td>
</tr>
<tr>
<td>Medium</td>
<td>5</td>
<td>16.12%</td>
</tr>
<tr>
<td>Low</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Very Low</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Based on Table 8 it can be seen that 9.67% of students have very high social attitudes, 74.19% of students have high social attitudes and 16.12% of students have moderate social attitudes. Based on the results of the analysis it can be concluded that the geometry learning device based on multiple intelligence theory is effective in terms of the achievement of social attitude competencies.

The development of learning tools has been carried out using the Thiagarajan, Semmel & Semmel 4D development model stages. Through the stages of development carried out, it can be known the quality of learning devices developed. Based on the results of expert validation and field trials it was found that the geometry learning device based on multiple intelligence theory was developed valid, practical and effective in terms of the achievement of spiritual attitude competencies, achievement of social attitude competencies and achievement of knowledge competencies. However, the learning tool has not been effective when viewed from the achievement of skill competencies.

Based on the assessment conducted by experts, the final product of learning tools (Lesson Plan and Student Worksheet) based on multiple intelligence theories in geometry material has met valid criteria with very good categories. This learning device is valid because in its development it has been based on relevant theories.

From the results of the trial it is known that Lesson Plan and Student Worksheet based on the multiple intelligence theory produced has reached a practical category. This can be seen from the results of teacher assessments, student responses, and observations of learning implementation. Based on the teacher's assessment of Lesson Plan and Student Worksheet, it can be concluded...
that Lesson Plan and Student Worksheet have been practically in very good categories. Based on the results of student responses it can be concluded that the learning device has been practically in a very good category. Based on the results of observations of learning implementation, it can be concluded that Lesson Plan and Student Worksheet are stated to be practical with the implementation of Lesson Plan reaching > 80%.

Based on the results of field trials that have been carried out, the geometry learning device based on the multiple intelligence theory developed has met the effective criteria in terms of the achievement of spiritual attitude competencies, achievement of social attitude competencies and achievement of knowledge competencies. However, the learning tool has not been effective when viewed from the achievement of skill competencies.

The effectiveness of mathematics learning based on multiple intelligence theories in achieving spiritual attitude competencies, social attitudes and learning achievement in accordance with several research results. In Bas & Beyhan's research (2010) the results of his research show that there is an influence in multiple intelligence learning that is supported by project-based learning. The learning influences student achievement and attitudes in English lessons. Previous research was Xie & Lin's (2009) research. The results of his research showed that polytechnic students in Taiwan in classes that implemented multiple intelligence-based learning were significantly better than students in class who did not apply multiple intelligence-based learning, especially in working on project design tasks.

In addition to that far before, Temur's (2007) study of the effect of learning was based on multiple literacy theories on mathematics learning achievement of fourth grade elementary school students at Gazi University Foundation Private Primary School. The results of his research showed that the students' mathematics learning outcomes increased after implementing mathematics learning based on multiple intelligence theories.
Conclusions and suggestions

Based on the results of the research and discussion, it was concluded that the geometry learning tools (Lesson Plan and Student Worksheet) based on multiple intelligence theories oriented to the achievement of competencies according to the 2013 curriculum have fulfilled the criteria of validity and practicality. For effectiveness, geometry learning tools (Lesson Plan and Student Worksheet) based on effective multiple intelligence theory in terms of the achievement of spiritual attitudes, social attitudes and knowledge competencies. However, it has not been effective in terms of the achievement of skill competencies.

As for suggestions for other researchers, can develop mathematical learning devices based on multiple intelligence theories on other material and different levels of school.

Literature Reference


How to Teach Calculation Through Realistic Mathematics Education Based on Multisensory

The Theory of Applying Multisensory Methods to Realistic Mathematics Education in Primary Schools

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Abstract

The teacher in teaching the concept of calculation to low-grade primary school students requires specific stimulation. This is because primary school age students are between 6-12 years old who according to Piaget are in a concrete operational phase. The characteristic of this phase is that the child is capable of thinking in order to operationalize logically but concrete objects are still needed. The concept of calculation can be taught through realistic mathematics education according to the stages, i.e. concrete, representation, and abstract stages. Efforts to optimize realistic mathematics education can be done through multisensory methods. Realistic mathematics education based on multisensory is a teaching and learning approach that is able to accommodate students various types of learning to calculate by optimizing various senses that students have, i.e. auditory, visual, kinesthetic, and tactile. The preparation of this paper aims to review the literature in the application of multisensory methods on realistic mathematics education. The scope of this paper is: (1) realistic mathematics education based on multisensory form students about the learning culture of calculating in a diverse and variety; (2) students are able to learn to calculate through the application of realistic mathematics education based on multisensory.

Keywords: calculation, multisensory, primary school, realistic mathematics education

Introduction

Knowledge of calculation is the basic ability of mathematics. Knowledge of calculation fosters human thinking skills about the ability to think logically, analytically, systematically, critically, and creatively. Calculating ability in mathematics underlies the development of science and technology in the world, such as the ability to calculate in the fields of algebra, geometry and statistics used in the development of technology and science. Therefore, knowledge of calculation
and mathematics need to be studied as optimally as possible to support technological advances in the future.

Mathematics subjects have been taught since primary school. Even so, there are still many students who claim that learning mathematics is difficult. This is based on the assumption of the general public towards mathematics that mathematics is a difficult and frightening subject. What's more, when mathematics is taught to children who are just learning to calculate and get to know mathematics. This was supported by Fardana & Suprapti's research (Fardana and Tairas, 2012) which showed that 19.5% of primary school students indicated learning difficulties to calculation. Therefore, the teacher in teaching the concept of calculating to low-grade primary school students requires specific stimulation, in order to attract children's interest in calculating and understanding mathematics.

Children of primary school age are between 6-12 years old who according to Piaget are in a concrete operational phase (Wood, Smith, and Grossniklaus, 2001). The characteristic of this phase is that the child is capable of thinking in order to operationalize logically but concrete objects are still needed. The concept of calculation can be taught through realistic mathematics education according to the stages, i.e. concrete, representation, and abstract stages (Kamina, and Iyer, 2009).

Piaget (Ghazi and Ullah, 2015) stated that in teaching the concept of calculation to students in concrete to abstracts stages can be done by enriching students' experiences in representing mathematics. Students' ability to represent mathematics plays a role in increasing calculation competence (Kartini, 2009).

Each student has a different way of constructing mathematical knowledge. Therefore, the teacher needs to try various representations to teach calculation. One effort to optimize the representation stages in realistic mathematics learning can use the multisensory method. Through realistic mathematics education based on multisensory, students are taught knowledge of calculation that can be used to solve various problems in life. This is because the concept of realistic mathematics education based on multisensory is organized based on reality assisted by the use of representations that is able to accommodate student various types of learning to
calculate by optimizing the various senses that students have, i.e. auditory, visual, kinesthetic, and tactile. Realistic mathematics education based on multisensory can also increase learning motivation to calculate because it is contextual in nature, the order of material from easy to more difficult, using media and activating students to do activities (Komalasari and Wihaskoro, 2016; 2017). Thus, through the application of realistic mathematics learning can help teachers in teaching calculation primary school students.

**Literature Discussion**

**The Concept of Learning to Calculate Primary School Students**

The purpose of learning mathematics is to develop problem solving, reasoning, communication and connection skills. Even in the 2013 curriculum, the essence of learning mathematics is also no different from the previous curriculum. But in the implementation of mathematics learning in schools, most teachers focus on material components and procedural abilities. As stated by Yurniwati (2015) that the purpose of mathematics learning present time is to achieve the target of graduation. This is evident in the monotonous learning process, one-way communication, more focus on procedural abilities and depending on the textbook.

The learning process results in students only memorizing mathematics and not having an understanding of the correct concept of calculating. This is very unfortunate because reasoning, connection, communication and problem solving are soft skills that help students master other disciplines and help students follow the next level of education. Even needed in the world of work if they mature later.

Based on learning development concept (Thoonen et al, 2010), the teacher's role in teaching calculation in primary school students is to motivate students to find pleasure in learning to calculate. In line with this, there are three stages in learning to calculate:

1. **Concrete**

   At this stage, students are given understanding and understanding of counting using concrete objects.
2. Representation
At this stage, the student's thinking process begins to be introduced with a mathematical symbol while being explained through concrete objects.

3. Abstract
At this stage, students have understood the mathematical abstraction used.

**The Concept of Realistic Mathematics Education Based on Multisensory**

Improving the quality of mathematics learning needs to be done continuously. The quality of learning includes the learning process, classroom climate, teaching materials, and learning media (Mustika, 2015). Ratih, Sunardi, and Dafik (2013) suggests that students' absorption of material depends on the learning process carried out by students. One of the efforts to improve the quality of learning that can be done is by applying the multisensory model.

The multisensory model is based on the assumption that we move everyday using all the senses. Objects and events can be detected properly, precisely and in accordance with the stimulus, because our brain works by using information derived from (Bhinney, 2008). According to Feni, Jura, and Paudi (2017) the physical environment and the interaction between students and concrete objects (props) by using a variety of tools that are significant to the quality of learning.

The application of multisensory in learning has the use of teaching aids and the occurrence of discussions between students. One method of learning that has multisensory characteristics is realistic mathematics education. Realistic mathematics education has implementation principles such as contextual, modeling and student contributions. Contextuals become a key form in everyday life that is modeled using teaching aids. In learning using teaching aids, teachers create concept models that can be used with teaching aids, and students can find their own concepts.

Realistic mathematics education based on multisensory is a learning activity that uses the senses in the form of auditory, visual and kinesthetic activities.
to obtain knowledge. Auditory, visual and kinesthetic are interconnected with each other to achieve optimal learning and accommodate individuals in learning.

Application of Realistic Mathematics Education Based on Multisensory in Teaching to Calculate Primary School Students

Children who aged primary school are easier to learn to calculate using a concrete model by functioning all senses that are through the process of vision, hearing, movement, and touching. This is reinforced by the opinion (Rose and Nicholl, 2002) which suggests that the more you see, hear, say and do something, the easier it is to learn to calculate.

Realistic mathematics education based on multisensory is based on Freudenthal's view of mathematics as a human activity. From this perspective, students must learn mathematics with mathematical subjects from realistic situations and with their own mathematical activities [Freudenthal, 1991].

Realistic mathematics education based on multisensory involves or activates some sensory in children, i.e. vision (visual), hearing (auditory), movement (kinesthetic), and touching (tactile). The media forms are various card numbers, various color rubber counters, and some media from flannel. This media can be used to introduce the concept of sequence, comparison, pairing, pattern, addition and subtraction by playing with movements such as jumping or clapping (Fitri, Mustaji, and Bachri, 2017).

Activities in realistic mathematics education based on multisensory that vary and involve all sensory children will make it easier for children to understand the material, especially in learning to calculate. These activities are:

1. Visual
   Examples of activities carried out by students are looking at a number card, observing the form of numbers and matching the same number card.

2. Auditory
   Examples of activities carried out by students are listening to the sounds of the number symbols displayed in the learning video media or spoken by the teacher.
3. **Kinesthetic**

Examples of activities carried out by students are imitating hand movements in writing number symbols, writing numbers on the table or on the back of friends and continuing with sticking a number card according to the number of objects.

4. **Tactile**

Examples of activities carried out by students are using media such as paper or plasticine to feel the shape of numbers that symbolize mathematical abstraction.

There are three basic principles of realistic mathematics education based on multisensory teaching in calculating primary school students, i.e.:

1. **Rediscover the calculating process guided through progressive mathematization**

   The rediscovery process is guided through a realistic problem solving process. Based on this principle, students can build formal mathematical knowledge when students can move from the realistic world to the world of symbols and move in the world of this symbol. Providing appropriate guidance is an important role of the teacher in this process.

2. **Didactic phenomenology**

   The importance of choosing or designing realistic problems that have the potential to produce formal mathematical knowledge. Therefore, the important role of the teacher is to enrich the student's representation experience.

3. **Self-developed model.**

   Emphasize the use of the student's own model in solving problems. This is because the teacher is a person who should be able to understand the type of student learning, which must be diversified and varied.

Based on the description above, the primacy of the application of multisensory-based realistic mathematics learning is expected to have an impact,
i.e. (1) the teacher is able to form students about the learning culture of calculating in a diverse and variety; (2) students are able to learn to calculate according to their type and needs in learning.

**Conclusion**

Based on the discussion, it can be concluded that: (1) realistic mathematics education based on multisensory form students about the learning culture of calculating in a diverse and variety; (2) students are able to learn to calculate through the application of realistic mathematics education based on multisensory.

**Literature References**


The Classification of Mathematical Literacy Ability in *Cognitive Growth* Learning Viewed From *Multiple Intelligences*

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**Abstract**

The purpose of this research was to determine the quality of the Cognitive Growth mathematical learning model towards mathematical literacy ability and to describe the classification of mathematical literacy ability viewed from multiple intelligences. This type of research was descriptive qualitative research. The subjects of this research were 30 grade VIII students of SMP IT Ihsanul Fikri in Magelang City who had a tendency to each type of multiple intelligences. The instruments used in the research were in the form of test and interview instruments. Data analysis in this research used the Miles and Huberman model. The results of the research were as follows: (1) the quality of mathematical learning using the Cognitive Growth model was in a good category; (2) the classification of mathematical literacy ability in Cognitive Growth learning viewed from multiple intelligences of grade VIII students was: mathematical literacy ability of students with verbal-linguistic, logical-mathematical, and musical intelligences was at level 4; mathematical literacy ability of students with visual-spatial intelligences was at level 3, mathematical literacy ability of students with intrapersonal intelligences was at level 2, and mathematical literacy ability of students with bodily-kinesthetic, interpersonal, and naturalistic intelligences was at level 1.

**Keywords**: cognitive growth model, mathematical literacy ability, multiple intelligences

**Introduction**

One of the objectives of mathematics learning in elementary and secondary educational levels is to develop the students’ potential to become faithful and fearful people of God Almighty, noble, healthy, knowledgeable, capable, creative, independent, democratic, and responsible citizens (BSNP, 2006). In addition, it is expected that the students can use mathematics as a way of reasoning (logical, critical, systematic, and objective ways of thinking). According to Gagne (in Ruseffendi, 2008), the indirect object of learning mathematics is that the students should have the ability to solve various problems. Based on Gagne's opinion and the purpose of the curriculum on mathematics, it can be concluded that in order to solve a problem, the students need to have adequate reasoning abilities that can be obtained through learning mathematics.
The low quality of Human Resources (HR) of the Indonesian people currently is due to the low quality of education, especially Mathematics. This can also be seen from various indicators. At the national level, the evaluation of Mathematics learning at schools is carried out through the Standard Computer-Based National Examination (UNBK). Meanwhile, at the international level, there are currently two main assessments that assess the students' mathematics abilities, namely TIMSS (Trend in International Mathematics and Science Study), and PISA (Program for International Student Assessment).

In terms of Mathematics abilities, the survey of the results of the *Trends in International Mathematics and Science Study* (TIMSS), which is conducted every 4 (four) years starting in 1999, placed Indonesia in 36th position out of 40 countries in 2011. In 2015, the results showed that the Indonesian students had not yet shown satisfactory achievements. The Mathematics ability of the Indonesian students is only able to rank 45 of 50 countries, with the score of 397 and still below the international average score of 500.

The low quality of education can also be seen in the 2015 Program for International Student Assessment (PISA) report in Indonesia. Indonesia's ranking for Science was 62, Mathematics 63, and Reading 64 from 70 countries (OECD, 2016). In 2012, the ranking of Science and Mathematics was 64 out of 65, while Reading was 61 of 65 countries. The average scores for PISA 2015 (and 2012) was the Science scored 403 (382), Mathematics 386 (375) and Reading 397 (396).

The Mathematics literacy is very important. This is because it emphasizes on the students' ability to analyze, reason and communicate ideas effectively on the mathematical problems they encounter (OECD, 2009). This is what connects mathematics studied in the classroom to various real-world situations. According to the OECD (PISA, 2012) the mathematics literacy is the ability to formulate, implement, and interpret mathematics in various contexts. In this case, it includes mathematics reasoning and uses mathematics concepts, procedures, facts and tools to describe, explain and predict phenomena/events.

Based on the results of observations of eighth grade students at an Ihsanul Fikri Islamic Junior High School in Magelang City, and SMP N 8 Magelang, it
was observed that the questions given to students were still at a usual level. The teachers had not yet provided more varied questions, especially related to mathematical literacy. The students solve many standard problems without deep understanding. As a result, their mathematical literacy abilities and strategic competencies do not improve. This is supported by Rusmining, Waluya and Sugianto's research (2014) which advised mathematics teachers that they should begin to familiarize students with problems which are related to mathematics literacy.

Many efforts have been made to improve the students' ability in terms of achieving the PISA mathematics structure. Solving this problem does not only emphasize in the scope of learning achievement, but should also consider the students’ psychology and characteristics as the inseparable elements. The students' mathematics literacy skills can be viewed from various dimensions. The dimensions of individual differences include the ability to think logically, creativity, cognitive style, and intelligence.

Multiple Intelligences is a theoretical framework for defining, understanding, developing and assessing different intelligences. The teachers apply this theory as a framework for teaching and learning in class. Learning mathematics is not a simple task. The teachers must try to be creative in the learning process (Gouws, 2007). The concept of multiple intelligences that focuses on the aspect of uniqueness always finds the advantages of each child. This is supported by Rafianti's research (2013) stating that improving the students' understanding of mathematics concepts and reasoning ability that receive multiple intelligence-based mathematics learning was better than those receiving conventional learning methods.

The learning quality must also be considered in the applied learning method. One of the influencing factors is the accuracy of the learning model. Based on the observations made on Mathematics teachers of grades VII and VIII at SMPIT Ihsanul Fikri, Magelang City in March 2017, it was reported that the use of learning models by the teachers in mathematics learning was still minimal. They realized that they rarely used new models to help the students in learning,
especially for learning geometry. Some teachers until now still teach using traditional methods which emphasizes training or practice and procedural questions. In this learning model, the teachers function as the center or source of the materials, and it is only they who are active in the learning, while the students passively receive the material. This situation is the main cause of the low quality of students' understanding of mathematics (Zulkardi, 2001).

The Cognitive Growth Model is one of the learning methods that can improve the students’ mathematic literacy abilities. According to Piaget in (Joyce, 1992), the Cognitive Growth Model aims more at improving the students’ thinking abilities (cognitive). Therefore, the Cognitive Growth Model attempts to match the stage of learning development and improve the students' mathematic literacy abilities. The role of students in this learning is to generate responses and ask for justification in conveying the results in the learning process. Through this process, the teachers are also required to prepare well the materials and condition of the class so that learning activities are appropriate to the learning objectives. This encouraged the researcher to examine the quality of Cognitive Growth learning on the students’ mathematic literacy abilities and to classify the mathematic literacy abilities of eighth grade junior high school students.

The formulation of the problems in this research is: how is the quality of Cognitive Growth learning influence the students’ mathematic literacy abilities? Is the classification of mathematic literacy abilities of the eighth grade students related to the multiple intelligences? The purpose of this study is to determine the quality of Cognitive Growth model in the mathematics learning compared with the students’ mathematic literacy abilities, and to describe the students’ mathematic literacy abilities in terms of multiple intelligences.

**Research Methods**

This was a descriptive research. The main matter described in this study was the quality of cognitive growth learning model and mathematics literacy ability of class VIII students based on multiple intelligences that arose from the research subjects. This study classified the students’ mathematical literacy ability according to multiple intelligences.
The research was carried out on the eighth grade students of SMP IT Ihsanul Fikri in Magelang city based on multiple intelligences. The selection of research subjects was based on the results of multiple intelligence tests. There were at least 2 persons for each level. There were at least two subjects because the data analysis method used was constant comparative. Because the selection of this subject was snowball, it meant that the selection of the next subject was done after the results of the analysis of the previous subject were obtained. Then, if there was no subject occupying a level, then it was done repeatedly until the proper subject was selected.

The main instrument in the study was the interviewer (the researcher herself) who was guided by interview guidelines. As the main instrument, the researcher acted as a planner, data implementer and collector, analyzers, data interpreters, and eventually became the reporter of the results of her research. Other instruments were in the form of mathematics literacy questions, interview guidelines, observation sheets, lesson plans and syllabus, and multiple intelligences tests.

1. **PISA-based Mathematics Literacy Questions**

The instrument of the question sheet used in this study was the mathematics questions based on mathematics literacy. The questions were built based on PISA criteria (OECD, 2013). The question sheet was in the form of mathematics questions referring to PISA in the form of story questions taken from realistic daily life problems. This instrument of mathematics literacy questions was validated by experts, consisting of four mathematical education experts/mathematicians; two lecturers of mathematics education of Semarang State University and two teachers of SMP IT Ihsanul Fikri Magelang. Validation was done to find out that the use of language and construction of the questions was in accordance with the indicators. Based on the assessment of the validators, in terms of the construction of the questions, the language of the questions, and the subject matter, it was in accordance with the formulation of the research problem.
2. Interview Guideline

The interview guideline in this study contained a list of questions that would be asked orally by the researcher to the students with multiple intelligences who had been selected as the research subjects to uncover the students’ literacy based on the mathematics literacy indicators. This interview guideline would be validated by three experts, consisting of mathematics education experts. During the validation process, there were some improvements to the interview guidelines that had been made.

3. Mathematics Literacy-Based Learning Devices

Learning devices were validated by three mathematics education experts. During the validation process, the learning devices needed to be considered from various aspects, namely syllabus indicators and lesson plans that must be in accordance with the mathematics literacy competencies and also on aspects of learning objectives. Therefore, after the instruments were revised according to the validators’ advice, they could be used in the research.

4. Multiple intelligences test

The instruments were in the form of questionnaires using Likert scale. This questionnaire was adopted and modified from multiple intelligences measurement tools that had been developed previously by Hasputri (2006), and Rogers’ modification, Rogers Indicators of Multiple Intelligences Test (RIMIT). The modification of this questionnaire was adjusted to local conditions and used language that was easily understood by the respondents who were still at junior high school level. The assessment of this multiple intelligences test results was done by calculating the number of scores of the students’ answers on each item.

The instruments of mathematics literacy, interview guidelines, observation sheets, and lesson plans and syllabus would be validated by the experts who consisted of mathematicians/mathematics educators. The validation on multiple intelligences test instruments was limited only to the suitability of the language used, because the contents of the test questions were adopted directly from the Golmen and the nature was standard. As with other instruments, the multiple intelligences instrument was validated by two education experts and one
psychologist. After the validation process, the instrument was declared feasible for use.

Results and Discussion

1. Results of Multiple Intelligences Test

This multiple intelligences test aims to determine the type of the students’ intelligence and is used as a consideration in choosing the subjects to be interviewed in depth about the mathematics literacy ability. The multiple intelligences test is assisted by psychologists and accompanied by eight observers in each category of multiple intelligences. Based on multiple intelligences test results, it can be seen the distribution of multiple intelligences of VIII B class students in Table 1 below.

<table>
<thead>
<tr>
<th>Students’ Category</th>
<th>Number of Students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal/linguistics</td>
<td>3</td>
<td>10,00 %</td>
</tr>
<tr>
<td>Logical Mathematics</td>
<td>4</td>
<td>13,33 %</td>
</tr>
<tr>
<td>Visual/Spatial</td>
<td>5</td>
<td>16,67 %</td>
</tr>
<tr>
<td>Kinesthetics</td>
<td>2</td>
<td>6,67 %</td>
</tr>
<tr>
<td>Musical</td>
<td>5</td>
<td>16,67 %</td>
</tr>
<tr>
<td>Interpersonal</td>
<td>4</td>
<td>13,33 %</td>
</tr>
<tr>
<td>Intrapersonal</td>
<td>4</td>
<td>13,33 %</td>
</tr>
<tr>
<td>Naturalists</td>
<td>3</td>
<td>10,00 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
<td><strong>100,00 %</strong></td>
</tr>
</tbody>
</table>

2. The quality of mathematics learning using Cognitive Growth model on the achievement of mathematics literacy abilities

The quality of mathematics learning using the Cognitive Growth model in the achievement of mathematical literacy abilities was rated in the good category. The learning quality is classified as good if 3 minimum domains are met at in the good category, namely planning and preparation, classroom management and organization, and assessment (Mac Gregor, 2007). The three domains can be specified as follows.
a) Planning and preparation

The measurement of the learning quality on the preparation stage is carried out using a validity test on the minimum device in the good category.

<table>
<thead>
<tr>
<th>No.</th>
<th>Learning device</th>
<th>Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Syllabus</td>
<td>3,070</td>
<td>Good</td>
</tr>
<tr>
<td>2.</td>
<td>Lesson plans</td>
<td>3,670</td>
<td>Very Good</td>
</tr>
<tr>
<td>3.</td>
<td>Students’ worksheets</td>
<td>3,780</td>
<td>Very Good</td>
</tr>
<tr>
<td>4.</td>
<td>Students’ jobsheets</td>
<td>3,580</td>
<td>Very Good</td>
</tr>
<tr>
<td>5.</td>
<td>Material supplement</td>
<td>3,625</td>
<td>Very Good</td>
</tr>
<tr>
<td>6.</td>
<td>Math literacy abilities test</td>
<td>3,580</td>
<td>Very Good</td>
</tr>
<tr>
<td>7.</td>
<td>Multiple Intelligence test</td>
<td>3,070</td>
<td>Good</td>
</tr>
</tbody>
</table>

b) Classroom management and organization

The next stage is the learning management in the classroom. The average score for learning mathematics is 3.93. This score belongs to the good category. The results of the assessment of the learning outcomes obtained from the observation process are shown in Table 3.

<table>
<thead>
<tr>
<th>No.</th>
<th>Learning Quality</th>
<th>Average Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Observation 1</td>
<td>3.81</td>
<td>Good</td>
</tr>
<tr>
<td>2.</td>
<td>Observation 2</td>
<td>3.96</td>
<td>Good</td>
</tr>
<tr>
<td>3.</td>
<td>Observation 3</td>
<td>4.21</td>
<td>Very Good</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>3.99</td>
<td>Good</td>
</tr>
</tbody>
</table>

c) Assessment

The evaluation stage is an assessment to measure the achievement of the learning objectives. In this study, the quality of the learning on the evaluation stage is obtained from the results of the Mathematics Literacy Ability Test (TKLM) and students’ response questionnaire. The average score for the Mathematics Literacy Ability Test is 72.31. This average score belongs to the good category. The results of students’ response research on mathematics learning using the Cognitive Growth model show the percentage of students’ positive response to all aspects which is higher
than 50%. So, it can be said that more than 50% of the students give a positive response toward the learning process.

3. Classification of mathematics literacy abilities on Cognitive Growth learning viewed from Multiple Intelligence of the VIII grade students

Data of Mathematics Literacy Test from try-out 1, 2 and 3 shown in Table 4.

Table 4. Results of Mathematics Literacy Test

<table>
<thead>
<tr>
<th>No.</th>
<th>Notes</th>
<th>TKLM 1</th>
<th>TKLM 2</th>
<th>TKLM 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Average Score</td>
<td>60.39</td>
<td>76.54</td>
<td>80.01</td>
</tr>
<tr>
<td>2</td>
<td>Lowest Score</td>
<td>52.00</td>
<td>53.00</td>
<td>56.25</td>
</tr>
<tr>
<td>3</td>
<td>Highest Score</td>
<td>70.00</td>
<td>72.70</td>
<td>81.39</td>
</tr>
<tr>
<td>4</td>
<td>Number of level 1 students</td>
<td>21.00</td>
<td>10.00</td>
<td>8.00</td>
</tr>
<tr>
<td>5</td>
<td>Number of level 2 students</td>
<td>8.00</td>
<td>9.00</td>
<td>5.00</td>
</tr>
<tr>
<td>6</td>
<td>Number of level 3 students</td>
<td>1.00</td>
<td>8.00</td>
<td>5.00</td>
</tr>
<tr>
<td>7</td>
<td>Number of level 4 students</td>
<td>0.00</td>
<td>3.00</td>
<td>12.00</td>
</tr>
<tr>
<td>8</td>
<td>Number of level 5 students</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>9</td>
<td>Number of level 6 students</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Based on Table 4, it is found that there is an increase in the average score of mathematics literacy ability, from 60.39 in TKLM 1 to 76.54 in the second trial, and increased again to 80.01 in the trial 3. Besides, it is also supported by the achievement of increased level from TKLM 1 where the students only reached level 3, and the number increases for level 3 at TKLM 2, and at TKLM 3, the students successfully achieve level 4.

4. Mathematics literacy abilities of verbal/linguistics type

Based on the results of the Mathematics Literacy Abilities Test (TKLM), the verbal type students have diverse abilities in written tests of the math literacy questions. From the results of in-depth interviews, the achievement of the average ability of verbal / linguistic students is at level 4. The mathematics literacy abilities of verbal / linguistic students are classified as good at level 4.
The results indicate that the verbal /linguistic students' mathematical literacy abilities from the indicators of communication, mathematising, representation, reasoning and argument, solving problems for devising strategies, using symbolic, formal and technical language and operations, using mathematics tools are at the good category (level 4). However, the verbal/linguistic students cannot evaluate solutions toward the mathematics literacy problems. The advantages of the verbal /linguistic students is in solving mathematical literacy problems and the indicators are communication and reasoning in the argument process. In the communication and reasoning argument process, verbal students give more responses. This can be seen during the interview as they provide a complete description at level 4, even though the draft answers are not as complete as what the verbal type students convey. This is in line with the results of Sari's (2014) study which stated that the students who have high verbal abilities are well able to convey problems of mathematics stories.

5. Mathematics literacy abilities of logical-mathematical students

Based on the results of the Mathematical Literacy Ability Test (TKLM), the logical-mathematical students have homogeneous abilities on the written test of mathematical literacy questions. From the results of the in-depth interview, the achievement of the average ability of the logical-mathematical students in the mathematics literacy is at level 4. The mathematics literacy abilities of the logical-mathematical students are classified as good at the level 4.
The mathematics literacy abilities of the logical-mathematical students on the indicators of communication, mathematising, representation, reasoning and argument, solving problems for devising strategies, using symbolic, formal and technical language and operations, using mathematics tools are classified as level 4. However, at level 5 they begin to experience difficulties in the process of solving the literacy problems that have not been fully implemented and representation that has not been fulfilled. This shows that the logical-mathematical students' understanding at level 5 in the representation process is still low. The indicator on PISA is in line with the results of this study that the students at level 4 can work effectively using implied models in concrete situations, but are quite complex in facing obstacles or make assumptions.

6. Mathematics literacy abilities of visual/spatial students

Based on the results of the Mathematics Literacy Ability Test (TKLM), the visual-typed students have diverse abilities on the written tests of math literacy questions. From the results of in-depth interviews, the achievement of the average ability of visual/spatial students' mathematics literacy abilities is at level 3. The mathematics literacy abilities of the visual/spatial students are classified as good at level 3.
The prominent thing in the visual students lies in the images created. During the interview, the visual students also said that they preferred the pictorial literacy questions because it made them easier to find out information about the problem. In a research conducted by Boakes (2009), he stated that the spatial/visual are important parts of geometrical thinking. Spatial visual intelligence is the ability to visualize two or threedimensional objects (images) to solve mathematical problems in daily life. Likewise, Ningsih's research (2014) showed that the students with visual spatial intelligence learn more effectively by looking at pictures/images.

7. Mathematics literacy abilities of kinesthetic students

Based on the results of the Mathematics Literacy Ability Test (TKLM), the kinesthetic type students have a homogeneous ability on the written test of mathematics literacy questions, at level 1. Based on the results of in-depth interviews, the achievement of the average ability of the mathematical literacy level of the kinesthetic students is also located at level 1.
8. Mathematics literacy abilities of musical students

Based on the results of the Mathematics Literacy Ability Test (TKLM), the musical students have heterogeneous abilities on written tests of math literacy questions. From the results of the in-depth interviews and study, the achievement of the average ability of mathematics literacy level of the musical students is at level

![Figure 5. Level of mathematics literacy abilities of musical students.](image)

The outstanding aspect of the musical students lies in the analysis and representation made. They convey ideas in solving mathematical literacy problems. This is in line with the results of Damar’s study (2012) which stated that there is a positive and significant relationship between musical and mathematical abilities.

9. Mathematics literacy abilities of intrapersonal students

Based on the results of the Mathematical Literacy Ability Test (TKLM), the intrapersonal students have various abilities in written tests of mathematics literacy questions. From the results of the in-depth interview, the achievement of the average ability of intrapersonal students is at level 2. The mathematics literacy skills of the intrapersonal students are low, at level 2.

![Figure 6. Level of mathematics literacy abilities of intrapersonal students.](image)
The intrapersonal students convey ideas well in solving the problems of mathematical literacy. This is in line with the results of Susilowati's research (2014) which stated that the students with intrapersonal intelligence can communicate mathematics in writing well. During interviews, they also said that they preferred literacy problems in form of simple questions because it made them easier to find out information about the questions.

10. Mathematics literacy abilities of interpersonal students

Based on the results of the Mathematical Literacy Ability Test (TKLM), the interpersonal students have a homogeneous ability on written tests of math literacy questions. From the results of the in-depth interview, the achievement of the average ability of the level of interpersonal students is at level 1. The mathematics literacy abilities of the interpersonal students are low because they are at level 1.

This research is not in line with the results of Hidayati's study (2014) which stated that students' mathematics learning achievement with high intrapersonal intelligence is better than those having moderate and low intrapersonal intelligence. This study is supported by the results of the in-depth interviews. The achievement of the average ability of mathematics literacy abilities of the interpersonal students is also at level 1. There is one student who is able to reach level 4, which can be seen in the multiple intelligence test; the logical- mathematical student places the second after the interpersonal type.
11. Mathematics literacy abilities of naturalist students

Based on the results of the Mathematical Literacy Ability Test (TKLM), the naturalist students have a homogeneous ability on written tests of mathematics literacy questions. From the results of in-depth interview, the average achievement of of naturalist students in the mathematics literacy is at level 1.

![Figure 8. Level of mathematics literacy abilities of naturalist students.](image)

This can be seen in the results of the students’ works who are not yet given any completion arguments and explanations that are not in line with what is expected in the level 2 mathematical literacy problems. This is in accordance with the research of Sanusi (2015) which explained that the naturalist students have less ability in delivering their ideas of solving the mathematics problems but they are outstanding when being asked to look for the data from surrounding environment, so that students who have naturalist intelligence can learn mathematics in pleasant circumstances.

Conclusions and Suggestions

The conclusions of this research are as follows: (1) the quality of mathematics learning in the Cognitive Growth model of mathematical literacy abilities is in the good category, and it is shown from the three domains of quality learning criteria fulfilled at least in good category, including (a) planning and preparation (b) classroom management and organization (process), and (c) assessment (evaluation); (2) the classification of mathematics literacy abilities in the cognitive growth learning in terms of the multiple intelligences of eighth grade students, are verbal/linguistic, logical/ mathematical, and musical-typed students.
located at level 4, visual/spatial students located at level 3, intrapersonal-typed students located at level 2, while kinesthetic, interpersonal, and naturalist students are at level 1.

The writer suggests that the Cognitive Growth model may be useful in monitoring the students’ mathematics literacy abilities. Further research is necessary to expand upon the observed dimensions, for example in terms of the students’ ability to think logically, creativity, learning style, and cognitive style. These dimensions are estimated to be able to influence the students’ mathematics literacy abilities.

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Portofolio Application as Authentic Assessment by Developing "Basic Algebra" Student's Book under Guided Discovery

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**Abstract**

The purpose of this study is 1) to know the development of algebraic understanding 2) to know the improvement of learning activities, 3) to train independence and to measure the actual ability of students (authentic) in the form of a collection of student work or portfolio. It is expected that with this ability students are able to develop their life skills and train responsibility. This research was conducted in Junior High School 1 Karangploso in the seventh grade of the 2017/2018 school year using a two-cycle classroom action research method. The results of this study showed that portfolio as authentic assessments can describe the development of understanding algebraic forms and carry out operations on algebraic forms (addition, subtraction, multiplication, and division), mathematizing word problem in algebra. Application of portfolio as authentic assessment of algebra learning with guided discovery can improve student learning activities, independence of students in completing assignments to 7th grade students. Based on the results of the research can be suggested as follows: (1) Referring to the findings of the study, the application of portfolio assessment in the implementation of the teacher must always give attention, direction and guidance to students (2) future portfolio assessment activities should be carried out optimally by involving students to determine portfolio tasks.

**Keywords**: Authentic Assessment, Guided Discovery, Portofolio.

**Introduction**

When students move from elementary school to high school, algebra skills are generalizations from arithmetic to symbol utilization, mathematical modeling, reasoning and problem solving to very important mathematics learning tasks (Dooren, Verschafel, & Onghena, 2002). Observation results found several problems. First, students in learning are still limited to memorize teacher explanations.

Variables are an important part of early algebra which concepts must be mastered correctly. Variable research has been carried out by several experts including (Malisani & Spagnolo, 2008; Asquith, Stephens, Knuth, & Alibali, 2007; Soedjadi, 2000). The results show variable material is a crucial material transition from arithmetic to algebra, so it takes a right understanding of variables in a variety of different situations and problems (Malisani & Spagnolo, 2008).
Teachers rarely identify misconceptions about understanding variables and signs as equals, even though misunderstanding concepts of variables and signs is the same as inhibiting students' ability to solve problems (Asquith, Stephens, Knuth, & Alibali, 2007). Mathematical objects that can be seen as a transition from arimatica to algebra are "variables". (Soedjadi, 2000). Jupri, A, Drijvers, P, Van den Heuvel-Panhuizen. M (2014) algebra has been widely recognized as one of the most difficult topics, In Indonesia, algebra performance is an important issue. In the Trends in International Mathematics and Science Study (TIMSS) 2007, Indonesian students’ achievement in the algebra domain was significantly below the average student performance in other Southeast Asian countries such as Thailand, Malaysia, and Singapore.

Mathematics textbooks in schools have a very central role in determining the success of learning. The author has developed an early algebra student book that facilitates student learning activities to facilitate student learning a guided discovery method is needed to train students to find concepts that will be mastered. Based on the description above, class action research is carried out with the title: Portfolio Application as Authentic Assessment by Developing "Basic Algebra" Student's Book under Guided Discovery

Based on the background as described, the research problem is formulated as follows (1) can the application of student book development portfolio characterized by guided discovery describe the development of algebraic understanding for students? (2) Can it increase student learning activities? (3) Can it train student independence?

**Literature Review**

**Discovery Learning in the view of constructivists**

Subanji (2013) states that learning with discovery is learning as a result of manipulation, structuring and transfer of information so that students find new information. Goos et al (2007) said the subject of constructivists is active learners constructing knowledge and self-meaning with prior knowledge with new knowledge combined with interaction with the world. Slavin (2006: 243) said constructivist learning the teacher does not provide knowledge, but students must
construct knowledge with their mind. The teacher can give the ladder for better understanding, but the student himself must climb the ladder. It was also stated by Trianto (2011) that in constructivists teachers not only provide knowledge but students must build their own knowledge in their minds. The teacher can give students stairs that bring students to a higher understanding, with notes of the students themselves who have to climb the stairs.

**Guided Discovery**

According to Bell (1978: 241) emphasizing learning with discovery is the result of manipulation, compiling or transferring information so that students get new information. The essence of discovery, in discovering this new information students must be actively involved as possible by making conjectures / hypotesis / inductive / deductive / observation and extrapolation. Bruner (2006: 58) stated the benefits of learning with discovery were first to increase intellectual potential, second awarded change from extrinsic to instructive, third learned the heuristics of discovery and fourth help the process of remembering.

**Study of Basic Algebra Material**

Ryan & William (2007) mentioned that algebraic symbols confused the students, represented a number, any number or collection of numbers or all numbers. In this study defined variables of a set are symbols symbolizing each member of the set. Constants are symbols symbolizing or representing a member of the association. Arbitrary constants are symbols symbolizing any member of the set. Algebraic operations include addition, subtraction, multiplication and division. Van de Walle (2010) mentioned that algebraic thinking or algebraic reasoning including forming generalizations from experiences with numbers and calculations, formalizing these ideas using strong meanings of the symbol system, and exploring the concept of patterns and functions.

**Portfolio as Authentic Assessment**

According to Kemp and Topoff (1998) the characteristics of portfolios are as follows (1) Portfolios are assessment models that require collaboration
between students and teachers (2) Portfolios are not collections of tasks, but are the results of selection in which students are involved in selecting and considering works that portfolio will be included. (3) Portfolio is a collection of students' work that shows progress over time. The collection of works is used by students to reflect so that they can be used to find out their own strengths and weaknesses. These weaknesses can also be used as an objective in the next learning process. (4) The contents of the portfolio completion and assessment criteria must be clear for the teacher and for students in the implementation of the process.

Authentic assessment is assessment that involves students in authentic task assignments that are useful, important and meaningful (Hart, 1994). Portfolios are defined as a container containing a number of evidences collected for a specific purpose (Collin, 1992). According to Susilo (2003) the portfolio is a collection of student work over a certain period of time. The collection should represent an organized history of learning and demonstration of something (Susilo, 2003). According to Collins (1992) there were four types of evidence that may be collected in the portfolio, namely objects or goods produced by human intelligence, reproductive or photocopying results, the results of the endorsement and production of portfolios can be in the form of artifacts (real products of students' work) articles, journals and reflections that represent what students have done in their subjects (Ibrohim, 2002). Meanwhile, according to Hart (1994) any item displaying evidence of ability and development of students' abilities can be included in the sample portfolio.

Each item in the portfolio must be dated to allow development evaluation until a year (Hart, 1994). Evaluating portfolios provides opportunities for teachers and students to enter into dialogue about what students have learned. So the real portfolio is self-evaluation by students who have made it. Portfolio assessment can be used for various purposes, as stated by Berenson and Certer (1995) One recommendation of the national reform movements in mathematics and science is to change the way students are assessed. In this article five formats of alternative assessment forms are described, and suggestions are given on how these methods can be implemented within science and mathematics classrooms. Benefits of each
type of assessment are discussed and potential pitfalls are elucidated. Samples of the five formats, journal writing, open-ended problems, portfolios, interviews and performance assessments, are included. (a) Documenting student progress over a certain period of time (b) Knowing the parts that need improvement (c) Generating confidence and motivation for learning (d) Encouraging student responsibility for learning. While according to Gronlund (1998) portfolio has several advantages (a) Student learning progress can be seen clearly (b) Emphasis on the results of the best work of students has a positive influence on learning.

Research Methods

This study uses a type of classroom action research (CAR), which is a series of action research conducted cyclic in order to solve the problem until the problem is solved. The subjects of this study are students of 7H Junior High School 1 Karangploso. Research location on Jl. PB Sudirman 49. This research was conducted for 4 months starting from February to May 2017. The role of researchers in this research is as observers, data collectors, data analyzers, as well as reporters of research results. This is consistent with the statement of Moleong (1999) that in qualitative research the position of researchers as planners, data collectors and finally reporters of the results of the research.

Research Design and Procedure

The research design of this class is carried out in 2 (two) cycles. The design of this study refers to the model of Kemmis and Tagart (1992) which consists of four stages, namely action planning, implementation of action, observation (observation) and reflection.

Data collected in this study is portfolio documents in this study are (1) Formative Test Questions (2) Observation Sheet Guidelines to obtain data about students' activities and stagnation. (3) Scoring rubrics for tracking clips and self-reflection (4) Class events records.

Data collection procedures performed in this study are as follows. (1) Observation, (2) Documentation, (3) Researchers carry out documentation through tasks collected in the student Mathematics portfolio map (4) Field Notes
Field notes about things that happened during the learning and teacher-student interaction, students related to learning with guided discovery and portfolio assessment were not recorded in the observation sheet.

Checking the validity of the data in this study uses triangulation techniques, which utilize something other than data for the purpose of checking or comparing the data. Triangulation between researchers is done by using more than one person in data collection and analysis. This technique is recognized to enrich the repertoire of knowledge about the information extracted from the subject of research. But it should be noted that the person invited to explore the data must have research experience and be free from conflicts of interest so as not to harm researchers and give birth to new biases from triangulation.

Data analysis is performed every time the action is ended. Data analysis in this study uses flow analysis of qualitative models. (1) Development of algebraic understanding, Determination of improvement in Algebraic understanding, quantitative data on learning evidence scores in portfolios from cycle I compared to cycle II, (2) Student Learning Activities Student learning activities can be identified during the teaching and learning process. Percentage of success of student activity actions was obtained by the following formula.

\[ PA = \frac{\sum X}{n \times X_{\text{max}}} \times 100\% \]

- \( PA \) = Percentage of success of learning activities.
- \( \sum X \) = Number of score descriptors of learning activities achieved by sample students.
- The score of each descriptor is 1 (one)
- \( X_{\text{max}} \) = The maximum score of all learning activities, that is 5
- \( n \) = Number of sample students.

(3) Student Independence

The independence of students in doing assignments can be identified during the learning process by using observation sheets.

The process of successful action on student independence is obtained by using the following formula.
\[
PK = \frac{\sum Y}{n \times Y_{\text{max}}} \times 100\%
\]

**PK** = Percentage of student independence  
**\(\sum Y\)** = Number of independent descriptors reached by sample students.  
**Y\text{max}** = The maximum number of scores for all descriptors, that is 5. 
**n** = Number of sample students

Category of success level of learning activities and student independence in table 1

<table>
<thead>
<tr>
<th>Percentage of Success</th>
<th>Letter</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-100</td>
<td>A</td>
<td>Very Good</td>
</tr>
<tr>
<td>70-84</td>
<td>B</td>
<td>Good</td>
</tr>
<tr>
<td>55-69</td>
<td>C</td>
<td>Enough</td>
</tr>
<tr>
<td>40-54</td>
<td>D</td>
<td>Less</td>
</tr>
<tr>
<td>Less than 40</td>
<td>E</td>
<td>Very Less</td>
</tr>
</tbody>
</table>

Students' skill scores in writing self-reflection are obtained through scoring rubrics.

The final portfolio assessment is carried out at the end of each cycle. The final value of the portfolio is obtained by adding up the score of all learning evidence collected in the portfolio folder. Each proof is given weight as listed in Table 2.

**Table 2. Format of Final Portfolio Value**

<table>
<thead>
<tr>
<th>No</th>
<th>learning document</th>
<th>Score</th>
<th>Max Score</th>
<th>Final Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Worksheet</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Clippings</td>
<td>4</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Formative Tests</td>
<td>4</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Activeness</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>Independence</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>Reflection</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>FPV</td>
<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

**Indicators of Successful Measures**

Indicators of the success of the action can be seen in the following manner. First improving Algebraic understanding can be seen from several evidence of learning, namely: (a). Increasing worksheet score from cycle I to cycle II. (b) Increasing clipping scores from cycle I to cycle II (c). Increasing formative test
scores from cycle I to cycle II. Second increasing in learning activities from cycle I to cycle II. Third Increasing in independence to complete the tasks from cycle I to cycle II. Fourth Comparing the final score of the first cycle of the portfolio with the second cycle.

Furthermore, the success criteria for actions can be seen as shown in Table 3

<table>
<thead>
<tr>
<th>Aspects Observed</th>
<th>Criteria for Successful Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cycle I</td>
</tr>
<tr>
<td>Algebraic Understanding</td>
<td>T1</td>
</tr>
<tr>
<td>Formative Tests (T)</td>
<td>L1</td>
</tr>
<tr>
<td>WORKSHEET score (L)</td>
<td>K1</td>
</tr>
<tr>
<td>Clipping Score (K)</td>
<td></td>
</tr>
<tr>
<td>Activeness (PA)</td>
<td>PA1</td>
</tr>
<tr>
<td>Independence (PK)</td>
<td>PK1</td>
</tr>
<tr>
<td>Final Value of portfolio (FPV)</td>
<td>FPV1</td>
</tr>
</tbody>
</table>

**Data Exposure And Research Findings**

**Data Exposure**

Cycle 1, 1st meeting on the 1st of April 2017, Second Meeting April 4, 2017, Third Meeting on April 8, 2017 before continuing on the next material the teacher distributed corrected worksheet and asked students to pay attention to the value obtained because this value is evidence of learning included in the portfolio folder. The teacher also motivated students by informing them that the worksheet scores determine the value of report cards. This was done so that students were serious about working on worksheet. The teacher reminded them to study for formative tests at the next meeting. Fourth meeting on 11 April 2017. In the fourth meeting a formative test was held with a time of 75 minutes. Essay questions 5 numbers. After completing the first test, the next period was used to discuss test questions.
A square with a side length $2a$ cm. $a$ element of natural number.

Determine

a. The circumference of the square is stated in $a$.
b. If the circumference is 80 cm, arrange the equation that states the circumference inside
c. Find the solution point b.
d. How long the side of the square.

The teacher gave feedback which was written by students classically.

Data Description

Algebraic Understanding.

Data on algebraic understanding including formative tests of worksheet scores and kliping scores are listed in table 4, Learning Activities. The score data of learning activities for each student in cycle I is listed in table 5, Student Independence. Student Independence score data completing the assignment are listed in table 6 Final value of the portfolio. The final value of each student's portfolio refers to table 2 Chapter III. The results of the FPV calculation for each student are listed in table

<table>
<thead>
<tr>
<th>Table 4 Score of Algebra Learning in Portfolio Documents in Cycle 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>Amount</td>
</tr>
<tr>
<td>Average</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5 Student Learning Activity Scores in Cycle 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>Amount</td>
</tr>
<tr>
<td>PA(%)</td>
</tr>
<tr>
<td>Category</td>
</tr>
</tbody>
</table>
Table 6 Student Self-Reliance Scores Complete Tasks in cycle 1

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Study Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Amount</td>
<td>42</td>
<td>47</td>
</tr>
<tr>
<td>PA(%)</td>
<td>56</td>
<td>62.6</td>
</tr>
<tr>
<td>Category</td>
<td>C(Enough)</td>
<td>C(Enough)</td>
</tr>
</tbody>
</table>

Table 7 Final Portfolio Value (FPV) for each student in cycle 1

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Worksheet B(3)</th>
<th>Clip B(4)</th>
<th>Tes B(4)</th>
<th>Act B(3)</th>
<th>Indep B(3)</th>
<th>Reflection B(2)</th>
<th>FPV Tes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BxS</td>
<td>BxS</td>
<td>BxS</td>
<td>BxS</td>
<td>BxS</td>
<td>BxS</td>
<td>152</td>
</tr>
<tr>
<td></td>
<td>Amount</td>
<td>10,13</td>
<td>15,46</td>
<td>16,26</td>
<td>9</td>
<td>9,26</td>
<td>7,46</td>
<td>66,26</td>
</tr>
</tbody>
</table>

**Reflection**

Based on the description of the course of learning and the description of the data found weaknesses in cycle I. These weaknesses will be corrected and used as a reference for the implementation of cycle II actions. Weaknesses are found as follows: Percentage of success Student learning activities (PA) from the first to the third meeting in cycle one experienced an increase of 53.3% (D or Less) at the first meeting increased to 63.3% (or enough) at the second meeting. In the second meeting to the third meeting despite an increase in PA by 4% but the category did not change, namely C (enough). This still needs to be improved in the second cycle. The independence of students in carrying out assignments has a percentage of success (PK) from the first meeting to the third meeting which increased from 56% (C or Enough) increased to 62.6% (C or Enough) and increased again to 68% (C or Enough) this increase is very small because it doesn't change categories. Because it still needs to be improved in the second cycle. The average score of WORKSHEET from meeting I to the third meeting is between 56-76-75. This is because students find it difficult to compile questions and make hypotheses, and give answers. Self-reflection written by students has not been in accordance with the request. The average final value of the portfolio is 66.26 from a maximum of 100. This FPV needs to be maintained with KKM 70.
Efforts to improve the cycle II.

Some of the actions taken to correct weaknesses in cycle I are as follows: The teacher gave motivation to students that students who actively asked, answered and argued and worked with friends would be given points. Likewise students who are on time to collect tasks, work according to instructions get more points. The teacher guides students to make hypotheses and write reflections.

Cycle II
A description of learning

The material discussed in the cycle, which was the subject of basic competencies 4.3, creates and completes a mathematical model of the real problem that relates to one variable linear equations and inequalities. The description of the class situation during learning as follows. First Meeting April 15, 2017. Second Meeting on April 18, 2017. Third Meeting on April 22, 2017. In the third meeting a formative test was held with a time of 2 x 40 minutes. After completing the test, 1 hour later was used to discuss the test questions. Before the lesson ended, observers said goodbye to the students.

Data Description

Algebraic understanding. Data on algebraic understanding algebraic forms and carry out operations on algebraic forms (addition, subtraction, multiplication, and division), mathematizing word problem in algebra including formative tests of WORKSHEET scores and clipping scores are listed in table 8. Learning Activities. The score of learning activity data for each student in cycle II is listed in table 9. Student Independence. Student independence score data in completing the assignment are listed in table 10. The portfolio final score. The final score of each student refers to table 2 Chapter III. The results of the calculation of the FPV for each student are listed in table 11.
Example worksheet

Misalkan $x$ variabel pada himpunan bilangan asli. Tentukan selesaian dan himpunan selesaian pertidaksamaan $3x + 2 \geq 20$

Misalkan $n$ variabel pada himpunan bilangan asli, tentukan hubungan ($<$ [kurang dari]; $>$ [lebih dari] atau $=$ [sama dengan]) nilai dari bentuk aljabar $3^n \ldots n + 6$.

Table 8. Score of Algebra Learning in Portfolio Documents in Cycle II

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>LKS</th>
<th>Formative test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
<td>Amount</td>
<td></td>
<td>1215</td>
<td>1305</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>81</td>
<td>87</td>
</tr>
</tbody>
</table>

Table 9. Student Learning Activity Scores in Cycle II

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Learning Activity</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Amount</td>
<td></td>
<td>59</td>
<td>63</td>
</tr>
<tr>
<td>PA(%)</td>
<td></td>
<td>78,6</td>
<td>84</td>
</tr>
<tr>
<td>Category</td>
<td>B (Baik)</td>
<td>B (Baik)</td>
<td></td>
</tr>
</tbody>
</table>

Table 10. Student Self-Reliance Scores Complete Tasks in Cycle II

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Learning activity</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Amount</td>
<td></td>
<td>55</td>
<td>62</td>
</tr>
<tr>
<td>PA(%)</td>
<td></td>
<td>73,3</td>
<td>82,6</td>
</tr>
<tr>
<td>Category</td>
<td>B (Baik)</td>
<td>B (Baik)</td>
<td></td>
</tr>
</tbody>
</table>

Table 11. Final Portfolio Value (FPV) For Each Student In Cycle II

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>LKS B(3)</th>
<th>KLip B(4)</th>
<th>TES B(4)</th>
<th>Akt B(3)</th>
<th>Mand B(3)</th>
<th>Refleksi B(2)</th>
<th>FPV Tes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BxS</td>
<td>BxS</td>
<td>BxS</td>
<td>BxS</td>
<td>BxS</td>
<td>BxS</td>
<td></td>
</tr>
<tr>
<td>Amount</td>
<td></td>
<td>1231</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>82,06</td>
</tr>
</tbody>
</table>
Reflection

Based on the learning activity and descriptions in the second cycle, the following points can be stated: (a) The learning process runs smoothly, students were familiar with learning by applying portfolios as authentic assessments. Students had been able to compile questions from readings or drawings on the worksheet, compile hypotheses and prove hypotheses by searching for information and reflecting. This fact could be seen from an increase in worksheet scores and reflection scores from cycle I to cycle II (b) Activities students fluctuate, (3) Clippings / tasks are increasingly in accordance with the instructions (4) Writing reflection skills increase (5) Student independence has increased compared to cycle I.

Research Findings

Based on the description of the course of learning and descriptions obtained research findings are the scores of algebraic understanding of learning evidence collected in portfolio folders increased from cycle I to cycle two as shown in table 12. The score of learning activities of students from cycle I to cycle II increases as stated in table 13. The score of students' independence in completing tasks increased from cycle I to cycle II increased as stated in table 14. Final portfolio value (FPV) increases from cycle I to cycle II as shown in table 15.

<table>
<thead>
<tr>
<th>No</th>
<th>Proof of Learning</th>
<th>Average Cycle I</th>
<th>Average Cycle II</th>
<th>score increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>Worksheet</td>
<td>56,6</td>
<td>67,6</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(C)</td>
<td>(C)</td>
<td>(B)</td>
</tr>
<tr>
<td>2</td>
<td>Clipping</td>
<td>78,6</td>
<td>78,6</td>
<td>84,3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(B)</td>
<td>(B)</td>
<td>(A)</td>
</tr>
<tr>
<td>3</td>
<td>Formative test</td>
<td>74,6</td>
<td>74,6</td>
<td>81,6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(B)</td>
<td>(B)</td>
<td>(B)</td>
</tr>
</tbody>
</table>

Information
A: Very good  B: Good  C: Enough  D: Less  E: very lacking
students answer the following 3 questions; (1) compare [greater or lesser or equal] 3n value with n + 6, n natural number, (2a) form 3n, n natural number, 3n have any meaning, (2b) form n + 6, n natural number, n + 6 means what, (3) explain the meaning of variables. In Figure 1.1, the answer no (1) 3n < n + 6 is correct for n = 1 and n = 2. If n = 1 then 3n < n + 6 has a value of 3 × 1 < 1 + 6 or 3 < 7 is true. When n = 2, 3n < n + 6 is correct, because 6 < 8; but at n = 3, 3n < n + 6 is wrong because 9 = 9: for n = 4, 3n < n + 6 is wrong because 12 > 10. Then for n > 3, 3n < n + 6 is wrong because 3n = n + 2n > n + 6. This question has never been discussed or asked by the teacher and is not found in student books or books in the library. Answers no (2a) and (2b) have not answered the questions, this shows that students' understanding of variables is not yet complete. In the student book they do not teach variables meaningfully which involves students constructing an understanding of variables. For answer no (3) students only copy variable definitions.

Table 13. Increase in The Percentage of Successful Learning Activities From Cycle I to Cycle II

<table>
<thead>
<tr>
<th>No</th>
<th>PA(%)</th>
<th>Average Cycle I</th>
<th>Average Cycle II</th>
<th>score increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53,3</td>
<td>(D) 61,3 (C) 65,3 (C) 59,96 (C)</td>
<td>78,6 (B) 84 (B) 84 (B)</td>
<td>21,34</td>
</tr>
</tbody>
</table>

Information
A: Very good B: Good C: Enough D. Less E: very lacking

Table 14 Increases the Percentage of Student Success (PK) From Cycle I to Cycle II

<table>
<thead>
<tr>
<th>No</th>
<th>PK (%)</th>
<th>Average Cycle I</th>
<th>Average Cycle II</th>
<th>score increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>56,6 (C) 62,6 (C) 68 (C)</td>
<td>73,3 (B) 82,6 (B) 77,95 (B)</td>
<td>15,85</td>
<td></td>
</tr>
</tbody>
</table>
Table 15 Increasing the Final Portfolio Value From Cycle I to Cycle II

<table>
<thead>
<tr>
<th>The final value of the portfolio</th>
<th>Cycle I</th>
<th>Cycle II</th>
<th>score increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>66,26</td>
<td>82,6</td>
<td></td>
<td>15,8 %</td>
</tr>
</tbody>
</table>

Based on the research findings listed in table 12 to table 15 and referring to the indicators of action efficacy listed in table 3 concerning the success criteria for action, the application of portfolios as authentic assessment in its efforts to improve algebraic understanding, activity and independence complete assignments to class students 7 SMP Negeri 1 Karangploso was declared successful.

**Discussion**

In the beginning of learning activities, in the first cycle the teacher informed students about tasks that could be used as evidence of learning included in the Algebra portfolio. This was done so that students understood and accepted the planned portfolio assignments. As suggested by Karim (2003) that portfolios could be arranged by students, students with teacher direction. Which alternative was chosen depended on the purpose of portfolio procurement. The teacher still played a role in giving direction to students especially to those in need.

The teacher examined the work of the worksheet students in this case the results of working on the student's book, the teacher fixing the wrong student work and giving comments were a means of teacher-student communication. As stated by Slater (1997) that portfolios provided opportunities for students to classify problems through discussions with teachers. The same thing stated by Berenson and Certer in Rusoni (2001), that portfolio benefits were to find out the repaired parts were the Final Value Portfolio (FPV) data on the final value of the portfolio in cycle I and cycle II are listed in table 4.12. The final portfolio value of each cycle was obtained from the amount of learning evidence collected in the portfolio folder, each learning evidence was given a weight as shown in Table 3.2.
Based on Table 4.12 it can be seen that the increase in FPV from cycle I to Cycle II was 23.84%. The increase in FPV shows several things, namely: (a) The skills of students in developing a portfolio increase from cycle I to cycle II. (b) algebraic understanding of students increases from cycle I to cycle II. (c) Student activity increases from cycle I to cycle II. (d) The independence of students in completing tasks increased from cycle I to cycle II.

The research findings in Table 4.12 are in accordance with Poulson (1991) 's opinion that portfolios are a collection of student work that shows their effort, development and skills in one or more fields. The same thing was conveyed by Kemp and Toperoff (1998) that portfolios are a collection of students' work that shows development over time. According to Hart (1994) any item displaying evidence of students' abilities and development can be included in the portfolio including written work, group reports, tests and quizzes, peer review, self-evaluation.

**Overview of the Development of Algebraic Understanding**

Based on Table 4.9 it can be seen that portfolio documents can describe the development of algebraic understanding. The average score of WORKSHEET in cycle I meeting I is 56.6 (C or enough) increased to 67.6 (C or enough). The findings of this study are in accordance with what was stated by Rusoni (2001), that portfolios can be used to document student development.

**Student Learning Activities**

Research on a material in a student's book that has been developed, students are required to be actively involved in finding their own understanding and it is possible to overcome the difficulties obtained by asking the teacher. The involvement of students in finding a concept according to Hudojo (2005: 95) impacts the understanding of concepts to be better, remembering longer and being able to use them in other contexts. In the student book that was developed to learn a student concept is not given in the form of a finished concept, but students are involved in constructing the concept. This is in the opinion of Bruner (1973: 406) "Discovery in learning has the effect of leading students to be constructionists".
Cobb (1994) learning mathematics was a process by which students actively construct mathematical knowledge. Nurhadi (2004: 43) stated that teachers in this discovery method must always design activities that refer to finding activities. Subanji (2013) argues that the important thing in discovery learning is that students must be an active part in formulating and in achieving or getting new information.

Closing

Conclusions

Based on the results of classroom action research in two cycles can be concluded as follows. (1) The application of portfolios as authentic assessments of algebra learning with guided discovery illustrates the development of algebraic understanding in 7th grade students of SMP Negeri 1 Karangploso. (2) The application of portfolios as authentic assessment of algebra learning with guided discovery increases student learning activities in 7th grade students of SMP Negeri 1 Karangploso (3) The application of portfolios as authentic assessments of algebra learning with guided discovery increases students' independence in completing assignments to grade 7 students SMP Negeri 1 Karangploso

Suggestions

Based on the results of the study can be proposed some suggestions as follows (1) Referring to the findings of the study, the application of portfolio assessment in the implementation of the teacher must always give attention, direction and guidance to students. (2) Future portfolio assessment activities should be carried out optimally by involving students to determine portfolio tasks.

Literature References


Does The Geoboard Props Affect Student’s Ability to Understand Mathematics Concepts?

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Abstract

Conceptual understanding will lead to more advanced reasoning in mathematics. However, most mathematics concepts are difficult to acquire, hence some students tend to memorize concepts. The geoboard props were developed to test whether they can be used as an alternative learning aid that improves students’ conceptual understanding. When learning the mathematics topic of circumference and area of squares and rectangles, thirty-nine junior high school students were asked to use the learning aid. Some control class students used conventional learning methods during the learning process while the experimental class used the teaching aids. A pretest-posttest control experimental design was conducted. The test consisted of four questions related to the learning material. The results indicated that the use of geoboard props improved the ability of students to understand concepts.

Keywords: geoboard props, mathematics, conceptual understanding

Introduction

Learning is one of the human efforts to learn new ones or deepen their knowledge. According to Suneetha, Rao, and Rao (2011) learning is a change in the behaviour of a child, and behavior refers to any activity displayed by the learner. Behavioral change is the result of learning carried out in the learning process. This statement is supported by the concept of learning from Article 1 point 20 of Law Number 20 concerning the National Education System of 2003, namely learning is the process of interaction between students and teacher and learning tools in a learning environment. The design of the learning model is one of the important factors that must be considered by the teacher, in order to create an enjoyable learning environment and achieve the desired learning goals.
The purposes of learning are the development of abilities that can be used by students after they have carried out certain learning processes (Sanjaya, 2009). The use of teaching aids can be an alternative strategy for teachers in the learning model to help students understand the concept of the material being studied. This is because students are not invited to memorize concepts but they construct concepts. Props are tools that are used to help clarify the subject matter shared with the students and prevents just memorizing by the students (Usman, 2009). The teacher not only teaches with the lecture method but can use the learning tools to support the learning process. With the teaching aids the teacher can explain the abstract concepts in order to make them to be more real for the students. The learning of mathematics contains many abstract concepts.

Mathematics is one of the subjects taught at every level of education in Indonesia. Mathematics in Dutch is called *wiskunde* which means the science of learning (this is in accordance with the meaning of Mathein's words in mathematics), all of which are related to learning (Fathani, 2009). Whereas according to National Professional Certification Agency (BNSP) (2006) mathematics is a universal science that underlies the development of modern technology and has an important role in various disciplines and advances the power of human thought. Geometry is one aspect of mathematics that is taught in elementary and secondary schools, but with different levels of depth. Geometry is important to learn, due to the fact that geometry is not only related to mathematics, but also related to the development of cognitive, affective and psychomotor abilities of students, such as investigating, researching, criticizing, creative thinking, describing what students have learning and self expression (Erdogan, Akkaya & Akkaya, 2009).

Although it has been studied in elementary school, the fact that middle school students still have difficulty in understanding the concepts of basic geometry, can be seen from the results of the pretest tests conducted with students of class VII at one of the junior high schools (SMP) in Aceh. It shows that students still have difficulties when they are faced with questions or problems that do not only require the application of formulas but require an in-depth
understanding. Difficulties in learning geometry can occur one of which results from the habits of the methods used in learning geometry. Geometry learning is usually carried out by the teacher simply by using text descriptions, 2D graphics and recording mathematical formulas on the board or paper (Hwang, W.Y., et.al: 2009). The methods that use by teaching can make student low interest in learning geometry. Research conducted by Galadima (2002), found an association between students' low interest and achievement in mathematics towards teacher teaching methods. Amoo (2002) said the low level of student activity can be caused by students' low interest in learning. So teacher must use the relevant learning methods to lead student more interest in learning, because the relevant learning methods will lead student to high interest in learning, and will have an impact on improving learning and the improvement of mathematical performance (Ajai, J. T: 2013).

Geometry problems can be solved with several approaches such as conducting a trial and doing direct practice in which the problem is solved by taking measurements and calculations. This is supported by the view of the constructivist theory that argues that learning is not just memorizing but is a process of constructing knowledge through experience (Sanjaya, 2008). Therefore, it is argued that using teaching aids or concrete manipulative appoarch students will help students to construct their own knowledge, in order to be able to foster a better understanding of concepts. The results from the research conducted by Akaazua, J.T., et al. (2017) found the benefits of learning by using a concrete manipulative appoarch including (1) concrete manipulative appoarchs can be used by students in Geometry learning because it helps form a positive attitude in learning Geometry. (2) concrete manipulative appoarch is used by mathematics teachers, because its use helps students to get many things from what they have learned. (3) The use of concrete manipulative approach can improved the performance of students taught Geometry concepts in Mathematics.

Conceptual understanding is one of the 5 mathematical processes expected of students. Conceptual understanding is a basic ability that must be possessed with other abilities, because the other ability are supported by this ability to
understand the concept. Conceptual understanding is the understanding of students of concepts, operations, and mathematical relations (Kilpatrick, 2001). In addition, he added that the most significant indicators for measuring the ability to understand concepts are the ability to represent mathematical situations in different ways and to know how to use different representations for different purposes (often termed multiple representations). But in general the indicator of conceptual understanding is used to determine if the student is able to: (1) restate the concepts that have been learned; (2) classify objects based on whether or not the requirements are met to form the concept; (3) provide examples or non-examples of concepts learned; (4) present concepts in various forms of mathematical representation; (5) link various concepts; and (6) develop necessary requirements and or sufficient conditions for a concept.

Geoboard props are simple teaching aids that can be made by the teacher to assist the teaching of the concept of geometry. Geoboard, or better known as nail boards, are shaped like a braille board, but the geoboard is equipped with rubber bands and nails that are stuck in half of the board. The arrangement of nails has the same distance so as to form small rectangles or a grid. Some of the benefits of geoboard props are 1) teachers can quickly show various geometric shapes such as square, triangle, rectangle, trapezoid; 2) the students are able to follow quickly in making geometric shapes without requiring a lot of time to draw, and without requiring erasers, rulers, pencils and paper; 3) the geometrical shapes that occurs are more in line with the reality than if the geometry is presented by building the geometry on cardboard, plywood, or other paper; 4) can be used to find various lengths of segments with fractional or rational numbers; 5) with a geoboard students can also calculate the area of various regions using irregular shapes; and 6) to demonstrate circles and circle diagrams teachers can make a circular geoboard (Russeffendi. 2007).

Allen, K.C (2013) said the teacher uses geoboards to train students to conduct interesting investigations on geometry and mathematics discrete. Simply it can be said that the teacher uses geoboard to help students learn about various topics, including transformations (for example in translation, rotation, reflection),
polygons, angles, area, circumference, etc. (Wheeler, A and Champion, J : 2016). Geoboard not only can be displayed in concrete form, but can be displayed online so students can use it from concrete to semi-concrete or representational forms (Furner, J. M, and Marinas, C. A: 2011). but in this study, researchers used concrete geoboards to see their effectiveness in shaping students' conceptual understanding of geometry material. The use of teaching aids is argued to be more effective and able to attract and foster students' conceptual understanding of the geometrical material. So that more in-depth research is conducted to test the hypotheses made.

### Research Methodology

This research was carried out by using experimental research methods that sought to find out the influence of certain variables by controlling the condition of other variables. This research was carried out in one of the junior high schools (SMP) in Aceh in 2014. Titled the manipulation of learning with geoboard teaching aids, involved an experimental class consisting of 20 students, while the control class consisted of 19 students who experienced ordinary learning or conventional learning. The two sample groups had previously been tested for cognitive equality, to see whether the two groups had the same level of ability.

The instrument used was in the form of 4 pretest questions to determine the initial ability of students and 4 posttest questions based on indicators of understanding concepts. It was used to determine students' ability to understand the concept of geometry that had been studied. The test results were then processed by looking for normality, homogeneity, average differences and t-test. At the end, the data would show the influence of the application of the props that were used in the teaching process. The ability to understand students' mathematical concepts was assessed based on the indicators shown in table 1.
Table 1. Rubric Assessment of Concept Comprehension Ability

<table>
<thead>
<tr>
<th>Number</th>
<th>Conceptual Understanding Indicators</th>
<th>Criteria</th>
<th>Skor</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Re-state a concept</td>
<td>Can mention and restate a concept correctly and completely</td>
<td>4</td>
<td>1,3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can answer, mention and restate a concept but not complete and correct</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can answer and restate a concept but wrong</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can't answer and re-mention a concept</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does not answer at all the concept</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Implement concepts in problem solving</td>
<td>Can solve problems using the concept correctly and completely</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can solve problems using the concept but not complete and correct</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can solve problems using the concept but wrong</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does not solve problems using the concept</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Do not answer at all using the problem of a concept</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Presenting concepts in various forms of mathematical representation</td>
<td>Can mention and present concepts in various ways for true and complete mathematical representations</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can answer and present concepts in a variety of mathematical representations but are less true and complete</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can mention and present concepts in various mathematical representations but wrong</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can not answer and present concepts in various mathematical representations</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does not answer at all or presents concepts in other representations</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Result and Discussion

This study used a series of tests and data analysis to obtain answers to the research questions that had been formulated: Is there an influence by teaching with geoboard props upon the student’s ability to understand mathematical geometric concepts. The tests attempted to be homogeneous, normally distributed,
and included the use of a t-test. The results obtained are as described in table 2 below:

**Table 2. Results**

<table>
<thead>
<tr>
<th>Number</th>
<th>Data Analysis</th>
<th>Results</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normality test</td>
<td>Experimental class: x̄₁ = 12.55 and S₁ = 2.76 Opportunity, the biggest L₀ is 0.1495. With n = 20 and a significant level of 0.05, from the table the critical value L for the Lilliefors test is obtained L = 0.190. Because, that is 0.1495 0.190</td>
<td>Data is normally distributed</td>
</tr>
<tr>
<td></td>
<td>Control class: x̄₂ = 10.47 and S₂ = 2.26 Opportunities, the biggest L₀ is 0.12526. With n = 19 and a significant level of 0.05, from the table of critical values L for the Lilliefors test obtained L = 0.195. Because, that is 0.12526 0.195</td>
<td>Data is normally distributed</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Homogenity Test</td>
<td>s₁² = 7.62 (variance from the experimental class) s₂² = 5.15 (variance from the control class) F_count is F = 1.47 significant level = 0.05, F₀.05 (18.19) because it is not in the table, the Interpolation approach is used and is obtained = 2.20, because F_count &lt; F_table is 1.47 &lt; 2.20</td>
<td>Both sample groups have the same level of ability</td>
</tr>
<tr>
<td>3</td>
<td>t-test</td>
<td>t₀.05(37) = 1.6879 t_hitung = 2.56 Significant level α = 0.05 t hitung &gt; t table that is 2.56 &gt; 1.6879</td>
<td>H₀ is rejected. So that it can be concluded that &quot;There is an influence from the use of geoboard props on students' ability to understand concepts&quot;</td>
</tr>
</tbody>
</table>

Based on the data that has been collected and after processing the data, so hypothesis testing is carried out using the t-test. In testing the hypothesis the significant level = 0.05 with dk = 37 obtained the price for = 2.56 and = 1.6879. So based on the criteria for testing the reject hypothesis H₀, which is t_count> and the result is 2.56 > 1.6879; thus it can be concluded that there is an effect on students' understanding of mathematical concepts of using Geoboard props compared to those taught without using Geoboard props on geometric problems. This shows that based on the results of the tests carried out, it was found that the
use of geoboard props had an effect on the student ability to understand mathematical concepts in geometric material. Evidence from the posttest results that students who learn by using geoboard props got better grades than those without learning aids in geometry. The results above are in line with the benefits of manipulative props. Swan, P and Marshall, L (2010) based on their findings in previous studies. These researchers found that manipulatives were beneficial for learning and teaching mathematics. This study also found that the use of concrete manipulative is strongly related to the formation of concepts in student learning.

The findings above are also in line with the results of the research conducted by Saidu, S and Buyamin, S (2016), which states that there is a significant difference between the performance of the experimental group (which is taught using Geoboard) and the control group (which is taught without using the teaching material). Besides Wheeler, A and Champion, J (2016) states that based on his experience in presenting student activities with geoboard, he found that geoboard can help students see the beauty and relevance of mathematics at the secondary school level, and this is often overlooked. Scandrett (2008) in his research concluded that important geoboard was used as a real prop in mathematics classrooms. This can provide direct experience for students. Direct experience is seen as very important in the cognitive development of students.

In addition, by using teaching aids students were not only actively listening, but students were invited to get involved and build their own knowledge. So that the acquired knowledge was more inherent and meaningful. For example, by using geoboard to find formulas and definitions of square area, students were firstly directed to make a flat square in accordance with the size specified on the student worksheets that have been distributed. Then the students were asked to calculate the number of small squares (squares / small squares) in the rectangle that was created earlier. So that by calculating the number of small squares in the shape students could find the area of the square and could deduce the square area formula.

Another example of the implementation of geoboard: if the length/side is 2 cm and width/side is 2 cm, how many small squares are in it? Answer = 4 small
squares. If the length/side is 3 cm and the width/side is 3 cm, how many small squares are in it? Answer = 9 small squares. So it can be concluded that the square area formula = sxs. And this activity also gives an understanding that the area of a square is limited by the length and width that are the same (sides). So that whatever the problem is, if it’s asked about the area, especially the square, students will imagine that the question is about the size or extent of a built area. So, in this activity the teacher's contribution is only to monitor the course of the discussion and guide the group that has difficulty working on the worksheet.

Group discussion condition, the researches show that students were more active in discussing, asking questions and being more courageous in expressing their opinions in front of their friends and teachers. This discovery is in line with the results of the research conducted by Freire, A.F., et.al (2018) that during the workshop, it was seen that there was effective participation in the classroom and also an increase in student performance during learning. In addition, students were required to be involved directly in finding the facts of the problem so that the understanding gained longer and better. So that the students' mastery of the perimeter material and the square and rectangular area by using teaching aids is higher and the students' grades have increased compared to learning without using teaching aids.

Condition during Learning process, the researchers found that students who learned using geoboard were more actively involved in learning than those who learned using conventional methods. The statement is in line with the benefits of using concrete objects in learning. Yara (2009) observed that students who learned to use concrete manipulatives were more attentive, involved in learning and participating more actively in class than those who did not. This can be seen when the teacher explains the material, some students do listen well, but others are sleepy and engrossed in talking with their friends. And in the other situation, when the teacher asks students the questions they more silence, even when solving questions students do not know what to write and which formulas to use. In addition, when the teaching and learning process takes place students are very rarely asked, even when given the time to ask students to remain silent as if they
have understood, but in reality, they say they do not know what to ask. This happens because students do not understand the material being studied, the cause is the learning method used by the teacher is mention and places students only as recipients of information conveyed by the teacher, without involving students directly.

The use of geoboard props can affect the ability to understand students' mathematical concepts because with this teaching aids the subject matter is not just presented to students but students are accustomed to doing activities by being guided to find their own concepts that must be mastered by utilizing student experience. However, it should be underlined that not all subject matter is suitable to be taught with teaching aids. Only certain materials that really need teaching aids can be used to help students understand the concept of the material. Therefore, in the learning process, it is necessary to pay attention to learning methods that are truly in accordance with the material being taught, so that the purpose of the learning can be achieved.

Conclusions

Learning by using geoboard props and by using conventional learning gives different results in the student learning process. This is evidenced by the difference in average values between the two classes given different treatments in their learning. The value of students learned using geoboard teaching aids is higher than the average value of control class students. This is because with geoboard props students are trained to construct their own knowledge so that students more easily understand and remember the knowledge gained. Students in the conventional class obtain knowledge through direct exposure by the teacher, so that students are more passive in learning, this has an impact on understanding. So that through this research we conclude that for these two classes the use of geoboard props on student ability to understand the concept of geometry was a positive influence on one of the students of junior high school in Aceh. Due to the small samples used in this study, the researchers are unable to claim that this would also happen if used elsewhere.
Literature References


The Development of Instrument for High School Mathematics Assessment with Partial Credit Model Scoring 
(A Need Assessment)

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Abstract

Assessment is an important matter that has been regulated in government regulation number 23 of 2016 concerning assessment standards. The assessment in question must be valid, objective, and fair where all this is needed by students in carrying out the learning process. In the regulation, it was explained that sahih means that assessment measures what will be measured, objectively means in accordance with the guidelines in the assessment, and fair means that the teacher gives an equal assessment according to the ability of each student without being harmed. However, in reality rarely given a fair assessment rubric for students. The teacher sometimes unconsciously brings personal feelings in the assessment process. Therefore, the purpose of this study was to describe the teacher's needs related to the use of instruments for high school mathematics assessment by partial credit model scoring. The method used in this research is qualitative explorative descriptive with participants of 8 high school mathematics teachers and 2 policy stakeholders. Data obtained by direct interviews and indirect interviews. The results of the interview explain that so far there has been no rubric in accordance with government regulations. Rarely the scoring rubric takes into account the fair weight of each item tested. Scoring rubrics are rarely known to students, which students must know what mistakes are made in the test. Instrument development can be used as an example of a teacher in scoring rubrics with different test questions. Thus, developing instruments for the assessment of high school mathematics with partial credit model scoring can be an alternative to assist teachers in the need to use a fair scoring rubric. Partial credit models use a fair principle in giving a score on each item. Each step used to answer a question is appreciated using ordinal scoring and each step does not have to be ordered

Keywords: assessment, fair, partial credit model, scoring, mathematics

Introduction

Mathematics is one of the subjects that must exist in every level of school in Indonesia. In learning activities, a teacher will carry out a measurement and assessment activity. Measurement and assessment are important in learning
activities. Assessment as a foundation for students' completeness to the indicators of the material given. The government in supporting this activity has issued a regulation regarding the assessment requirements. Assessment is carried out in a fair way without bias and no students are harmed.

Assessment is an important component in the running of the educational process. This assessment can gather information that can be used to overcome problems or innovate to improve the quality of education in Indonesia. Regarding assessment, this cannot be separated from the rapid development of the 21st century. The government also supports this with the Presidential Regulation Number 87 of 2017 concerning strengthening character education in Indonesia. According to Hendriana (2017) said that hardskill ability can also be obtained through mathematics, namely students learn to hone problem solving skills, critical thinking, creative thinking, have mathematical reasoning skills, mathematical communication skills, and mathematical understanding abilities.

In line with the aim of Indonesian National Education, one of them is to realize quality human resources, namely individuals who are independent, willing and capable to realize the ideals of their nation. Learning outcomes are inseparable from the existence of an assessment instrument that is used as a tool for evaluating students. A justice assessment is certainly expected by all parties. In reality, this has never been considered by educators in conducting an evaluation. Equitable education is intended to reduce the bias and subjectivity of educators in evaluating.

In this case, there are several item response models besides dichotomus, namely the politomus model. The politomus model on item response theory includes Nominal Respons Model (NRM), Rating Scale Model (RCM), Partial Credit Capital (PCM), Graded Response Model (GRM), and Generalized Partial Credit Model (GPCM). So, by using a politomus model, mathematical test items can be scored using Partial Credit Capital (PCM), each step to get the correct answer using ordinal scoring (Heri, 2014).

Mathematics in finding the right answer, obviously through the right steps and in accordance with the question. Therefore, the teacher needs an example of a scoring guide that matches the form of the question and the response of the student.
so that the value obtained is really the result of the indicator to be measured. Pressing with Partial Credit Models is very suitable with this learning. With this scoring, every step that is done by students will get a value according to the level of difficulty faced.

**Research Methodology**

This study uses qualitative exploratory descriptive. By using qualitative research researchers try to explore and understand the meaning of a number of individuals or groups of subjects (Creswell, 2015: 4). Arikunto (2010) in explorative descriptive research, researchers try to describe a phenomenon and do not intend to test certain hypotheses but only provide a real picture of symptoms or circumstances. The phenomenon referred to in the study is the development of a high school mathematics assessment instrument with partial credit model scoring related to the teacher's need for a fair assessment process. The subjects in the study were eight high school mathematics teachers and 2 policy stakeholders. Data collection techniques used are direct and indirect interviews. Interview questions submitted to research subjects related to.

**Table 1 Interview Questions**

<table>
<thead>
<tr>
<th>High School Mathematics Teacher</th>
<th>Policy Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How is the competency of students for mathematics subjects?</td>
<td>1. What is the result of the Mathematics UN this year?</td>
</tr>
<tr>
<td>2. Does learning always use a subjective model of funding or dichotomous?</td>
<td>2. Has the assessment used the appropriate assessment rubric in the assessment? Especially for questions other than multiple choice</td>
</tr>
<tr>
<td>3. If not, how is the application and results obtained when using an assessment rubric that is in accordance with the standards?</td>
<td>3. If not, what obstacles are found in making the appropriate rubric?</td>
</tr>
</tbody>
</table>
### High School Mathematics Teacher

4. If so, what are the obstacles faced in making an assessment rubric that meets the standards?

5. What obstacles have occurred regarding the application of a fair scoring rubric?
   - How is your opinion related to charting with a partial credit model?

### Policy Stakeholder

4. If yes, has the rubric used been socialized to the school or students?

<table>
<thead>
<tr>
<th>High School Mathematics Teacher</th>
<th>Policy Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. If so, what are the obstacles faced in making an assessment rubric that meets the standards?</td>
<td>4. If yes, has the rubric used been socialized to the school or students?</td>
</tr>
<tr>
<td>5. What obstacles have occurred regarding the application of a fair scoring rubric?</td>
<td></td>
</tr>
<tr>
<td>How is your opinion related to charting with a partial credit model?</td>
<td></td>
</tr>
</tbody>
</table>

### Result and Discussion

The results of interviews with mathematics teachers and policy makers informed that in the learning process the teacher always tried to design research that was in accordance with the form of tests being tested and in accordance with government regulations. Fair assessment makes students get maximum results and in accordance with the knowledge that has been obtained. With the use of an assessment that suits your needs, it is expected to be able to measure what you want to measure so as to motivate students to be more diligent in learning. However, in the learning process the teacher uses a subjective scoring system. For example, in problem number 1 has a score of 10, number 2 has a score of 20, and so on. The fact number 1 sometimes students are wrong in carrying out their computation, so the value decreases. It is clear that the teacher will give a score below 10. However, there is no clear rubric which students will get what score for any step. Besides that the teacher still brings feelings in giving value to the student's response. For example, student writing that is less neat or unreadable, the attitude of students in learning activities, and others.

The factors behind this are the teacher is still lacking in knowledge about the scoring model that can be used and in accordance with the form of the test and the subjects it teaches. Little training that all teachers are required to attend the
training. From one school only a few teachers were included, others only received information from the teachers included. Of course the knowledge conveyed cannot be as perfect when following training directly. Another reason is rarely examples of instrument valuation with partial credit model scoring for high school mathematics learning. Thus, the teacher cannot imitate the example of the instrument, even though he has knowledge. Limited access to knowledge is a major obstacle in the development of partial credit model-based scoring. Some teachers also still do not know the importance of socializing the assessment rubric as a more motivational tool for students. In addition, of course students will know what mistakes are made when they know what kind of assessment rubric is used.

The teachers are aware of the importance of using partial credit model writing as a way to improve the competence of students. The teacher hopes that with the assessment rubric that has been listed on the exam questions, it can make students more enthusiastic about working and confident in their abilities. However, in reality there are still not many references which include training questions and assessment rubrics. Although there are, sometimes the assessment rubric is still subjective and creates multiple interpretations. In essence, teachers have high potential to develop high school mathematics research instruments by independently scoring partial credit models. However, this is rarely done because of the lack of academic ability, namely the teacher has not been able to make a high school mathematics assessment instrument with partial credit model scoring in accordance with the government assessment standards.

Based on the above explanation it is known that the high school mathematics assessment instrument with partial credit model scoring must be developed through valid and reliable instruments. This assessment instrument can be done in the classroom during the process of measuring student abilities. Therefore, the importance of the availability of high school mathematics assessment instruments with partial credit model scoring is not matched by the many references that contain partial credit model scoring rubrics. Therefore, various efforts must be made to overcome this and one of the right efforts is to
develop a high school mathematics assessment instrument with partial credit model scoring.

**Conclusion**

Partial credit model scoring is a scoring that should be used in measuring students' mathematical abilities during the exam. The use of this assessment instrument can be used in daily tests, midterm replications, final tests, even mathematical exams which are descriptions. Because of the difficulty of developing mathematical assessments by partial credit model scoring by the teacher and the lack of development of assessment with the appropriate partial credit model scoring, an appropriate solution is needed to overcome this. Thus, developing an assessment with partial credit model scoring can be an alternative to assist teachers in the need to use an assessment rubric that suits their needs.

**Literature References**


Determine the Area of Trapezoids Using Reshaping Way with SPS-Bansho (a Lesson Plan)

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Abstract
To solve trapezoid area problems, most of seventh grade students at the researcher’s school just memorized and applied its area formula. The learning process did not support students’ understanding of trapezoid area concept. The purpose of this research is to create a lesson plan for teachers to gain students’ better understanding of trapezoid area concept. The researcher applied structured problem solving (SPS) approach using bansho (blackboard organization). This research combines design research (preliminary research, prototyping stage, assessment phase) and lesson study. Started by designing a first lesson plan, presenting, validating, peer teaching and revising it. Doing the second validation, refining the hypothetical learning trajectory (HLT), implementing the revised lesson plan in a real teaching, doing the third validation and ended by finishing then implementing final design lesson plan. In developing the HLT, trapezoid area determined by reshaping it into other shapes. Three mathematics experts, nine mathematics teachers, fifty nine 7th grade students are involved during this research. Based on the data collected, all of students’ group (eight groups) solved the given problem. They reshaped trapezoid into rectangle (three groups), parallelogram (two groups), used two trapezoids and reshaped them into rectangle (a group), parallelogram (a group). Only one group cut the trapezoid into two parts (rectangle and triangle) then added each area. By using the final lesson plan, teacher has been successful in guiding students to solve trapezoid area problem. It is absolutely necessary for teacher to design a good lesson plan before the learning is conducted.

Keywords: HLT, lesson plan, reshaping, trapezoid

Introduction
Determine the area of trapezoids is one of the mathematics subject matter has been taught since students in fourth grade of primary school. (BSNP, 2006). In the seventh grade of the secondary school, they also learn about quadrilaterals including the trapezoid with its characteristics, circumference and area formula. (BSNP, 2006 and Kemendikbud, 2016).

Based on the researcher’s experience in teaching mathematics at the researcher’s school, SMPN 18 Tangerang, most of seventh grade students just memorized the trapezoid area formula. They have given only a formula by their teacher at primary school, they did not understand about trapezoid area concept.
Based on the researcher’s interview with students, they did not understand where the formula is derived and why the formula work. They will depend on their memorization abilities of the trapezoid area formula so that they often could not solve the trapezoid area problems.

The researcher observed teaching and learning process of all of mathematics teachers at researcher’s school. Teachers did not design lesson plan before the learning was conducted. They did not start the activities with a contextual real life problem. They gave the trapezoid area formula directly, explained the trapezoid area problem and its solution, then gave students other problems to solved. The activities also dominated with teacher centered learning process. Students have not given opportunity to develop their creative ideas. The learning process did not support students’ understanding of trapezoid area concept. In a teacher centered learning, the teacher is seen as the sole source of knowledge and the student is merely a passive learner, with no control of the teaching or learning process (Hawker, 2000). Meanwhile, the students should have twenty first century skills such as critical thinking skills, ability to connect mathematics to real life problem and collaborate or work together with friends. It would be difficult to achieve it, if students is given teacher centered learning process. Student-centered practices increases the control students have in their learning because learning is active, uses primary sources, higher order thinking skills, and allows students to have a hand in developing learning goals, making decisions in the pacing to achieve such goals, and how it will be determined that learning has taken place (Evertson & Neal, 2006).

**Why Structured Problem Solving (SPS)?**

Based on the aforementioned reason, it is needed a lesson plan which emphasize the students’ activities in teaching and learning process for trapezoid area material so that the learning process become meaningful and can support students to gain their better understanding of trapezoid area concept.

The researcher designed a lesson plan that can accommodate students centered learning. The researcher used structured problem solving (SPS)
approach. Using this approach, teacher should presenting and promoting a challenging and appropriate problem. Problems specify should result in a variety of students’ solution that can be compared and analyzed to draw out key mathematical points. It began with a word or practical real life based on learning objective. Students are expected to solve a mathematics problem using their own mathematics knowledge, to be taught through applying previously learned knowledge, also require students to think deeply and critically to connect it to the new concept (Leong, C.K., Teoh, B.T. & Warabhorn, P, 2012).

SPS sequence include some steps. First, reviewing the previous lesson. It is very important to know students’ prior knowledge as the prerequisite knowledge to learn the new material. The second is presenting the problem for the day. Teacher begin with a problem and then determines whether the students understand the problem well. Third, students working on their own to find ways. They may works individually, in pairs or a small groups. Fourth, whole-class discussion. It is an arrangement of students’ solutions to guide the students to intended learning based on previous knowledge. The fifth, summing up to highlighting and summarizing the main point. It is a reviewed briefly what students have discussed in the whole class discussion and what they have learned through the lesson. Teacher leads students to reflect on and make a conclusion what they have learned from today’s lesson. Sixth, given exercises or extension. It is for reinforcement to know how well students are learning and can enhance their knowledge about the material they have learned. (Leong, C. K., Teoh, B. T. & Warabhorn, P, 2012).

**What is Bansho?**

The first learning goal of this lesson plan is to determine the area formula of a trapezoid based on polygon area that students have known before. The polygon is specified on quadrilaterals (such as square, rectangle, parallelogram) or triangles. As the prior knowledge, students should have understood well about area concept of quadrilaterals and triangle.

In addition, the researcher need a way to organize students’ work so everyone can see the range of their thinking. Thus, the researcher chosen to apply
SPS approach using *bansho*. *Bansho* is a technical word developed by the Japanese education community that are effective use of the blackboard (or whiteboard), organisation of blackboard (whiteboard), literal translation “board writing”. The researcher use *bansho* to show the flow of teaching and learning process. Using *bansho* lets students see their own thinking in the context of the similar thinking of others. Students are expected to follow and be able to describe all the work represented, not just their own. They listen to the explanation of other students and restate, in their own words, the strategies of other students used. All students have a chance to learn more about the lesson in developing solutions, and to clarify their understanding of the concepts and procedures. *Bansho* engages the teacher in examining student work, organizing and displaying annotating and discussing solutions. This figure 1 bellow is the *bansho* scheme. (Leong, C. K., Teoh, B. T. & Warabhorn, P, 2012).

![Figure 1. Scheme of Bansho](image)

The utility of a *bansho* are: to keep a record of the lesson, help students see the connection between different parts of the lesson and the progression of the lesson, compare, contrast and discuss ideas that students present, help organize student thinking and discovery of new ideas, foster organized student note taking skills by modelling good organization. (Yoshida, M, 2002).

The researcher hope, by using *bansho*, students can connect parts of the lesson coherently together in order to build their better understanding.
**Methodology**

This research combines design research and lesson study. According to Van den Akker, design research comprises of a number of stages or phases: preliminary research, prototyping stage and assessment phase. (Van den Akker, Jan, 2010).

The researcher explained the phases of the design research applied in this research, can be seen in table 1.

<table>
<thead>
<tr>
<th>Table 1. The phases of the design research</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preliminary Research</strong></td>
</tr>
<tr>
<td>First Design</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>First Lesson Plan</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Revision 1 Lesson Plan</td>
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<tr>
<td></td>
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<tr>
<td>Revision 2 Lesson Plan</td>
</tr>
</tbody>
</table>

The researcher also used some steps of lesson study method. Makoto Yoshida explained an example of lesson study: teachers work together in teams to consider an area of interest or difficulty in mathematics for their students. The teachers develop student goals, research together the math content, and carefully plan a lesson. The lesson is taught by one of the teachers and observed by the team, who gather data about how the lesson is going. The research lesson is then revised through reflection and thoughtful improvement for reteaching. (Wiburg, Karin M. 2007)
Three mathematics experts (Wahid Yunianto, M.Sc, Fajar Sadiq, M.App.Sc and Dr. Wahyudi from SEAMEO Regional Centre for QITEP in Mathematics), nine mathematics teachers (selected teachers in mathematics teaching and learning models competition), fifty nine 7 grade students participated in this research. The students involved in this research are from two schools. Twenty five students of SMP Budi Mulia Yogyakarta participated in the trial of teaching and learning process (real teaching) and thirty four students of SMPN 18 Tangerang participated in the final implementation teaching and learning process.

**Result and Discussion**

**First Lesson Plan Design, Presentation Phase 1 and Feedback**

In this research, the researcher developed mathematics teaching and learning goal, researched the mathematics content and arranged a lesson plan, then named “First Lesson Plan”. At first, the learning goal is determining the area formula of a trapezoid based on polygon area. The learning method used are group discussion and presentation. The researcher also used worksheets for helping students in solving the problem. In this lesson plan, the researcher applied structured problem solving (SPS) approach using *bansho*, an organization of blackboard in teaching and learning process. *Bansho* used to organize and display all of the steps in the SPS approach. The *bansho* created to display a prerequisite material, the problems, students' answers or ideas, summary, task, reflection and exercise.

The main activity of instructional procedures of the first lesson plan shown in table 2.
Table 2. Main Activity of the First Lesson Plan

<table>
<thead>
<tr>
<th>Teacher’s Activity</th>
<th>Student’s Activity</th>
<th>Structured Problem Solving Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher asks the prior knowledge which is related area of polygon (the area of square, rectangle, triangle and parallelogram)</td>
<td>Students give answer</td>
<td>Reviewing the previous lesson</td>
</tr>
<tr>
<td>Teacher ensures students understand about polygon and area of polygon by question and answer</td>
<td>Students read the problem and the task carefully</td>
<td>Presenting the problem</td>
</tr>
<tr>
<td>Teacher informs the problem then poses and guides students to understand the problem and gives the worksheet to each group</td>
<td>Students discuss to solve the problem in group</td>
<td>Students working on their own</td>
</tr>
<tr>
<td>Teacher ensures that students understand the problem well</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher moves around and guides the students in group to solve the problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observe the students as they work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Give suggestions or help students who are having difficulties</td>
<td>Students present their work on the board</td>
<td>Whole-class discussion</td>
</tr>
<tr>
<td>Look for ‘good’ ideas with the intention of calling them in a certain order during discussion</td>
<td>Other groups give response by asking question or give other solution</td>
<td></td>
</tr>
<tr>
<td>Encourage alternative method to solve the problem</td>
<td>Make the conclusion about solution of the problem</td>
<td>Highlighting and summarising the main point</td>
</tr>
<tr>
<td>Teacher guides and lets students discuss among themselves</td>
<td>Each group present their work on the board</td>
<td></td>
</tr>
<tr>
<td>Teacher gives rewards to the group that has done a good presentation, quickly and clearly correctly</td>
<td>Students attach the rewards on the board</td>
<td></td>
</tr>
<tr>
<td>Teacher asks students about their answer in solving the problem</td>
<td>Students explain the strategy of solving the problem</td>
<td></td>
</tr>
</tbody>
</table>

Meanwhile, the researcher and nine mathematics teachers invited to participate in “Mathematics Teaching and Learning Models Programme”, a workshop on developing mathematics teaching and learning models, conducted by SEAMEO Regional Centre for QITEP in Mathematics on 4th until 8th April 2016. Before it, we have sent our lesson plan design to the committee of this programme. We were very lucky being the ten best selected mathematics teachers and can participated on this programme. We are from various school level, the elementary school (three person), junior high school (four person) and senior high school (three person) from different provinces in Indonesia.

The researcher presented the first lesson plan. The presentation observed and assessed by the experts team and all participants of the workshop on developing mathematics teaching and learning models. They gave reflection and feedback to the researcher related its contents such as the learning goals, the main activities and the roles of teacher.
Then, on this workshop, the experts alternately gave the material about ‘how to design a good lesson plan’ to all participants. A lesson plan is an important component of teaching, and a good lesson plan can help teachers teach well and students learn well.

Revision and Refinement, Presentation Phase 2 (Peer Teaching) and Feedback

These are the feedback and recommendations of the researcher’s first lesson plan:

- Teacher did not use a contextual trapezoid area problem. The problem used should be a contextual problem in student daily life.

- Teacher could give a specific 'rules' to remind students to stay focused on the learning process.

- There is no hypothetical learning trajectory (HLT). It’s very important to design it.

- Teacher used any trapezoid to guide students finding the trapezoid area formula. Start learning process using the problem with right trapezoid that is a trapezoid that contains one right angle. Predicted that by using the right trapezoid, students will be easier to find trapezoid area formula.

The researcher realized that teacher should presenting a practical real life problem based on learning objective in his/her lesson plan. It was according to the second step of SPS sequence that teacher begin with a problem and then determines whether the students understand it well. (Leong, C. K., Teoh, B. T. & Warabhorn, P, 2012). The researcher also arranged the instructional procedures of the lesson plan included steps of the lesson, students and teacher’s activities and the method of evaluation.

Emphasizing the hypothetical learning trajectory (HLT), the researcher agreed that it’s very important to prepare it. HLT is refer to the teacher's
prediction as to the path by which learning might proceed. According to Gravemeijer, teacher has to investigate whether the thinking of students actually evolves as conjecture, and he or she has to revise or adjust the learning trajectory on the basis his or her finding. It is a possible taken-as-shared learning route for the classroom community. (Koeno Gravemeijer, 2003).

In developing the HLT, the trapezoid area determined by dividing the trapezoid into parts and then summing the areas, and also by reshaping the trapezoid into other shapes that students have known before.

Based on recommendations of the experts and all of the observers, the researcher revised the first lesson plan into “Revision 1 Lesson Plan”. The design changing is seen on table 3.

Table 3. The Design Changing (First Lesson Plan into Revision 1 Lesson Plan)

<table>
<thead>
<tr>
<th>Steps</th>
<th>First Lesson Plan</th>
<th>Revision 1 Lesson Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening</td>
<td>No specific ‘rules’ to remind focused on the learning process, for example if the</td>
<td>Already has certain ‘rules’ to remind students to stay</td>
</tr>
<tr>
<td></td>
<td>students to stay focused on the teacher says 'hi' then the student must answer</td>
<td>focused on the learning process, for example if the students to stay focused on the</td>
</tr>
<tr>
<td></td>
<td>'hello' and immediately focus back on learning, or the teacher can use other rules</td>
<td>teacher says 'hi' then the student must answer 'hello' and immediately focus back on</td>
</tr>
<tr>
<td></td>
<td></td>
<td>learning process, for example if the students to stay focused on the teacher says</td>
</tr>
<tr>
<td></td>
<td></td>
<td>'hi' then the student must answer 'hello' and immediately focus back on learning, or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the teacher can use other rules</td>
</tr>
<tr>
<td></td>
<td>It was not present the contextual problem related the trapezoid area yet</td>
<td>Present the contextual problem related the trapezoid area</td>
</tr>
<tr>
<td>Presenting the</td>
<td>Showing problem with any trapezoid</td>
<td>Using problem related to the right trapezoid</td>
</tr>
<tr>
<td>problem</td>
<td>Determining the area of a trapezoid by dividing the trapezoid area and then</td>
<td>Determining the trapezoid area by dividing the trapezoid area and then summing the</td>
</tr>
<tr>
<td></td>
<td>summing the areas, and also by reshaping the trapezoid into other shapes</td>
<td>areas, and also by reshaping the trapezoid into other shapes that students have</td>
</tr>
<tr>
<td></td>
<td></td>
<td>known before</td>
</tr>
<tr>
<td>Students work</td>
<td>No hypothetical learning trajectory (HLT)</td>
<td>Already has hypothetical learning trajectory (HLT) design</td>
</tr>
<tr>
<td>on their own</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Then the researcher presented the “Revision 1 Lesson Plan” on a lesson study method. The researcher as teacher model did a peer teaching while the expert team and nine mathematics teachers were become both of students and observers. After peer teaching, we reflected and evaluated the teaching and learning process. All of the observers gave feedback that can be used for revising the lesson plan.
The reflection and recommendations of the “Revision 1 Lesson Plan” and the researcher’s performance are:

- Teacher’s speaking speed was rather fast, recommend to speaks more slowly so that students could understand well about the topic being discussed.

- Describe the problem by using a picture of a unique building in the world with trapezoid shape.

- Find the trapezoid area by reshaping the trapezoid into other shapes that as prerequisites shapes. Teacher could give students a trapezoid and they have to reshape it into other shape then find the area.

The recommendations are related to the one of teachers’ responsibilities which is teacher should stimulate and manage classroom discourse so that the students are clearer about what is being learned. The revision 1 lesson plan is then revised into “Revision 2 Lesson Plan” through validation and thoughtful improvement.

**Real Teaching, Reflection, Revision and Improvement, Final Implementation**

In the Mathematics Teaching and Learning Models Programme, the researcher have became the one of the three best teachers so that the researcher together with the other two best teachers given an opportunity by SEAMEO Regional Centre for QITEP in Mathematics to participated in the Programme of Mathematics Teaching and Learning Models Development. It hold on 11th until 15th April 2016.

SEAMEO Regional Centre for QITEP in Mathematics gave the researcher an opportunity to trial the revision 2 lesson plan together with the experts team and two other teachers. The real teaching used a lesson study method. The researcher implemented the revision 2 lesson plan, the experts and the other teachers became the observers. The real teaching was conducted in 7th grade with 25 students at SMP Budi Mulia Yogyakarta.
Figure 3. Students’ activities in the real teaching

After reflection and evaluation, several things need to be improved:

- Teacher better guide the students to determine the trapezoid area only by reshaping way, forget the trapezoid area formula.
- To display the problem, teacher may use LCD, it also may use a color images with rather large size.
- The problem can use the existing number, or can use other more beautiful numbers such as Rp 100,000,00 for the price of glass per square meter, so that students needn’t to multiply by 2 (if that price is Rp 200,000,00). For another choice, teacher use the price in dollars.
- Do not use ruler, let students draw or reshape by using their hand, without a ruler or other aids.
- If possible, lead students to get the stage of determining the trapezoid area formula by reshaping the trapezoid into various shapes they have known as the prerequisite material. If the time is not enough, do this at the next lesson.
- The rewards (colorful stars sticky images) can be replaced with other forms of rewards that are more suitable for seventh grade students.

The researcher evaluated the lesson plan and then found that the scenario of teaching and learning process in it were directed students to find trapezoid area formula in various ways. Many students were a bit confused doing it. Most of them directly count the trapezoid area using the formula of trapezoid area they’ve already known. The researcher noticed the student's confusion, immediately reminded them not to use the trapezoid area formula directly and then guided them to find the trapezoid area by using other previously known shapes areas such as triangle, rectangle, and parallelograms. However, according to Wahid
Yunianto, the researcher’s supervisor, students should be guided to use only the 'reshaping' way. Based on his research, Yunianto said that students have understood that by reshaping or cutting and pasting will not change the area of its original shapes. Students will learn that the reshaping activity will preserve the area. (Yunianto, W, 2014). Reshaping is based on the cutting and pasting activity that students will make a new shape from the trapezoid. In this activity, students expected to reshape the trapezoid into a quadrilateral. They may do to cut and paste to reshape the trapezoid into a new shape. It is possible that students would use trial and error strategy to cut and paste the trapezoid and then find a new shape. This activity could give the students’ understanding that by cutting and pasting will not change the trapezoid area.

Based on the discussion with the researcher’s supervisor about the revision 2 lesson plan, the researcher did the supervisor suggestions. Remembering the first learning goal of this lesson plan is to determine the area formula of a trapezoid based on polygon area that students have known before, then the researcher developed it into determine the area of trapezoids by reshaping and using area formula of quadrilaterals and triangle. The following table explained the design changes.

Table 4. The Design Changing (Revision 2 Lesson Plan into Final Lesson Plan)

<table>
<thead>
<tr>
<th>Steps</th>
<th>Revision 2 Lesson Plan</th>
<th>Final Lesson Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presenting the problem</td>
<td>Only using LCD media to display the trapezoid area.</td>
<td>Mentioned that to display the trapezoid area, may use various media contextual problem. (LCD, a large size picture or others).</td>
</tr>
<tr>
<td></td>
<td>Using number Rp 200,000.00 for the price of glass per square meter</td>
<td>Choose to keep using Rp 200,000.00 for the price of glass per square meter, and mention that teacher can replace it with other numbers or use the price in dollars.</td>
</tr>
<tr>
<td></td>
<td>Determine the trapezoid area by dividing the trapezoid into other shapes and by reshaping way.</td>
<td>Determine the trapezoid area only by reshaping way.</td>
</tr>
<tr>
<td>Rewards</td>
<td>The rewards are colorful star</td>
<td>Written that teachers can choose other forms of rewards.</td>
</tr>
</tbody>
</table>
The revision 2 lesson plan validated by Wahid Yunianto, and then the researcher revised it into the “Final Lesson Plan”.

To ensure that the final lesson plan can help students to gain their understanding about trapezoid area, the researcher implemented it in a final implementation teaching and learning process at the researcher’s school. Thirty four grade 7th students of SMPN 18 Tangerang were involved in this implementation. The researcher implemented all of the parts of the Final Lesson Plan. The data showed that students mostly determine the trapezoid area by reshaping way. All of the students groups (eight groups) answered the given problem. They solved the problem by cutting the trapezoid and pasting its parts and then found the new shape. The students became more enthusiastic, they did the various reshaping ways. Three groups reshaped the trapezoid into a rectangle. They determined the trapezoid area by cutting the trapezoid into two parts, then pasting them into a rectangle. They used a rectangle area formula to find the trapezoid area. Two groups reshaped the trapezoid and used the area formula of parallelogram. There was a group that used two trapezoids and combined them into a rectangle. They counted the area of two trapezoid by using a rectangle area formula and then divided the result by two. Another group did the same way, they used two trapezoid but they did not combine them into a rectangle. They got a new parallelogram and then found the trapezoid area by using area formula of the parallelogram and divided the result by two. Only one group cut the trapezoid into two parts and applied area formulas of a rectangle and a triangle then summed them. All of students groups solved the given problem correctly. The students’ answer and the bansho can be seen on figure 3.

Figure 3. Students’ answer and the bansho.
Conclusion and Suggestion

Based on the research data, it can be concluded that the final lesson plan that the learning goal is to determine the area of trapezoids by reshaping and using area formula of quadrilaterals and triangle, with structured problem solving approach (SPS) using *bansho* (the whiteboard organizing) which is equipped with hypothetical learning trajectory (HLT), can facilitated teachers in the mathematics teaching and learning process to gain the students’ better understanding about trapezoid area. Step by step is clearly explained, the learning activities give opportunities for students to construct their knowledge. Students activities to find trapezoid area by reshaping or cutting and pasting the trapezoid into other shapes, have also been described in the HLT. Empowering students to work and collaborate in groups and present the results of group work in front of the classroom can also enrich the experience of students in the learning process (learning by doing). By using this final lesson plan, teacher has been successful in guiding students to solve trapezoid area problem by reshaping way. Students solved trapezoid area problem by reshaping the trapezoid into other shapes. Students became more excited, active and creative to solve the problem by exploring their own ways. Students succeed to find the correct answer of the problem. They have gained their better understanding related to the trapezoid area.

It can be said that to achieve students’ better understanding, it is absolutely necessary for teacher to design a good lesson plan before conduct the learning process. The material of the lesson plan in this research is about trapezoid area, so the next researcher should design lesson plan about the area of other quadrilateral.

The final lesson plan in this research was only applied at the researcher’s school. It is needed to apply it by other teachers, at other schools or other regions.

Acknowledgements

The researcher would like to thank to Wahid Yunianto, M.Sc, for his expert guidance and supervision, Fajar Sadiq, M.App.Sc and Dr. Wahyudi for their motivation throughout the research, Southeast Asian Ministers of Education Organization (SEAMEO) Regional Centre for Quality Improvement of Teachers
The 5th International Symposium on Mathematics Education Innovation
SEAMEO Regional Centre for QITEP in Mathematics

and Education Personnel (QITEP) in Mathematics to gives an opportunity for the researcher to be a participant of Mathematics Teaching and Learning Models Programme, the 7th grade students at SMP Budi Mulia Yogyakarta and the 7th grade students (class 7.10) at SMPN 18 Tangerang for their cooperation and participation.

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Integrating STE(A)M Education into English Classroom of Primary School:
A Mission Possible

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Abstract

This paper tackles the issue on integrating STE(A)M into foreign language education, with special attention to English as a foreign language. As a local content in the curriculum, English has a major role as a means to convey the meaning and the core of STE(A)M. The integration of STE(A)M into English classroom is a way to maintain the skills needed in the 21st century. This paper reveals the way to integrate STE(A)M in all of lessons taught in school, including English which serves as a local content in primary school level in Indonesia. This paper suggests methods of integrating STE(A)M education elements and principles in foreign language classrooms. These methods are provided in chapters about integrating lessons in the STE(A)M field. Finally this paper reports on effective pedagogies for successful STE(A)M and foreign language integration. The research seeks to answer the need for an integrative and interdisciplinary approach that supports deeper learning, the purpose for student learning, and the students’ interest. This writing discusses four approaches used in the primary school level i.e. Content-Based Instruction (CBI), Task-based Instruction (TBI), Problem-based Learning (PBL), and Inquiry-based Instruction (IBI). The methods used in the research were documents study in the form of lesson plan documents and a simple teacher survey. The results showed that while teachers still hesitate to integrate the STE(A)M in the English classroom due to the lack of information and skills; the support from the school, access to sources, and other assistances promoted teachers’ performance on the integration of STE(A)M in English classroom. It also reveals that the integration of STE(A)M into English lesson in the primary school setting begins with the content mapping of each learning indicators to emphasis on what should be promoted in each unit.

Key words: English, Integrated, STE(A)M
INTRODUCTION

A. BACKGROUND

The idea of STE(A)M integrated education approach emerged as a new idea to develop 21st century skills. STE(A)M, an acronym for Science, Technology, Engineering, Arts and Mathematics, linked several lessons to become an integrated effort to meet the demands of future employment. STE(A)M which originally came from the STEM idea by adding "Art" to it means that the students learn the concepts of science, technology, engineering, art, and mathematics through solving real problems and experiences they experience themselves. STE(A)M allows students to be able to use their own ideas, hypotheses, conclusions, and strategies to solve problems they face and offer solutions to these problems (Roberts, 2012: 1).

Integration of STE(A)M in learning is considered to have a major role in improving the quality of human resources and the competitiveness of Indonesian workforce. The integration of STE(A)M in school subjects is expected to become a large bridge connecting the gap between the needs for and the availability of workforce equipped with 21st century skills. 21st century skills include the ability to learn and think critically, being able to solve problems, creative and innovative, communicative and collaborative, information and communication skills; skills of adaptability, flexibility, initiative, productive, trustworthy, and leadership attitude (Kesuma, 2017: 2).

In the context of primary and secondary education, STE(A)M education aims to develop students who are STE(A)M literate (Bybee, 2013), have knowledge, attitudes, and skills to identify questions and problems in their life, explain natural phenomena, design, and draw conclusions based on evidence regarding STE(A)M related issues; understand the specific characteristics of the STE(A)M discipline as forms of knowledge, inquiry, and design initiated by humans; have an awareness of how disciplined STE(A)M discipline forms a material, intellectual, and cultural environment, has the desire to be involved in the study of STE(A)M-related issues (e.g. energy efficiency, environmental quality,
limited natural resources) as constructive, caring, and reflective citizens using ideas of science, technology, engineering, and mathematics.

According to data reported by the National Science Foundation, the next 10 years as much as 80 percent of jobs will require reliable STEM competency capabilities. In fact, the United States Bureau of Labor Statistics released, that in the next 4 years nearly 30 rapidly developing jobs will require workers with satisfactory knowledge and skills in the STEM field (news.oke.zone.com November 2014). Data on this global situation is the basic reason to increase efforts so that people of Indonesia as part of the global community can compete and possess 21st century skills in terms of quality and quantity.

Foreign language skills also have an important position in 21st century skills that Indonesian children must possess to be able to compete in the global community. The Samarinda City Government stipulates that the recommended local content taught at the primary school level is English language, considering the importance of the role of foreign language skills in future community competition. In general, the position of English language in Indonesia is a foreign language, not a mother tongue nor a second language. Attention and interest in English language learning today is influenced by the idea of the importance of mastering foreign languages to become part of the global community. Various researches on the benefits of foreign language learning have been conducted, one of the results is that the ability to speak foreign languages increases the potential of work in increasingly open competition (Sukainah, 2014: 3).

The integration of STE(A)M in learning English at the primary school level is an important effort to do in order to upgrade Indonesian generation’s quality with 21st century skills. Integration of STE(A)M in English classroom as a local content prepares Indonesian children to possess 21st century skills, meet future worker needs, as well as increases engagement and integration in STE(A)M lesson.

STE(A)M-based education demands a shift in conventional learning where the processes are teacher-centered. In this learning, teachers as educators rely on knowledge transfer. In STE(A)M based education, the learning shifted to
learner-centered. In the learner-centered, learning relies on the activeness and collaboration of students. According to Schottler & Danielle (2015:2) learning design, teacher support, and adjustments to the learning environment are the three main factors to support integrating STE(A)M in foreign language learning at any levels of education.

Based on this background, the author makes a report on Best Practices "Integrating STE(A)M Education in English Classroom of Primary School: A Mission Possible".

**B. PROBLEM**
The problem reviewed in this best practice is formulated as follows:
How to integrate STE(A)M in English Classroom of the primary school level that has been performed at Bunga Bangsa Islamic Primary School?

**C. PURPOSE**
The purposes of writing this best practice are:
1. Disseminating learning approaches that can be used to integrate STE(A)M in learning English at the primary school level.
2. Providing alternatives to STE(A)M integration models into foreign language learning at the primary school level.

**D. BENEFITS**
The benefits of writing this best practice are as follows:

**For Teachers and School Supervisors:**
1. Increasing STE(A)M literacy for language teachers.
2. Promoting changes in teaching practice.
3. Increasing STE(A)M and pedagogical content knowledge.
4. Increasing the ability of teachers to make connections between STE(A)M disciplines.

**For Students:**
1. Increasing the interest in STE(A)M.
2. Supporting STE(A)M identity development.
LITERATURE REVIEW

A. STE(A)M

The term STEM was first coined in 2001 by Judith Ramaley, Assistant Director of the Department of Education and Human Resources at the National Science Foundation, STEM refers to the terms science, technology, engineering and mathematics. Daugherty (2013:10). Initially the term STEM was never used as an educational term. By the time, STEM ideas and terms are used in the world of education and can be adapted to educational needs.

STE(A)M is STEM which with “art” content integrated into it. The author considers it important to include "art" into STEM to balance the learning process. The inclusion of "art" as one of the elements in STE(A)M combines what scientists and artists think. This will deepen the concept of understanding and meaning in STEM itself. (Wynn & Harris, 2012 43; Daugherty 2013: 11)

STEM is an approach to teach two or more fields in STEM by emphasizing the relationship between each fields to improve student learning. In STEM, subject areas are taught by giving more time for learners on finding solutions to problems and abandoning conventional learning structures that are teacher-centered. Learning models in integrating STEM emphasize student-centered activities and erode the concept of memorizing learning.

STE(A)M, which is an acronym for Science, Technology, Engineering, Arts and Mathematics, is an integration of various connected and supportive learning content. The following is an explanation of each component in STE(A)M as described by Assefa & Rorissa (2013: 2520-2523).

Table 1. The Components in STE(A)M

<table>
<thead>
<tr>
<th>S</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A study of natural phenomena which involves observation and measurement as a device to objectively explain the ever-changing nature. Science learning that starts from and includes basic levels in primary school to higher education and tertiary levels, including faculty of teaching, research activities, and special units such as biology, chemistry, physics, educational technology, environmental education life and mathematics education.</td>
</tr>
</tbody>
</table>
Technology refers to human innovation used to modify nature to meet human needs and desires, thus making life more comfortable and safer. Technology makes humans able to travel quickly, communicate directly with people in distant places, get healthy food, and safety tools. Technology education encapsulates the arts of industry, design, electronics, internet, information technology, vocational education, energy, factories, transportation and all the results of human organization and devices intended to produce objects.

The knowledge and skills to acquire and apply scientific, economic, social, and practical knowledge to design and construct machinery, equipment, systems, materials and processes those are beneficial to humans economically and environmentally. Engineering education includes civil engineering, chemical engineering, electrical engineering, software, electronic devices, engineering education.

Educational elements of "art" or "art" that are included in STE(A)M contain pure arts, language, literature, philosophy, politics, psychology and theology.

Mathematical education elements contain several keywords that involve pure mathematics and applied mathematics, such as algebra, geometry, calculus, the concept of numbers, numeracy, computerization, problem solving, mathematical concepts and mathematical skills.

### B. APPROACH IN STE(A)M

Integrating STE(A)M in learning is linking interdisciplinary lessons that use contextual terms to connect with the student environment in the classroom, school environment, and community. Some approach models that can be applied in teaching STE(A)M are explained by Schoettler & Danielle (2015: 56-59). In their research they emphasized the STEM approach in German language learning in the United States.

#### Table 2. Models of Integration

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILO</td>
<td>Learning with the silo approach separates learning into each part. This approach is characterized by solid learning in each element. Teaching with this silo approach will reduce STE's (A) M learning effectiveness as a whole.</td>
</tr>
<tr>
<td>EMBEDDED</td>
<td>Learning by using STE (A) M with embedded or embedded approach focuses on one material in STE (A) M and ignores the other. The focus of learning activities is on one field of STE (A) M and making the others complementary. Fields that are used as complementary are not emphasized to be evaluated and evaluated.</td>
</tr>
<tr>
<td>INTEGRATED</td>
<td>In an integrated or integrated approach, STE charges (A) M are taught in an integrated and not separate manner. This integrated or integrated approach is best taught to students at the basic level.</td>
</tr>
</tbody>
</table>
The integration of STEAM in learning English at the primary school level is conducted using an integrated approach. This is done to maximize STEAM-based learning given the integrated approach allows students to learn thoroughly to get a complete and complete view of the things they learn.

Some approaches in this integrated integration model include: Content-Based Instruction (CBI), Task-based Instruction (TBI), Problem-based Learning (PBL) and Inquiry-based Instruction (IBI).

**Table 3. Approaches of Integration**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content-Based Instruction (CBI)</td>
<td>In the content-based instruction approach, students learn language from the content or content of the lesson. The syllabus or curriculum adapted to the CBI approach will focus on the content of the lesson rather than on the language. The choice of text or reading can be linked to one of the lessons in STE(A M) or actual literary work, derived from a children's book that relates to the theme of STE (A) M's lesson and articles related to the desired lesson. Hoffman, et al (2016: 91) states that students' understanding of the content of reading texts can be helped by helping students find scientific concepts in mother tongue. The variation in the use of the Content-based Instruction approach is to bring the mother tongue into the class to explain the concepts and keywords in the subject matter to be studied and then slowly taught again in English. Another variation in the use of Content-based Instruction is to adjust learning objectives and level of understanding in accordance with the conditions in the classroom. Lems, et al (2015: 3-4) mention several ways to understand new vocabulary which is the scientific language through understanding morphemes. Through syllable pieces, students can determine the meaning of the new vocabulary (English, Latin) and be able to use it in the STE(A)M concept.</td>
</tr>
<tr>
<td>Task-based Instruction (TBI)</td>
<td>Task-based Instruction is a method used in the Content-Based Instruction approach. In Task-based Instruction organize syllabus, the lesson in STE(A)M is the same as in the Content-based Instruction approach, but in the form of assignments (Schoettler &amp; Danielle, 2015: 66). Assignments are selected focusing on language applications in real terms and using authentic material.</td>
</tr>
<tr>
<td>Problem-based Learning (PBL)</td>
<td>Problem assignments given to students focus on how the student's process finds answers to the problems given by the teacher. In Problem-based Learning individually or in groups, students are given problems to explore with the knowledge they have.</td>
</tr>
<tr>
<td>Inquiry-based Instruction (IBI)</td>
<td>Like the scientific method, Inquiry-based Instruction starts with questions and ends by communicating the things that have been obtained in the presentation. (Schoettler &amp; Danielle, 2015: 69).</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

A. METHODS

This research is a best practice. The idea in this best practice is integrating STE(A)M into English learning at the primary school level. Best practices are used to describe the best experience of a person or group in conducting out tasks, including in overcoming various problems in conducting out their duties. In the field of education, best practice is conducted by teachers, principals and supervisors in conducting out their duties and roles. Arandale (2018) defines best practice as a note that describes a series of educational practitioner activities about activities, policies, programs, or approaches that aim to produce positive changes in student attitudes and students’ academic performance.

Data collection was conducted with a study document in the form of lesson plans and STE(A)M analysis mapping. The data was collected from the deep study of lesson plans analysis and STE(A)M analysis mapping of the English Language curriculum in grade 2. The author took 3 samples of lesson plans made by each teachers to see how they link the STE(A)M lessons into their English teaching.

A simple survey was also conducted on English teachers at the Islamic Bunga Bangsa Samarinda primary school. There were 13 teachers were given survey on their knowledge on STE(A)M, whether they had implemented it in their classroom, and what factors supported or did not support them in implementing integration of STEAM into English learning. However, for the purpose of analyzing lesson plans as documents to study, authors only carried lesson plans of 4 English teachers in grade 2.

B. DISCUSSION

In Bunga Bangsa Islamic Primary School, the synergy of integrating STE(A)M in English learning is structured and planned from the top of management to ensure the implementation and integration process of STE(A)M, 2013 Curriculum, Islamic curriculum, and local contents learning goes well. The
The school has a teacher as a coordinator of English teachings. She made plans and manages the role of curriculum used in the school. She is also in charge to check all of the lesson plans and give feedbacks to the results of English teaching supervisions. The school employs both local and international of English curriculum.

Integrating STE(A)M in learning English must be made well organized in the curriculum, it is must be clearly stated in lesson plans where KI (core competency), KD (basic competency), goals, methods, approaches, materials, and resources used by the teacher in the learning process.

After a deep investigation of lesson plans, author figures out that most of the teachers used texts and tasks to teach the STE(AM) lessons in their English classroom. Most of the teacher used content-based and task-based daily and project-based monthly. They chose the texts or passages that are related to the STE(A)M lesson, taken from children’s book, simplified news, browsing the internet, or written by themselves. Teachers also consider some resources like textbook from various publishers. The teachers prepared the task in the same way of preparing the reading texts. After each units ends, the teacher gave the students a project to choose and to complete. Teachers stated in their lesson plans that they made the task available both personal and team tasks. This was made in order to enable collaborative work and discussions on making decisions.

STEAM analysis showed that the distribution of material on STE(A)M subjects were not always available in each unit. For example in unit 3 with the theme The Desert, only science, art, and mathematics available, while in unit 2 under the theme Family and Memory, the subjects mapped were only technology, engineering, and art. However, the completeness of each subject in STE(A)M was fulfilled in the one semester planning.

Table 4 The Analysis of STE(A)M

<table>
<thead>
<tr>
<th>Unit 2 FAMILY AND MEMORY</th>
<th>Content</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Science</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Technology</td>
<td>Using Camera</td>
</tr>
<tr>
<td>3</td>
<td>Engineering</td>
<td>Making a simple fan</td>
</tr>
<tr>
<td>4</td>
<td>Art</td>
<td>Hand Painting</td>
</tr>
<tr>
<td>5</td>
<td>Math</td>
<td>-</td>
</tr>
</tbody>
</table>
Integration of STE(A)M into English learning in primary schools faces several obstacles. The biggest obstacles are the human resources and learning resources. Since English is used as a local content and optional content, English teachers at the primary school level mostly are classroom teachers with backgrounds not from English education or English literature. Although pedagogically good, but to integrate STE(A)M in learning, teachers need more supports in the form of training, workshops, and books on STE(A)M integration. The teachers stated that they were still hesitate on the idea of STE(A)M integration. However, the coordinator of English language teaching assisted the teacher to set and prepared the lessons.

Teachers’ responses showed that they need to be facilitated with workshops or training that supports them to be able to conduct out the integration of STE(A)M in their classes. Although workshops and or training are not the only way to learn, but teacher involvement and interaction in learning communities will increase teachers' self-confidence to teach STE(A)M in their classrooms. They emphasized on the evaluation processes where it is more complex including individual assessments, group assessments, portfolios, assessment by classmates, self-assessment, and projects.

Teachers mentioned the supports they have in integrating STEAM in their English classroom, which are the experts like coordinator of English language, books, widely open source in the library and the routine small
discussions among English teacher. Regarding the books, the careful selection of textbooks must be made since the books work as guide for students and teachers. Not too many domestically-published English books that support the integration process of STE(A)M. Teachers were required to search a lot of literature, reading books and other authentic sources around.

C. SUMMARY

The idea of integrating STE(A)M is not just to meet the future workforce of skillful person in the area of STE(A)M, but beyond that, the integration of STE(A)M in education is aimed at producing generations who have 21th century skills.

Integration of STE(A)M in learning English is one way to improve meaningful learning, practical and applicable skills in all subjects. English is a proper device for the development of STE(A)M-based learning.

There are 4 major approaches that can be counted to integrate STE(A)M in learning English, local languages and other foreign languages. Content-Based Instruction (CBI), Task-based Instruction (TBI), Problem-based Learning (PBL) and Inquiry-based Instruction (IBI) which all have a focus on making English a communication tool in understanding other lessons in STE(A)M.

The results of this best practice can be used as an applicable model that can be applied to other foreign language learning including local language learning. The similarity of principles and skills that must be mastered by a language teacher, allows these approaches to be conducted in general language learning.
REFERENCES


A Case of How Senior Mathematics Teachers in Bantul Regency Implemented CPD Programs Into Actions

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Abstract
This study aimed to describe the Continuing Professional Development (CPD) implementation of senior high school mathematics teachers in Bantul Regency. This type of study was a descriptive research using mixed method. The design of this study is sequential explanatory design. Subjects in this study were 73 civil servant senior high school mathematics teachers in Bantul Regency. The teachers were divided into employment groups III/c, III/d, IV/a, and IV/b. Data were collected through questionnaires, document observations, and interviews. Technical analysis of data was descriptive data analysis. The continuing professional development consists of three aspects, namely self-development, scientific publications, and innovative work. The results showed that the implementation of CPD of high school mathematics teacher in Bantul Regency was very poor (30%) with details of self-development aspect was poor (41%), scientific publication aspect was very poor (9%), and aspect of innovative works was very poor (39%). The results of the study identified that the implementation of mathematics teacher professional development still needed to be improved.

Keywords: mathematics, teacher, professional, development

Introduction
Teacher preparation is an important element in achieving quality teaching (Hollins, 2011). Quality teaching, in return demand quality teachers. Teacher quality involves two things, namely bright and knowledgeable teachers (Kunter et al., 2013). The way that is done so that the teacher can be bright and knowledgeable must of course go through various things. The teacher's cognitive abilities must be prepared before entering the teaching environment. It is very difficult for teachers to gain practical knowledge only through instructions and material without practice and reflecting on their knowledge (Singh, 2016). Through teaching practice, the teacher can learn from two perspectives, namely teacher and student (Hollins, 2011). Special skills of the teaching profession need
to be established and expanded to achieve teaching success (Kunter et al., 2013). Teaching success can be seen from student achievement. Therefore to improve students’ academic achievement, it is necessary to improve the quality of teaching on an ongoing basis (Jenkins, 2018).

The government of Indonesia must improve teacher professional competence because students’ learning outcomes in Indonesia are still relatively low (OECD, 2015). The report from the United Nations Development Program (2016) shows that of the four categories of Human Development Index (HDI), namely very high, high, medium, and low, Indonesia is in the medium category. One indicator used in HDI is the quality of education in a country. Thus it can be indicated that there are still educational problems that must be improved in Indonesia. With such educational conditions, the government of Indonesia held a Continuing Professional Development (CPD) activity to improve teachers' professional abilities. In Indonesia, there are three components of CPD implementation, namely self-development, scientific publications, and innovative works (Ministry of Education and Culture, 2016).

CPD is formal or non-formal learning which leads to an increase in the knowledge, skills and personality needed to carry out professional tasks (Doherty, 2011). Professional development can also be defined as a long career process for teachers to meet their students' needs in learning (Diaz-Maggioli, 2004). There are many any types of CPD implementation, including: conferences, networking, magazines, materials, membership, mentoring, observation, reflection, research, specialization, training, and workshops (Davidson, Kaplan, Soriano, Kennedy, & Phillips, 2012). The conference can be used by teachers as a place to study with experts and fellow teachers in the world of education. Through networking, teachers can form communication networks with other teachers to share information and also find solutions to problem-solving. The teacher can also streamline the development of the teacher's knowledge of educational issues through magazine activities by collecting papers into journals. This professional development can also facilitate teachers in searching for new material that is
relevant to the subject of learning. Training activities can improve teacher competencies and abilities. While workshops for teachers can stimulate responsiveness to new issues and ideas in learning.

Mathematical teacher professional development is an ongoing and lifelong process (Roesken, 2011). Professional development is very important to improve and maintain teacher quality because it will have an impact on students (Phillips, 2008). In professional development teachers do not only learn about the material but also their skills in teaching. Likewise with math teachers, teacher professional development is designed to increase mathematics teacher's knowledge of mathematics and mathematics teacher's skills to teach mathematics effectively to students (Stevens, Harris, Aguirre-Munoz, & Cobbs, 2009). Teacher professional development can influence teacher teaching practices so that it will have an impact on changes in student learning outcomes (Guskey, 2002). This is because the teacher's ability to support students is strongly related to the teacher's professional knowledge (Hoth et al., 2017). Professional development that focuses on the academic subject matter (content), provides opportunities for teachers to practice directly (active learning), and is integrated into school day-to-day life (coherence), tends to produce more knowledge and skills for teachers (Garet, Porter, Desimone, & Birman, 2001).

**Methods**

This research is a descriptive study with quantitative and qualitative approaches. The subjects of this study were 73 civil servant mathematics teachers. The mathematics teacher is spread across 24 high schools in Bantul district, Yogyakarta, Indonesia. The age of 73 teachers varies with the age range of 33 to 59 years. The instruments used in this study were questionnaires for implementing CPD, document observation sheets, and interview guides. The implementation of CPD which was examined in this study was the implementation of CPD conducted by the teacher for the last 5 years. The CPD implementation questionnaire used a modified Likert scale to become a multiple choice form. There are 5 answer choices, with a specific score in each answer option. After the teacher filled out the
CPD implementation questionnaire, the researcher conducted document observation. Document observation sheets are filled by researchers. The sheet is used to view documents owned by the teacher as proof of CPD implementation. The result data of the research questionnaire in quantitative research is followed up qualitatively through an interview.

Instrument validity is proven using content validity and constructs validity. Content validity uses expert judgment. Next, look for construct validity through factor analysis. The reliability of the research questionnaire on CPD implementation was 0.884. The data analysis technique of this study uses quantitative descriptive. CPD implementation scores of high school math teachers who have been obtained are then classified into 5 categories shown in Table 1 below.

Table 1. Categorizing CPD Teacher Mathematics Implementation

<table>
<thead>
<tr>
<th>Questionnaire Score</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 &lt; X ≤ 100</td>
<td>Very Good</td>
</tr>
<tr>
<td>70 &lt; X ≤ 85</td>
<td>Good</td>
</tr>
<tr>
<td>55 &lt; X ≤ 70</td>
<td>Enough</td>
</tr>
<tr>
<td>40 &lt; X ≤ 55</td>
<td>Poor</td>
</tr>
<tr>
<td>X ≤ 40</td>
<td>Very Poor</td>
</tr>
</tbody>
</table>

Findings

Based on the results of CPD implementation research, the average score of high school mathematics teacher questionnaires in Bantul Regency was 35.60 (Very Poor category). The average ideal score is 50, the ideal standard deviation is 16.67, the ideal minimum score is 0, and the ideal maximum score is 100. The percentage of the results of the CPD implementation of the mathematics teacher is presented in Table 2.
Many teachers are in the very poor category. This is an indication that the activeness of mathematics teachers in implementing CPD is still very poor. The CPD implementation of mathematics teachers includes three aspects, namely self-development, scientific publications, and innovative work. The results of the CPD implementation in each aspect vary. These results are presented in Figure 1 below.

**Figure 1. Aspects of Implementing CPD**

The implementation of CPD is in the poor category for aspects of self-development, very poor category for aspects of scientific publications, and poor categories for aspects of innovative work. The results of the study are presented in more detail in Table 3 to see the implementation of CPD mathematics teachers in Bantul Regency in each aspect and sub-aspects.
Table 3. Percentage of CPD Implementation in Various Aspects

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Indicator</th>
<th>Percentage</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Development</td>
<td>Continuing education level</td>
<td>13%</td>
<td>Very Poor</td>
</tr>
<tr>
<td></td>
<td>Follow functional education and training</td>
<td>49%</td>
<td>Enough</td>
</tr>
<tr>
<td></td>
<td>Follow the teacher's collective activities</td>
<td>61%</td>
<td>Good</td>
</tr>
<tr>
<td>Scientific Publication</td>
<td>Presentation at scientific forums</td>
<td>11%</td>
<td>Very Poor</td>
</tr>
<tr>
<td></td>
<td>Publish the results of scientific research</td>
<td>5%</td>
<td>Very Poor</td>
</tr>
<tr>
<td></td>
<td>Publish learning books</td>
<td>11%</td>
<td>Very Poor</td>
</tr>
<tr>
<td>Innovative Work</td>
<td>Develop mathematics learning tools</td>
<td>61%</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Develop mathematics learning media.</td>
<td>33%</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>Implement innovative learning</td>
<td>24%</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Based on the data in Table 3, there are many sub-aspects whose implementation is in the very poor category. There are no sub-aspects in the category of good or very good. These results indicate that the teacher has not been able to implement optimally in almost all sub aspects of CPD. In Table 4 presented data on the implementation of CPD based on employment groups. From the table, we can see in detail the implementation of CPD mathematics teachers in group of employment.

Tabel 1. Percentage of Achievement of CPD Implementation Based on Employment Groups

<table>
<thead>
<tr>
<th>Employment Group</th>
<th>Aspect</th>
<th>Self-Development</th>
<th>Scientific Publication</th>
<th>Innovative Work</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>III/c</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category</td>
<td></td>
<td>57%</td>
<td>9%</td>
<td>39%</td>
<td>35%</td>
</tr>
<tr>
<td>Category</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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Based on the data in Table 4, information was obtained that the overall implementation of CPD mathematics teachers based on the level of staffing was included in the very poor category. CPD consists of three aspects, namely: self-development, scientific publications, and innovative work. The following is data on the implementation of CPD high school math teachers in Bantul Regency in each aspect.
Discussions

Self-Development

Indicators of teachers who carry out self-development are continuing education levels, attending functional education and training, and following functional activities. As many as 13% of teachers continue their education. Actually, the school allows and supports its teachers to continue their education. However, there are still many teachers who are reluctant to continue their education due to several obstacles they face. Many schools have only a few math teachers so that every math teacher has a lot of teaching hours. This is the teacher's consideration to continue education. Even though the teacher is permitted by the principal to go to college, they still have the burden of teaching in school. Therefore, teachers must look for universities that open day or afternoon lecture classes which are usually held by private universities. Teachers who continue to study must be smart to divide their time to teach in the morning and then continue to study in the afternoon.

In addition to time problems, teachers are also constrained by cost problems. Support from the family is also influential. Some teachers prefer to pay for their children's tuition rather than pay for their own college. Moreover, teachers whose age is approaching retirement are not motivated to continue their education. However, teachers who have not approached retirement but do not yet have the motivation to continue their studies are not few either. This is because basically the willingness of teachers to continue their education is greatly influenced by the teacher's motivation. Teacher motivation, school culture, and working conditions affect the effects of professional development (Whitworth & Chiu, 2015).

Functional education and training is very beneficial for teachers. Through these activities, teachers can get a lot of knowledge about learning. Through education and training teachers can improve the ability to work with colleagues, obtain new information and follow through on previous learning (Opfer & Pedder, 2010). Functional training activities will also improve teacher competencies and abilities (Davidson et al., 2012). Many benefits are obtained by teachers through these educational activities and functional training. But the implementation has not
been maximized. Many teachers have experienced several obstacles to carrying out this activity. This education and training is usually carried out by an educational training institution. This activity is carried out in a certain place within the time specified by the institution. Usually the functional training and training is not only completed in one day. This kind of training allows the teacher to gain knowledge and experience that is numerous and profound. However, teachers who take part in such training usually have to leave their teaching assignments at school. Not all teachers can attend functional education and training. Teachers who participate in training are usually teachers who are active in the teacher's collective activities. So that at one time of the training, only a few teachers had the opportunity to participate. In addition to face-to-face training, educational institutions also conduct online training for teachers. The teacher has tasks that must be sent online with a certain time limit. But this online training is still not much in demand by teachers because many teachers are not yet proficient in using the system.

The teacher's collective activity is the most popular CPD activity for teachers. Teacher participation in collective activities can support increased teacher knowledge and skills and teacher changes in teaching practice in the classroom (Garet et al., 2001). This collective activity consists of high school math teachers called the Subject Teacher Council (MGMP). This activity is carried out regularly every month. The material for collective activities varies, such as learning method training or learning device studies. MGMP administrators usually invite speakers who are experts in mathematics education to provide various trainings. Not infrequently, lecturers are also invited to fill in material at the MGMP meeting. The implementation of the teacher's collective activities reaches 61%. There are a number of things that become obstacles so that these activities cannot be implemented optimally. MGMP activities are carried out in each district. The implementation of these activities moves from one school to another. By using the system, some teachers did not attend MGMP due to remote activities. But at each MGMP meeting representatives from each school were present even though not all teachers were present.
Scientific Publication

The participation of mathematics teachers for presentations in scientific forums is still very low. The scientific forum in question is like a mathematics education seminar. These seminars are usually held by universities or educational institutions. Some schools complained about the lack of information on conducting seminars from several universities. The time for conducting the seminar is usually not as comfortable as the teacher's free time so the teacher must leave teaching hours in class. Many teachers object if they have to leave class, so they choose not to attend seminars which are not appropriate. In addition, the teacher must also issue his own costs so that he can participate in the activity. These costs are one of the constraints for teachers to present in scientific forums or mathematics education seminars.

There are still very few mathematics teachers in Bantul district who publish scientific research. Many of them have not carried out action research. Though the implementation of classroom action research will help the teacher in observing the learning process which will have an impact on improving their abilities and skills (Davidson et al., 2012). In addition to scientific research, teachers are also not interested in compiling learning books. Many teachers are still limited to compiling dictates or mathematics learning modules. Usually the module or dictate is used by the school itself, not to be published to the publisher. There are many obstacles experienced by teachers so that they have not maximally published their work. Most teachers do not have strong motivation to write scientific papers. They do not understand the importance of writing and publishing scientific work. Due to lack of motivation from within, many teachers claim that it is difficult to take the time to write scientific papers. Many teachers have solid teaching hours. This certainly makes it difficult for them to write scientific papers. But with low motivation, they choose not to make it. In addition, the cost of publication is also the reason for some teachers in publishing their work.
Innovative Work

The task of the teacher is not only teaching in class. The teacher has the responsibility to develop learning tools. The learning framework includes lesson plans and worksheets. Many mathematics teachers in Bantul Regency have developed mathematics learning tools well. They have often received training so they don't experience many obstacles. However, there are some teachers who are not yet proficient in using computers so they cannot develop themselves maximally. There are also teachers who work together with several other teachers to develop lesson plans and worksheets on mathematics learning. They use MGMP activities to work together.

In delivering mathematics material, the teacher certainly needs learning media. Many mathematics teachers said that they were still used to teaching mathematics using material books and blackboards only. Moreover, high school mathematics material is already abstract, so not every material requires teaching aids to teach it. Some teachers present mathematics material in the form of PowerPoints to attract students' attention and also facilitate the delivery of material. There are also teachers who develop teaching aids in the form of various spaces and there are also those who develop teaching aids for opportunity material. Actually, there is software that can support mathematics learning, for example, GeoGebra. The use of learning that uses software can improve their creativity in teaching and learning activities in the classroom (Ahmad & Awang, 2018). However, to use dynamic geometry software such as GeoGebra, teachers must be given professional education about active use in the learning process (Yildiz & Baltaci, 2016). From the results of the study, many teachers have heard the name of the application. Some teachers have also participated in training using GeoGebra. But few teachers have ever used the application. They claimed they could not use the application properly. Therefore they choose not to use it rather than learning to not run smoothly.
Innovative learning can increase student learning motivation. Many learning methods and approaches have been developed. The teacher only chooses which learning approach is appropriate to convey various mathematical materials. In fact, from the results of the study, many teachers have not learned many learning methods/approaches. They are comfortable with the learning they usually use, explain the material using the blackboard and give practice questions. Many teachers say that a small amount of time and material allocation is an obstacle for them to apply various kinds of learning methods. But there are also teachers who are not interested in learning and applying other learning approaches.

**Conclusion**

Continuing professional development is important for improving the quality of mathematics teachers in teaching. Professional development requires a long and continuous time. There are several aspects that must be met in carrying out professional development. From the results of the research, there is a high level of professional development development, there is a low level of professional implementation in the category of lacking. This is influenced by various constraints experienced by teachers such as teacher motivation and teacher's teaching hours. In some aspects, teachers also lack training such as the use of mathematical software and publication of textbooks. Researchers can further deepen the various obstacles experienced by teachers in implementing CPD.

**References**


Taxonomy of Spatial Reasoning to Measure Spatial Reasoning Level’s

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Abstract
Spatial thinking is an important component in our daily activities. The application of spatial thinking enables us to exercise it in order to assist in the completion of our daily chores such as locations finding, book arrangement on shelf, drawing a picture, making patterns, etc. Graphs, sketches, images, auditory, kinesthetic forms are tools of representation to describe, explain, and communicate information about objects. Spatial Reasoning is one part of spatial thinking because spatial thinking needs complex reasoning, and in this paper, we name spatial reasoning. Spatial reasoning is an individual capacity to think spatially, make sense of the world, and understand their world. Spatial reasoning processes are included recognizing, defining, listing, combining, evaluating, synthesizing, and generalizing. Taxonomy of spatial reasoning is input, processing, and output. The components of input, processing, and output will be described below. This paper explores the taxonomy of spatial reasoning, the processes of spatial reasoning component used to evaluate subjects through problem solving. The problem was resolved by the subject and analyzed by the taxonomy of spatial reasoning to get the subject's level’s. Explorative description through qualitative approach was used in this study. This study showed that a boy is in the highest level of the 3rd taxonomy of spatial reasoning, and a girl is in a higher level of the 2nd taxonomy of spatial reasoning.

Keywords: Spatial thinking, spatial reasoning, taxonomy of spatial reasoning, geometry

Introduction
Indonesia has progressed rapidly at developing and applying the rules of mathematical especially in education and various aspects of life well. Indonesian classic problems can be found in teaching and learning process of mathematics especially geometry. Students have difficulties in geometry problem solving, although the geometry object is very close to our daily activities. Students 5th grade at Elementary School have difficulties to take differences characteristics between parallelogram and square. They also have the opinion that for building a cube, they need parallelogram and square. This is a big problem in geometry
Spatial thinking can be defined as constructive combination of cognitive skills comprised of knowing concepts of space, using tools of representation, and applying processes of reasoning (NRC, 2006: 12). People have used spatial thinking to solve problems, find answers, express and communicate solutions. Spatial thinking has always been a fundamental cognitive skill and space is a key for organizing the concept. There are three components of spatial thinking, i.e. representation, transformation and reasoning. A map is form of representation and who have reached the place needs process to move, it is form of transformation. Collecting, organizing and analyzing information to solve problem need reasoning. This research explores the current position of spatial reasoning in education as a component of spatial thinking. First we briefly review definitions of spatial reasoning and how spatial reasoning develops in individuals.

Spatial Reasoning

Ball and Bass (2003: 28) reasoning is a “basic skill” of mathematics and is necessary for a number of purposes – to understand mathematical concepts, to use mathematical ideas and procedures flexibly, and to reconstruct once understood, but forgotten mathematical knowledge. Although all threads are important and interdependently influential, reasoning becomes gluten to connect concepts and procedures in sensible manners. Reasoning suggests consideration as central to teaching learning because the students have been confused to transform 3 dimension objects to 2 dimension objects and vice versa.

Spatial is a part of geometry, which is a rule control in concept development. It is an important element that needs attention. In the 5th grade, student case is a big problem that need to explore, what is the student spatial thinking, especially in reasoning. Reasoning includes what students do, involves and communicates a path between idea or concept by visual, auditory or kinesthetic approaches. Through this research, the researchers found out about how student reasoning level’s in spatial reasoning is.
opinion adaptive allows the justification and developments of arguments. The key of reasoning are justifying and generalizing, in which they need representing, and transforming. Reasoning needs representing practices supporting for communicating idea become visual, auditory and kinesthetic information. We need to be able to justify and explain ideas in order to make their reasoning clearly. Justifying is a key of element of adaptive reasoning to provide sufficient reason for. Russell (1999: 1) said that mathematical reasoning is “essentially about the development, justification and use of mathematical generalizations”. These generalizations create an interconnected web of mathematical knowledge – conceptual understanding in Kilpatrick et al.’s terms (2001: 4). For Russell (1999: 5), “seeing mathematics as a web of interrelated ideas is both a result of an emphasis on mathematical reasoning and a foundation for reasoning further”. Creating generalizations also enables the problem solving, as generalizations support learners to see the underlying structures of the problem and the biggest class of problems or ideas that it instantiates (Brousseau and Gibel 2005; Kilpatrick et al. 2001; Russell 1999).

Role of Spatial Reasoning

Kilpatrick et al. (2001: 129) argue that “such reasoning is correct and valid, stems from careful consideration of alternatives, and includes knowledge of how to justify the conclusions”. It means that to get the correct reasoning, it needs consideration of alternatives opinion, evaluation to justify the conclusion. Reasoning includes formal and informal explanations, sometimes the intuitive is needed to build the reasoning and based on pattern, analogy and metaphor so the reasoning is tool to think with.

Taxonomy of Reasoning

Taxonomy of reasoning is the classification of reasoning based on reasoning process of the questions. Jo and Bednarz (2009: 35) use this system below to identify the level and type of spatial thinking.
Taxonomy reasoning in this paper is based on Jo and Bednarz (2009: 35). The reasoning component processes evaluates the cognitive level of the question. Taxonomy of reasoning is divided to input, processing and output. Input is the reasoning lowest level. Students are able to define, name, list, identify, recognize, recite, recall, observe, describe, select, complete, count, and match which are classified as the lowest reasoning level. Processing is the higher level reasoning. Students are able to analyze information, including: explaining, analyzing, stating causality, comparing, contrasting, distinguishing, classifying, categorizing, organizing, summarizing, synthesizing, inferring, analogies, exemplifying, experimenting, and sequence which are classified as the higher reasoning level. Output is the highest level reasoning. Students who able to uses the analysis of information received to evaluate, judge, predict, forecast, hypothesize, speculate, plan, create, design, invent, imagine, generalize, build a model, or apply a principle. They are classified as the highest reasoning level.
Methods

Explorative descriptive through qualitative approach was used in this study.

Subject
The subjects of this study were the 5th grade of visual learning style of both boy and girl students. The 5th-grade students were chosen because they have learned space matter in school and still in concrete operation phase, also it is important to study this subject in the earliest of cognitive development. By choosing a visual subject, students are expected to optimize spatial thinking that is closely related to visualization. The pilot studies of this research showed that the gender influences students’ performance and concept in mathematics and that boys do better in in space [11-13] than the girls. Thus, beside exploring the spatial thinking of students, the author also distinguished between boys’ and girls’ works to provide comprehensive information.

Technique
Subjects did geometry test for three days with one problem in each day. The subjects’ work in solving geometry test were explored and analyzed through an unstructured interview where the interviewer follows the interviewee's narration and generates questions spontaneously based on his or her reflections on that narration. A deep interview conducted to the subject regarding what they thought, done, written and spoken while doing the test. The audio and video format were used to record subjects along the research process from solving geometry test until interview section.

Instrument
Two types of instruments were used in this study: main instrument and tracer instrument. The main instrument contained statements about the spatial concepts with which the students could explore the cube nets from the given cube objects The tracer instrument was used to classify student learning style. Four validity test data were used in this study: 1) credibility test (internal validity), 2) test of dependency (reliability), 3) confirmation test (objectivity) and 4) transferability test.
Result and Discussion

Manipulation processes that occurred in the subject both boys and girls included several things: 1) trying to make a model of cube nets by imagining familiar objects and can be made into cube nets, 2) plotting location side, 3) placing the dots on the three-dimensional object to the corresponding side of the cube net. In constructing a cube net, both boys and girls are alike. This manipulation is done by observing the cube form elements and imagining familiar objects to be made into cube nets. After manipulation of the 3-dimensional object into 2-dimensional object, the subjects started to determine the side pair i.e. determining which side is in front, back, left or right side.

Girl: ... then I defined the pair of sides which match with the cube net I made. Then, I marked it with a dot in the left-right side, up-down side, and front-back side by looking at the cube object. The pair sides I marked on the square must be a pair of opposing side if the net is converted into a cube.

Boy: I mark all the squares on the cube nets as the same number as the cube object. First I mark an arbitrary square on the cube nets. I made it as a standard, then marked its opponent. The process was going on until all the squares on the cube nets all marked. I set the first benchmark 1 dot on the bottom side, then 6 dots on the top side, 5 dots on the front side, 2 dots on the back side, 3 dots on the right side and 4 nodes on the left side.

This process requires consideration and leads to the decision that is obtained by the side pair. This indicates the subject was doing the reasoning process. When marking the cube nets corresponding to the number of nodes on the side of the cube in which position corresponds to each square in the cube net. There was a different way between boys and girls about how they placed the dots to the cube net. In this activity, the subject used a scanning technique to check the square in the cube nets whose position corresponds to the sides of the dotted cube. The process of sketching the cube nets requires manipulation of matching such that each square in the cube net is marked with dots as many as dots on the cube object. This process requires consideration of some information i.e. using side pairs and placing dots. This shows that there is a reasoning process in this activity. When they asked to make different cub net, subject solved a similar problem by
splitting the cube, predicting the direction of movement, cutting the cube and arranging parts. This creates a consistent attitude in using the sketching steps of the cube webs.

The subject explained the reason for choosing the method they used. The process of choosing involves grouping things according to the criteria, taking into consideration some of the ways it knows, comparing, interpreting and deciding which way to choose and deciding in a conclusion. This indicates that the subjects have made the process of reasoning while expressed the reasons why choose it. Drawing different net is a manifestation of reasoning process because there is a processing information, comparing manipulations, considering making decisions before draw cube net until understanding the way. Revealing a different way to obtain different cube net is one of the reasoning processes. This indicates the subject has done the reasoning process. The subjects are able to make a conclusion of what they have done. The subjects revealed what need to be done in solving the problem and in making a conclusion. This shows that the subjects have done the reasoning process.

Figure of a cube net a boy and a girl shown below.

Figure 2 Boy’s [left] and girl’s [right] cube net drawing

**Conclusion**

This study shown that a boy is in the highest level’s, the 3rd taxonomy of spatial reasoning. He is able to uses the analysis of information received to evaluate, judge, predict, forecast, hypothesize, speculate, plan, create, design, invent, imagine, generalize, build a model, or apply a principle through this imagination. He imagines transform car became robot transformer look like a cube become a cube net.
A girl is in a higher level’s, the 2nd taxonomy of spatial reasoning. She is able to analyzing information, includes: explaining, analyzing, stating causality, comparing, contrasting, distinguishing, classifying, categorizing, organizing, summarizing, synthesizing, inferring, analogies, exemplifying, experimenting, and sequence. She was analyzing a cube become a cube nets by sketch and comparing the object with another object. She has used analogy in her mind, through imagine the railway as tool for build the new cub net.

References


The study aims to determine: (1) which one have a better mathematics achievement, students who taught by cooperative learning model STAD by STEM approach or STAD (2) which one can increase the student interest to learn about the coordinate of 8th grade of Junior High School 1 Magetan. This study was experimental research design. The population of this study was all students of junior high school 1 in Magetan Regency in Academic Year 2018/2019. Sampling was done by stratified cluster random technique. The total of sample was 172 students, with details of 86 students for experiment class one and 86 students for experiment class two. The requirements test for data included the population normality test using Lilliefors method and the population homogenity variance test using Bartlett method. It can be concluded that sample come from the population with normal distribution and have homogeny variance. The balance test of students prior knowledge in mathematics data used t-test and concluded that two of experimental classes have balance prior knowledge in mathematics. The testing of hypothesis uses 1-way analysis of variance with unbalance cell. The testing of hypothesis concludes that: (1) students who taught by cooperative learning model of STAD by STEM approach type have better mathematics achievement than students who taught by cooperative learning model of STAD (2) students who taught by cooperative learning model of STAD by STEM type can increase the student interest to learn about the coordinate of 8th grade of Junior High School 1 Magetan.

Keywords: stem, innovation, googlemap, mathematics, research

Introduction

The development of science and technology is very rapid lately. Digital libraries can almost be taken anywhere. Google with its search engine can search for files that are unlimited in number, can be selected in a seconds. Android can be an interface for many applications, so various needs can be supported by it. Searching for the position of a city or an address can be done very simply and super fast by using Google Map. Someone who wants to find a taxi / car is fulfilled quickly and simply by using the Grab application. Deleting files on someone's handphone can be done remotely, just by using the internet. Sophistication can be felt in everyday life today. Almost all parts of this life develop rapidly following the development of other fields.
The sophistication of this era must be followed by the speed of the development of high education at all levels. Laziness to follow the developments that occur can cause someone or a nation to be colonized economically. One role that can be done at junior high school is to make students happy and comfortable to learn all the useful knowledge. All teachers must try to find ways so that all students can manage the knowledge in these subjects and try to develop it.

Mathematics is a scary and boring lesson for most students. The king of all science is mathematics. Someone who cannot manage mathematics well, Events in schools show that students tend to dislike mathematics.

One chapter in the mathematics lesson of class 8 junior high school (SMP) is coordinates. The coordinates are seen as simple material but the presentation on Indonesia Goverment Mathematics books and in monotonous teaching and learning activities can cause students not to manage perfectly. From that view someone feels bored and lazy to learn. The material does not attract the attention of class 8 students. Coordinates as if there is no use in everyday life.

Students who do not manage coordinate material can not learn other subjects related to natural science and technology and cause the test scores to be low. Low test scores indicate that students do not understand the material being studied. Other chapters that require coordinate prerequisite material, such as linear equations and quadratic equations. Thus the importance of coordinate material for mastering other material. In real life application, one needs to locate and position himself to reach a destination. It is very important in the field of aviation and marine.

Believing in its importance, so it must be studied and managed well. The right way in teaching and learning must be sought, so that students are interested and willing to deepen the material. Various learning methods must be investigated, which is possible to support its.

One of the most suitable alternatives for the above is the STAD learning method with the STEM approach. The STAD method allows students to group and share knowledge with their members, while using the STEM approach allows students to be more interested and able to improve their performance. STEM is
more interesting because STEM combines science, technology, engineering and mathematics.

**STAD type cooperative learning model**

According to Trianto (2009: 68) explains that cooperative learning type Student Teams Achievement Division (STAD) is one of the cooperative learning models using small groups with the number of members of each group of 4-5 people heterogeneously. Beginning with explaining learning objectives, delivering material, group activities, quizzes and group awards. According to Tran (2013: 4-15) explains that:

*The frequent reciprocal interaction among participants in the treatment group stimulated cognitive, promoted higher levels of achievement and enhanced positive attitudes toward learning. This study supported the findings of previous studies from different cultures, and claims that cooperative learning is an effective teaching approach. In this study, the effective teaching cooperative learning on students is compatible with the requirements of teaching innovation in Vietnamese higher education.*

This study explains that reciprocal interactions that occur between group participants have stimulated cognitive activities, increased achievement and positive attitudes towards learning. This research supports previous research from different cultures, and explain that cooperative learning is an effective teaching approach. In this study, the effectiveness of teaching with cooperative learning to students in accordance with the requirements in Vietnamese higher education.

The steps of the STAD type cooperative learning model are based on cooperative steps consisting of six steps or phases which was explained by Trianto, (2011: 70-71). The steps or phases in STAD type cooperative learning are as follows.

1. Phase 1: Delivering goals and motivating students
   - The teacher's activities in phase 1 are conveying all the learning objectives to be achieved in the lesson and motivating students to learn.

2. Phase 2: Presenting or conveying information
   - Teacher activities in phase 2 are presenting information to students that can be done through direct demonstrations or reading material.
3. Phase 3: Organizing students in study groups
   The teacher's activities in phase 3 are explaining to students how to form study groups and helping each group to make the transition efficiently.

4. Phase 4: Guiding groups to work and study
   The teacher's activities in phase 4 are guiding the learning groups when they do their work.

5. Phase 5: Evaluation
   The teacher activity in phase 5 is evaluating learning outcomes about the material that has been taught or each group presents their work.

6. Phase 6: Giving appreciation
   Teacher activities in phase 6 are looking for ways to appreciate both individual and group effort and learning outcomes.

According to Slavin (2011: 14) explains that STAD is one of the simplest cooperative learning models, and it is the best model for beginners for new teachers using a cooperative approach. Based on the above opinion, it can be explained that learning using STAD is right for teachers who are accustomed to using conventional learning. According to Zakaria and Chung (2010: 272-27) explains that:

…cooperative learning methods improve students’s achievement in mathematics and attitude toward mathematics.

Their study indicate that cooperative learning methods improve student’s achievement in mathematics and attitudes toward mathematics.

Furthermore, Slavin (2011: 143) explain that STAD consists of five main components, namely class presentation, team, quiz, individual progress score, team recognition.

**STEM Learning Approach**

STEM stands for an interdisciplinary learning approach between Science, Technology, Engineering and Mathematics. Torlakson (2014) explains that the approach of these four aspects is a harmonious pair between problems that occur
in the real world and problem-based learning. Pfeiffer, Ignatov, & Poelmans (2013) explain that in STEM learning skills and knowledge are used simultaneously by students. The four characteristics are based on the definition described by Torlakson (2014), namely: (1) science that represents knowledge about laws and concepts that apply in nature; (2) technology is a skill or a system used in regulating society, organization, knowledge or designing and using an artificial device that can facilitate work; (3) engineering or Engineering is the knowledge to operate or design a procedure to solve a problem; and (4) mathematics is the science that connects quantity, numbers and space which only requires logical arguments without or accompanied by empirical evidence. All of these aspects can make knowledge more meaningful if it is integrated in the learning process.

Gonzalez & Kuenzi (2010) found that STEM means teaching and learning related to the fields of Science, Technology, Engineering and Mathematics. The application of the STEM approach in learning is certainly integrated throughout the learning process. The four aspects of STEM take part in every implementation of the learning steps. The steps of each implementation of these aspects are as follows; (1) Aspects of Science in the STEM approach defined by Hannover (2011) are the skills to use knowledge and scientific processes in understanding natural phenomena and manipulating these symptoms so that they can be implemented; (2) Technology Aspects are the skills of students in knowing how new technologies can be developed, skills in using technology and how technology can be used in facilitating human work; (3) Engineering aspects have five phases in the learning process; and (4) Aspects of Mathematics are skills that are used to analyze, reason, communicate ideas effectively, solve problems and interpret solutions based on calculations and data mathematically. Bligh, (2015) classifies aspects of engineering referring to the application of scientific knowledge and skills in using technology in creating a method that has benefits.
Research Methods

This research is a quasi-experimental study. Data analysis was performed with Anava 1 cell path together. The study population was the eighth grade students of SMP 1 Magetan in the 2018/2019 academic year. The study was conducted at Magetan with a sample of 172 students. From all students two classes were taken randomly as experimental class one and experimental class two. Homogeneity test using Bartlett test, normality test using Liliefors test and balance test using t-test. The results obtained, both groups came from a homogeneous population, had normal distribution and had the same initial ability. Data collection techniques are: (1) test method; (2) documentation method. The research instrument consisted of: (1) initial ability assessment test; (2) assessment test of mathematics learning achievement.

The dependent variable is mathematics learning achievement on the subject of coordinates, while the independent variable type STAD cooperative learning model in experimental class one and STAD with STEM approach in experimental class two.

Research and Discussion Result

In accordance with the research implementation, the following results are described in the following sequence.

The material which will be indicated is coordinate, coordinate connected to Google Map. If someone discovers coordinate, maybe something will be known by them. There is a connection between its. Google map can show the distance and the time which will be used to trip from a place to another place on the world. A question may be asked, how to look for the distance and the time.

STAD cooperative learning model with STEM approach try to look for coordinate of two places on Google Map.
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 1. Space looked by satelit
Figure 2. Space on the coordinate

<table>
<thead>
<tr>
<th>No.</th>
<th>ORIGIN</th>
<th>DIRECTION</th>
<th>t</th>
<th>n</th>
<th>t²</th>
<th>n²</th>
<th>d²</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>8</td>
<td>14</td>
<td>3</td>
<td>12</td>
<td>-5</td>
<td>144</td>
<td>2.50E+01, 1.69E+02, 13.00</td>
</tr>
<tr>
<td>2</td>
<td>-3</td>
<td>9</td>
<td>5</td>
<td>-7</td>
<td>8</td>
<td>-16</td>
<td>64</td>
<td>2.56E+02, 3.20E+02, 17.89</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
The 5th International Symposium on Mathematics Education Innovation
SEAMEO Regional Centre for QITEP in Mathematics
Prerequisite test for testing hypotheses using one-way variance analysis with the same cell includes population normality test and population variance homogeneity test. Therefore, for each group of data, the normality test was conducted in this study using the Lilliefors method and the homogeneity test in this study used the Bartlet method.

Population normality test is conducted to find out whether the sample comes from a population that is normally distributed or not. With a significance level is 0.05, a summary of the results of the population normality test using the Lilliefors method on students' mathematics learning achievement data is presented in the following table.

Table 4.10 Summary of Population Normality Test Results on Student Mathematics Learning Achievement Data

<table>
<thead>
<tr>
<th>Source</th>
<th>n</th>
<th>$L_{max}$</th>
<th>$L_{0.05;n}$</th>
<th>Test Decision</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_1$</td>
<td>86</td>
<td>0.0853</td>
<td>0.0955</td>
<td>Hois not rejected</td>
<td>Normal</td>
</tr>
<tr>
<td>$a_2$</td>
<td>86</td>
<td>0.0686</td>
<td>0.0955</td>
<td>Hois not rejected</td>
<td>Normal</td>
</tr>
</tbody>
</table>

Based on the results of the population normality test, each sample has a Lhit value less than the value of $L_{0.05;n}$. This means that at a significant level is 0.05, the decision to test population normality for each sample is Ho is not rejected. Thus, it can be concluded that all samples in this study came from populations that were normally distributed.

The population variance homogeneity test is done to determine whether the populations are compared to have the same variance (homogeneous) or not. The homogeneity test of population variance was carried out on the sample with a significance level is 0.05, the summary of the results of the population variance homogeneity test using the Bartlett test on students' mathematics learning achievement data is presented in the following table.

Table 4.11 Summary of Homogeneity Test Results of Population Variants Against Student Mathematics Learning Achievement Data.

<table>
<thead>
<tr>
<th>Source</th>
<th>$k$</th>
<th>$\chi^2_{hit}$</th>
<th>$\chi^2_{0.05;k-1}$</th>
<th>Test Decision</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_1$ vs $a_2$</td>
<td>2</td>
<td>0.1753</td>
<td>3.8415</td>
<td>H_o is not rejected</td>
<td>Homogeneous</td>
</tr>
</tbody>
</table>
Based on the results of the population variance homogeneity test, each pair of samples has a value of $\chi_{hit}^2$ less than the value of $\chi_\text{hit}^2$ (0.05; k-1.) $^2$ This means that at the significance level of 0.05, the decision to test population variance homogeneity is not rejected. Thus, it is concluded that the populations compared have the same variance (homogeneous).

**Hypothesis Testing Results**

Hypothesis testing was done to find out whether there are differences in the influence between each category of learning models, on learning achievement in mathematics. Because of the prerequisite test results conclude that all samples came from populations that were normally distributed and populations compared had the same (homogeneous) variance, then testing this hypothesis can be done by analyzing 1 way with the same cell.

Summary of the results of the calculation of variance analysis of 1 way with the same cell and the significance level of 0.01 can be presented as follows:

Table 4.12 Description of Student Mathematics Learning Achievement Data in Each Learning Model Category

<table>
<thead>
<tr>
<th>Learning Model</th>
<th>$n$</th>
<th>Min Value</th>
<th>Max Value</th>
<th>$\bar{x}_{marginal}$</th>
<th>$s$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STAD</strong></td>
<td>86</td>
<td>40</td>
<td>96</td>
<td>67.5349</td>
<td>14,0107</td>
</tr>
<tr>
<td><strong>STAD with STEM approach</strong></td>
<td>86</td>
<td>48</td>
<td>100</td>
<td>74.8837</td>
<td>14.6636</td>
</tr>
</tbody>
</table>

1) $H_0 : \mu_1 \leq \mu_2$ (STAD method with STEM approach is no better than STAD method)
2) $H_1 : \mu_1 > \mu_2$ (STAD method with STEM approach is better than STAD method)
3) Test statistics used:

$$Z = \frac{(\chi_1 - \chi_2) - d_o}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \sim N(0,1)$$
4) Computing :
\[ d_0 = 0 \]
\[ Z = \frac{(67,5349 - 74,8837)}{\sqrt{\frac{14,0107}{86} + \frac{14,6636}{86}}} \]
\[ Z = 3,360 \]
5) Critical Area :
\[ Z_{0.01} = 2,327 \]
\[ D_K = \{ z \mid z > 2,327 \} \]
dan \[ Z_{obs} = 3,360 \]
6) Test Decision : \( H_0 \) rejected
7) Conclusion: STAD method with STEM approach is better than STAD method.

Thus, it can be concluded that students' mathematics learning achievement in STAD cooperative learning model with STEM approach was better than students' mathematics learning achievement who were taught in STAD cooperative learning model. So it can be concluded that students who taught by cooperative learning model of STAD by STEM approach can increase the student interest to learn about the coordinate of 8th grade of Junior High School

References


Why I Am Confused To Apply Mathematical Literacy: Student Perspective of Mathematics Role in Daily Life

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Abstract

Mathematics is a subject that has many benefits to solve problems in daily life, but many students still confused using mathematical literacy in daily life. This study aims to identify student perspective of mathematics role in daily life, the cause of the student's perspective, and the strategy to overcome the perspective. The study is phenomenological research. The data were collected using interview and questionnaire. The data analysis was done using Bogdan & Biklen approach. The results of the study show that students argue only basic mathematics is used in daily life. The cause of these students' perspective is that students do not feel the mathematical concepts learned at school can be used to solve the problems in daily life and the students are too focused to solve the problem without integrating mathematics in daily life. The strategy used to improve students' perspective are giving students more examples of the use of mathematics in STEM, using contextual based learning models, and providing projects assignment to students related to mathematical applications.

Introduction

Mathematics is a subject that has many benefits to solve problems in daily life. Cognitive research has shown that the most effective learning when students active, good group participation, interaction and feedback, and applying material to the real world context [1]. The learning really happens if there is a relationship between students' cognition and the world context [2]. Mathematics learning also basically has two effective goals, namely as an exploration of solving mathematical problems in the context of textbooks and the experience of using mathematics in real life [3]. The experience of using mathematics in the real world can develop knowledge, understanding, and skills, and reflect the characteristics of mathematics. When students involve mathematics learned in schools with mathematics that is used outside of school, students tend to have
positive curiosity and motivation to learn mathematics [4]. This is because students are faced with problems related to personal, social, work, and scientific issues in daily life related to the application of mathematics. If students master mathematics well, it can help in solving the problem.

Learning mathematics in schools is useful for translating mathematical knowledge, making students' behavior more positive, and involving students in learning. Mathematics learning curriculum in several schools aims to model real situations mathematically, solve problems, and interpret whether the solutions obtained are realistic that will be useful for connecting knowledge with the application of mathematics in the real world [5]. Some of the mathematical characteristics in the learning process that take place in secondary schools are objects that are studied abstractly, the truth is based on logic, learning is multilevel and continuous, there is a link between the material, using symbolic language, and can be applied in other fields of science. Secondary school students are expected to be able to make decisions, determine strategies, find their own concepts, associate between concepts, use symbols in thinking, and communicate the concepts they get when learning takes place. Learning cognitive abilities influences the mathematical reasoning in arithmetic, algebra, and geometry [6]. Improving mathematics learning can be done by developing and analyzing curriculum with teaching materials that are in accordance with the cultural activities of their students [7] because mathematics in schools is influenced by formal practices while in the world it is influenced by culture [8]. Learning is expected to be able to develop reasoning due to the involvement of students in learning, encourage creativity and creative production capacity in students, and overcome complex problems that have broad social significance and intersect with the lives of students can develop active citizenship capacity in students [10].

The role of a mathematics teacher is as a connector between students and mathematics, building knowledge, learning experiences and understanding the diversity of students [11]. Teachers must be able to organize all class discussions, ask deep questions, and pose tasks that help students to reflect and build their thinking at this time must prepare students to apply mathematics in all kinds of
work situations and daily life in mathematics learning [8]. Although mathematics is increasingly influencing everyday life, mathematics remains the most unpopular subject in school to make scientific topics easier to understand, interesting and relevant for students because there are still many mathematics displayed in abstract, decontextual terms. Students have difficulty answering National Examination questions because of lack of understanding of concepts, difficulty in calculating and choosing information, stuck with obstacles, and not accustomed to working on complex questions, contextual presented in numerical form or narrative text and inaccurate student calculations [9]. In overcoming these problems there have been many learning models that enable students to solve problems in various situations and actual real-world contexts such as contextual learning, realistic mathematics education, and problem based learning. Learning that helps students in connecting learning material with the context of the lives of students so that they can find deep meaning in what is being learned.

**Method**

The research is a qualitative research using phenomenological approach [12]. The research was conducted in August 2018. The data were obtained through an open questionnaire to 29 students of senior high school with high mathematical abilities. The data were collected through questionnaires and interview. The questionnaires consisted of the student's perspective on mathematics at school, student's perspective of role mathematics in daily life, the mathematics material that relates to students' lives, the relationship of mathematics to technology, and activities that the teacher teaches mathematics. The interview was conducted in a semistructured manner to teacher. The materials for the interview include the teacher challenges in implementing the mathematics learning and efforts of students to feel the role of mathematics in everyday life. Data were analyzed using Bogdan & Biklen [13] approach, through reducting data, categorizing the data into themes and sub-themes, and then making conclusions as results.
Result and Discussion

The information about student perspectives on mathematics at school through questionnaires on student perspective on mathematics at school. The information about student perspectives on mathematics role in daily life was obtained by student on mathematics role in daily life perspectives, the mathematics material that relates to students' lives, mathematical relationships with technology. The information about teacher strategies about the challenge was obtained through the activities carried out by the teacher in teaching mathematics.

Student perspective of mathematics at school

According to the students, the perspective of mathematics at school would be presented in Table 1.

Table 1. The perspective student about mathematics

<table>
<thead>
<tr>
<th>Result Data Reduction and Data Display</th>
<th>Theme</th>
<th>Inter-Theme Appropriateness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical lessons in schools is difficult</td>
<td>Students have not felt comfortable in learning mathematics</td>
<td>Students are confused in using mathematical concepts. This shows that students do not understand the concept of mathematics and do not know when to use the concept because students only memorize the formula.</td>
</tr>
<tr>
<td>Mathematics is confusing lessons</td>
<td>Students are not interested in learning mathematics</td>
<td></td>
</tr>
<tr>
<td>Students are not interested in learning mathematics</td>
<td>Mathematics is not related to the future</td>
<td></td>
</tr>
<tr>
<td>Mathematics is not related to the future</td>
<td>Mathematics makes hard thinking</td>
<td></td>
</tr>
<tr>
<td>Mathematics makes hard thinking</td>
<td>Mathematics is to use formulas</td>
<td></td>
</tr>
<tr>
<td>Mathematics is to use formulas</td>
<td>Mathematics is science with count as the basis</td>
<td></td>
</tr>
<tr>
<td>Mathematics is science with count as the basis</td>
<td>Mathematics is only used in schools</td>
<td></td>
</tr>
<tr>
<td>Mathematics is only used in schools</td>
<td>Mathematics is learning counting</td>
<td></td>
</tr>
<tr>
<td>Mathematics is learning counting</td>
<td>Mathematics is for university entrance tests</td>
<td></td>
</tr>
</tbody>
</table>

Based on the data presented in Table 1, students still consider mathematics as learning that uses formulas only and feels confused when working on math problems. Researchers asked more deeply the teachers who taught, it was found that students were still experiencing difficulties and confusion to use the concepts learned. The teacher chooses to use modules that contain material, examples of solutions and practice questions. Whereas for word problems it is very rarely found, especially the application and role of mathematical material in daily life. So it is not wrong if there are still many students who experience confusion to
apply the mathematical concept to the application problem in the previous test, students are more quickly working on the questions commonly used for examples [14]. Mathematics in secondary schools teaches knowledge more than understanding, different tasks between mathematics in school and the role of mathematics in real life. Though mathematics is not just a subject that applies formula, but for high school students can recognize and use connections to mathematical ideas, understand connectedness between various mathematical ideas, and applying mathematics to the outside context of mathematics [15]. Research has also shown that students who succeed in school mathematics do not necessarily solve problems in their lives [16]. If students can understand the relationship between mathematics and life and are more interested in learning mathematics.

**Student perspective of mathematics role in daily life**

The connection of a material learned in school to the real world context can increase students' motivation and interest in these subjects. Learning that prioritizes context can be an opportunity for students to learn mathematics, develop insight into the usefulness of mathematics, and strategies in problem solving [17]. Students will be able to develop reasoning skills, improve problem solving skills, and their analytical thinking skills when prioritizing the context in learning. This is because students will more easily develop mathematical concepts for problems, students conclude and interpret mathematical concepts and can relate to each other [17]. When students know the role of mathematics in everyday life, it will make the material more meaningful and in accordance with the real objectives of mathematics learning.
Table 2. Student prespective of mathematics role in daily life

<table>
<thead>
<tr>
<th>Result Data Reduction and Data Display</th>
<th>Theme</th>
<th>Inter-Theme Appropriateness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not all mathematical material is used in everyday life, for example trigonometry</td>
<td>Solving problems in daily life does not use complicated mathematics</td>
<td>Students think mathematics does not play a significant role in their lives.</td>
</tr>
<tr>
<td>In life only need basic mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning in school is too difficult and not worth the application in life.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do not use mathematical formulas to solve everyday problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problems are not solved by mathematics but in their own way</td>
<td>Students are not aware of the use of mathematics in daily life</td>
<td></td>
</tr>
<tr>
<td>Mathematics is more for reasoning and logic while formulas are only in school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not find life problems related to mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technological progress makes math useless</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn mathematics to get good grades and not remedial</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After reducing students' opinions on the role of mathematics in daily life, researchers conclude that students think mathematics does not play a significant role in their lives. Researchers want to know more about the answers given by students to find out how much students understand about the role of mathematics in everyday life, such as mathematical material that is often used in everyday life. The result is that students can only mention basic math materials such as profits, buying and selling, multiplication, addition, subtraction, division, discount, savings, statistics, guessing age and building area. These results are in accordance with the results of the study that three types of material used in life are related to time, finances and counting calculations [5]. Whereas the participants of this study were high school level two who had known a lot of other complex mathematics materials while the material mentioned by them was elementary and junior high school material. Participants are also students in schools that have high quality. This shows that students still have not found high school mathematics material that plays a direct role in their lives. So that it corresponds to the previous question which states students are still confused in using mathematical concepts in the role of mathematics in everyday life.

Furthermore, the researchers also asks students' opinions about word problems that are usually related to the role of mathematics in daily life. But
students argue that the word problem used by the teacher are unreasonable, unrealistic, absurd, impressed, and the numbers used are chosen so that they are easy to calculate. Students also put forward the opinion that technology has developed so that the basic mathematics taught in schools is no longer useful. Students also argue that mathematics material does not play a significant role in solving the problem but logic and other factors that are more instrumental in solving the problem. Students' opinions illustrate that students have not felt the role of mathematics in everyday life, the reason for using logic as a solver of their life problems is not realized by students that this is part of the application of mathematical material, especially mathematical logic. Students have not been able to represent the mathematical concepts that have been learned to solve problems in everyday life. Even if students have been able to apply mathematical concepts in their daily lives the problems faced in real life tend to have many solutions and many influencing factors.

**Teacher strategies about the challenge**

The teacher has an important role in the learning process. Researcher conducts interviews with the teacher to confirm students' answers to the teaching facts carried out by the teacher in the class. According to the teacher the cause of students' confusion in using mathematical concepts is because teachers still have difficulty using learning models that can help students recognize the role of mathematics in daily life. Examples are Contextual learning, Problem Based Learning or Realistic Mathematics Education. This is because the teacher feels that the learning models waste a lot of time and in the end students will also ask the teacher to explain in front of the class even though learning is oriented towards the student center. In addition, teachers also have difficulty in finding examples of the application of mathematics in everyday life because the mathematics material in secondary schools is more abstract and not all materials in secondary schools are suitable for using real-world contexts such as the composition of functions and inverse, squared inequality, limits, integral, polynomial, etc.
Furthermore, the teacher agrees to the students' opinion that the story questions made by the teacher are actually absurd because the function used is not based on real context and prioritizes numbers that are used round so it is easy to calculate and work on. Then the researcher continued with the question of integrating mathematics with other subjects or commonly referred to as Science, Technology, Engineering, and Mathematics (STEM). The teacher argues that the teacher still lacks understanding of other subjects, according to the teacher if he wants to associate with STEM then he should at least learn other subjects such as physics, biology, chemistry, engineering and other subjects which of course will take the teacher's time while the teacher has other duties besides teaching. Students also do not like the context that involves other subjects in mathematics learning because students do not understand these subjects [18].

However, at the end of the interview the teacher gives advice so that students know more about the role of mathematics in their daily life and are able to apply the concepts that have been learned by giving projects at the end of the semester which is to make papers on the application of mathematics in daily life. According to the teacher, this assignment was quite effective because many students tried themselves to apply mathematics learning. For example, there are students who make the application of trigonometric material to measure tree height without having to measure using a meter but using elevation angles, trigonometric comparisons with clinometer media. The numbers used are also based on the results of observations so there is no procurement of numbers so that they are easy to calculate. The researcher then confirmed to the students about the assignment, according to them the refinement of the application of mathematical material in daily life indeed made students able to apply the mathematics that was learned in school which would lead to the meaning of learning. However, because the task is devoted to the final semester assignments and students may choose one of the material that has been studied for application so that not all material is known to play a role in daily life.

Learning mathematics will be abstract if learning continues to show the abstractness of mathematics and will affect the use of students' mathematical
concepts. Mathematics learned in school is different from real life students and only relies on algorithms and formulas will cause students not to realize that in this life they have used mathematics [19]. So that learning needs to show the role of mathematics in the lives of students so that students have a sense of the mathematical concepts that have been learned. If students only rely on real life with mathematics from math books, this is not enough [20]. This is because there are other relationships such as social and cultural between mathematics and real life that the solution is not only one. Learning can begin with the theme of the role of mathematics that is used is the use of mathematics related to the work to be taken by students. Besides that, contextual problems represent problems in realistic contexts such as biology, physics, engineering [8]. If this is done, there is a possibility that the learning time will be delayed because students will need time to remember other learning materials. This can be overcome by starting pre-learning prerequisite material contained in the module, allocating special time, assigning tasks, and integrating prerequisite material into the teaching and learning process [21]

Mathematics is effective when students can transfer mathematical knowledge between fields of application so that students can solve problems in a variety of situations and contexts that are real-world real [20]. The role of mathematics in real life will be more felt by students when they can apply mathematics by themselves. Integrating mathematics with other learning materials is very important for the future success of students in a global era that is increasingly high-tech and competitive [22]. The way that is done is by connecting with other material between science and other disciplines every day. Learning that brings together mathematics and other subjects in school has also been a concern by the organizations of the School of Science and Mathematics Association (SSMA), the National Council of Teachers of Mathematics (NCTM), the American Association for the Advancement of Science (AAAS), and National Research Council (NRC) [23]. Teachers should teach application of mathematics that is learned for everyday life based on the topic, relevant, meaningful and
authentic [24]. The teacher can also use contexts that reflect real situations rather than artificial situations so that they are easy to calculate.

Table 3. The Strategies so that students feel the role of mathematics in everyday life

<table>
<thead>
<tr>
<th>Student Perspective</th>
<th>Teacher's Perspective</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students do not understand the concept of mathematics and do not know when to use the concept because students only memorize the formula.</td>
<td>Teachers are not used to using learning that links real context. The teacher considers the use of context-based learning models to be a waste of time</td>
<td>Students are more often given assignments to apply material mathematics in daily life that has been learned. The teacher motivates students that in developing knowledge mathematics is needed as a basic.</td>
</tr>
<tr>
<td>Students think mathematics does not play a significant role in their lives.</td>
<td>Teachers rarely provide examples of the application of mathematics in everyday life</td>
<td>More students are given examples of the application of mathematics in life</td>
</tr>
<tr>
<td>The role of mathematics in life has been replaced by technology</td>
<td>The teacher has not linked mathematics to technology and other subjects</td>
<td>The teacher associates mathematics with other subjects especially in the form of STEM Students use technology / software to solve mathematical problems</td>
</tr>
</tbody>
</table>

Technological progress will make it easier for humans to carry out activities, but that does not mean that they will forget the knowledge base that forms the technology. Students must remember that mathematics is not only able to solve problems using formulas that have been studied but mathematics can make students think critically in mathematical calculations so that there will be better technology development. The development of the role of mathematics with problems related to STEM and integrated science can be used as objectives in the education system [25]. Moreover, mathematics used in everyday life does not always reflect the formal calculation process taught in schools [26]. Mathematical education must prepare students to apply mathematics in all kinds of work situations and daily life. It does not make a gap in the thinking of society digitizing between schools and workplaces in the future. The role of mathematics in digital society which is taught in primary, secondary education may not be visible because almost all work can be done by computers but mathematics is still important to be studied as a change [8].
When working on math problems in real life students should involve steps to recognize mathematical positions, translate problems into mathematics, solve problems, and interpret and evaluate the results obtained [27]. Real mathematics is indeed used for certain jobs and technology is used to help workers [28] so that mathematics is not visible and is not felt to have a role in student life. The majority of teachers think that teaching mathematics in a real-world context will require more time than teaching abstractly and making real-world relationships difficult to cover all the national curriculum topics that are determined. This can be overcome by using and linking the role of mathematics with the real world at the beginning or at the end of the math lesson and adjusted to the nature of [5]. Change needs to be done if it will bring students better understanding of concepts. The development of learning by giving students a context to better feel the role of mathematics can motivate, improve the transfer of mathematical knowledge from context and real life. Students are able to generalize mathematics in the role of life from the results of discussions generated by the task, openness, negotiation and interpretation, and students are given a degree of autonomy [29].

Conclusion

Mathematics has a role in everyday life, but students feel that only basic mathematical material plays a role in everyday life, while more complex mathematical material does not play a role. Technological progress is also one of the reasons students perceive that the mathematics learned at school is no longer relevant. The cause of these students' perspective is that students do not feel the mathematical concepts learned at school can be used to solve problems in everyday life and the students are too focused to work on the problem without integrating mathematics in daily life. The strategy used to improve students' perspective shows that students are more examples of the use of mathematics in STEM, using contextual based learning models, and providing projects assignment to students related to mathematical applications.
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Kacerja S 2011 Albanian students' motives for preferring certain real-life situations for learning mathematics : original research Phytagoras 32 (2) 1-9
Using Songket Silungkang Patterns’ to Introduce the 2D Shapes: New Way to Fun Learning

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Abstract

Mathematics learning in class is often considered as abstract learning because mathematical concepts often do not start from simple things but directly on formulas. This of course makes students feel that mathematics is a difficult lesson. The use of local cultural contexts in learning is one of the best ways to get learning that is close to students and more real in nature because learning starts from the things students know in everyday life. This article was written based on the results of classroom action research of applying local culture context "Songket Silungang" on learning 2 D shapes for first grader at elementary school. This study aims to increase the fun of learning atmosphere by applying realistic mathematic education (RME) approach by using local context “Silungkang Waving Patterns” that can be used in elementary school in learning 2D shapes. The research method consists of planning, taking an action, observing, and reflecting in two cycle at grade 1 SDN 09 Manggis Ganting where 28 students were involves in this research. Data collection techniques used are test and non-test techniques. The results showed that students' feeling of learning pleasure increased each cycle from an average score of 25 (good category) to 35 (excellent category). Student enthusiasm increases every cycle, from an average score of 9 (good category) to 12 (very good category). Learning climate increases every cycle, from an average score of 12 (good category) to 17 (excellent category). Learning material increases each cycle, from an average score of 12 (good category) to 15 (excellent category). Learning media increases each cycle, from an average score of 11 (good category) to 14 (very good category). Student learning outcomes increase each cycle, namely from the acquisition of an average score of 62 with 71% classical completeness to 78 with 88% classical completeness. The conclusion of this research showed that the local culture context “Traditional Songket Silungkang Waving Pattern” can be used as a subject matter to introduce the 2D geometry shapes for first grader at elementary school in Bukittinggi.

Keywords: fun learning, geometry shapes, local context, RME.

Introduction

The quality of learning is quality or effectiveness as a level of success in achieving its goals or objectives. Learning is considered has a high quality if it feels fun for students. According to Smith and Ragan several indicators that can be used to determine the success of the learning process are factors that are effective, efficient, interesting and fun (Arsaythamby & Zubainur, 2014).
Quality learning can be interpreted as learning that achieves learning goals through an effective, efficient, interesting and fun learning process. Low quality learning is an unpleasant learning so that the learning objectives are not optimally achieved. Based on the results of preliminary observations, it is known that the quality of mathematics learning, especially geometry in class I SDN 09 Manggis Ganting is still low. This is indicated by the lack of the teacher's ability to integrate the learning environment with the subject matter to create a learning process that is fun, meaningful, effective, and efficient, the delivery of learning material that is still unidirectional and authoritarian, students who are passive and less eager to take lessons, lack of reinforcement and motivation for students, the learning climate is less conducive, geometry learning media is less attractive, student learning outcomes are low, 18 out of 28 students of grade 1 SDN 09 Manggis Ganting get an average daily score under the KKM (75), only 9 students complete. Based on these problems, the quality of learning in class I SDN 09 Manggis Ganting needs to be improved so that the learning objectives are optimally achieved.

One of the local cultural media that can be used by teachers in learning geometry in class I is the use of Songket Silungkang patterns’. The use of local culture in the form of Songket Silungkang patterns’ in this learning is in accordance with the life of the Realistic Matematic Education approach which emphasizes the use of local context as a basis for learning. The RME approach implies that learning must start from things that are real and close to students. In addition to learning geometry, by recognizing Songket Silungkang patterns’, students also participate in preserving and loving their own culture. This is in accordance with the opinion of Guler which states that the use of local culture is one of the best ways to instill subject matter in students so that learning becomes meaningful (Guler & Arslan, 2015).

That is why the author tries to conduct a classroom action research using Songket Silungkang patterns’ in geometry learning in class 1 to create an effective, efficient, interesting and fun learning. Based on this fact, it is necessary to improve learning through classroom action research.
This classroom action research is carried out by applying the characteristics of the RME approach. The advantage of the RME approach is that it is in line with the three levels of learning mathematics that the process of learning proceeds through three levels (Sitorus & Masrayati, 2016) (Heuvel-Panhuizen, 2000): (1) a pupil reaches the first level of thinking as soon as it can manipulate known characteristics of a pattern that is familiar to him/her; (2) as soon as he/she learns to manipulate the interrelatedness of the characteristics he/she will have reached the second level; (3) he/she will reach the third level of thinking when he/she starts manipulating the intrinsic characteristics of relations. With the RME approach and the use of Songket Silungkang patterns’, students are easier to understand learning material, get meaningful learning, and make students active with the use of media that contains beautiful local culture.

**Literature Review**

**Philosophy of RME**

RME is stands for Realistic Mathematics Education, mostly determined by Freudenthal's view on mathematics. Two of his important point of view are: mathematics must be connected to reality; and mathematics should be seen as human activity. First, mathematics must be close to children and be relevant to everyday life situations. However, the word ‘realistic’, refers not just to the connection with the real-world, but also to problem situations which are real in students' mind. Second, the idea of mathematics as a human activity is stressed. Mathematics education organized as a process of *guided reinvention*, where students can experience a similar process compared to the process by which mathematics was invented. In this case, the reinvention process uses concepts of mathematization as a guide. Later, it is categorized by Treffer into horizontal mathematization and vertical mathematization (Fauzan, Plomp, & Gravemeijer, 2013).
Principles and Characteristics of RME

The characteristics of RME are historically related to three Van Hiele’s levels for of learning mathematics (de Lange, 1996). Here it is assumed that the process of learning proceeds through three levels: (1) a pupil reaches the first level of thinking as soon as he can manipulate the known characteristics of a pattern that is familiar to him/her; (2) as soon as he/she learns to manipulate the interrelatedness of the characteristics he/she will have reached the second level; (3) he/she will reach the third level of thinking when he/she starts manipulating the intrinsic characteristics of relations.

Traditional instruction is inclined to start at the second or third level, while realistic approach starts from first level. Then, in order to start at the first level that deals with phenomena that are familiar to the students, Freudenthal’s didactical phenomenology that learning should start from a contextual problem, is used. Furthermore, by the guided reinvention principle and progressive mathematizations, students are guided didactically and efficiently from one level to another level of thinking through mathematization. These two principles and the concept of self developed models can be used as design principles in the domain- specific instruction theory of mathematics education (Sembiring, 2010).

Classroom Action Research

This research is a classroom action research. The research variables are teacher skills, student activities, and student learning outcomes. Classroom action research consists of two cycles. Because the problem were happened in teacher own class, so the classroom action research is the best research to be conducted. Teachers focus on their practices and handle their problems directly in Action Research. Teachers themselves are also influenced by the changes and improvements they make. It is seen that participants involved in an action research consider themselves as more effective teachers and have a more positive attitude towards their profession (Yigit & Bagecci, 2017) (Kunlasomboon, Wongwanich, & Suwanmonkha, 2015).
Action Research is a practical way of going over one’s work to check whether it is in the desired way. It is mostly considered as practitioner-based research as it includes thinking and reflecting about one’s work. Furthermore, it could be regarded as a kind of self-reflective practice. A number of action research cycles could be found in the literature. Two new ones were created by Yigit as a result of literature survey and then action research workshops and practices (as it is said to be flexible in the literature) and one of these action research cycles could be seen in Figure 1 below:

Figure 1  Action Research Cycle (Yigit, 2017)

Steps are briefly explained below:

Stage 1: Several tools are employed to specify the problem, set the goal and find necessary tools to active it. Stage 2: Literature is surveyed and data are collected with respect to the problem. Stage 3: Action is initiated after using several tools to solve the problem and drawing an action research proposal/plan. Stage 4: Action plan is revised after missing points are determined and observation is made again regarding the problem. Stage 5: Teachers reflect about the results of the action researches and inform their colleagues and/or shareholders.
Research Methodology

Participants

This research was conducted at SDN 09 Manggis Ganting Kota Bukittinggi West Sumatra. The participants of this research were the teacher and 28 students of grade 1 SDN 09 Manggis Ganting Kota Bukittinggi. The research was carried out in two research cycles. The subject matter taught was the introduction of 2D geometry using Songket Silungkang patterns’ patterns’.

Instruments

The instruments that were used in this research were a questionnaire, an end-of-unit test and an interview. Instruments were filled by observer together with teacher. The data obtained were analyzed using percentage techniques. The types of data in this study are quantitative and qualitative data. Quantitative data were analyzed using quantitative descriptive analysis techniques by determining the value based on the theoretical scores achieved by students and determining the minimum limit of individual completeness values that is ≥ 75 and the minimum limit of students classical completeness value is ≥ 80% of the number of students who complete individually. Qualitative data of this study were obtained from observations on teacher skills, student activities, climate, material, and learning media. Qualitative data were analyzed using qualitative descriptive analysis techniques by determining the lowest score, highest score, and dividing the range of values into 4 categories: very good, good, sufficient, and less.

Research Question

The results of the research result are discussed in the rest of discussion part of this paper. The formulation of the problem in this study can be formulated as “is using Songket Silungkang patterns’ on geometry learning can create fun mathematics learning in class I SD 09 Manggis Ganting?”
Findings and Discussion

Based on the results of the study can be seen an increase in student activity from cycle I to cycle II, namely by increasing the acquisition of the average score of student activity from a score of 9 (good category) in the first cycle to 12 (very good category) in the second cycle. The increase in student activity is marked by the willingness of students to be more active in learning, namely by the availability of students listening to stories read by the teacher about the elements of geometry in the Songket Silungkang patterns’, observing material explanations from the teacher, presenting the results of the discussion in front of the class, responding to presentations from other groups, conducting activities question and answer with the teacher, work on the worksheets seriously, conduct group discussions and assignments, record the conclusions of the material being studied, and record the homework or assignments of the teacher.

The results showed that students' feeling of learning pleasure increased each cycle from an average score of 25 (good category) to 35 (excellent category). Student enthusiasm increases every cycle, from an average score of 9 (good category) to 12 (very good category). Learning climate increases every cycle, from an average score of 12 (good category) to 17 (excellent category). Learning material increases each cycle, from an average score of 12 (good category) to 15 (excellent category). Learning media increases each cycle, from an average score of 11 (good category) to 14 (very good category). Student learning outcomes increase each cycle, namely from the acquisition of an average score of 62 with 71% classical completeness to 78 with 88% classical completeness.

The skills of teachers in the first cycle of meetings 1 and 2 and in the second cycle of meeting 1 and 2 teachers have grown students' interest in learning with interesting apperceptions, conveying learning objectives, general material coverage, and descriptions of learning activities, expressing questions clearly and briefly, giving thinking time to students before answering questions, giving students the opportunity to answer first. Teachers have been seen holding shifts to answer answers, linking theories with examples of their application, delivering material clearly, making changes in standing positions while teaching, making
variations of body movements, changing facial expressions, or head movements, making alternating use of media (songket silungkang, worksheets, geometry pattern). This is in accordance with the opinion of Shepard that states that by utilizing local culture in learning mathematics, in addition to establishing the concept of material in students also creates a sense of love for their own culture (Shepard, 2000).

The role of the teacher is also quite clear when formulating the objectives and topics of discussion, increasing student participation by providing opportunities and provoking students to argue, ask or comment on questions and opinions of their friends, provide reinforcement in the form of praise, applause, thumbs up, nods or smile variedly, provide reinforcement to students individually or in groups, provide instructions on the assignment given, refocus student attention with the words of invitation to students, provide evaluation questions, direct students who are confused in understanding the purpose of the problem, supervise students in doing evaluation questions, guide students conclude the material, celebrate students' shared learning by singing, pat, or cheering as feedback on the learning process and results, and conveying the learning plan in the future to students.

**Conclusion**

Based on the results of the study, it was concluded through the use of Songket Silungkang patterns’ in geometry learning that it was proven to create a fun and meaningful learning atmosphere. In addition, the use of Songket Silungkang patterns’ can also improve teacher skills, student activities, climate, material, media, and student learning outcomes. Besides learning about mathematics, students also learn their culture and hopefully they will continue to preserve their culture.
References


Application of Cooperative Learning Two Stay Two Stray Techniques to Improve Student Mathematics Learning Outcomes

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Abstract
This study is Classroom Action Research consisting of two cycles that aims to improve the learning process in terms of the activities of teachers and students so as to improve students’ mathematics learning outcomes through the application of cooperative learning two stay two stray techniques. The research subjects were 28 eighth grade students from one of the junior high schools in Indragiri Hilir consisting of 7 male students and 21 students women with heterogeneous abilities. Data collection techniques in this study were conducted with observation and test. The observation technique was carried out with observation sheets of teacher and student activities which were analyzed descriptively qualitative. While the test technique was carried out through tests on each cycle which were analyzed quantitatively by learning completeness analysis and average analysis with comparing scores before and after action. The results of research showed that there was an increase in students' mathematics learning outcomes. This can be seen from the number of students who reached the value of minimum completeness criteria increased from 15 students (53.57%) on the base score to 18 students (64.29%) in the first daily test then increased to 20 students (71.43%) in the second daily test. In addition, the average score of students in the base score of 68.21 increased in the first daily test to 70.96 then increased in the second daily test to 76.36.

Keywords: Cooperative Learning, TSTS, Mathematics Learning Outcomes

Introduction
Mathematics is a very important component to be mastered by students. So the mathematics lesson should have received serious attention so that the quality of mathematics learning in schools can be improved. However, in reality the process of learning mathematics in schools still uses a mechanistic approach, namely teachers actively teach mathematics and transfer their knowledge without considering aspects of knowledge and aspects of student readiness, as a result
students experience mental depression such as boredom and sleepiness (Inda, 2017). In addition, in the process of learning mathematics there are still many teachers who have not been able to create conditions and situations that allow students to perform critical thinking processes. This can be seen from the activities of teachers and students when the learning process takes place (Abdurahim, 2016).

Based on the observations of researchers at one of the junior high schools in Indragiri Hilir, it appears that the learning process in the classroom is still centered on the teacher. From the beginning to the end of the meeting the teacher explained the subject matter to students, then the teacher asked the students about the material he had explained. Student activities only follow the learning flow carried out by the teacher, so that students become inactive in following the learning process and students pay less attention to the explanations given by the teacher and only some students do the tasks given by the teacher. Whereas the other students are just waiting for answers from their friends. This will hamper students' creativity in thinking because students only accept by listening to the lessons given by the teacher without students having to act to find problem solving. This means that the teacher only transfers knowledge and information passively.

Then in terms of students, in the implementation of learning there are still students who move to their friends when the learning process takes place. But the teacher also did not stay silent so what the teacher did was to give direction so that the students sat in their respective seats so that the learning process went well. With these symptoms, a teacher must be able to facilitate students in the learning process, namely by using the right model and technique so that the student transfer process has a positive impact, namely to obtain information from friends.

In connection with the above, the expected learning process is learning that can make students more active as a whole in expressing their opinions and communicating their thoughts both with the teacher, friends, and the mathematics material itself. One alternative to learning is the cooperative learning two stay two stray techniques (TSTS). Slavin (1985) states that cooperative learning is a
structured and systematic learning method that can be used at all grade levels and in most subjects at school. In other words, each group is a combination of four to six students in a heterogeneous level of academic achievement, gender, and ethnicity. Whereas according to Richard and Kilcher (2010) Cooperative learning is a teaching model or strategy characterized by cooperative tasks, goals, and reward structures, and requires students to be actively involved in discussion, debate, guidance, and teamwork.

Cooperative learning encourages a sense of mutual learning and respect among students with a variety of different talents, abilities, and backgrounds. Hozain and Tarmizi (2013) states that cooperative learning is one of two ways to regulate the classroom learning environment to be more competitive. This is in line with the opinion of Kagan and Kagan (2009) which states that cooperative learning methods have a positive influence on students' mathematics learning including: (1) improving student achievement, especially for students with low achievement; (2) improving inter-ethnic relations; (3) help in the success of students who are disabled; (4) facilitate in maintaining minority cultural values; (5) maintaining positive social relations; and (6) increasing love among students to learn together and independent.

Lie (2008) states that cooperative learning has five elements of the learning model including positive interdependence, individual responsibility, face to face, communication between members, and group process evaluation. In line with this opinion Richard and Kilcher (2010) stated that the main objectives of cooperative learning are cognitive and social. The main results of cooperative learning can be illustrated in the following figure:
Richard and Kilcher (2010) explained that the learning process that uses cooperative learning methods has the following steps:

Table 1. Steps of Cooperative Learning Methods

<table>
<thead>
<tr>
<th>Phase</th>
<th>Teacher's behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase-1 Clarify goal dan motivate students</td>
<td>The teacher conveys all the learning objectives to be achieved in the lesson and motivates students to learn.</td>
</tr>
<tr>
<td>Phase -2 Present information</td>
<td>The teacher presents information to students by demonstration or reading.</td>
</tr>
<tr>
<td>Phase -3 Organize students into learning teams</td>
<td>Teacher Explains to students how to form study groups and helps each group to make the transition efficiently.</td>
</tr>
<tr>
<td>Phase -4 Assist with teamwork and study</td>
<td>The teacher guides learning groups as they work on their assignments.</td>
</tr>
<tr>
<td>Phase -5 Presentation of group work or test over materials</td>
<td>The teacher evaluates the learning outcomes about the material that has been studied or each group presents their work.</td>
</tr>
<tr>
<td>Phase-6 Recognition of individual and group effort and achievements</td>
<td>Teachers look for ways to appreciate both individual and group learning and learning outcomes.</td>
</tr>
</tbody>
</table>

Besides learning methods, the selection of techniques used in the learning process becomes an equally important factor. One technique that can be collaborated with cooperative learning methods is the learning Two Stay Two Stray technique (TSTS). According to Suyatno (2009) TSTS technique learning is the way students share knowledge and experience with other groups. Meanwhile, Kagan and Kagan (2009) stated that the TSTS technique provides an opportunity for groups to share results and information with other groups. This is done because many teaching and learning activities are colored by individual activities. Students work alone and are not allowed to see the work of other students.

According to Lie (2008) the stages of implementing cooperative learning, TSTS techniques are as follows:

1. Students work together in groups of four as usual.
2. When finished, two people from each group will leave the group and each visit the other two groups.
3. Two people who live in groups are tasked with sharing their work and information with their guests.
4. Guests ask themselves and return to their own groups and report their findings from other groups.
5. Groups match answers and discuss the results of their work.

To be able to see more clearly the learning process of TSTS technique note the following picture:

Figure 2. TSTS Technical Cooperative Learning Steps

It is expected that students seek information from other groups, it will get many benefits and help students communicate, digest, and solve problems faced by students in learning mathematics. With the improvement of the learning process, it is expected that in the end it can improve students' mathematics learning outcomes.
Research Method

This research is Classroom Action Research (CAR). The research subjects were 28 eighth grade students from one of the junior high schools in Indragiri Hilir which consisted of 7 male students and 21 female students with heterogeneous abilities. This study was carried out in two cycles and each cycle consisted of three times the implementation of learning and one time of daily tests. Each cycle has 4 stages, namely planning, implementation, observation, and reflection. The procedures of CAR according to Cohen, Manion, and Keith (2007) are as follows:

Figure 3. Chart of Classroom Action Research

1. Planning
   At this stage the researcher plans the action taken, namely implementing cooperative learning TSTS technique. In this stage, the researcher compiles a syllabus, lesson plan, student worksheets, prepares learning outcomes tests and observation sheets of teacher and student activities.
2. Implementation

Implementation is an application of planning that has been planned in classroom action research. Activities carried out by teachers and researchers are an effort to improve the quality of learning in the direction expected. The action is carried out by the teacher in a structured manner in accordance with lesson plan that have been made and provides the student worksheet by implementing cooperative learning TSTS techniques. During the learning process students are grouped according to the application of cooperative learning TSTS techniques.

3. Observation

In this case acting as an observer there are two people namely researchers as observers of teacher activities and assisted by a teacher as an observer of student activities. Observations were made on the activities of teachers and students, interaction and progress of students during the learning process. Observations are carried out along with the execution of actions. In the implementation of observations the researcher uses the observation sheet that has been provided. This observation aims to observe the implementation of actions in the form of the application of cooperative learning TSTS techniques whether there are things that must be improved so that the action can achieve the desired goals.

4. Reflection

This stage is an activity where the teacher and researcher reflect on the impact on what is done so that it can be used as a reflection of the activities that have been done. The activity can be used as a reference for the success of students in learning or researchers stop their activities. Therefore this reflection can be used as a step to plan new actions in the implementation of the next learning. This stage also aims to assess, see the results or impact of an action so that it is very important for the implementation of the cycle or the next stage. The four stages in the classroom action research are elements to form a cycle, which is one round of successive activities that returns the first step.
Analysis of data about teacher and student activity was analyzed of descriptively qualitative, namely by explaining activities that were appropriate or not appropriate during the learning process. While the completeness of students' mathematics learning is analyzed by calculating individual completeness and percentage of classical completeness (Rezeki, 2009).

\[
KI = \frac{SS}{SM} \times 100
\]

\[
KK = \frac{JST}{JS} \times 100\%
\]

Information:
KI = Individual completeness  
SS = Student score  
SM = Maximum score  
KK = Percentage of Classical completeness  
JST = Number of students completed  
JS = Total students

The improvement of student learning outcomes in this study was also seen from the average. The formula used to calculate the average is as follows (Sudjana, 2001):

\[
\bar{X} = \frac{\sum x_i}{n}
\]

Information:
\bar{X} = Average  
\sum x_i = Amount of each data  
n = Lots of data

**Result and Discussion**

The data analyzed in this study are data on the observation of teacher and student activities in the circle material as well as the success data of the action in two cycles during the application of cooperative learning TSTS technique. The results of the analysis can be described as follows:

**Cycle I**

In the initial activity the teacher begins the learning process by conditioning students to be calm and ready to take lessons. But at the first meeting the teacher did not convey the learning objectives and
apperception. However, in the next two meetings the teacher has conveyed the learning objectives and apperception of the material to be studied even though the delivery of the teacher is not optimal. This means that the teacher has not been able to convey clearly to students about the relationship between the previous material and the material to be studied. Then the teacher gives motivation by linking subject matter with everyday life such as the surface of the moon and wall clocks. Furthermore, the core activities of the teacher explain the subject matter in outline. This is because the learning carried out is TSTS technical cooperative learning. However, at the first meeting students were still confused in moving to another group as a result of noise in the classroom. This is because the teacher does not convey the learning steps that will be implemented. Furthermore, when students match their findings from other groups with the results of their discussions in their own group, at the first meeting the teacher only observes but does not guide students so that there are still some students who are not actively involved in working together, but in the next two meetings the teacher have made improvements by observing and guiding each group alternately when they discuss the results of the discussion. Then at the time of the presentation of the results of the group work, at the first and second meetings the students still looked scared and timid when asked by the teacher to go forward to be the representative of his group. Whereas in the final activity the teacher together with students concludes the material that has been studied, but at the first meeting the teacher does not provide an understanding test and homework. But at the meeting the two teachers gave homework in the form of questions in the student worksheets, while at the meeting the three teachers were able to provide an understanding test and give a few questions to be used as homework. Then the teacher asks students to learn the next material.

**Cycle II**

In the initial activity the learning process begins with the teacher conditioning students first to be ready to take lessons. Then when
conveying the objectives of learning and apperception, the teacher has been able to convey it in accordance with what is expected, namely by explaining the relationship between the material that has been studied with the material to be studied. Then at the fifth meeting to evoke the motivation of learning the teacher gives gifts to students and groups that get the highest score, this causes from the fifth to seventh meeting students are seen competing to become the best group. Furthermore, at the core activities in the fifth to seventh meeting the teacher and students are accustomed to TSTS technique cooperative learning so students can condition themselves so that there will be no more noise in the classroom. Then at the fifth meeting when students were discussing in a combined group, there were still students who told stories and just kept quiet seeing their friends work, but in the next two meetings the teacher improved this by reminding them firmly to all their students to carry out their respective duties well. Then at the time of the presentation of the results of the group work, the students looked enthusiastic and competed to be able to advance to become the group representatives. Whereas in the final activity the teacher together with students concludes the material that has been studied, but at the fifth meeting the teacher does not provide an understanding test because of lack of time in the learning process. However, in the next two meetings the teacher has provided an understanding test that aims to find out how far the students' understanding of the material that has been learned and provide some questions to be used as homework. Before closing the lesson the teacher asks students to learn the next material.

Based on the description above, it can be seen that teacher and student activities tend to increase at each meeting. The learning process in cycle II is better when compared to the learning process in cycle I. While the analysis of the success of the actions in cycles I and II in this study was analyzed by looking at the completeness of students' mathematics learning.
Table 2. Completeness of Student Mathematics Learning

<table>
<thead>
<tr>
<th>Student Mathematics Learning Outcomes</th>
<th>Basic Score</th>
<th>Daily Test I</th>
<th>Daily Test II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students completed</td>
<td>15</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>% Number of students completed</td>
<td>53.57</td>
<td>64.29</td>
<td>71.43</td>
</tr>
</tbody>
</table>

Based on Table 2 above it can be seen that the number of students who complete is always increasing in each cycle. From the basic score to daily test I there was an increase of 3 students or about 10.71%, while from daily test I to daily test II there was an increase of 2 students or around 7.14%. The increase in the number of students who complete this shows a good change in each evaluation carried out. In addition, an increase in student learning outcomes can also be seen by using an average analysis of student mathematics learning outcomes.

Table 3. Average Student Mathematics Learning Outcomes

<table>
<thead>
<tr>
<th>Value</th>
<th>Basic Score</th>
<th>Daily Test I</th>
<th>Daily Test II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rata-rata</td>
<td>68.21</td>
<td>70.96</td>
<td>76.36</td>
</tr>
</tbody>
</table>

Based on Table 3 above it can be seen that the average value of student learning outcomes has increased from the base score to daily test I and daily test II. The average increase in student learning outcomes from the baseline score to daily test I is 2.75 while the average increase in student learning outcomes from daily tests I to daily tests II is 5.4. Thus there is an increase in student learning outcomes in each evaluation carried out. Then, the improvement of students' mathematics learning outcomes can also be seen from the development values and criteria of group awards obtained by students from the evaluation results in each cycle.

Table 4. Student Development Value in Cycle I and Cycle II

<table>
<thead>
<tr>
<th>Development Value</th>
<th>Cycle I</th>
<th>Cycle II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The number of Students</td>
<td>Percentage (%)</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>21.43</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>21.43</td>
</tr>
<tr>
<td>20</td>
<td>14</td>
<td>50</td>
</tr>
<tr>
<td>30</td>
<td>2</td>
<td>7.14</td>
</tr>
</tbody>
</table>
Table 5. Group Awards in Cycle I and Cycle II

<table>
<thead>
<tr>
<th>Group</th>
<th>Cycle I</th>
<th>Cycle II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group Score</td>
<td>Group Awards</td>
</tr>
<tr>
<td>I</td>
<td>10</td>
<td>GOOD</td>
</tr>
<tr>
<td>II</td>
<td>22,5</td>
<td>BETTER</td>
</tr>
<tr>
<td>III</td>
<td>13,75</td>
<td>GOOD</td>
</tr>
<tr>
<td>IV</td>
<td>16,25</td>
<td>BETTER</td>
</tr>
<tr>
<td>V</td>
<td>20</td>
<td>BETTER</td>
</tr>
<tr>
<td>VI</td>
<td>16,25</td>
<td>BETTER</td>
</tr>
<tr>
<td>VII</td>
<td>8,75</td>
<td>GOOD</td>
</tr>
</tbody>
</table>

With the improvements that occur from the activities of teachers and students as well as improving student learning outcomes so that it can be said that cooperative learning TSTS techniques is one alternative to create a conducive learning environment by building good communication and interaction between teachers and students so as to improve results student mathematics learning. Johnson & Johnson said that the main goal of cooperative learning is to maximize student learning to improve academic achievement and understanding both individually and in groups (Trianto, 2010).

Based on the discussion of the results of the research above, it can be concluded that the application of cooperative learning TSTS techniques can improve the learning process and improve students' mathematics learning outcomes. So, this analysis supports the proposed action hypothesis, namely the application of cooperative learning TSTS techniques can improve the learning process and improve the mathematics learning outcomes of eighth grade students from one of the junior high schools in Indragiri Hilir to the subject matter circle.

In carrying out the actions in this study there are also some weaknesses experienced by teachers, students, and researchers/observers themselves. In the implementation of the action the teacher has not been able to manage the time well so that sometimes not all activities in the RPP can be carried out. This causes the learning process not to go as expected. Then when viewed from the side of students, they have not been able to condition themselves well so that when they move both into the original group and into the combined group there is noise and noise in the classroom. While the researchers/observers themselves have difficulty in describing the results of observations on the observation sheet.
Conclusion

It can be concluded that the application of cooperative learning TSTS techniques can improve the learning process and improve mathematics learning outcomes of eighth grade students from one of the junior high schools in Indragiri Hilir. This can be seen from the number of students who reached the value of minimum completeness criteria increased from 15 students (53.57%) on the base score to 18 students (64.29%) in daily test I then increased to 20 students (71.43%) in daily test II. In addition, the average score of students in the base score of 68.21 increased in daily test I to 70.96 then increased in the second daily test to 76.36.

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The Use of Powerpoint-assisted Teaching Materials to Improve Curiosity and Mathematical Learning Achievements in the Relations between Angles Materials

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Abstract

The purpose of this study is to describe how the use of PowerPoint-assisted teaching materials can increase the curiosity and achievement of mathematics learning in relations between angles for students of class VIIA SMPN 2 Karangdowo in academic year 2017/2018. This research used classroom action research method that developed by Kurt Lewin. The study was carried out in 2 cycles. Each cycle consists of 4 stages: planning, acting, observing, and reflecting. Data collection techniques used tests and non-tests. Test was carried out to obtain mathematics learning achievement scores. Non-test was carried out by using curiosity questionnaires and documentation of students' attitudes during the learning process. The data obtained were validated by source triangulation and analyzed by comparative descriptive and qualitative descriptive. The results showed increase in curiosity and learning achievement in mathematics. From 32 students in VIIA class, the number of students who have a high curiosity from the pre-condition to the final condition has increased from 4 people to 15 people or increased 3 4.375%. The increase also occurred in learning achievement values for material relations between angles. If in the pre-condition, there were 5 students who can reach the minimum completeness criteria, but in the final condition it can be achieved by 31 people or increased 81.25%. It means that the use of PowerPoint-assisted teaching materials can increase the curiosity and learning achievement of mathematics in the relations between angles for students in class VIIA SMPN 2 Karangdowo in academic year 2017/2018.

Keywords: curiosity, mathematics learning achievement, powerpoint assisted teaching materials

Introduction

The development of mathematics education in the 21st century is very rapid now. The process of mathematics learning does not depend on the teacher as the only source of learning. There are many learning resources that can be utilized by teacher and students in process of mathematics learning. The teacher and students can use various literary books, objects around the environment, experts, computers or laptops, software and the internet.

Mathematics is an abstract subject. Therefore, students in SMPN 2 Karangdowo generally have difficulty in mathematics learning. Students generally have not been able to think abstractly so that they need media in mathematics
learning. The learning media uses the concrete and visual media. The students will be easier to learn with the learning media.

The availability of computers, laptops, LCDs and several software are very helpful for teacher and students in learning. Teacher can compile teaching materials using PowerPoint. PowerPoint-assisted teaching materials can be made more interesting and easy to understand for students because teacher can make various appearance by utilizing the various facilities available in software. The addition of motion animation can help concretize abstract material too.

The use of PowerPoint-assisted teaching materials in mathematics learning can improve the of 21st century skills of teachers and students automatically. Teachers and students are expected to adapt with all changes. Teachers can compile teaching materials by utilizing Microsoft PowerPoint and other facilities so that mathematics learning can run more interesting and challenging for students. Students can develop their own knowledge through observing teaching materials that are displayed, asking questions, trying, associating, and presenting their work.

However, mathematics learning in the class VIIA SMPN 2 Karangdowo generally does not utilize PowerPoint-assisted teaching materials. The teacher stills use textbooks and paper-based achievement tests. Therefore, the students have not been familiar with mathematics learning that use PowerPoint and online test. Students only use teaching materials in written form and depend on the explanation from the teachers. Students have not utilized other learning resources, such as PowerPoint teaching materials which are presented with more interesting images and various motion animations. Most students difficult to develop a mathematics equation from mathematics problems because they only read the text book and have not seen the demonstration. Mathematics learning has not applied technology facilities. As a result, students have not been familiar with technology in learning activities and not been able to develop 21st century skills appropriately.

Based on the observations of students’ attitudes during the learning process, students are generally less interested in mathematics and seem difficult to understand the materials being studied. Generally, students are confused to solve a mathematics problem. Students are difficult to make an equation that expressed a
mathematics problem. Students are always afraid to make mistakes when working on questions. Students easily give up when try to solve mathematics problems. Students prefer to wait for their friend's work. They are not confident when they solve mathematics problems. Students prefer to be quiet and not ask to the other people when they encounter difficulties. Some students also seem to pay less attention to the lesson and have fun talking something else with their friends.

Based on the results of the mathematics learning achievement test, the values of some students have been beyond expectations. This can be seen from the pure value in the even semester mid-test of 2017/2018. There were only 5 people of 32 students in the class or 15.63% who get more or equal to "minimum completeness criteria".

The gap between expectations and reality shows learning problem. Curiosity and mathematics learning achievement of students in class VIIA SMPN 2 Karangdowo in 2017/2018 has not been as expected. So, it needs to be improved. The teacher tries to solve the above problems by utilizing PowerPoint-assisted teaching materials in mathematics learning. The teacher compiled the relations between angles materials by using PowerPoint. Through the use of PowerPoint in mathematics learning, students were expected to become more interested and easier to understand the subject matter. If the students can easily understand the subject matter and they are interested in mathematics learning, learning achievement of mathematics will increase, especially in relations between angles.

Based on the background above, the problem discussed in this study is "How the use of PowerPoint can assist teaching materials increase curiosity and learning achievement of mathematics in the relations between angles for students in class VIIA SMPN 2 Karangdowo in academic year 2017/2018?"

Through the implementation of this classroom action research, the curiosity and the mathematics learning achievement of students are expected increase, especially in the relations between angles. This research is expected improve 21st century skills of students in class VIIA.
Theoretical Review

Mathematics Learning Achievement

Hardaniwati (2003), achievement is the result achieved. According to Sudjana in (Haryati, 2012), achievement is the ability of students after receiving the learning experience. According to Dimiyati and Mudjiono (2006), achievement is defined as the results achieved in the form of numbers or scores, after being given a test on each learning outcome. The numbers or scores obtained by students can be seen after students take daily assessments, midterm assessments, end semester assessments, class upgrades, school examinations and national exams.

If someone does an effort so that he gets intelligence then that person can be said to have learned. Slameto (in Darmadi, 2008: 8), Someone who does an effort so that he experiences behavioral changes that have not been previously owned because something that has been experienced in his environment means that the person is said to be learning. According to Lambas (2004), learning is a process of seeing, observing, listening, feeling and understanding something that is learned.

Mathematics learning achievement in this study is defined as the results obtained by students after going through the process of seeing, observing, listening, asking, trying, associating and presenting the material of mathematics learning, especially the relations between angles in the form of daily assessment values.

Curiosity

Curiosity in learning is the desire to know more about the teaching material being studied. The curiosity of each student in learning mathematics varies. There are those who are low, medium or high. A student with high curiosity will definitely have a stronger effort in understanding mathematics lessons than students with medium or low curiosity. Students with medium curiosity are sure to do less effort as students with high curiosity do. The students with low curiosity are generally less interested in mathematics, like waiting for the
work of friends, giving up easily and lazily trying to do the exercises or lazy to learn.

In this study, students are said to have high curiosity in learning mathematics when doing things as follows: 1) learning at night if there is a schedule of mathematics lessons tomorrow, 2) paying attention to the lesson, 3) trying to solve every exercises, 4) want to ask questions if they have difficulties, 5) feel curious about the material being studied, and 6) try to understand the subject matter.

**PowerPoint**

PowerPoint is one application that is familiar to the teacher. PowerPoint is usually used by the teacher in compiling a teaching material or to present it. By compiling PowerPoint-assisted teaching materials independently, the teacher can make teaching materials that are appropriate to the situation of students in their classrooms. Presentation materials can be made as attractive and as clearly as possible so that students become more interested and more easily understand the content of the lessons.

The use of PowerPoint in learning is often chosen as one way to improve student learning outcomes. This is because PowerPoint has many advantages. Nisha Raninga (2010), "CAI (computer assisted instruction) method is effective for teaching mathematics to the students’ standards as compared to the traditional method." Taner Buyukkorogulu, et al (2006), "the use of computers has a positive effect on students in understanding the concept limit because students assume that the computer explanation is a real fact”. Dian Sudiantini and Nurjanah Dewi Shinta (2015)," ... the mathematical reasoning ability of the set of subjects which in the learning process uses higher PowerPoint learning media than students who learn through use conventional learning media".

Some of the advantages of PowerPoint media according to M. Nur Rockhman, Aman, and Grendi (2007: 3) include easy to use, easy and can be compiled or created by the teacher himself, can be used individually, can be used repeatedly, affordable, attractive, flexible its use, can be used at the same or different time and place.
The PowerPoint utilization was also chosen by the researcher as an alternative in presenting mathematics learning because: 1) can help students understand abstract material to be more concrete, 2) teaching materials can be made more attractive because they can be presented in various colors, shapes and movement animations, 3) interesting teaching materials can increase students' attention and curiosity about the material being studied, 4) teaching materials can be used repeatedly, not easily damaged, easily revised, and effective and efficient, 5) can improve the competence of the teacher in presenting teaching materials, 6) relevant to the development of education in the 21st century.

**Learning Theory**

The process of learning mathematics in junior high school will run more effectively if the teacher also master and apply appropriate learning theories. The learning theory applied in this research is the learning theory developed by Piaget and Bruner. According to Piaget, every child will experience 4 stages of cognitive development. The stages of cognitive development according to (Piaget, in Haryati, 2012) are divided into 4 stages: the sensory motor stage, the pre-operational stage, the concrete pre-operational stage, and the formal operation stage.

Based on the division of cognitive development stages above, students in class VII A of SMPN 2 Karangdowo currently range between 12 years and 14 years. Students should be able to think abstractly and can imagine the angles with their relations if there are two lines intersecting or if there are a pair of parallel lines cut by the transverse line. Because the speed of cognitive development of each student is not the same, most students are often confused and difficult to solve problems related to relations between angles. Students often forget and are hesitant in making an equation if there are angular partners who are supplementary angles, complementary angles, opposite angles, co-direction angles, interior alternate angles, exterior alternate angles, interior co-direction angle, and exterior co-direction angles.

In order for students to learn more easily and more impressively, the teacher tries to compile teaching materials, especially the material of relations
between angles using PowerPoint. With the PowerPoint and the facilities available in the software, students can see visual impressions and proof of the relations of the angles that occur if there are two lines intersecting or if there is a pair of parallel lines cut the transverse line. If students are more interested, students are easier to understand the concepts learned. The above is fit with the Bruner theory. According to (Bruner in Lambas, 2004), the learning process will occur optimally if it has gone through three stages: enactive, iconic and symbolic.

**Research Methodology**

This research was carried out in class VII A SMPN 2 Karangdowo even semester in 2017/2018. The subject of the study was curiosity and mathematics learning achievement of class VII A students totaling 32 people. The study was conducted from March to May 2018. The research method used in this study refers to the classroom action research method developed by Kurt Lewin (in Lambas, 2004). The study was carried out in 2 cycles. Each cycle consists of 4 stages, namely planning, implementing, observing, and reflecting. The results of reflection at the end of the cycle are taken into consideration to determine the actions to be taken in the next cycle.

Data collection techniques used tests and non-tests. Test techniques are carried out to obtain mathematics learning achievement scores. Non-test techniques are carried out by using curiosity questionnaires and documentation of students' attitudes during the learning process. Furthermore, the data obtained were validated by source triangulation and analyzed by comparative descriptive and qualitative descriptive. Comparative descriptive is used to compare the results of learning achievement tests from the pre-conditions, cycle I and cycle II. The qualitative descriptive is used to compare the learning process and curiosity questionnaire in learning mathematics in the pre-conditions, cycle I and cycle II. This class action research is said to be successful if 80% of students in class VII A SMPN 2 Karangdowo get a score of mathematics learning achievement more than or equal to "minimum completeness criteria".
The research process starts from the pre-conditions. In the pre-condition, the researcher recorded the pure grades of midterm assessment and reflected on the students' curiosity in learning mathematics. The data obtained is used to determine the problem and determine the actions to be taken in cycle I.

The next stage is cycle I. Cycles I consist of 4 stages, namely planning, implementing, observing and reflecting.

At the planning stage, the teacher does the following. The teacher submits a research permit. The teacher informs students in class VII A SMPN 2 Karangdowo that research will be held in the class. The teacher prepares a learning plan. The teacher compiles teaching materials in PowerPoint, especially on material the supplementary angles, complementary angles, and opposite angles. The teacher compiles an online achievement test which can be accessed through http://gg.gg/mate-eskarlo. The teacher also compiles a curiosity questionnaire accessible through http://gg.gg/angketrasaingintahu-eskarlo. The achievement test contains 10 multiple choice questions related to the material being studied. The curiosity questionnaire contains 6 statements which are indicators of curiosity, among others: 1) learning when there will be a schedule, 2) paying attention to the material presented by the teacher, 3) trying to work on the problem, 4) asking friends or teachers when having difficulties, 5) feel curious about the material that will be explained by the teacher, and 6) try to understand the subject matter. A student is said to have a “high curiosity” if doing 5-6 indicators, "medium curiosity" if doing 3-5 indicators, and "low curiosity" if doing 1-2 indicators. In addition to the preparations above, the teacher also prepares LCDs and laptops.

At the implementation stage, researchers carry out learning in according with the learning plan. Because students who have laptops are only 2 people, some of the students' HPs cannot access the picture or symbol, and some students do not have any devices so the teacher presents mathematics learning by displaying PowerPoint teaching materials by classically. The teacher presents several demonstrations and explores students' knowledge by asking questions to find relationships between angles. Furthermore, the teacher provides several
examples of problems that must be solved by students. After that, students present the results of their work and continue with the discussion together. At the end of learning activities, students are given an online achievement tests and fill out curiosity questionnaires.

At the observation stage, the researcher observed students' attitudes during the learning process. The teacher observed how students respond during learning. The teacher observed the students who pay attention. The teacher observed the students activities as try to solve the problem, present their work, discuss with their friends or the teacher, and express the student's face. In addition, the teacher also took several pictures for documentation.

At the reflection stage, the teacher analyzes the findings obtained. Based on the results of the learning achievement test, the results of curiosity questionnaire, documentation and observation of students' attitudes during the learning process, identifying the learning problem in the cycle I, the teacher determines how the steps need to be taken in the next cycle.

After the first cycle is complete, the study continues cycle II. The steps taken in the second cycle are similar to those carried out in cycle I but the PowerPoint teaching material is presented about co-direction angles, interior alternate angles, exterior alternate angles, interior co-direction angle, and exterior co-direction angles. The address for filling out the curiosity questionnaire is the same as the address used in cycle I, while the address of the learning achievement test in cycle II can be accessed through http://gg.gg/mate-eskarlo2.

**Results and Discussion**

**Pre-conditions**

In the pre-conditions, mathematics learning in the class VIIA SMPN 2 Karangdowo generally does not utilize PowerPoint-assisted teaching materials. The teacher stills use textbooks and paper-based achievement tests. Therefore, students have not familiar with mathematics learning that use PowerPoint and online test. Students only use teaching material in written form and depend on the explanation from the teacher. Students have not utilized other learning resources,
such as PowerPoint teaching materials which are presented with more interesting images and various motion animations. Most students difficult to develop a mathematics equation from the mathematics problems because the students only read the text book and have not seen the demonstration. Mathematics learning hasn’t utilized technology facilities. As a result, students have not utilized technological progress in learning and they have not been able to develop 21st century skills to the max.

The students are generally less interested in mathematics and they seem difficult to understand the material being studied. Some students also often seem to pay less attention to the lesson and sometimes have fun talking to their friends. From the results of the mathematics learning achievement test, students in class VII A of SMPN 2 Karangdowo haven’t as expected. Based on the data of the pure value of the test in the middle of the even semester of 2017/2018 school year, there were only 5 people out of 32 students in the class, or 15.63% who obtained scores more than or equal to "minimum completeness criteria".

**Cycle I**

The learning process in cycle I began with the presentation of teaching PowerPoint materials by classical. Students observed and asked questions related to the teaching material that is displayed. After students understood the concept of the supplementary angles; complementary angles; and opposite angles pairs, students are given several practice questions. After students finished their working, some students are asked to present their work and other students gave a respond. If there are things that are not clear, the teacher and students discuss together. At the end of learning, students are asked to do the learning achievement tests and fill out a curiosity questionnaire through the site address that has been prepared.

During the learning process of cycle I, students look more attentive and interested in mathematics. Almost all students active try solving the exercise. When students are asked to present their work to the class, many are willing. The students didn’t prefer waiting for their friend's work. Students didn't talk about
another topic with their friends. The students didn’t hesitate in developing equations and solving problems.

Based on the results of the curiosity questionnaire, there were 10 students who have a low curiosity, 5 students who have a medium curiosity and 17 students who have a high curiosity. As for based on the results of the learning achievement test, there were 5 students who failed to reach the "minimum completeness criteria and there were 27 students who can reach for the minimum completeness criteria.

Based on the observations during the learning process, the results of learning achievement tests, as well as the results of curiosity questionnaire entries in the first cycle indicate an increase in the quality of learning and learning achievement tests. But, in the implementation of the first cycle there were also some obstacles, some of the mobile phones couldn’t access the picture on achievement test, some of the mobile phones couldn’t connect to the site address, some students didn’t have any tools so that some students must borrow their friends' HPs to input answers learning achievement tests and some students must fill out questionnaires at a later time. Therefore, the researchers decided to continue the research into cycle II with the following corrective steps. For students who didn’t have a mobile phone or computer, they are permitted to work on paper and the teacher helped to input the response from students. Learning achievement test items and curiosity questionnaires were also displayed on the board. The researcher decides to continue the research to cycle II to test the find out in cycle I consistent in cycle II.

**Cycle II**

The steps of the learning process in cycle II as implemented in cycle I. Learning begins with the presentation of PowerPoint teaching materials by classical. Students observed and asked questions related to the teaching material that is displayed. The PowerPoint teaching materials includes co-direction angles, interior alternate angles, exterior alternate angles, interior co-direction angle, and exterior co-direction angles. After students understood the concept of the relations between angles, the students are given several practice questions. After students
finished their work, some students are asked to present their work and other students gave their respond. If there are things that aren’t clear, the teacher and students discuss together. At the end of learning, students are asked to do the learning achievement tests and fill out a curiosity questionnaire through the site address that has been prepared.

During the learning process of cycle II, the students' attitudes also showed the same tendency as the conditions in cycle I. Students also looked attentive and interested in learning mathematics. Students also enthusiastically try to work on the given practice questions. Students didn’t afraid to work on and present the results of their work. Students look confident.

Based on the results of the curiosity questionnaire, there were 8 students who have a low curiosity, there were 9 students who have a medium curiosity and there were 15 students who have a high curiosity. As for based on the results of the learning achievement test there was 1 student who failed to reach the minimum completeness criteria and there were 31 students who can reach the minimum completeness criteria.

Based on observations during the learning process, the results of learning achievement tests, as well as the results of curiosity questionnaire entries in cycle II also showed the same tendency with the results in cycle I. The learning process and learning achievement tests were also better compared to the conditions in the pre-cycle.

Discussion
Research data from the beginning to the end about the curiosity and learning achievement of students in class VIIA SMPN 2 Karangdowo in the academic year 2017/2018 related to the use of PowerPoint-assisted teaching materials in learning on the material of relationships between angles are as follows.

Based on the results of observations of the attitudes of students during the learning process, the student activities are increase from the initial conditions to the final conditions. If in the initial conditions, some students be less attentive, less interested in mathematics, prefer to wait for a friend's job, easy to give up,
rarely ask if they encounter difficulties, always afraid of being mistake, lack confidence, rarely willing to present the results of their work, and some prefer to talk alone with friends. But in the first cycle and second cycle, these things tend to decrease. Through the use of PowerPoint teaching materials in cycles I and II, students look happy in learning and pay more attention to lessons. The students look happy when they saw the PowerPoint teaching materials. They saw the presentation with enthusiasm because it does different from the previous days. If in the initial conditions, students only use the book and depend on the teacher's explanation, but in the first and second cycles the teacher has used the PowerPoint teaching materials. Teaching materials look more attractive for students because the display of PowerPoint teaching materials is made more colorful and accompanied by motion animations that can help the students to understand the relations between angles. By looking directly at how the relationships between angles are demonstrated, students will find the relations and easier to build their knowledge. With motion animation, students can understand better which angular pairs are the same size or which angular pairs are 90° or 180°. Students easier to understand the concepts learned and can arrange equations when get problems related to relations between angles. In the learning process cycles I and II also found several improvements. Generally, the students try to solve the exercises or the questions. The majority of students can find solutions, be more confident, willing to be asked to present their work, and want to ask to their friends or teachers when they encounter difficulties.

Diagram 1. The development of curiosity
Based on Diagram 1 about the curiosity questionnaire, the number of students who have a high curiosity is increasing. If in the initial conditions, there are 4 people who have a high curiosity, but in the final condition it becomes 15 people or an increase of 34.375%. Besides that, it was also found the fact that there were many students who had a low curiosity, in the initial conditions there were 11 people, but in the final condition there were only 8 people or decreased by 9.38%.

The same increase can also be seen from the results of mathematics learning achievement tests on the material of relations between angles. Based on the Diagram 2 about the development of learning achievement value, the number of students who can reach the minimum completeness criteria is increasing. If in the pre-condition, there are 5 students who can reach the minimum completeness criteria, but in the final condition it can be achieved by 31 people or an increase of 81.25%.

In general, based on the data obtained through filling out the curiosity questionnaire, the results of learning achievement tests and teacher observation during the learning process, it was proven that the use of PowerPoint-assisted teaching materials in this study can improve the learning curiosity and learning achievement of students in class VIIA SMPN 2 Karangdowo in 2017/2018.
Conclusion

Based on theoretical studies and relevant research, it is clearly proven that the use of media in learning can improve mathematics learning achievement. With the use of PowerPoint-assisted teaching materials proven can make abstract material look more concrete for students. The same results are also shown from this class action research. Through the use of PowerPoint-assisted teaching materials, learning becomes more interesting and easier to understand by students. Students are more confident to solving problems and presenting their work. Students do not prefer wait their friend work. Students are more active trying to solve the exercises and find their own solutions. In addition, the value of mathematics learning achievement in the final condition is also better than the achievement value in the initial condition.

So, based on theoretical studies and empirical evidence obtained in this class action research, it can be concluded that the use of PowerPoint-assisted teaching materials can increase the curiosity and achievement of mathematics learning in the material of relations between angles, for the students in class VIIA SMPN 2 Karangdowo in 2017/2018.

Suggestion

In order for maximum use of PowerPoint instructional materials to be utilized by students, it may be more effective if the teaching material is also uploaded on the internet so that students can learn independently even at home or can study with their friends anytime.
Literature References


Fragmentation of Thinking Structure Translation in Solving Mathematical Modelling Problems

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Abstract

Fragmentation of thinking structure is the construction of information in the brain that is inefficient, incomplete, and not interconnected, which hinders the process of mathematical problem solving. In solving mathematical modeling problems, students need to do translation thinking which is useful for changing the initial representation (source representation) into a new representation (target representation). This study aims to find out how the process of the occurrence of fragmentation of thinking structure translation student in solving mathematical modeling problems. The method used is descriptive qualitative with the instrument in the form of one question of mathematical modeling of necklace pendants and semi-structured interview sheets. The results showed that there were three errors that occurred in solving mathematical modeling problems. First, the error in changing verbal representation to the graph. Second, errors in changing graph representation to symbols (algebraic form). Third, errors in changing graph representation and symbols into mathematical models. The three errors that occur are described based on the four Boose frameworks, namely (1) *unpacking the source* (UtS), (2) *preliminary coordination* (PC), (3) *constructing the target* (CtT), and (4) *determining equivalence* (DE). In this study, presented 3 subjects who experienced fragmentation of thinking structure in solving mathematical modeling problems. One of the highlights is the fragmentation of the structure of translation thinking often starting from the unpacking source process due to incompleteness in considering all the available source details.

*Keywords*: Fragmentation of thinking structure, translation process, problem solving, mathematical modelling.
Introduction

In solving mathematical modeling problems, students often experience difficulties and produce wrong answers (Kiat, 2005; Yost, 2009; Dorko, 2011; and Serhan, 2015). Complex problems require variations in ideas, strategies and mathematical formulations used. This results in students having to think hard in order to arrive at the right answers and in accordance with the problems at hand. Difficulties are often the first thing experienced and felt by students, because the solution to the problems encountered is not immediately known by using ordinary procedures. This situation has been studied by several researchers such as Kiat (2005), Yost (2009), Zakaria, et al. (2010), Dorko (2011), Wibawa (2013), Booth, et al. (2014), Subanji (2015); Veloo, et al. (2015), and Serhan (2015). The research that has been done only identifies errors that occur through the work of students. The studies carried out have not yet arrived at the discovery of sources of error through the disclosure of students' thinking processes in solving mathematical problems. Kiat (2005) reveals that there are three types of errors in solving mathematical problems, (1) conceptual errors, (2) procedural errors, and (3) technical errors (technical errors). In this case Kiat (2005) has not traced the thinking process of students who experience errors, therefore it is necessary to do further research related to how students think in solving mathematical problems. In particular, Serhan (2015) said that there is a need for further research to investigate students' thinking processes when solving mathematical problems.

In the process of solving the problems of mathematical modeling, the structure of thinking that is formed through difficulties and errors that occur, often seems like not organized and not well connected (Skemp, 1976, 2006). In this case, Skemp (1976, 2006) describes it as an instrumental understanding, which is described as separate (unconnected) ideas without meaning. The term without meaning means that a person does not understand well the concepts that have been learned, cannot relate to other concepts so as to give rise to incomplete understanding. Conditions like this lead to separate or not well connected ideas. Ideas without meaning can also mean that the idea has ever been in its memory (because it has been learned) but is forgotten accidentally over time (Sternberg,
2012). For example: when a student encounters a problem to determine an integral form of course as a mathematical model of a rotating object, the student is unable to emerge and associate all the components related to it. In fact, students have studied it during high school and in the previous semester. This shows that, material that has been stored in memory is forgotten accidentally over time. Someone who learns new concepts without meaning, the concept is stored in a separate structure.

Wahono (2009) stated that in the learning process, when students receive information in the form of concepts, procedures, and others, actually the student managed to construct what was taught. But there are those that are well constructed (concepts are understood in their entirety) and some are constructed not well (concepts are not fully understood). The information conditions that are not fully understood, according to Wahono (2009) resulted in the information being not well connected or "messy" (unorganized). Wahono (2009) called it a fragmentation in the student's storage system.

The term fragmentation is very popular in the computer world which is defined as the condition of a file that is placed on a storage system that does not occupy the sector (storage space) efficiently. The same thing was also conveyed by Subanji (2016: 113) that fragmentation of computers is interpreted as a phenomenon in storage space that is used inefficiently, reducing storage capacity. Fragmentation occurs when the operating system cannot allocate enough space in adjacent storage sectors to store files in a neat structure. This happens because someone often deletes files and then adds them again with files of the same size and type. Fragmentation results in system work delay in calling stored data or data that has been constructed.

In this study, it was studied how the fragmentation structure of translation thinking occurred in students in solving mathematical modeling problems. The translation process is important in solving mathematical modeling problems. Students need to do thinking translations ranging from verbal to pictures, graphics to graphics, verbal to algebraic forms, algebraic forms and pictures to
mathematical models. However, in fact there are still many students who experience difficulties and make mistakes in doing translation thinking.

**Research Method**

The data collected in this study are words or sentences so that the results of this study are descriptive data. Data analysis in this study is inductive because the data analysis activities use facts from the field and the results of think alouds to find the process of translational structure fragmentation in solving mathematical modeling problems (certainly integral applications on the volume of rotating objects). According to Creswell (2007), Bogdan & Taylor (in Moleong, 2007), and Yin (2011), this kind of research is classified as qualitative research.

This research was carried out in Mathematics Education Study Program FMIPA State University of Malang for even semester students in 2014 and 2015 (Semester 4 and 6). Researchers choose mathematics education students who have learned integral concepts since high school and re-study in lectures (according to the syllabus of integral application material of course on the volume of rotary objects taught in semester 2), assumed to have a more complete and in-depth thinking structure so that the exploration process carried out by related researchers by tracing the fragmentation of the structure of thinking more visibly. This also makes it easier for researchers to adapt various ways of structuring when students experience difficulties or are wrong in solving problems given.

In accordance with the preliminary study, in this study students' answers are grouped into 3 categories: (1) Students with very essential errors, where students are not aware of an "irregular" build or curved residual space, (2) Students with essential errors, where students are aware of an "irregular" building or a curved space but do not use integrals of course to solve them, and (3) students with errors are essential, where students are aware of irregular builds or curved spaces and use integrals of course to solve it but the answer given is wrong. Researchers conducted a study on 83 students who were divided into three further categories, three subjects in this study were selected for each category.
Result and Discussion

In this study, students experience errors in making new representations of previously made representations, which aim to facilitate solving problems encountered. Representation in question is an external object in the form of graphs, symbols (algebraic forms), words (situations), and mathematical models that function as coding symbols, describe mathematical relationships or ideas, communicate mathematical knowledge, and operate mathematical constructions (Cobb, et al. 1992 and Kaput, 1987). The new representation made by the first student is in the form of graphs or drawings in the Cartesian diagram. The image aims to facilitate students in determining the equation. The second new representation is in the form of symbols or algebraic forms which aim to facilitate students to determine mathematical models or integral forms. The third new representation is in the form of a mathematical model or integral form which aims to facilitate students to determine the remaining volume of drilling results. Each of the representations made by students experienced an error which resulted in students having difficulty continuing their work and experiencing errors in determining the final answer.

The process of changing representation, from the initial representation (source representation) to the new representation (target representation) is called translation (Bosse et al. 2014). Explicitly Bosse, et al. (2014) call translation as a cognitive process that occurs to formulate source representation to the target representation. The process of cognition that occurs can be observed through the results of interviews (think aloud) and the results of student work. In this study the mistake of making a new representation of a previously made representation is called a translation error. Because translation is a process of cognition, the translation errors that occur can also be observed through the cognitive processes that occur in students when solving mathematical problems.

The student's cognition process in translating can be observed through the structure of students' thinking. The wrong pattern of students' thinking structure is called the fragmentation of thinking structure or thinking structure that are not
organized, separate, and not interconnected. In this case, structural fragmentation thinks what is meant is fragmentation of the structure of translation thinking.

The process of the fragmentation of the structure of translation thinking in terms of the framework created and used by Bosse, et al. (2014), which includes: (1) unpacking the source (UtS), (2) preliminary coordination (PC), (3) constructing the target (CtT), and (4) determining equivalence (DE). Unpacking the source or dismantling the source representation is defined as reading and considering the concepts that exist in the re-presentation of the source or often called the micro concept used to build the idea of making a target representation. Preliminary coordination or preliminary coordination is defined as identifying and typing the same mathematical relationships between micro concepts in source representation and micro concepts in target representations. Constructing the target or constructing the target representation is defined as formulating and making target representations based on micro concepts that exist in the source representation and planned coordination. Determining equivalence or determining equality is defined as re-structuring the target representation or re-checking the similarity of ideas that are in accordance with the rules of the source representation.

The idea of building new representations or translating is mentioned because there are gaps between existing facts or fact gaps (Bosse et al. 2014). In the construction process, which is seen from the occurrence of structural fragmentation, thinking that the translation occurs, the fact gaps can be seen as a scheme of gaps (SG) or gap between schemes. The gap or non-conformity that occurs is one reason students make new representations or restructure the new representation that has been made.

In this study found three types of structural fragmentation of translation thinking, namely, fragmentation of structure thinking translation from verbal to graph, from graph to symbol (algebraic form), and from graphics and symbols to mathematical models (integral forms). Students when experiencing the structure of translation fragmentation do not directly do the restructuring or arrangement of the existing micro concepts. Students restructure after being given limited intervention by researchers. In this case, the restructuring that occurs is deliberate restructuring
called structural thinking defragmentation or translation scheme adjustment defragmentation. The following is an explanation regarding the translation scheme adjustment defragmentation that occurs for each type of fragmentation.

**Fragmentation of Thinking Structure Translations from Verbal Representation to Graphics**

Students are aware of the fragmentation of the structure of translational thinking after researchers invite students to reflect by providing limited interventions. The process that occurs is as follows:

![Fragmentation Thinking Structure Translation from Verbal Representation to Graph](image)

Students initially understand that the problem faced is the problem of the ball being drilled (G1). The results of this drilling are partitioned into three shapes, namely a sphere that has a radius of 10 mm (G2), a tube that has a height and radius of 5 mm (G3), and a part that builds a space with one of its curved surfaces related to the radius ball and tube radius (G4). In order to determine the building space where one of its surfaces is curved using an integral concept, students think of making an image in two dimensions (G5). Students experience a scheme gap /
scheme gaps (SG1) between images on two dimensions with the aim of determining the function or equation contained in the integral form (G6).

![Verbal situation “Sphere drilled”](image)

**Figure 2. S3 draws Sphere drilled into Cartesian diagram**

The gap between schemes that occurs stimulates students to create new representations (target representations). In this case, the planned preliminary coordination is to sketch graphs on the Cartesian plane. The student then constructs the target by making the Cartesian diagram first (G7) then drawing a space with one of its curved surfaces in the Cartesian diagram (G2) with center (0.0) (G8) and the radius of the drill bit 5 mm (G9). Through the results of the construction, the students produced a drawing of the remaining space with one curved surface centered at point (0,0) (G10).

The graphs made by students actually still leave a gap between the existing facts or the gap between schemes (SG2) but the gap is not realized by students. Student awareness (low awareness) results in students not doing the process of determining equivalence or restructuring of the representation of the target made. Another thing that is a cause is the low sense of geometry that is in students, which students do not consider the facts that exist in the representation of sources, such as: the radius of the ball and the radius of the tube that should be adjusted with the graph made. In this context, students have experienced structural fragmentation thinking translation from verbal (the problem of the ball being drilled) with a graph (drawing of a ball being drilled in the Cartesian plane).
Fragmentation of Thinking Structure Translations from Graph Representation to Symbols (Algebraic Forms)

Students are aware of the fragmentation of the structure of translational thinking after researchers invite students to reflect by providing limited interventions. The process that occurs is as follows:

Students initially make ball graphs drilled in two dimensions (H5). The first time, students think about the existence of a ball that is drilled (H1), then mention that the build formed from drilling is done by ball (H2), tube (H3), and build a space with one of its curved surfaces (H4). Students draw a ball drilled in the Cartesian plane (H6) in which there are $X$ and $Y$ axes. Students focus on curved structure for drawing on the Cartesian plane (H7). Students understand that the wake is like a bowl (H8) and students say they will make an equation from the picture made. In this case, there is a gap between schemes (SG1) which results in students having a reason to make an equation or make a new representation of the image created.

Before students determine the equation, students experience cofounding schemes...
or ambiguity schemes (CS) between the curves with a bowl shape. The ambiguity is an error of assumptions built by students that affect the making of new equations or representations.

![Figure 4. S2 create quadratic equation form picture in Cartesian diagram](image)

Students focus on the curved building in the Cartesian diagram created. Students assume that the build is like a bowl (H7) so that it can be seen as a quadratic function (H10). Students then test the intersection, such at $y = 0$ and $x = 0$ (H11). Then do the substitution (H12) in the formula of the quadratic equation that has been determined, namely $y = a(x - x_1)^2 - x_2$ (H13). Based on these results, students determine the quadratic equation, $y = -x^2 + 2x$ (H14). After finding these equations, students did not directly perform equivalent equivalence or restructuring on the representation of the target made. Whereas in the representation of the target constructed there is still a gap between the schemes (SG2) which is between a curved shape which is assumed to be a bowl with a quadratic function. In this case, students experience structural fragmentation thinking translation from graphical representation to symbolic representation (algebraic form) caused by superficial student assumptions about the graphs made and their low understanding of quadratic functions.

1. **Fragmentation of Thinking Structure Translations from Graph and Symbol Representations (Algebraic Forms) to Mathematical Models**

   Students are aware of the fragmentation of the structure of translational thinking after researchers invite students to reflect by providing limited interventions. The process that occurs is as follows:
Students initially construct their ideas which are referred to as a collection of micro concepts in source representation. In the representation of sources there is a construction representation of graphs and symbols or equations of circles. Through the scheme formed on source representation, there is a gap between schemes (SG1) which stimulates students to create new representations. The process that occurs is as follows.

Students initially draw the ball drilled in the Cartesian diagram in the direction of Y axis (I1). From the results of the drilling, students pay attention to the circle image which is seen as a graph (I2) and the drill bit that crosses the circle (I3). Students determine the equation of the circle (I4) and the radius of the drill bit 5 mm (I5). From the similarities and radii of the drill bit, students focus on the remaining part of the drilling results (I7). Students think about solving the problem using integrals. Then the student determines the integration area (I8) and thinks of making an integral form (I9). In this case, there has been a gap between the schemes it has (between I8 and I9) (SG1). The gap between these schemes
stimulates students to make new representations. Students do preliminary coordination by planning to create mathematical models or of course integral forms.

Students begin to construct new representations by focusing on the integrated integration area (I8). The integrated area is in the form of building up the remaining drilling results (I10). Students use the equation of the circle that is \( x^2 + y^2 = 25 \) (I4) and change it in the form \( y = \sqrt{25 - x^2} \) (I12). Students think of integration limits (I13), namely, the lower limit = 0 (I14) and the upper limit = 5 (I15). Circle equations and predetermined boundaries are then used as the basis for creating a mathematical model (integral form) (I16). The result of the substitution is \( \int_0^5 y^2 \, dx \) (I17) = \( \int_0^5 (25 - x^2) \, dx \) (I18). In determining the mathematical model, students are not able to justify the existence of boundaries, functions \( y^2 \), dan \( dx \). Students only say that "usually like that" to create an integral form of the volume of a rotating object. The new representation made by students is not in accordance with the representation of the appropriate source.

When viewed from the scheme that has been constructed, there are still gaps between the schemes that result in errors. In this case, students experience the

Wrong into determine integral bounded

There is no reason to determine mathematics model (Wrong answer)
fragmentation of the structure of translational thinking from graphs and symbols to mathematical models (integral forms). Students do not do determination equivalence or restructuring the scheme on new representations or targets because students are not aware of the mistakes made and their understanding of determining the integral form has no strong basis.

**Conclusion**

Based on the results of the research and discussion, it can be concluded that the characteristics of the translation structure's fragmentation of thinking appear when students make mistakes in changing the old representation (source representation) to a new representation (target representation). Errors that occur can be seen in the construction of the scheme on new representations and old representations. The construction error is named as a confounding schemas or schemes that are ambiguously constructed. Fragmentation structure of translation thinking in solving mathematical problems there are three, namely fragmentation of thinking structure translation from verbal representation to graphs, fragmentation of thinking structure translation from graphical representation to symbols (algebraic forms), and fragmentation of structure of translation thinking from graphical representations and symbols to mathematical model representations. Each fragmentation that occurs basically has the same characteristics. It's just that there are different processes, especially when doing coordination preliminary and constructing the target.

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Literature References


Appendix 1

TASK SHEET

Hint:
1. Read and understand the problem before working on it.
2. Do it by writing down the solution on the page provided.

A company wants to produce the latest gold necklace with two solid ball-shaped beads that look like the picture on the side. How to make these beads by punching holes in beads diametrically using a drill bit of 5 mm. For aesthetic purposes, the radius of a solid ball is determined twice the radius of the drill bit. This company wants to know how much the remaining 2 beads are in the necklace (before being carved).

Help this company to solve it.
Learning Trajectory in Mathematics: Teacher's Perception

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Abstract

In recent years, Mathematics teachers have made improvements in their learning process. This includes in synthesizing and elaborating students' knowledge thinking on certain concepts as core progressions or it called 'learning trajectories'. This study describes the perception of mathematics teachers of secondary school about learning trajectory in mathematics. This is a descriptive qualitative research using Miles & Huberman’s steps to analyze the data. Data were collected through interviews of 10 mathematics teachers of secondary school which come from five cities in the province of Central Java, that had to teach more than a year. The result showed that 4 of 10 math teachers have heard and knowing what is learning trajectory and also ever applied it in mathematics learning activities. Furthermore, all teachers agree that the important thing to consider in the learning process is the learning trajectory because it can help them to plan, conceptualize, and facilitate learning.

Keywords: learning trajectory, teachers’ perception

Introduction

Mathematics began to develop along with the development of science. Mathematics is a universal science and underlies various kinds of science. This is in line with the opinion of Wen Chun & Su Wei (2015) which states that "Mathematics is a basic and critical foundation subject". Furthermore, Kilpatrick, et al, (2001) states that "mathematics is a universal, utilitarian subject - so much a part of modern life that anyone who wishes to be a fully participating member of society must know basic mathematics." This opinion means that mathematics is a useful and universal science so that everyone in the life of modern society must understand the basics of mathematics.

High-quality mathematics education according to Van De Walle (2004) can be achieved by teachers who understand deeply the mathematics they teach, understand how students learn mathematics, including knowing individual mathematics development individually and choosing tasks and strategies that will
improve the quality of the teaching process. In other words, effective teaching is a series of student-centered activities. This is in line with Vygotsky's learning theory that students need to construct a concept that is acquired individually through the activity of constructing their own knowledge from the process of interaction with the objects they face and their social experiences.

The mathematics learning process in schools cannot be separated from the planning that should have been compiled by the teacher before the learning activities. This planning is needed in order to achieve the learning objectives that have been predetermined. This means that the role of the teacher is very important in achieving the learning objectives through the planning that has been prepared. In addition, the effectiveness of a learning can be seen through the achievement of learning goals.

According to Kilpatrick et. al. (2001) "Effectiveness depends on enactment, on the mutual and interdependent interaction of the three elements - mathematical content, teacher, students as instruction unfold .." That means that effectiveness depends on the reciprocal interaction of the three components, namely math content, teachers, and students. in line with this, NCTM (2000) stated that "effective mathematics teaching requires understanding and need to learn and then challenge and support them to learn it well." Effective mathematics learning requires an understanding of what students know and need to be learned which will then challenge and support them to learn it. Teachers need to support students in learning mathematics well and knowing their students' mathematics learning needs. Therefore, the teacher is very instrumental in the effectiveness of a learning.

Arends & Kilcher (2010) argue that mathematics learning is said to be effective if it is supported by teachers who use best practices in achieving learning goals. Effective learning is learning that is able to succeed students to achieve learning goals set by the teacher (Kyriacou, 2009: 20). Thus, learning can be said to be effective if it has clear goals and students are able to achieve goals. So, to achieve learning goals, a learning plan is needed and becomes effective when it goes according to plan.
In planning a learning, a teacher needs to consider aspects of the relationship between the teacher, the material, and students. Learning planning must also be prepared through the analysis of all components to achieve learning objectives. One part of the lesson plan is to study the design of learning trajectories (Retnawati, 2017). By seeing the trajectory learning of students and choosing the right strategy in learning can help students have mathematical competencies. The existence of an effort to create a good relationship between the teacher, the material, and students will produce an effective learning process. So, the teacher needs to formulate hypotheses or allegations related to activities that will be carried out during learning.

According to Confrey, et. al. in Wilson, et. al. (2013) mentions that learning trajectory is the researchers’ assumption, a description that is empirically supported about the network that is structured to build student learning through learning. For example, activities, tasks, tools, forms of interaction, and research methods derived from informal ideas towards more complex concepts. Wilson, et. al. (2013) revealed that mathematics learning trajectory supports teachers in creating models of students' thinking and rearranging teacher's understanding of mathematics and student reasoning.

The teacher should have a guess or hypothesis about the reaction of students in each stage of the learning trajectory towards the learning objectives carried out in designing learning activities in the classroom. The stages that students go through during the learning process to master the planned learning goals are called learning trajectories (Prahmana, 2017). Any activities or answers that arise from students should be anticipated by the teacher through hypotheses or predictions. The hypothesis or prediction of students' thinking and understanding in a learning activity is called Hypothetical Learning Trajectory (HLT) (Prahmana, 2017). With the learning trajectory to make learning oriented to social aspects, the existence of a continuous repetitive cycle, and activities that allow the teacher to achieve learning with a theory that is tailored to the ability and level of student reasoning (Gravemeijer, et al., 2003)
Based on the previous description, the learning path is a description of students' thinking and learning mathematics in a particular domain. The hypothesis of student learning trajectory relates to a series of instructional tasks that are designed to give rise to a process or action to achieve learning objectives. The series of activities that have been designed contain hypotheses or allegations of student learning. In mathematics learning, learning trajectory is a description of how students think and learn about a mathematical material and an estimate that is connected through a set of learning tasks designed by the teacher to produce mental processes or activities that are expected to advance the development of a mathematical material learned (Clements & Sarama, 2004).

This study aims to describe the perception of junior high school / MTs mathematics teachers on learning trajectory (learning flow) in mathematics learning. In the short term, the perception of junior high school / MTs mathematics teachers on learning trajectory in mathematics learning can be used as a reference or criterion in implementing mathematics learning that is adjusted to the learning trajectory that has been prepared. In the long run, the results of this study will be used to develop learning trajectories to be applied to all the material that exists in mathematics learning in schools.

Research Method

The research was a descriptive qualitative research. According to Bogdan and Taylor, qualitative methodology is called a research procedure that produces descriptive data in the form of written or oral words from people and observed behavior (Moleong, 2014). The research was conducted in order to describe the perception of mathematics teachers about learning trajectories. The subject of this research is a junior high school mathematics teacher who has taught at least 1 year with a total of 10 people. All subjects under study teach in different schools, which come from some cities in the province of Central Java. Data collection was conducted with semi-open questionnaires and was carried out in stages on 22 December 2017 - 6 January 2018 based on the questions derived from the questionnaire guidelines.
Analysis Interactive Model from Miles and Huberman used to analyze the data in this research. This model divides the steps into data analysis activities with several parts, 1) data collection (data collection), 2) data reduction (data reduction), 3) data presentation (data display), and 4) drawing conclusions or verification (conclusions). Data collection conducted by interviews using semi-open questionnaires. Furthermore, data reduction means summarizing, choosing key things, focusing on important things, looking for themes and patterns, and removing unnecessary things. This aims to provide a clearer picture in accordance with research needs. Then the presentation of data, which is in the form of organizing and arranging in a relationship pattern so that it is more easily understood and allows for conclusions to be drawn. Finally, drawing conclusions is based on the results of the analysis of previously collected data.

**Result**

The first result is about the knowledge taught by each mathematics teacher about learning the path as in diagram 1 below.

![Diagram 1. Teacher's knowledge of learning trajectory](image-url)

*Figure 1. Teacher’s knowledge of learning trajectory*
Based on figure 1, it can be seen that there are 4 out of 10 mathematics teachers who know what learning trajectory is. Furthermore, researchers find out more about the application of learning trajectory in learning. The results are presented in figure 2 below.

**Diagram 2. Teacher's knowledge of learning trajectory related to lesson plans**

- Using the same lesson plan in every year
- Using the same lesson plan in parallel classes at one level
- There is a section on the lesson plan that contains student response predictions
- Make improvements and development on their lesson plans

**Discussion**

Most teachers consider that it is important to develop lesson plans before learning activities are carried out. The purpose of preparing lesson plans, in general, is to plan learning activities to be carried out so that learning objectives can be achieved. Another goal is to facilitate and expedite the learning process to be carried out effectively and efficiently. This is reinforced by the percentage of teachers who use the same lesson plan in the next school year by 40%. The teacher realizes that the lesson plan is structured differently or there are changes to the lesson plan that is arranged for each turn of the school year. The lesson plan is used for one period of the school year and will develop a new lesson plan again in the next school year. Thus, the teacher has determined the learning objectives to be achieved in learning clearly through the planning that has been prepared.

On the other hand, teachers generally use the same lesson plan in parallel classes at one level, ie 60% of teachers think so. The reason why not using the
same lesson plan is that apart from the same curriculum being used, most teachers assume that students in parallel classes at one level have abilities that are not much different or even almost the same. The ability of homogeneous students makes teachers do not compile different lesson plans in each class. As many as 40% of teachers who use different lesson plans in parallel classes at one level argue in general that the reason for the difference in lesson plans is due to the different learning speeds of students, so it needs adjustment in using the learning method to be used. According to the teacher, it is very possible to use the same planning in parallel classes at one level but in classes that have almost the same characteristics.

Knowing the condition of students is needed in the process of preparing lesson plans. This is because the character of students in each class varies. The consideration of the condition of students also affects the selection of learning methods that will be used by the teacher. Then there will be time adjustments used at each stage of learning activities. This is consistent with the opinion of Sztajn, Confrey, Wilson, & Edgington (2012) that learning trajectory is expected to be developed through empirical research designed to identify the steps of activities that are very likely to be followed by students when they develop their initial mathematical ideas in a formal concept, with each track (path) of students.

The learning process will be different in classes with different conditions. Like the opinion of the 8th subject that the condition of students in each class will affect the learning process, so the lesson plan needs to be prepared with consideration of the condition of students. This is similar to the percentage of 80% of teachers who think that there is a lesson plan section that includes adjustments to student conditions. This is in accordance with Clements & Sarama (2004) which asserts that learning trajectory has three main parts, namely: mathematical goals, development pathways where students can develop to achieve learning goals, and a set of instructional or task activities, which matched with each level of students' thinking that can help students to develop thinking skills. Thus, it can be concluded that the teacher has considered and considered the conditions of
students to develop instructional steps that are in accordance with the developmental flow of students.

Furthermore, as many as 60% of teachers think that there is a section on lesson plans that predict student responses. The form of prediction of student responses in question is a response when the teacher asks and students answer questions from the teacher. The response prediction can be in the form of how students respond when given a question, how students analyze the question, and so on. In addition to predicting students' answers when the teacher asks, the student's questions that appear can also be predicted by the teacher. Like the opinion of the 10th subject that the prediction of student response can be known by the teacher when students ask what questions after the teacher explains a material and provides a stimulus so that students ask. In addition, student response predictions can be known when responding to presentations made by classmates. Although in the lesson plan there is a section that contains student response predictions, in general, the teacher does not write down any form of response prediction in writing on the lesson plan. Whereas in the mind of the teacher there is already a prediction of how students respond to learning activities. In this case, it can also be said that students' learning hypotheses are in the form of predictions of student responses to learning activities.

Almost all teachers make improvements and development on the lesson plan that has been implemented which is 90%. This shows that every teacher has the awareness to make improvements and development on the lesson plan that has been implemented. The general improvements made by the teacher in the form of evaluation of learning processes and results. In addition to evaluating, developing and improving the lesson plan, it is continued by analyzing the lesson plan section that cannot be carried out in the learning activities and reflects why the activity cannot be carried out. Like the opinion of the 3rd subject that the improvement and development of the lesson plan is done by evaluating learning. Next, find out if there are parts that are not appropriate, then analyze the lesson plan in the section that needs to be improved for the lesson plan in the next material. In terms of the achievement of the implementation of the lesson plan that is prepared also
becomes a consideration in determining whether the lesson plan will be used and developed again in the next school year.

Some parts that often become evaluation material in the lesson plan are part of the learning method used. According to some teachers, if the method used by the teacher has not made students active in learning activities, then the method needs to be reviewed or even replaced with other methods that make students more active in learning activities. However, when the method used is able to facilitate students in their active roles in the classroom, the method is likely to be applicable to other materials with various developments. Furthermore, in the core activities of learning, improvements are often made. This is due to the incompatibility of teacher predictions of the core activities in learning. This discrepancy occurs in an allocation of time that is not suitable so that not all core activities that have been arranged in the lesson plan can be carried out properly.

Based on the previous description, it is seen that the teacher basically has a clear goal in every learning activity. Learning objectives will help the teacher to direct students to the stage of thinking. The preparation of learning plans is also adjusted to the conditions of their students. In addition, the response of students to the learning activities predicted by the teacher through the preparation of these plans. Although the prediction is already in the mind of the teacher, it is not written in detail and systematically in the lesson plan. The preparation of such learning activities will help students to develop their thinking processes. Some of these important points refer to a picture of the transformation of student learning. This is in line that there are three main components in learning trajectory, namely learning goals (learning goals), learning activities (learning activities), and student learning hypotheses (hypothetical learning process) (Andrews-Larson, Wawro, & Zandieh, 2017).

As many as 5 out of 10 teachers who were the subjects in this study had heard the term learning trajectory. The teacher's knowledge of learning trajectory is (1) the 1st subject argues that learning trajectory is a learning process or process that must be done by students in order to understand the material that is well studied; (2) the 7th subject argues that learning trajectory is learning about how
children think and how the stages of thinking in children. When the teacher guides students it is expected to understand how students think, so as not to impose students' ways of thinking; (3) the 8th subject argues that learning trajectory is the stages of students' thinking patterns; (4) the 9th subject argues that every student has a learning flow or innate concept that he has from the learning process at the previous level/level in this case in his elementary school.

Furthermore, based on the opinion of the 9th subject, the material in mathematics when viewed from its content is a continuation of the material at the previous level and the material will continue and repeat as a cycle. According to him also, the challenge for teachers is to overcome the concepts that students have at the previous level is not appropriate but they assume that what is taught at the previous level is correct. Not only the material at the previous level, but the mathematics material in one chapter could be the initial knowledge for the next material. So that it can be concluded that the material with each other will have a mutual and the concept that has been learned will be the provision of initial knowledge for the next concept to be studied.

From the percentage of 50% of teachers who have heard and found out about learning trajectories, it turns out that 40% of teachers have applied it in the learning process in the classroom. As for some materials that have been used by the teacher, namely in the matter of building space, linear equations, Pythagoras, social arithmetic, straight line equations, algebra, sets, SPLDV, number patterns, cartesian coordinates, relations, and functions. However, the learning flow used by the teacher has not been fully detailed, especially in terms of predicting student responses. This is as said by the 7th subject that the learning trajectory is only used as a reference for how the teacher delivers the learning material. The real form of the learning trajectory is not actually written in the lesson plan.

The teacher's knowledge of trajectory learning will help the teacher in constructing student knowledge based on the plot that has been prepared by the teacher. Although the teacher does not yet understand in depth what is meant by learning trajectory or student learning flow, most teachers have indirectly used it in the process of preparing learning planning. The planning process has described
how students develop over time through a series of tasks and roles so as to bring more goals and clarity about the concept of learning in line with the opinion of Wilson et al., 2013 which states that teachers have knowledge of learning trajectories which increases knowledge so that it can guide students in deciding and improving their thinking skills.

Of the percentage of 50% of teachers who have heard and learned about the learning trajectory, in fact, 40% of teachers have applied it in the learning process in the classroom. As for some of the material that has been used by teachers, namely in space building material, linear equations, Pythagoras, social arithmetic, straight line equations, algebra, sets, spldv, number patterns, cartesian coordinates, relations, and functions. However, the learning flow used by the teacher has not been fully detailed, especially in terms of student response predictions. This is as said by the 7th subject that learning trajectory is only used as a reference for the order in which teachers convey learning material. This real form of learning trajectory is not actually written in the lesson plan.

Learning paths or trajectories allow the teacher to develop students' way of thinking that develops naturally so that the teacher will know the goals and activities carried out are within the student's abilities. Learning trajectory also provides an overview of theoretical considerations and components to teachers to make planning, concept formation, and facilitate learning (Clements & Sarama, 2004). Students' thinking in school will follow the pattern of the scientific level when learning or in the process of its development. The level pattern is learning through abilities and ideas in their own way. If the teacher understands the levels and activities that are in it, then students have built an appropriate and effective learning environment. Thus, the basis for the preparation of the learning trajectory is the pattern of the level.

The important thing that needs to be considered in the learning process is the flow of learning trajectory students' learning paths. Trajectory learning guides teachers to make learning decisions. Learning trajectory will provide a theoretical description of the components and considerations for the teacher to plan, conceptualize, and facilitate learning. In line with this, Clements & Sarama (2004)
states that learning trajectory also provides an overview of theoretical considerations and components to teachers to plan, conceptualize, and facilitate learning. By making learning trajectory a material consideration in delivering material, it will help students to be able to understand the material presented in its entirety.

**Conclusion**

Teacher's perception of learning trajectory gives more or less view that actually what the teacher has done through the preparation of learning planning is in accordance with the components that exist in learning trajectory. However, in the process of preparing the learning plan, the teacher does not write it in detail related to the learning activities that include students' learning hypotheses in the form of predictions of student responses to learning activities. Whereas in the mind of the teacher there is already a prediction of how students respond to learning activities. Teachers who know the learning flow of students have applied it to some learning materials.

**References**


Effectiveness of NHT And TPS Learning Models with Scientific Approach Viewed from Critical Thinking Ability

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**Abstract**

Mathematics is known as a basic science that is needed in everyday life. Given the important role of mathematics, the improvement of the quality of Mathematics education at all levels of education must always be pursued. This research aims to examine the effectiveness of numbered heads together (NHT) and think pair share (TPS) using the scientific approach and which of the two learning models is more effective in terms of the critical thinking ability of the students in circle learning. The research population comprised all grade VIII students of SMPN 2 Toroh. Of the population it is randomly taken two classes, class VIIIA and VIIID. To know the effectiveness of NHT and TPS using the scientific approach in each variable, the data was analyzed using a one sample t-test \((\alpha=5\%)\). Furthermore, to compare the effectiveness of NHT and TPS using the scientific approach, the data was analyzed using the multivariate analysis with T² Hotteling \((\alpha=5\%)\) and analyzed again using the independent sample t-test with Bonferoni criteria. The results of this research show that: (1) NHT using the scientific approach is effective viewed from the critical thinking ability; (2) TPS using the scientific approach is ineffective viewed from the critical thinking ability; (3) NHT using the scientific approach is more effective than TPS using the scientific approach viewed from the critical thinking ability. Based on the results of the study, the writer suggests the teachers should apply NHT with the scientific approach to improve their critical thinking abilities.

**Keywords:** circle learning, critical thinking, NHT, scientific approach, TPS

**Introduction**

Mathematics is known as a basic science and is an important requirement that is needed in everyday life. Mathematics is also a science that underlies the development of modern technology (attachment III of the Regulation of Minister of Education and Culture (*Permendikbud*) No. 58 of 2014). The importance of mastering mathematics is also emphasized by the National Council of Teachers of Mathematics (NCTM) which states that those who understand and can apply "Mathematics" well will have significant opportunities and choices to emphasize their future, because the mathematics competencies open the door widely toward more productive future (NCTM, 2000). In the attachment of *Permendikbud* number 58 in 2014, it is also stated that Mathematics should to be delivered to all
levels of students, starting from elementary school, to provide them with the abilities to think logically, analytically, systematically, critically, innovatively and creatively, and to cooperate. This competence is strongly required so that they can have the abilities to acquire, manage, and utilize information to live better in dynamically changing, uncertain, and very competitive state.

Given the important role and function of Mathematics, the improvement of the quality of Mathematics education at all levels of education must always be pursued. One effort that can be done is to teach Mathematics as best as possible. Mathematics learning is very closely related to the learning process and learning success or outcomes. This is similar to what Nitko & Brookhart (2011) have stated that the focus of learning should generate the students’ achievement that is as good as the learning process.

Essentially, teaching is helping the students gain knowledge, abilities, values, ways of thinking, means to express themselves, and ways of learning. Through the thinking process, it is expected that the students are be able to gather information relations recorded until an opinion is formed so that the conclusions can be drawn. As with any skill, critical thinking requires training, practice, and patience. Students may initially resist instructional questioning techniques if they previously have been required only to remember information and not think about what they know. Students who can critically think for themselves and solve real world problems (Ebindele, 2012). During the Mathematics learning process, the students are often faced with problems that cannot be resolved immediately. This is in accordance with what was stated by Shakirova (2007) that the critical thinking skill is very important because it allows the students to solve various social, scientific, and practical problems effectively.

Based on the data obtained from the National Education Standards Agency (BSNP) regarding the report on the results of the National Examination (UN) in the academic year 2011/2012 and 2012/2013 concerning the absorptive capacity of the circle material, there was apparently a significant decrease. In the academic year 2011/2012, there result was 77.29%, but in 2012/2013 there was decrease to 62.34%. Some factors that cause the decrease in the students’ achievement are the
Mathematics learning is not yet conducted optimally, learning Mathematics is limited only in the delivery of information so that it cannot develop the students' thinking abilities, and lack of interaction, communication, and active participation from the students. The learning is monotonous and tends to be boring. The students also do not have much opportunity in interacting, communicating, and actively participating in the learning process. As a result, the students feel happy when the Math teacher is unable to attend to teach them.

Responding to this problem, it is necessary to improve and innovate in the implementation of the learning process. The innovation means the teachers can help the students to build relationships in real life. When the students find the use of Mathematics as a medium to solve daily problems, they begin for something interesting (Anthony & Walshaw, 2009). One effort that can be done is to apply scientific approach, based on Permendikbud no. 65 of 2013 concerning Process Standards for Primary and Secondary Education which has signaled the need for a process guided by scientific approach norms.

The scientific approach in Mathematics learning involves observing, asking, gathering information, reasoning and communicating. To be able to conduct more optimal Mathematics learning, the educators should combine various scientific approaches that have been implemented with cooperative learning models. Chianson, Kurumeh, & Obida (2010) in his research said that cooperative learning approaches can capture the students' attention in classroom activities and give them enthusiasm to work tirelessly in Mathematics class. Cooperative learning can also improve memorization and remember better on the geometrical concept of the circle that has been taught to them.

The learning models intended in this study are Numbered Heads Together (NHT) and Think Pair Share (TPS) cooperative learning models. Cooper (2011) stated that: Numbered Heads Together makes exercises and brief reviews become more interesting and productive for all students in the class. This might add the depth to involve the students in more complex academic assignments as well. Numbered heads are easy to use when there are already some learning teams, but can also adapt easily to any situations where the teams are formed for a single
subject. It has six components: (1) planning; (2) forming a team; (3) assigning numbers to the students; (4) asking questions; (5) calling the "head together"; and (6) calling the number of responses of other students. Furthermore, Ishabu (2013) stated that NHT is a general work procedure, where the students form the groups of 4-5, and each number has one number, the teacher asks a question to be discussed within the group, and the teacher points to one number to represent the group. Haydon, Maheady, & Hunter (2010, pp.236-237) explained, "Using NHT strategies has an added benefit of improving students' active participation, social abilities, and cooperative abilities while reducing disruptive behavior". That is, using NHT strategies has additional benefits to improve the students’ active participation, social and cooperative abilities while reducing disruptive behavior.

The research conducted by Muinah (2011) in grade VII students of SMP N 3 Gantiwarno showed the results that NHT and TGT were effective for the learning outcomes and interest in learning Mathematics.

Meanwhile, related to TPS learning model, Arends (2012) suggested the steps of the TPS learning model are (1) thinking: the teacher gives questions or a problem related to the material and asks the students to spend a minute thinking for themselves about the answers of the problem. The students need to be taught that speaking is not part of thinking; (2) pairing: the teacher asks the students to pair up and discuss what they have thought about. The students during this period can share their answers if the questions have been asked, or share their ideas if certain problems are identified. Usually, the teacher allows no more than four or five minutes for each partner; (3) sharing: in the final step, the teacher asks the each pair of students to share what they have discussed with all students in the class. It is effective to just go around the room from a pair to another and continue until about a quarter or half of the pairs having the opportunity to report the results in front of the class.

Cooper (2011) stated that there are several steps in the TPS model: (1) planning the TPS; (2) explaining strategies for the students; (3) forming pairs; (4) asking questions and giving a sign of the "thinking" stage; (5) "sharing" cues; (6) having two sharing partners; (7) having a partner to report in front of the class;
and (8) continuing the lesson (if necessary, repeat steps 4-7). Theobald (2011) in his research, the Think-Pair-Share has a positive effect on the students’ participation. In addition, Ledlow (2001) added that TPS is an easy strategy to implement and involves many students actively in all types of classes. In his research, Wahyuni & Abadi (2014) also concluded that this model is effective viewed from the aspect of mathematical thinking in junior high school students.

Both of the learning models above are expected to create an atmosphere of active learning and active classroom interactions by combining scientific approaches that have activities of observing, asking, gathering information, reasoning and communicating. Based on several relevant theoretical and research studies, it is suspected that the NHT cooperative learning model with the scientific approaches can be better than the TPS model. To be able to determine which method is a priority to be applied in learning Mathematics to the improve students' critical thinking abilities, a comparison is needed.

Based on the descriptions above, the purpose of this study is to examine the effectiveness of NHT and TPS cooperative learning models with the scientific approach viewed from the students' critical thinking abilities. Furthermore, it is expected that this research will be able to contribute to the Mathematics learning, especially those related to TPS and NHT cooperative learning models with scientific approaches.

**Research Methods**

This was a quasi-experimental research with a non-equivalent comparison group design. This research was carried out in grade VIII students of SMP 2 Toroh from 16th February to 02nd April 2015. The population in this study was all eighth grade students of SMP 2 Toroh academic year 2014/2015, with the total of eight classes. Then, two classes were randomly selected into the sample, namely VIIIA and VIIID. The independent variable in this study was NHT cooperative learning model with scientific approach (NHT-PS) and TPS model scientific approach (TPS-PS), and the dependent variable was the critical thinking abilities (KBK). The instrument used for the critical thinking abilities test was three essay questions.
The data collection process was carried out by giving tests and questionnaires before and after being treated with NHT and TPS models with the scientific approaches. Furthermore, the data analysis was conducted by describing the data and analyzing inferential statistics of the data obtained. The description of the data was done by looking for the average, standard deviation, theoretical maximum score, theoretical minimum score, maximum and minimum scores of the data obtained. To test whether NHT and TPS cooperative learning with the scientific approaches were effective in terms of the critical thinking abilities, it was used one sample t-test with following formula:

\[ t = \frac{\bar{x} - \mu_0}{s / \sqrt{n}} \]  

Note:
\( \bar{x} \) = Average score of the students’ competencies
\( \mu_0 \) = Hypothesized Minimum Criteria Score (60 for the critical thinking abilities)
\( s \) = Standard deviation of the sample
\( n \) = number of sample members  

The decision criteria is \( H_0 \) is rejected if \( t_{\text{count}} > t_{\text{table}} \) or significance value <0.05. Effectiveness testing could be done if normality assumption and homogeneity test was fulfilled. For the data before and after treatment, Multivariate Analysis of Variance (Manova) test was done to see whether or not there were differences in the students’ initial abilities and effectiveness between the two experimental classes. The formula was:

\[ T^2 = \frac{n_1n_2}{n_1+n_2} (\overline{y}_1 - \overline{y}_2)'S^{-1}(\overline{y}_1 - \overline{y}_2) \]  

Note:
\( T^2 \): Hotteling
\( n_1 \): number of members of the first group
\( n_2 \): number of members of the second group
\( \overline{y}_1 \): average vector of the first group
\( \overline{y}_2 \): average vector of the second group
\( S^{-1} \): invers matrix of variance covariance
After obtaining the value of $T^2$ Hotteling, the value was then transformed to obtain the distribution value of $F$ using the following formula:

$$F = \frac{\bar{n}_1 + \bar{n}_2 - p - 1}{(\bar{n}_1 + \bar{n}_2 - 2)p} T^2$$  \hspace{1cm} (3)

$p = \text{number of dependent variables}$ \hspace{1cm} (Stevens, 2009, p. 151)

The decision criteria was, if $F_{\text{count}} > F(p, \bar{n}_1 + \bar{n}_2 - p - 1, 0.05)$, or the significance value $> 0.05$ then $H_0$ was rejected. After it was discovered that there were no initial differences in the abilities of the two sample classes, then the students' critical thinking abilities data after the treatment were tested to see whether there were differences in the effectiveness of learning with TPS and NHT models with the scientific approach in terms of the students' critical thinking abilities using Manova formula (2) and (3). Whereas if there was a difference in effectiveness, then independent sample t-test was done on the data using Bonferroni criteria to see which was more effective between the two models in terms of critical thinking abilities using the following formula:

$$t = \frac{\bar{y}_1 - \bar{y}_2}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$  \hspace{1cm} (4)

Note:

$\bar{y}_1 = \text{average score of the group NHT-PS}$

$\bar{y}_2 = \text{average score of the group TPS-PS}$

$s_1^2 = \text{variance of the group NHT-PS}$

$s_2^2 = \text{variance of the group TPS-PS}$

$n_1 = \text{number of the group members NHT-PS}$

$n_2 = \text{number of the group members TPS-PS}$

With the degree of freedom $n_1 + n_2 - 2$, $s_1^2$ and $s_2^2$ are respectively the sample variances for groups 1 and 2. However, before performing the above analysis, the assumption tests were first done on the data of the students' critical thinking abilities, including normality and homogeneity tests for both pre-treatment and pots-treatment. The normality test was conducted using
Mahalanobis distance test \( (d_i^2) \) with the decision criteria that the data were normally distributed if about 50% of the data had the value of \( d_i^2 \leq x^2(0,5, 3) \) (Johnson & Wichern, 2007, pp. 183-184). Homogeneity test of covariance matrix was done by using Box’s M test with decision criteria that the data were classified homogeneous if the significance value was greater than 0.05. All tests in this study used SPSS 21.0 for Windows and Microsoft Excel 2010.

**Results and Discussion**

The implementation of NHT and TPS cooperative learning with the scientific approaches in this study has been carried out according to predetermined learning activities. Although all of these activities have been completely done, there are still a number of constraints that limit the implementation of this research. The summary of critical thinking abilities data for the classes using NHT and TPS models with the scientific approach can be seen in Table 1 below.

**Table 1. Summary of Critical Thinking Skills Data (CTS)**

<table>
<thead>
<tr>
<th>CTS</th>
<th>NHT-PS Pretest</th>
<th>NHT-PS Posttest</th>
<th>TPS-PS Pretest</th>
<th>TPS-PS Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>25,13</td>
<td>66,26</td>
<td>27</td>
<td>59,40</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>16,64</td>
<td>11,99</td>
<td>14,42</td>
<td>12,14</td>
</tr>
<tr>
<td>Ideal maximum score</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Ideal minimum score</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Students’ maximum score</td>
<td>68</td>
<td>92</td>
<td>80</td>
<td>92</td>
</tr>
<tr>
<td>Students’ minimum score</td>
<td>4</td>
<td>40</td>
<td>4</td>
<td>36</td>
</tr>
</tbody>
</table>

Based on the table above, it is shown that the average score of achievement of critical thinking abilities before treatment (NHT-PS and TPS-PS) has not reached 60, and after the it is above 60 for the NHT-PS class, but the TPS-PS class has not yet reached the minimum score criteria \( (\leq 60) \).

The normality and homogeneity tests of the students’ critical thinking abilities before and after the treatment of NHT and TPS model classes with scientific approaches can be seen in Table 2 below:
Table 2. Results of Multivariate Normality Test

<table>
<thead>
<tr>
<th>Class</th>
<th>(d_i^2) before treatment</th>
<th>(d_i^2) after treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHT-PS</td>
<td>56.41 %</td>
<td>48.72 %</td>
</tr>
<tr>
<td>TPS-PS</td>
<td>47.5 %</td>
<td>52.5 %</td>
</tr>
</tbody>
</table>

Based on Table 2 above, it can be seen that around 50% of the data have the value of \(d_i^2 \leq x^2(0.5, 3)\). It means, the variable of students' critical thinking abilities before and after being given treatment for NHT and TPS model classes with the scientific approach has fulfilled the normal assumption of multivariate.

Table 3. Results of Uji Homogeneity Test

<table>
<thead>
<tr>
<th>Before Treatment</th>
<th>After Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box's M</td>
<td>10.073</td>
</tr>
<tr>
<td>F</td>
<td>1.608</td>
</tr>
<tr>
<td>Sig.</td>
<td>0.140</td>
</tr>
</tbody>
</table>

Based on Table 3 above, it can be seen that the significance value is greater than 0.05. This means the variable of students' critical thinking abilities before and after being given treatment has fulfilled homogeneous assumption.

The test results of the effectiveness of NHT and TPS cooperative learning with the scientific approach in terms of critical thinking abilities can be seen in the following Table 4:

Table 4. Results of One sample t-test

<table>
<thead>
<tr>
<th>Class</th>
<th>Variable</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHT-PS</td>
<td>CTS</td>
<td>3.258</td>
<td>0.001</td>
</tr>
<tr>
<td>TPS-PS</td>
<td>CTS</td>
<td>-0.313</td>
<td>0.622</td>
</tr>
</tbody>
</table>

Based on Table 4 above, it can be concluded that the NHT learning model with the scientific approach is effective in terms of critical thinking abilities. Meanwhile, the TPS learning model with the scientific approach is not so significant in influencing critical thinking abilities.

This is because during the implementation of the learning process using the NHT-PS model, there is the process of mutual discussion during the learning
while exploring information and thinking together. Each student presents their ideas, concepts, and difficulties to their groups when the learning process takes place. In the reasoning activities, each student in one group also helps each other in solving the problem, but there are also groups that only depend on one or two students. When thinking together is conducted, each student is seen to discuss the problems given, expressing their opinions, and completing worksheets carefully. However, when viewed from the aspect of critical thinking abilities, the TPS-PS model is not quite effective caused by several things such as some students are not focused in observing and thinking stage, whereas this stage is the main factor to think critically before coming to stage of pair discussion.

In addition, when the learning takes place, many students interfere with other pairs so that the worksheets fulfilling is not yet fully optimal. During the discussion, there are students who still feel awkward with their partner. This hampers the discussion process, expresses opinions, and even influences the completion of worksheets that must be done. There are still many students who do not want to pair up with others so that when they are being paired by the teacher, they are less enthusiastic about the learning process. This lack of enthusiasm influences the discussion especially at the stage of information gathering.

The test results on whether there are initial abilities differences between the two sample classes before being given treatment and the difference in the effectiveness of NHT and TPS cooperative learning with the scientific approach in terms of critical thinking abilities can be seen in Table 5 below:

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Treatment</td>
<td>1.275a</td>
<td>0.286</td>
</tr>
<tr>
<td>After Treatment</td>
<td>2.917a</td>
<td>0.040</td>
</tr>
</tbody>
</table>

Based on Table 5 above, it is shown that the significance value is greater than 0.05. The initial abilities possessed by both classes are the same in terms of students' critical thinking abilities. Furthermore, after the treatment, the significance value is 0.040 <0.05 so H₀ is rejected. This means that after being given the treatment, there are differences in the effectiveness of NHT and TPS.
cooperative learning models with the scientific approach in terms of critical thinking abilities. Then, there should be further testing to find out which learning model is more effective in terms of critical thinking abilities. The next test results can be seen in Table 6 below:

**Table 6. Results of Univariate Test**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Significance</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTS</td>
<td>0.007</td>
<td>Ho rejected</td>
</tr>
</tbody>
</table>

Based on Table 6 above, it can be seen that for the comparison of the two groups in terms of critical thinking abilities, the significance value is 0.007 < 0.05, so it can be concluded that $H_0$ is rejected. This means that the NHT-PS learning model is more effective than the TPS-PS in terms of critical thinking abilities.

**Conclusions and Suggestions**

Based on the discussion above, it can be concluded that (1) the Numbered Heads Together cooperative learning model with the scientific approach is effective in terms of critical thinking abilities; (2) The Think Pair Share cooperative learning model with scientific approach is ineffective viewed from the critical thinking abilities; (3) the Numbered Heads Together cooperative learning model with the scientific approach is more effective than the Think Pair Share in terms of critical thinking abilities.

Based on the results and findings of the study by considering its limitations, the writer suggests some following points: (1) The teachers should apply cooperative learning models in class, especially the NHT cooperative learning with the scientific approach by considering the students’ characters to improve their critical thinking abilities, (2) For the next researchers, they should anticipate something that can influence the results of the research and establish good coordination and evaluation with the school, so that any obstacle can be immediately overcome using the best solutions.
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The Ethnomathematics Implementation of Batik Patterns
A Joyful Mathematics Learning Implementation

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Abstract
Indonesia has a diverse batik art as a part of its culture. Wearing batik with proudly is one form to cultivate batik. Applying batik art through learning is one of method to introduce Indonesian culture from an early age. Mathematics as one of the main subject to teach has many various learning methods, the joyful and meaningful method is needed to make students more interest to learn and it will make improvement for the achievements in mathematics learning. Math art is one of the learning method that can be implemented in the class. The application of batik art in mathematics learning can be implemented as the form of math art. The purpose of this research is to implement ethnomathematics of batik patterns in mathematics learning to create a joyful and meaningful learning. The reasearch has been implemented in learning mathematics in seventh grade students of junior high school. The ethnomathematics implementation on mathematics learning has been implemented in the topic angle with the subtopic of constructing angle. This type of research is a descriptive research with a qualitative approach. The results of this research are the student’s products of constructing angle into batik patterns and the student’s responses to the learning provided with the interviews. The result of this study indicates that the ethnomathematics implementation of batik patterns increases a positive response in students. Students shows their curiousity in forming a batik pattern through the step of constructing special angles. The interview response from the students concluded that the implementation of ethnomathematics produced a joyful and meaningful learning in mathematics learning. A further study is needed to implement batik pattern in another topics of mathematics to make a joyful and meaningful learning.

Keywords: angle, ethnomathematics, joyful learning

Introduction
Mathematics has played an important role and so has become a human activity in the daily life. "Mathematics as human activities" (Soedjadi, 2007: 6). It is unfortunate if in the process of learning mathematics itself it becomes a frightening specter for students. Mathematics learning that can be directly related
to daily life is very necessary to improve so that the enthusiasm of students in learning mathematics results on the learning outcomes themselves.

Culture is a habit that contains elements of important values and the fundamentals inherited from a generation to a generation. The habits carried out cannot be separated from the application of mathematical concepts so as to provide unique and diverse results. This can be seen from the forms of cultural results that exist, especially in Indonesia such as art, building forms, carvings, jewelry. Fathani, 2009: 87 in Arwanto (2017) said that "So that mathematics is part of culture and history". The term ethnomatematics was introduced by Ubiratan D'Amбросio 1985: 45 in Arwanto (2017) which states that ethnomatematics is mathematics used in identifiable cultural groups. Ethnomatematics can be understood as a field of study that studies the relationship between mathematics and culture.

Batik as one of Indonesian cultural heritages has many studies related to mathematics, one example of the results of research conducted by Arwanto (2017) which states that Cirebon batik Patterns were carefully observed, so there can be found some mathematical concepts contained in them. The Mathematical concepts from Batik patterns that can be applied include the concepts of symmetry, transformation (i.e. reflection, translation and rotation), congruency, and angle. This mathematical concept is not only considered from the motive, but can also be indirectly observed in the way of making this motif, without realizing that the culture of batik craftsmen have instilled mathematical values in it.

Constructing angles is one of the topics studied by junior high school students in grade 7. In conventional mathematics learning, students will be taught steps of how to construct angles using rulers and compass then they copy the steps. Commonly, the learning method for this topics is demonstrative, where the teacher shows the step then the students copied to their worksheet. Actually it can be a fun topic for students because students can explore further about the sketch formed of the constructing angles and develop their creativities.
Based on the above problems, exploration of ethnomathematics in increasing students' enthusiasm for learning is needed so that cultural heritage can be maintained and learning mathematics becomes more joyful and meaningful.

**Methods**

This research is a descriptive research. This research was conducted at Insan Rabbany Junior High School in Bumi Serpong Damai South Tangerang. This study uses a phenomenological approach which aims to get as complete information as possible about the implementation of ethnomathematics in Mathematics learning at the secondary school level. Data collection method uses observation, interview, and documentation techniques then they are analyzed based on logical analysis. The stages of data collection in this study are the orientation stage, exploration stage, and member check phase. The authors dig up information about batik patterns in Indonesia and the etnomathematics studies that have been carried out then they explore the results of the study by implementing batik patterns to students through the step of forming special corner angle material.

Result of the research is the products produced by the students are presented and analyzed with the suitability of batik patterns. Author also did some interviews to students regarding the impressions after carrying out the learning and to figure it out their ability in understanding and applying the topics of constructing angle in form of math art.

**Results and Discussions**

Mathematics has a close connection to daily life, not only in the form of counting but also can be in the form of patterns, and images that can be interpreted in every aspect such as social, cultural and artistic. The results of ethnomathematic studies in batik that have been carried out, including:

**Transformation Learning for Middle School**

Based on the study of Sri Wulandari (2011) geometric shapes can be found in batik in the form of dots, lines and flat fields such as circles, ellipses, rectangles and so on. Artistic form in batik is produced through the transformation of a point,
plane or flat process through translation, rotation, reflection, or dilation. The summary of transformation learning through batik patterns can be seen on the table below.

Table 1. Summary of Transformation Learning through Batik Patterns.

<table>
<thead>
<tr>
<th>No</th>
<th>Transformation</th>
<th>Batik Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reflection application</td>
<td>Patterns of Batik Kawung</td>
</tr>
<tr>
<td>2</td>
<td>Rotation Application</td>
<td>Patterns of Papua Batik</td>
</tr>
<tr>
<td>3</td>
<td>Translation Application</td>
<td>Patterns of Kalimantan Batik</td>
</tr>
<tr>
<td>4</td>
<td>Dilatation Application</td>
<td>Sasirangan Kangkung Kaumbakan Batik Patterns</td>
</tr>
</tbody>
</table>

**Exploration of Madura Batik**

The study conducted by Zayyadi (2017) on several Madura batik patterns can be used as a tool to introduce mathematical concepts as well as geometric concepts so as to make it easier to understand abstract mathematical concepts.
including straight lines, curved lines, parallel lines, symmetry, dots, angles, rectangles, triangles, circles, angles and concepts of congruence like the ones in the following figures.

Figure 1. Transformation in Batik Madura (Zayyadi (2017))
Implementation of Batik Patterns in the Topic Lesson of Angle Construction.

The results of the study showed that batik patterns have a close connection with mathematics. Based on the study review above, the writers explore the etnomathematics of batik patterns by implementing them in mathematics learning in the topics of constructing angles.

In the implementation of the 2013 curriculum, learning is emphasized on scientific, inquiry and problem solving learning process. These three lessons are expected to help students to have a high level of curiosity. The process of inquiry learning is the process of moving from observation to understanding, then students use critical and creative thinking skills.

Batik patterns contain two-dimensional geometry. In batik activities, students can learn to construct their understanding of geometric concepts of transformation such as reflection, translation and rotation as well as angles that can be created based on students' creativity to describe flat fields in the batik activity. The writers explore more in the concepts of angles.

Culture-based learning becomes a method for students to transform their observations into creative forms and principles about the field of science. Scientific learning with etnomathematics is learning that guides students to observe, to ask questions, to collect information, to process information, and to communicate observations about the concept of transformation geometry and
angular formation through cultural aspect which use Batik Patterns. In this research, students are free to sketch batik patterns in accordance with the creativity of students by using the principle of steps to construct angle.

The steps of research of the scientific approach adopted to batik activities are:

1. Observing can be done through the activities of seeking information, reading, listening, and seeing to identify the things we want to know. In this research students observed and recognized batik patterns in Indonesia and identified the characteristics of each batik motif. In addition, students learned to the principle of steps to construct special angles using rulers and runners/compass.

2. Giving questions which build the students' factual, conceptual, and procedural knowledge through discussion, group work, and class discussions. In this research students discussed (among students in one group or outside the group, and/or teacher) about the characteristics of the batik patterns observed and discussed the possibility of using the steps the principle to construct angles and shaped them into batik patterns.

3. Collecting information or trying to increase students' curiosity in developing creativity, can be done through reading, observing certain objects/events/activities, processing data, and presenting the results in written, oral or drawing form. Students explored the principle of steps to construct angles and developed them into batik patterns.

4. Associating can be done through analyzing data, classifying, categorizing, concluding and predicting. Students showed the products they had produced.

5. Delivering the results of conceptualization in verbal form, writing, pictures, diagrams, or graphs, can be done through presentations, making reports, or performance. Students discussed and explored the batik patterns that had been produced.
Students’ activities and products are shown in the following pictures:

Figure 3. Batik patterns formed by constructing angle of 45°.

Figure 4. Students’ activities in constructing angle.

Figure 5. Batik patterns formed by constructing angle of 90° and 30°.
Figure 6. Batik patterns formed by constructing angle of 60° and 90°.

The result of the research is showed by the products produced by the students (figure 3, 5 and 6). The batik pattern is produced by the step of constructing special angle. The students creativity in forming the batik pattern shows that majority the students explored further constructing special angle of 90° and some explored the constructing special angle of 60° and 45°. The development of batik patterns by students are various, allowing for further exploration.

The analysis results from interviews with students as research subjects is shows that majority students has a positive impression, they feel more joyful and easier to understand how to construct a special angle. They feel more motivate to increase their creativity to produce a good batik pattern through the step of constructing special angle.

Conclusion

Etnomathematics has grown and developed in batik patterns. There are several mathematical concepts found in batik patterns. These concepts are the concepts of symmetry, transformation (reflection, translation, rotation, and dilation), similarity, angles and congruence. Etnomathematics of batik patterns can be implemented in classroom learning. The learning copes symmetry folding learning, transformation, Similarity, and congruence. By incorporating
Etnomathematics into learning, an alternative for educators in teaching students about mathematical concepts has been provided. Besides, it can increase students’ motivation for learning mathematics, which ultimately has an impact on meaningful learning. Etnomathematics implementation in mathematics learning can be applied in the scientific approach to the 2013 curriculum which can provide motivational stimuli and so the students can apply the material to construct special angles directly in the form of batik patterns. This means that the implementation of ethnomathematics in learning does not only create innovative and learning but also can help preserving culture. Further study is needed regarding the effect of ethnomathematics implementation on Mathematics learning on students’ motivation and learning outcomes.

Acknowledgements

We would like to thank to the management of SMP Insan Rabbany and ASA FATIHA foundation for opportunity and permission to conduct this research. Also, thank to our beloved students of SMP Insan Rabbany for their feedback.

Literature References


Analysis of Mathematics Communication of Junior High School Students from Three Cultures in North Sumatera

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Abstract
Mathematical communication is an important part of mathematics education and integrates in our daily lives. For example, buying and selling, games like "patok lele" or "petak lele" (Karo language) players must be able to calculate how short the stick is from the hole using a long stick. This study aims to develop communication skills and mathematical abstraction based on the local culture of North Sumatera. This article describes the 7th grade junior high school mathematics communication skills, then the data in this study is the basis for creating mathematical learning models. Data obtained from observation, interviews, and tests of mathematical communication skills from three regions in North Sumatera. Subjects in this study were 180 students of class VII junior high school. Findings from this study 1) Students are not able to explain in writing problems in the form of pictures, tables or graphs to a situation, ideas or ideas or mathematical models, from the results of the interview found that culture is not to refute the words of parents even though the words are not appropriate during this they hold makes them less able to communicate with words. Students are able to interpret problems in the form of pictures or tables because the teacher teaches with teaching aids related to daily life. Therefore, a learning model is needed by linking positive local culture to improve mathematical communication and mathematical abstraction.

Keywords: Communication mathematics, culture

Introduction
Culture is a knowledge and conception that is applied in the form of symbolic and non-symbolic communication, about technology and skills, the behavior of customs, values, beliefs, and attitudes of society that have developed from past history, and recycled it massively to overcome the problems of the times (Bullivant in Owen, 2010). Various cultural products of our ancestral heritage reveal artistic creativity that contains mathematical elements. Everyone
has applied mathematics in everyday life, because mathematics has socio-cultural-historical properties. Therefore, it is not wrong that there are some expert opinions which say that mathematics is part of culture. This is in line with research conducted by D’Ambrosio (1990) who innovated mathematics learning by combining mathematics learning with a culture called ethnomathematics.

North Sumatra is an Indonesian territory with quite diverse indigenous people. Three of the indigenous tribes are the Mandailing, Malay and Karo tribes. Each tribe has its own characteristics of culture, grammar and the system of everyday life. Examples of woven fabric from the three regions of the community

![Figure 1. Uis Karo](image1)

![Figure 2. Ulos Mandailing](image2)

![Figure 3. Songket Malay Sumatera Utara](image3)
Of the three woven fabrics in Figure 1, Figure 2 and Figure 3, illustrate that these three cultures have communication tools such as different languages. *Uis* in *Karo* and *Ulos* in *Mandailing* society has different meanings for each color and architect. For example, to attend the funeral ceremony *uis* used is black. Usually relatives or neighbors who see the quiz or *ulos* ask the wearer where the sorrow is. While in the Malay community *songket* or woven fabric is used at an event that describes the excitement or party.

Tessellation is a special pattern consisting of a geometrical build-up constructed without a separator or distance to cover a flat plane. Tessellation is a concept between branches of science namely mathematics and art. The woven fabric in the picture above is one of the concepts of correlation. According to Puspadewi, et al. (2014), learning mathematics, correlation includes several deeper mathematical concepts such as irregularities, irregularities, congruency, inner angles, and value of angles in a multitude, symmetry, translation, reflection, and rotation. The symbols and symbols used on woven cloth in the three cultures in North Sumatra are communication tools in the past cultural times.

Mathematical communication is one of the abilities that must be developed in the learning process of teaching mathematics, because mathematical communication skills will support mathematical thinking skills both written and oral. Improving students' ability to communicate a major goal of the mathematics reform movement (Brenner, 1998). NCTM (2000) states that the indicators of mathematical communication skills in mathematics learning are as follows: (1) the ability to express mathematical ideas through oral, written, and demonstrate them and visualize them; (2) the ability to understand, interpret, and evaluate mathematical ideas both orally and in other visual forms; (3) Ability to use terms, mathematical notations and structures to present ideas, describe relationships and situation models. Based on the data above that mathematical communication skills are very important things developed based on the local culture of North Sumatra, especially Malay culture, *Karo* and *Mandailing*. 
The problem formulation in this study is "how is the ability of students' mathematical communication to be reviewed from the development of local culture?" Those students' mathematical communication profile will be used to develop mathematical learning models. This research is the first phase of development to develop Mean-Ends Analysis (MEA) model based on local culture wisdom to improve students' mathematical communication and abstraction ability of Junior High School students in North Sumatera.

Research Methods

This research was conducted on February 2018 in three regencies in North Sumatra that can represent the North Sumatra culture. The subjects of this study were 60 students from junior high school 1, 59 students from junior high school 2 and 60 students from junior high school 3. The data were obtained from 2 problems of the validated communication abilities test, i.e. interpret problems in the form of pictures or tables (indicator 1), and to explain in writing the problem in the form of pictures, tables or graphs to a situation, idea or idea or mathematical model (indicator 2). The development method is used adapted from Plomp (1997). This paper is a research on the assessment stage of students' mathematical abilities based on local wisdom.

Table 1. Rubric of scoring test

<table>
<thead>
<tr>
<th>Score 4</th>
<th>The information/explanation given is correct and complete.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score 3</td>
<td>The information/explanation given is correct but not complete at the end of the completion.</td>
</tr>
<tr>
<td>Score 2</td>
<td>The information/explanation given is complete but there is still an error at the end of the completion.</td>
</tr>
<tr>
<td>Score 1</td>
<td>The information/explanation given is correct only at the beginning of completion and cannot be developed.</td>
</tr>
<tr>
<td>Score 0</td>
<td>No information/explanation at all</td>
</tr>
</tbody>
</table>

...
Results and Discussion

The analysis results of students’ mathematical communication ability of junior high school 1, school 2 and school 3 can be seen from Figure 4.

![Figure 4. Graphic of the average score of students’ communication ability](image)

In Figure 4, the Indicator 1 shows (describing in writing the problem in the form of pictures, tables or graphs to a situation, idea or idea or mathematical model) that the average score of students' communication ability that school 1 obtained is 0.18, while in school 2 the average score is 0.11 and in school 3 the average score is 0.77. For the problem of Indicator 2 (interpreting the problem in the form of an image or table), the average score of communication ability that school 1 obtained is 1.96, while school 2 is obtained the average score of 0.21 and in school 3 the average score is 2.9. From the data, the students' ability to interpret problems in the form of pictures or tables is better than the students' ability to explain in writing problems in the form of pictures, tables or graphs to a situation, idea or idea or mathematical model. This made the researcher want to analyze what students answered in Figure 5.

<table>
<thead>
<tr>
<th>School</th>
<th>Indicator 1</th>
<th>Indicator 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>0.18</td>
<td>1.96</td>
</tr>
<tr>
<td>School 2</td>
<td>0.11</td>
<td>0.21</td>
</tr>
<tr>
<td>School 3</td>
<td>0.77</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Figure 5. Student’s answer no 4

A frog first stood still. The place where the frog stands, let's say the zero point. The frog can jump left or right. One jump away 5 units. The frog has jumped left and is on the 25th side of the zero. How many times do frogs jump? Explain how you solved the problem.
In the Karo region on February 24, 2018, after analyzing the questions that had been done by our students, the researchers asked three students randomly. Students K, L and M said for problem number 2 they were very confident that the question was a matter related to the number line. They say that usually the teacher teaches the number line material with the game, this game they often play at home or at school. Student K said that "The teacher asked us to provide long and short wood, the kurun wood is usually different for each group, the long wood is 25 cm and 30 cm. For short wood there are 10 cm and 12 cm. "Then we researchers asked again" What did you do with the wood? "Student L replied" The wood was made to patok lele, but was slightly different from the usual patok lele we play "The researcher asked" Where is the difference? "Student K" We chopped the wood short, then we calculated the distance with long wood "Simultaneously the three students answered with a laugh" We are very happy, Mom, when our teacher taught that way. So we remember more, mom. It turns out that mathematics can also “patok lele.”

The Serdang Bedagai area was conducted on the 22nd. The interviews were conducted to students. Students A, B and C. Student A said her answer was 25 divided by 5. Followed by the question of how you are sure of your answers. Student A "This is a matter of number lines, first my teacher taught me by using a rope and the teacher's teacher demonstrated the way to the left and right. Student B "I answer 125 divided by five, this problem is a matter of lines, but I don't understand making forward and backward. My teacher used to teach it using games. "Student C" I don't know how to do it "

Not much different from the two previous regions. It turns out that students who are able to answer problem number 2 are caused by remembering “Marcungkil's” game. This information was obtained based on the results of interviews with students P "It's easy (easy) bu number two, like playing marcil bu, we used to play in school at break hours, there we are like this, so we immediately remembered because our teacher also taught us like this is mom."
Based on the results of the interview, it can be concluded that learning mathematics will be very enjoyable and easily absorbed by students if the learning is associated with the culture of the local community. This is in line with the opinion expressed by Nur, et al. (2015: 1) states that “education and culture are an integral whole that applies in a society and education is a basic need for every individual in society”. Wahyuni (2013) research results say that the learning approach that is wrapped in local culture is very possible for students to understand the material more easily because the material is directly related to their culture which is their daily activities in society.

**Conclusion**

This research is held on three different regions of language and local cultural wisdom. Because the students are from the different local languages and wisdom culture, then the researchers want to learn about junior high school students' mathematical communication from third regions was different. The profile will be used to develop mathematical learning models to improve students' mathematical communication ability. If the profile of students is mathematical communication are different, then researchers will develop models and devices that are appropriate with the characteristics of each region. The results of this research showing the profile of students' mathematical communication evidently the same. The profiles are: 1) interpreting the problem in the form of pictures or tables because the teacher teaches with teaching aids related to daily life. 2) less able to explain in writing the problems in the form of pictures, tables or graphs to a situation, ideas or ideas or mathematical models, from the results of the interview, it was found that the culture was not to refute the words of the parents even though the words did not match what they had held made them less able to communicate with words. The results of the students' communication ability is influenced by the local cultural wisdom of a region. Mathematical development occurs because of the challenges of life faced and the ability of human beings to communication. Every culture and local wisdom develops mathematics according to the needs of its own society. Thus, it is necessary to develop mathematical
learning models and tools that can improve students' abstraction based on culture and local wisdom abilities.

**Literature References**


Productive Creative Approach Using Concept Card Media in Seventh Grade of Junior High School

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Abstract

The background of this lesson development is based on fact that this time learning activity is still based on teacher centered, not involved student actively. The aims were: 1) to describe lesson steps using “Concept Card” media; 2) to know the learning achievement especially the mathematical literacy ability. The lesson development was conducted at 7H Junior High School 2 Banjar Negara during four time learning. Best Practice design is used for this lesson development. Data collecting technique used was written test that measure mathematical literacy ability. It consists of ten number of multiple choice and five number of essay. Data analyzing technique were used from average and percentage of test. The result of this lesson are: 1) begin with student activity to make a group, then reconstructed concept card collaboratively, the last is individual task to make a mind map; 2) the result of test show that two student get the highest score 96, the average become 79.29 or increased 7.55 (10.52%); and 3) first, the completness clasically is 55.88 and now become 76.47. The conclusions of this best practice was productive creative approach using Concept Card media is effective to improve student activity and learning achievement especially in mathematical literacy ability.

Keyword: Mathematical Literacy Ability, Productive Creative Approach Using Concept Card Media

Introduction

Mathematics as one of basic lesson for student in elementary and intermediate school not only talk about counting and using a formula to solve the problem. But to develop student competence by using mathematical concept to solve daily problem. In line with this, “Permendiknas No.22 Tahun 2006” stated that mathematics is need to be given for student since Elementary, in order to be able to: 1) understand the mathematical concept; 2) use a reasoning in pattern and characteristic, doing manipulation in mathematics to made generalization, arrange proof or explain an idea and mathematical expression; 3) solving problem that consist of the ability to understand the problem, design the mathematical models, solving the models and interpreting the solution; 4) communicate an idea by symbol, table, diagram or other media to explicated the problem; 5) appreciated the useful of mathematics in life that is curiosity, attention and interest in
mathematics, with persevere and confident in problem solving; 6) thinking logically, analytically, systematically, critically, creatively and able to working together in a group.

Based on that statement, the essence of mathematics learning is not just counting and solving routine problem. But the competences need to be owned in order to employ mathematics in everyday life even in complex problems. In this time, that competence called mathematical literacy. The students said literate on mathematics, when they are not only know about mathematics, but able to apply their mathematical concept in daily life.

In fact, writer as a mathematics teacher aware that during this time mathematics learning has not been fully in accordance with the nature of mathematics learning. It looks from teaching practice in writer’s school. According to the writer observations obtained: 1) During eighty minutes, sixty minutes used to explain the content, to give example and then doing the exercise; 2) Learning has not actively involved student, showing low enthusiasm and passive student; 3) The exercise only emphasise in retention and understanding, the learning process has not been able to develop mathematical thinking skills to a higher level.

This situation encourage writer to innovate and designing learning that is able to engage student actively so that learning capacity will develop and increase. Furthermore, Huda (2014) stated that learning process which involved student actively can stimulate brain so that they will learn mathematics meaningfully, then the retention will be much more lasting.

Using media in mathematics learning makes students more enthusiastic, interesting, and generate student motivation. More of that, the student can easily understand the concept. Student not see mathematics as a difficult lesson anymore and not consider that mathematics is about number, calculation and formula. That positive attitude will makes student easily to develop mathematical literacy ability (Abidin, Mulyati, & Yunansah, 2017).
Those argument and finding above encouraged writer to conduct a lesson development by implementing productive creative approach using concept card media to improve mathematical literacy ability on rectangular of seventh grade.

**Theoretical framework**

**Mathematical Literacy Ability**

Mathematical literacy not only limited on ability to recall the basic facts, using the memory algoritm dan doing simple counting, but involve more understanding aspect (Abidin, Mulyati, & Yunansah, 2017). Moreover, De Lange (De Lange, 2006) conducted that mathematical literacy covers all of concept, procedure, facts and mathematics tools, in counting, number or space. Mathematical literacy emphasize on how student use mathematical knowledge to solve their daily problems effectively.

**Productive Creative Approach Using Concept Card Media**

Productive creative approach in this learning practice is emphasize on students thinking activity that involved cognitif and afective skill so that student makes more creative to collect information, modification or finding solution to encourage logical, critical and creative thinking in order to solving problem effectively. Concept card media in this learning pratice is learning media to help student to reconstructed by student themselves actively based on their privious knowledge.

**Method**

This lesson development aims to describe lesson steps using “Concept Card” media; to know the learning achievement especially the mathematical literacy ability. Whereas the subject of this lesson development was conducted at 7H Junior High School 2 Banjarnegara in 2017. Best Practice design is used for this lesson development. Data collecting technique used was written test that measure mathematical literacy ability. It consists of ten number of multiple choice and five number of essay. Data analizying technique were used from average and precentage of test.
Result and Discussion

Lesson development by implementing productive creative approach using concept card media to be held in Junior High School 2 Banjarnegara during four times, on Friday March 31’2017, Saturday April 1’2017, Friday April 7’2017 and Saturday April 8’2017. Writer doing preliminary lesson which are prepare the lessons plan, learning media and the assessment after learning.

The steps of lesson development by implementing productive creative approach using concept card media which are: begin with student activity to make a group, every group get six concept card and two rectangular. Then they work together to reconstruct the card become whole concept in available paper, and manipulate the rectangular become another shape to find how formula the area of shape. The last is individual task to make a mind map.

Writer use written test to get data from the lesson development. The test consist of ten number of multiple choice and five number of essay that measure student mathematical literacy. The test consist of reasoning, rectangular concept and fact that implementing to solve problem in daily live. Moreover, this test as a benchmark for the success of mathematical learning in rectangular topics. This test held on the end of the development lesson. Written test of mathematical literacy before and after development lesson was illustrated in Table 1.

<table>
<thead>
<tr>
<th>Pembelajaran</th>
<th>Hasil Penilaian</th>
<th>Ketuntasan Belajar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nilai Tertinggi</td>
<td>Nilai Terendah</td>
</tr>
<tr>
<td>Keadaan Awal</td>
<td>90</td>
<td>48</td>
</tr>
<tr>
<td>Keadaan Akhir</td>
<td>96</td>
<td>68</td>
</tr>
</tbody>
</table>

From Table 1 the writer found that the students taught by productive creative approach using concept card media performed higher score than before. There are 26 student get score up to minimum completion criteria (KKM) or 76,47%.
Generally, learning process is better than before implementing productive creative approach using concept card media. This development lesson gave good effect to improving the ability were presented on Figure 1.

![Figure 1. Result of Mathematical Literacy Ability](image)

From figure 1, the writer found that after implementing the lesson development the average became 79.29 or increased by 7.55 (10.52%). There are 26 students who got scores up to minimum completeness criteria (KKM) or 76.47%. Those findings indicated that productive creative approach using concept card media were successful in developing students’ mathematical literacy ability which is useful for students.

Productive creative approach using concept card media effectively involved the student in learning, unafraid to express their ideas, student learning collaboratively. Furthermore, using learning media make student learned enthusiastically. This positive attitude which performed during lessons will stimulate brain actively so that they can learn optimally. One of the studies related was reported by Huda (2014) stated that learning process which involved student actively can stimulate brain so that they will learn mathematics meaningfully, then the retention will be much more lasting. Moreover, Abidin, Mulyati and Yunansah (2017) stated that positive attitude will make students easily to develop mathematical literacy ability.
Conclusions

Based on the lesson development, the writer conclude that: 1) Learning steps by productive creative approach using concept card media begin with student activity to make a group, then reconstructed concept card collaboratively, the last is individual task to make a mind map; 2) the result of test that measure mathematical literacy, show that there are two student get the highest score 96, the average become 79,29 or increased 7.55 (10.52%).

Literature References


Investigating PjBL Models Towards Statistical Literacy Ability of Junior High School Students

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Abstract

The importance of statistics in everyday life and work place has led to calls for increased attention to statistical literacy in the mathematics curriculum. Statistical literacy in this study’s focus on the ability to understand statistical terms mean such as the use of simple statistical symbols, interpret the meaning of the information, and evaluate statistical results that permeate our daily lives. Teacher tends to use direct instruction model learning while they were teaching mathematics. Project Based Learning Project (PjBL)'s one of the learning models that beliefs by researcher can give good contribution for statistical literacy. The aims of this study as follows: 1) to find the difference of mean value before and after the implementation PjBL toward statistical literacy; 2) to describe statistical literacy ability of junior high school students. The sample of this study was 29 junior high school students of class VIII-K. The supporting instrument in this research was test question that consist of two diagrams with five questions. The method of this research was pra-experiment design one group pre-test post-test. Based on the result: 1) comparative two sample dependent analysis with $\alpha = 0.05$ has difference between mean value before and after the implementation PjBL learning model 2) the mean percentage result of students that satisfy statistical literacy definition as follows; pre-test result (understanding is 86,9%, interpreting is 43,4%, evaluating is 42,7%) and posttest (understanding is 89,7%, interpreting is 56,58%, evaluating is 50,34%). Those were concluded PjBL gives good contribution toward statistical literacy students.

Keywords: Project Based Learning Project (PjBL), Statistical Literacy

Introduction

Schools are being asked to prepare students to be flexible thinkers, to be lifelong learners, and to manage complexities of an uncertain world (Watson, 2006). Most of the learning model used by teacher while teach mathematics is direct instruction. Those learning model is not optimal to improve student understanding and the achievement of students. One of the success factors in improving learning achievement of students is to directly involve their contribution in the teaching process with the use of appropriate learning models. Successful
teachers are teachers who can implement learning models that match with the teaching material, student characteristics, and provide positive impact through the role of students increasingly widespread in the educational process.

According to Gould’s (2010) research, statistical data have different meanings for today’s students than for students 5-10 years ago. One of its possible reasons may also be considered as the problem of X-Y, and Z generation. This age group has special characteristic (Wolberg and Pokrywczynski, 2001) and can be efficiently taught with different methods (Nimon, 2007). Based on this, it is practical to gear the teaching methods to the students. For this, however, the results of the international statistical and general teaching methodology researches need to be known. In addition, teaching and learning of mathematics should emphasize student-centered approach that requires them to construct their own knowledge and ability to think mathematically. One of learning model that implement student-centered approach is Project-Based learning (PjBL). Phyllis (1991) said that PjBL is a comprehensive approach to classroom teaching and learning that is designed to engage students in investigation of authentic problems. PjBL is centered on the learner and affords learners the opportunity for in-depth investigations of worthy topics. The learners are more autonomous as they construct personally-meaningful artifacts that are representations of their learning (Michael (2002)). Further Strives (2010) said that PjBL, is an instructional approach built upon learning activities and real tasks that have brought challenges for students to solve. These activities generally reflect the types of learning and work people do in the everydayworld outside the classroom.

Based on the characteristics, the PjBL model is in line with statistics learning that applies real life aspects. However, it is necessary to examine the extent to which the effectiveness of the PjBL model in statistics material is compared to the classical model often used by teachers. Statistics is one important subject that relevant to our daily life. Kovac (2008) explained the benefit of statistical literacy such as to understand the happenings of today and our environment, we need a certain extent of statistical literacy, which can include knowledge of basic statistical key figures, understanding concepts describing
society (e.g. inflation, unemployment, GDP, etc.), basic information about research methods (from the viewpoint of both use and interpretation), basic information about visualization (about both visualization and interpretation) and the knowledge about data sources and the ability to evaluate the used data sources. Frost (2013) said that statistical literacy is especially important in a digital age where students are constantly presented with statistics from a variety of competing sources. English and Watson (2016) explained that citizens without statistical literacy may not be able to discriminate between credible and incredible information and will have difficulty in interpreting, critically evaluating and communicating reactions to such massage.

Those reasons show that students need more than just learning how to calculate mean, median and mode in statistics. They need experience to know how to calculate the centre of data and to represent data in the right diagrams. Furthermore, teacher needs to enhance teaching statistical literacy with appropriate teaching learning model.

There are several definitions of statistical literacy by the experts and most of them are based on the definition given by Wallman (1993). Statistical literacy is the ability to understand and critically evaluate statistical results that permeate our daily lives – coupled with the ability to appreciate the contributions that statistical thinking can make in public and private, professional and personal decisions. From the definition by Wallman, it said that students must develop their mathematics ability in the common of understand statistical information and the social context in which the information is set.

Further, Gal (2004) introduced two components of adult statistical literacy: knowledge elements and dispositional elements. The former deals with people’s ability to interpret and critically evaluate statistical information, data-related arguments or stochastic phenomena they may encounter in diverse contexts, and when relevant. The latter component deals with their ability to discuss or communicate their reactions to such statistical information, such as their understanding of the meaning of the information, their opinions on the
implications of this information, or their concerns regarding the acceptability of given conclusions.

Chick, Pfannkuch, and Watson (2005) describe statistical literacy as ‘transnumerative thinking’ where students will be able to make sense of and use different representations of data to make sense of the world around them.

According to Garfield, delMas, and Zieffler (2010) claim that statistical literacy involves understanding and using the basic language and tools of statistics: knowing what basic statistical terms mean, understanding the use of simple statistical symbols, and recognizing and being able to interpret different representations of data. It is argued that statistically literate behavior is predicated on the joint activation of five interrelated knowledge bases (literacy, statistical, mathematical, context, and critical), together with a cluster of supporting dispositions and enabling beliefs.

Sharma (2017) explained while statistical literacy in classroom, students should be able to interpret results from studies and media report, pose critical and reflective questions about those reports and communicate reaction where required. Even if students do not perform a study, understanding statistics can help them assess the quality of other studies and the validity of their finding.

Based on the definitions that were given by the expert, literacy statistical in this research focus on the ability to understand statistical terms mean such as the use of simple statistical symbols, interpret the meaning of the information, and evaluate statistical results that permeate our daily lives.

The aims of this study as follows: 1) to find the difference of mean value before and after the implementation PjBL toward literacy statistics; 2) to describe statistical literacy ability of junior high school students.

Research Method

The method that was used in this research is quantitative method. This research employed pra-experiment design one group pre-test post-test. Population of this research was grade VIII of SMP 3 Sidoarjo and the sample was VIII K class that consist of 29 students. The research instruments in this study was tests.
To collect the implementation of PjBL towards statistical literacy, the researcher used five essay questions. Researcher gave pre-test and post-test while before and after the implementation of PjBL. To get the data of statistical literacy further, researcher calculate the percentage of each indicator of statistical literacy that focus on understanding, interpreting and evaluating the data that were given.

**Result**

This research was held at SMPN 3 Sidoarjo by involving one class eighth grade students that consisted of 29 students. In the experimental class there were two tests, pretest and posttest with statistical literacy problems. In the experimental class before being given a post-test, students were given a treatment in the form of a PjBL model. The PjBL learning model requires students to play an active role to do a project in a group. In these activities students were asked to analyze data from BPS (Central Bureau of Statistics) based on the results of the National Socio-Economic Survey of 2016. The data includes data on the education, health, plantation, livestock, agriculture and population sectors. Each group students are observed different data to do a descriptive analysis of the mean, median, mode, quartile, range, interquartile reach, and quartile deviation. They also make a diagram that suitable with their data that they got. The following were some pictures of diagrams that they made.

![Figure 1 Diagrams](image)
Each group was made histogram to represent the data that they made. Those happened because students are familiar with histogram and they thought that histogram is suitable to represent for every data. By the implementation of PjBL activity, students also used statistical literacy skills such as understanding in central tendency, interpreting while present the results of central tendency and diagrams of the data they obtain, and evaluate when concluding the work their project. Each group done correctly calculate the mean, median, mode, quartile, range, interquartile reach, and quartile deviation from the data they obtain. Only one group tried to use Ms. Excel to find the results of the central tendency. They also illustrate the result in the bar diagram by using Microsoft Excel application.

![Figure 2 Calculating the centered of data by using Ms. Excel](image)

Most students only mention the highest data value and the lowest data value without further data growth predictions when they were interpreting the data from the diagram that has been made.

Based on the results SPSS 20.0 analysis on pretest and posttest data, the results showed that the posttest value (77,45) was that higher than the pretest value (60,90).

Before doing a comparative analysis of two dependent samples or commonly called t-dependent, first the assumption is tested, namely the
assumption of normality. In testing the assumption of normality using the Kolmogorov-Smirnov technique, the hypothesis is as follows:

\[ H_0 \text{ : the data is normally distributed} \]
\[ H_1 \text{ : the data is not normally distributed} \]

**Table 4. Test of Normality Data**

<table>
<thead>
<tr>
<th></th>
<th>pretest</th>
<th>posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Normal Parameters$^{a,b}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>60,90</td>
<td>77,45</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>19,680</td>
<td>18,204</td>
</tr>
<tr>
<td>Absolute</td>
<td>,157</td>
<td>,167</td>
</tr>
<tr>
<td>Positive</td>
<td>,157</td>
<td>,108</td>
</tr>
<tr>
<td>Negative</td>
<td>-,127</td>
<td>-,167</td>
</tr>
<tr>
<td>Kolmogorov-Smirnov Z</td>
<td>,846</td>
<td>,900</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.471</td>
<td>.392</td>
</tr>
</tbody>
</table>

Based on the results of the analysis using Kolmogorov-Smirnov in Table 1, it can be seen that the significant probability of pretest activity is 0.471 and posttest amounted to 0.392, both values greater than 0.05, which means that $H_0$ is received that may otherwise normal distribution of data or assumptions of normality are met.

By the fulfillment of the normality assumption, it can proceed to the next parametric analysis using t-dependent test or comparative analysis of two dependent samples. The hypothesis used in this analysis are:

\[ H_0 \text{ : There is no difference in the mean scores of pre-test and post-test with the application of PjBL learning model for statistical literacy skills} \]
\[ H_1 \text{ : There is a difference in the mean scores of pre-test and post-test with the application PjBL learning model for statistical literacy skills.} \]
By using $\alpha = 0,05$, the $t_{\text{table}}$ as follows:

$$t_{\text{table}} = \left(\frac{\alpha}{2}; (n - 1)\right)$$

$$= \left(\frac{0,05}{2}; (29 - 1)\right)$$

$$= (0,023; 28)$$

$$= 2,048$$

Based on the results of data analysis using SPSS 20.0 in Table 2., $t_{\text{test}}$ value is -4,176, because the value of $t_{\text{test}}$ value ($-4,176 \leq t_{\text{table}} (2,048)$) it can be stated that $H_0$ is rejected. In addition to using the decisions can also be made through the probability of significance that is equal to (0,000), the probability value of less than 0,05 so that $H_0$ is rejected. From the results of the decision making it can be concluded that there is a difference in the mean scores of pre-test and post-test with the application PjBL learning model for statistical literacy skills.

Table 5. Dependent -t Test With SPSS

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
<th>Paired Differences</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Std. Error Mean</td>
<td>95% Confidence Interval of the Difference</td>
</tr>
<tr>
<td>Mean</td>
<td>-16,552</td>
<td>21,347</td>
<td>3,964</td>
<td>-24,672</td>
</tr>
<tr>
<td>df</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After dependent-t test on PjBL learning outcomes of students, researcher analyze five questions on pre-test and post-test to find the percentage of students that satisfy statistical literacy definition, i.e.: understanding, interpreting, and evaluating. The following table was the result:
Table 6. Statistical Literacy Analyze Result

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Pretest Understand</th>
<th>Pretest Interpret</th>
<th>Pretest Evaluate</th>
<th>Posttest Understand</th>
<th>Posttest Interpret</th>
<th>Posttest Evaluate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>86,2%</td>
<td>10,3%</td>
<td>10,3%</td>
<td>82,8%</td>
<td>38%</td>
<td>24,1%</td>
</tr>
<tr>
<td>2</td>
<td>86,2%</td>
<td>44,8%</td>
<td>44,8%</td>
<td>93,1%</td>
<td>62,1%</td>
<td>55,2%</td>
</tr>
<tr>
<td>3</td>
<td>89,7%</td>
<td>48,3%</td>
<td>48,3%</td>
<td>93,1%</td>
<td>62,1%</td>
<td>58,6%</td>
</tr>
<tr>
<td>4</td>
<td>82,8%</td>
<td>51,7%</td>
<td>51,7%</td>
<td>86,2%</td>
<td>58,6%</td>
<td>55,2%</td>
</tr>
<tr>
<td>5</td>
<td>89,7%</td>
<td>62,1%</td>
<td>58,6%</td>
<td>93,1%</td>
<td>62,1%</td>
<td>58,6%</td>
</tr>
<tr>
<td>Mean Value</td>
<td>86,9%</td>
<td>43,4%</td>
<td>42,7%</td>
<td>89,7%</td>
<td>56,58%</td>
<td>50,34%</td>
</tr>
</tbody>
</table>

Based on the results of the descriptive analysis in Table 3, it can be seen that there is a significant increase in students' statistical literacy abilities in all indicators, namely understand, interpret, and evaluate, this indicates that PjBL learning has a positive influence on students' statistical literacy abilities. So that based on the results of the study can be explained that the role of PjBL learning model on students' statistical literacy skills are as follows:

1. Provide students to read data in real terms from their surroundings.
2. Provide students to be actively involved in various statistical problems in daily life,

Conclusion

Based on the results of data analysis using SPSS 20,0 it can be seen that there are differences in the average value of pretest and post-test with the application of PjBL learning model to statistical literacy skills with a significance probability value of (0,000) where the value is less than 0,05, The mean percentage result of students that satisfy statistical literacy definition as follows; pre-test result (understanding is 86,9%, interpreting is 43,4%, evaluating is 42,7%) and posttest (understanding is 89,7%, interpreting is 56,58%, evaluating is 50,34%), Those were indicates that PjBL has a positive influence on students' statistical literacy skills,
References


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Early Mathematics Teachers’ Understanding of Curriculum

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Abstract

Curriculum knowledge is one of teachers’ knowledge that important in teaching and learning process. This is the key to successful learning in school. This research aims to describe early mathematics teachers’ understanding about definition and role of the curriculum in Indonesia. The research was a qualitative research using phenomenological approach. Data were collected through in-depth interview followed by focus group discussion (FGD) that involved 5 mathematics teachers from different schools and provinces in Indonesia. They have teaching experience between 1 to 3 years. The data were analyzed by Bogdan & Biklen approach. The early mathematics teachers define the curriculum as a tool in the implementation of learning. However, only a few teachers were able to explain the role of each component in curriculum correctly. Almost all participants can explain the role of the curriculum components namely content standards, process standards and assessment standards, except in the components of the graduate competency standards.

Keywords: curriculum knowledge, early mathematics teacher

Introduction

A teacher must have various knowledge that supports teaching activities in school. One of them is curriculum knowledge. Shulman (1986) stated that curriculum knowledge is one of the seven basic components that teachers must possess in carrying out teaching activities. Furthermore, Shulman said that a teacher would be able to improve students’ understanding of a teaching material / content if they had subject matter knowledge, general pedagogical knowledge, pedagogical content knowledge, curriculum knowledge, learning knowledge and characteristics, teaching strategy knowledge, and learning context knowledge. In line with this, An, Kulm & Wu (2004) suggested that good teachers are not only able to master subject matter and pedagogy, but teachers also need to master the characteristics of students, curriculum, educational goals, and how to improve student understanding in order to achieve curriculum goals. An, Kulm & Wu
revealed that the curriculum is important as a guide in preparing and implementing learning. While Ball, Thames & Phelps (2008) said that a teacher must have three important components so that learning runs successfully. One of the components is knowledge of content and curriculum, which is the integration between knowledge of mathematical content and curriculum. In addition, Kilic (2011) includes curriculum knowledge as one of the things that must be owned by mathematics teachers so that mathematics learning is successful.

Oliver (1977) said that the curriculum is an educational program that includes three important elements such as studies, activities and guidance. In the words of Oliver, the curriculum is a carefully thought out scheme of values which is an educational goal. In the opinion of Silberstein (1984), there are three levels of teachers' curriculum knowledge in terms of curriculum material 1) teachers at level 1 are able to determine ready-made curriculum materials (for example: learning strategies, textbooks, computer software, modules, worksheets, and others) according to the teaching situation, 2) teachers at level 2 are able to develop curriculum materials in a limited scope to complement or enrich ready-made materials, 3) teachers at level 3 are able to plan, design, and develop curriculum materials in a wide, where there is still a few or no teaching material at all. Before reaching these three levels, the teacher must know the definition and role of the curriculum for their profession as a teacher. It is in line with Ariav (1991) who said that curriculum knowledge is an important component of teacher pedagogy knowledge that teachers must have, this is no exception for early mathematics teachers.

In Indonesia, the education curriculum is very important because it becomes a reference for the implementation of education such as the development of content standards, process standards, educational assessment standards, standards of educators and education personnel, facilities and infrastructure standards, management standards, and financing standards (Permendikbud No. 20 of 2016). The results of Collopy's (2003) study reveal that teachers are able to interpret and mediate curriculum resource content well. One factor that supports the ability to use the curriculum is the curriculum knowledge of a teacher (Kim,
2007). In addition, research by Stein, Remillard, & Smith (2007) shows that there are variations in the use or use of curriculum materials by teachers. This is influenced by knowledge about students, how students learn, and about mathematics material (Charalambous & Hill, 2012). In addition, there are large-scale studies in the USA which reveal that there is an increase in student learning outcomes after 1 year of applying a new curriculum design (Agodini et al. 2010).

From the description above, there should be a research to describe curriculum knowledge of teachers. This study focuses on examining how early mathematics teachers define curriculum and explain the role of curriculum for those related to their teaching activities.

**Research Method**

**Design**

The research was a qualitative research using phenomenological approach. This research aims to describe early mathematics teachers’ understanding about definition and role of the curriculum in Indonesia.

**Participants**

FGD participants consist of 5 mathematics teachers from different schools and provinces in Indonesia. This participant consisted of 3 female informants and 2 male informants. The qualifications of the teachers who were participants in this study were mathematics teachers who had taught at school for 1 to 3 years.

**Instrument and Procedure**

The researchers begin with FGD and then followed up with an interview so that data were collected in detailed information. Researchers conducted FGD activities with teachers from various provinces when they were in the city of Yogyakarta at the same time due to an event. Therefore, we took the opportunity to gather them and do our research when they were having free time. FGD and interview topics consist of two sub-themes: 1) curriculum definition according to the early mathematics teachers, 2) the role of curriculum for teacher work. The instrument used is an interview guide in the form of a questionnaire related to the two sub-themes.
Data Analysis

The importance of curriculum knowledge for a mathematics teacher was reviewed by FGD participants to give their opinions regarding the understanding of the education curriculum. After that, researchers identify the level of curriculum knowledge belonging to early mathematics teachers. Then, the FGD results were analyzed using a qualitative analysis model by Bogdan & Biklen (1982). Four steps of data analysis according to Bogdan & Biklen, namely reducing data, identifying sub-themes, forming inter-theme relationships, and drawing conclusions.

Research Result

The results of data analysis are categorized in term of curriculum definition and the role of curriculum according to the early mathematics teachers. There are kind of early mathematics teachers’ responses about what is the definition of curriculum. Some of the responses explained the definition of curriculum as well. This refers to following opinion:

“The curriculum is a program or design lesson that is structured to achieve certain educational goals”

“The curriculum is a set of rules or guidelines made by the government used by education units”

“The curriculum is a set of subjects conducted by an education unit where there is a learning process”

“The curriculum is things that relate to how the learning process should be carried out and arranged in such a way as to produce quality education”

“The education curriculum is a guide and reference in the learning process”

Based on these five opinions, almost all mention the same keywords in defining the curriculum. That is the curriculum as a 'tool' and curriculum as 'reference for the implementation of learning'.

Result also gives information about the role of curriculum according to the early mathematics teachers. The participants were asked a number of questions related to the components of the curriculum and the role of each component. The
first question is the role of graduate competency standards. Two of the five participants were able to explain well what is meant by a graduate competency standard and its role. This can be seen from the following answers.

“The graduate competency standard is a minimum criterion about the abilities students must achieve when graduating from an education level”

“The graduate competency standard is the minimum limits of the ability of students to graduate or otherwise have finished completing an education level”

Both of them mentioned the right keywords, namely "the minimum limit of students' ability to graduate from an education level". While the other three respondents said that the graduate competency standard is a target that must be achieved in learning so that students graduate. They miss one key, namely 'minimum limit'. So they consider the standard of graduate competency as an absolute reference as a graduation requirement in every school at the same level. In fact, schools can determine their own graduation standards according to the origin of meeting the minimum criteria that have been set.

The second, third and fourth questions are respectively the role of content standards, process standards and assessment standards. In these three questions, most teachers are able to explain correctly according to the curriculum in Indonesia. The answers of respondents when asked what the definition and use of content standards are as follows:

"Standard content is a plot of material or mathematical topics for each level of a particular school used to determine learning goals"

"The content standard is the teacher's guideline in determining the material to be taught to students at certain levels"

"The standard content contains the names of mathematical topics that must be taught to students in certain levels of school in order to graduate"

"The standard content is the criteria used by the teacher as a reference in assessing the students have mastered the material that fits the class or not"

"Content standards are criteria for what mathematical topics students should achieve at a certain level."
The answers of the respondents when asked what the standard definition and uses of the process are as follows:

"The standard process is a guideline for teachers in choosing learning strategies, learning media, and learning resources in order to be able to plan and implement learning in accordance with student competencies in each level"

"The standard process contains guidelines for teachers in planning and implementing learning such as choosing a good learning method, appropriate learning media, and using textbooks so that students are able to achieve graduate competency standards"

"The standard process is the guideline in planning learning activities to implement them in accordance with the existing curriculum so that students reach the predetermined graduate competencies"

"The standard process is the teacher's reference in planning and implementing learning in accordance with the competency standards of student graduates in each level"

"The standard process is a reference standard for teachers in planning learning (choosing learning methods and learning media) and implementing learning plans so that students achieve graduate competence"

The answers of the respondents when asked what the definition and uses of the assessment standards are as follows:

"Standard assessment is a criterion for assessing student learning outcomes at the level of certain types of education used to determine procedures and instruments for assessing student learning outcomes"

"The standard of assessment is the criteria used by the teacher in determining the mechanism and instrument for assessing student learning outcomes at a certain level"

"The assessment standard is the criteria for student learning outcomes at certain levels of education. Assessment standards are used as a teacher's reference in determining the procedures and instruments used to assess students learning outcomes"
"Standard assessment is the criteria for learning outcomes that should be achieved by students at a certain level and used by the teacher as a basis in determining the mechanism of assessment and test questions / tests"

"The assessment standard is a criterion for assessing student achievement during school in the academic field. The teacher uses it as a reference for making assessment instruments (test questions) and assessment procedures"

**Discussion**

According to the research results, it can be stated that almost all participants can answer the researcher's questions well. This can be seen from the answers of the respondents when researchers asked about what is the definition of curriculum. All respondents were able to answer well. This is probably because the respondents have gained knowledge about the curriculum, besides that they have used the curriculum. So, it is normal for all respondents to be able to answer questions well about the definition of the curriculum.

Uniquely, not all respondents were able to mention each component of the curriculum even though they had been teaching for several years. There are two ambiguous components, namely content standards and graduate competency standards. They think the two components are the same, even though they are wrong. even though they should already know because the assumption they have taught for several years must have been to use every part or element of the curriculum Other questions from the researchers were answered well by the respondents. That is the question about the benefits of process standards and assessment standards.

It is expected that the teacher's ability to implement the curriculum is also good so that they are able to improve students' understanding of mathematics subject matter. This is in line with Retnawati (2018), that the teacher's understanding of the curriculum has a major influence on students' understanding of the subject matter.
Conclusion

Five early mathematics teachers can explain the definition of a good curriculum that is a device used as a reference for the implementation of learning. There are 4 curriculum components related to the implementation of learning namely the graduate competency standard, content standards, process standards and assessment standards. The participants were able to explain the role of content standards, process standards and assessment standards, but only two participants were able to explain the role of graduate competency standard well. The researcher suggests future research to analyze the curriculum knowledge level of pre-service mathematics teachers such as Silberstein (1984), then it needs to be compared with their curriculum knowledge when they have been teachers for less than 10 years or called early mathematics teachers. This is so that we can find out where the curriculum knowledge is obtained by the teachers. Are most of the lectures or from teaching experience.

References


The Implementation of the Discovery Learning Model to Understanding Students' Mathematical Concepts: Grade XI IPA

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Abstract

Understanding of mathematical concept is one of the purposes in mathematical that must be achieved in the learning mathematics. Based on observation, understanding of mathematical concepts students of Class XI IPA the majority was still low. That was due to the teacher-centered learning and students not active. When the teacher gives different questions from the example that are given, students cannot do it. The purpose of this study is to determine understanding of mathematical concept senior high school students’ who apply the Discovery Learning model are better than students who do not apply the model. This research was a quantitative with type was quasi-experimental with the design of Static Group Design. The subjects of the study were two classes in grade XI students at one of a senior high school in West Sumatera, Indonesia which consists of two classes one as experimental class and one as control class. Data collection was done by tests and documentation. One of the alternatives to improve students understanding of mathematical concepts was by implementing learning methods. The model could be used Discovery Learning model. The results of data analysis showed that student who used discovery learning understand the concept was better than students who did not use it in class XI IPA in one school in Padang. The achievement of the average value of the test results of understanding the mathematical concepts of the experimental class students was 74.46 while the average value of the control class students was 47.92. This shows that discovery learning model helps students guide their concepts.

Keywords: Concept, Discovery Learning, Understanding.

Introduction

Education is very important to determine the progress of a country. Developed countries have a high level of education and produce resilient and talented young generations. In the end, by having a high level of education will produce quality people, have high competitiveness between each other and will be the determinant of the future of the country. Mathematics is one of the sciences
that play an important role in the world of education. Mathematics is a means of thinking logically, with other mathematical sciences can develop rapidly [1]. Mathematics is one of the subjects that are compulsory both in elementary school, junior high school, senior high school, and partly at the university.

One of the goals of learning mathematics in schools that must be owned by the student is understanding the mathematical concept. Understanding of two words concept namely, understanding the concept. An understanding was defined as a process way, act to understand. While the concept of abstract ideas allows one to classify objects or events, the conceptual understanding of two words, namely, understanding and concepts. An understanding was defined as a process, a way, act to understand. While the concept of an abstract idea that allows a person to classify objects or events is not into the abstract idea [2]. In addition, the process of learning mathematics, understanding concepts is an important part of achieving learning goals. Understanding mathematical concepts was an important foundation for mathematical problems and everyday problems in thinking in solving problems [3].

Mathematics is usually regarded as a subject of great precision in which concept can be defined accurately to provide a firm foundation for the mathematical theory [4]. Understanding mathematical concepts are a competence in explaining the interrelationship between concepts and using concepts and algorithms, flexibly, accurately, efficiently and precisely, in problem-solving [5]. Understanding concepts is a key aspect of learning. Understanding mathematical concepts is a basic part that must be possessed by students in learning mathematics because of the interrelated concepts between one another. Mathematical concepts are arranged hierarchically, structured, logically, and systematically from the simplest concepts to the most complex concepts [1]. If students have understood the previous concept well then students will be able to understand the next concept. If students do not understand the understanding of the concept properly it will be difficult to achieve other mathematics learning goals such as using reasoning, communicating ideas, solving mathematical problems, and appreciating the usefulness of mathematics. The role of the teacher in schools is needed in
achieving the learning objectives of mathematics, especially understanding of mathematical concepts. Teachers must be able to prepare effective and meaningful learning. But there are students who do not understand the concept of mathematics well.

Indicators of achievement of skills in mathematical concepts used in this study include: (1) redefined the concepts that have been learned, (2) classifying objects based on whether the concepts are fulfilled, (3) identifying the nature of operations or concepts, (4) applying concepts logically, (5) providing examples or examples of counter (not examples) of concepts learned, (6) presenting concepts in many forms of mathematical representations (tables, graphs, diagrams, drawings, sketches, models, mathematics, or other methods), (7) connecting many concepts in mathematics and outside mathematics, and, (8) developing the important requirements and / or sufficient requirements for a concept [5].

Based on the observations of students in class XI in one school in Padang, it was seen that students could not work on the questions given by the teacher. This can be seen during the learning process, where students still lack active participation. The teacher explains the topic by giving a few examples of questions in front of the class. The learning process occurs in one direction, students only receive the topic given by the teacher even though students do not understand the topic described by the teacher. This can be seen when the teacher asks students about topic that was poorly understood by students, but only a few students ask questions while other students were silent and have no questions. When the teacher asks questions about the topic, students who do not ask were not able to answer questions from the teacher. Students who ask were the same students in each meeting.

When the teacher was ask student to solve the problem, just a few students that can solve it, while the other students just copy from the students who have finished. Students have not been able to do it themselves. Seen after students solve was done were examined many of the same answers with other students' answers. In addition students tend to memorize the topic given by the teacher without understanding how the topic was obtained, so the teacher considers the students to
have understood the topic that had been taught by the teacher. These factors cause students were constrained in continuing the learning topic. Students will experience difficulties in understanding the concept of the topic to be studied further which was still related to the earlier topic. For that teacher as someone who has an important role in carrying out effective and conducive learning must make alternative so that students understand mathematical concepts.

One solution that can be done to overcome the problem above was to use the Discovery Learning model. The Discovery Learning model as a teaching model that was useful for learning mathematics. Discovery Learning was learning based on discovery. The findings were obtained from the students themselves, where the teacher helped students to obtain their findings. The Discovery Learning model will help students remember concepts that they had found themselves, students were required to play more active role because that models will guide students to construct their concept.

The guided discovery learning model was a learning model that involves the active role of students in critical thinking to find their own knowledge with guidance from the teacher. A discovery activity was an activity that teaches concepts and principles through their own mental processes. Discovery Learning had seen as a promising way of learning for several reasons, the main reason is that the active involvement of students with domains will result in a better structured knowledge base of learners who oppose more ways [6]. This means that students will find their own answers to problems presented by educators [7]. The Discovery Learning model is a teacher led discussion process to enable students to discover and resolve issues that have been given to reach a conclusion [8]. Discovery Learning steps according to Shah are: (1) starting with the preparation phase which includes the teacher learning objectives and preparing the topic of learning (2) giving stimuli by teacher to cause students, (3) identifying problems (4) The next step students will collect data (5) data processing (6) prove it (6) generalization is a general conclusion, and the teacher will refine the conclusions made by students [9]. This will increase student activity in learning which required to think and practiced so that the concept is obtained.
The advantages of the Discovery Learning model are as follows: (1) students are active in learning activities because they think and use the ability to find the final result; (2) students understand the topic properly, because they experience the process of finding it themselves. Something gained in this way is remembered for a longer time, (3) finding itself creates a sense of satisfaction. This inner satisfaction encouragement wants to create more discoveries until the interest in learning increases, (4) students who gain knowledge with discovery methods will be better able to transfer their knowledge to various contexts, (5) this method trains students to learn more themselves [1]. The role of teacher in learning using the Discovery Learning model was to made students use ideas, concepts, and skills that had been obtained by previous students to found new knowledge. This will affect students' mastery of mathematical abilities. Students will gain direct learning experience through the concepts that had been able to improve their understanding of the concept.

At the beginning of the learning, students were conditioned to sit in groups that have been given worksheet. Student worksheets were one type of learning aids [7]. Previously students were asked to read books about the topic to be studied. Next, students were asked to work on worksheet within a certain period. Students with their team work on worksheets that have been given. When students have finished working on the worksheet, the teacher asks one of the groups to present the results of the group discussion. Previously each group might have a different answer called first answer. Other groups can ask a question or give suggestions to the presentation group, until all groups have the same answer in finding the concept in working on worksheet.

The purpose of this study is to determine understanding of mathematical concept senior high school students’ who apply the Discovery Learning model are better than students who do not apply the model.

**Experimental Method**

The research used a quantitative research approach, with type of research to be used was quasi-experiment. The research design in the research conducted was
Static Group Design [10]. In the research design, two sample classes were chosen; they were experimental class and control class. The population in this study was all students of class XI IPA in one of the State High Schools in Padang. The sampling was carried out using a random sampling technique. From the use of the technique, class XI IPA 4 was chosen as the experimental group and class XI IPA 3 as the control group. The independent variable in this study was the Discovery Learning model, while the dependent variable was the understanding of students' mathematical concepts [11]. The data used in this study was students' test understanding of mathematical concepts 11th grade of High School.

Both classes were given a pre-test to see that students in both classes had the ability to understand the same concept. Then one class was chosen as the experimental class and the other as the control class. Learning in the experimental class applies the Discovery Learning model while in the control class applies the learning model that the teacher uses. The implementation of Discovery Learning was conducted in 6 meetings. Then the two classes carried out the same post test, namely questions that contained understanding of mathematical concepts. The topic of this study is the distribution of group data on statistics.

Learning Implementation and Student Worksheets, as well as preparing research instruments namely the final students' understanding of mathematical concepts. The implemented of the phase of the activity of the researcher carrying out the learning in accordance with the plans that have been prepared sample classes. Meanwhile, the completion stage was to process the final test results of the two sample classes to find out the results of the treatment that has been given and analyzed the data obtained. After that draw conclusions from the results obtained. The instrument used in this studied was a test of understanding students’ mathematical concepts. The final test results are used by students to learn with Discovery Learning it with conventional learning. The final test results data on understanding mathematical concepts were analyzed using test statistics with data processing.
Result and Discussion

An understanding test of mathematical concepts was carried out at the end of the study in both sample classes, so as to obtain the results of understanding student’s mathematical concepts. The results of data analysis carried out can be presented in Table 1.

Table 7. Statistics of Final Test Results Understanding Student Concepts

<table>
<thead>
<tr>
<th></th>
<th>K</th>
<th>N</th>
<th>$\bar{x}$</th>
<th>S</th>
<th>$X_{\text{max}}$</th>
<th>$X_{\text{min}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>KE</td>
<td>37</td>
<td>74,46</td>
<td>11,52</td>
<td>96</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>KK</td>
<td>37</td>
<td>47,92</td>
<td>23,21</td>
<td>84</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

Based on Table 1, it can be seen that the average understanding of mathematical concepts of experimental class students was higher than the control class. This shows that the students' understanding of the experimental class concept is better than the control class, judging from the standard deviation. The standard deviation of the experimental class was lower than the standard deviation of the control class. This shows that the value in the experimental class was more same than the control class. It means that the understanding mathematical concepts student's the average were more same compare with understanding mathematical concepts student's in the control class.

Based on the results of the analysis, the data obtained from the student’s understanding of mathematical concept in the experimental class were normally distributed with P-value for the experimental class of 0.280 while the control class was not normally distributed with a P-value < 0.005. Because the data was not normally distributed, to know the understanding of student’s mathematical concepts that apply the Discovery Learning model better than students who applied conventional learning using the U Mann Whitney test with the help of software. The results obtained from the Mann-Whitney test that was P-value obtained is smaller than $\alpha = 0.05$, which is 0.000. Thus the conclusion $H_0$ is rejected. In other words it can be said that the understanding of mathematical concepts in class XI IPA students who used the Discovery Learning model was better than the understanding of student’s mathematical concepts that use conventional learning.
Discovery Learning made all students construct their own knowledge, especially in finding their own understanding.

More detailed data on students final test results in mathematical concepts on tables of percentage of students based on the scale obtained by students in the final test of understanding of mathematical concepts, can be seen in Table 2.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Class</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>E</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>E</td>
<td>21.62</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>51.35</td>
</tr>
<tr>
<td>3</td>
<td>E</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>16.22</td>
</tr>
<tr>
<td>4</td>
<td>E</td>
<td>56.76</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>75.68</td>
</tr>
<tr>
<td>5</td>
<td>E</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>16.22</td>
</tr>
<tr>
<td>6</td>
<td>E</td>
<td>10.81</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>18.92</td>
</tr>
<tr>
<td>7</td>
<td>E</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>13.51</td>
</tr>
<tr>
<td>8</td>
<td>E</td>
<td>2.71</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>40.54</td>
</tr>
</tbody>
</table>

Based on Table 2 it can be concluded that, in general students understanding of the concept in experimental class was better than the control class students, this seen from experimental class score. The percentage of experimental students in the class that reached the maximum scale was higher than the percentage of students in the control class seen on each indicator. Even though the indicator 1 and indicator 2 the average the indicator acquisition for highest scale was achieved still low both in the experimental class and in the control class only the majority who obtained the maximum scale. However, the percentage of students in the experimental class who obtained the highest scale was still more than the control class.
Understanding the mathematical concept of experimental class students were better than understanding the mathematical concept of students classes due to the influence of the learning model during the learning process. The average value of the experimental class was 74.46 while the average value of the control class was 47.92. This was because students in the experimental class used the Discovery Learning.

Based on the stages in the Discovery Learning model, namely the provision of stimuli, where at this stage students are faced with something that causes confusion. Then there was curiosity to investigate. The teacher gives students the opportunity to identify as many topic issues as possible relevant to the subject matter and the teacher also provides opportunities for students to gather as much relevant information as possible from both the book and from other sources. Furthermore, all information from reading, observation, and so on, are all processed and calculated with a group of friends to gotten answers. The next stage is proof that was done by presenting the results of the discussions conducted in groups. The final stages where based on the results of the discussion and the answers that had been made will be obtained in general in conclusion [3]. The application of the Discovery Learning models was accompanied by the provision of Student Worksheets to each group that has been provided by the teacher which contains stages to found the mathematical concepts to be studied. At the end of the worksheet there was an exercise for each student, where the purpose was to see if all students have understood the topic on that day, so that students will better understand the concept better.

**Conclusion and Suggestion**

Based on the results of the study, it can be concluded that students who study with Discovery Learning model show better results. This was because the learning steps in this model are able to make students find their own concepts and construct their knowledge, so that students can better understand the concept. So, it can be concluded that understanding the students' mathematical concepts by applying the Discovery Learning model is better than conventional learning in class XI IPA in one school of Padang.
Based on the research that has been done, several things are suggested, including: 1) Teachers are expected to be able to use the Learning model as an alternative in learning mathematics to improve students' ability to understand mathematical concepts, 2) for researchers who interested in continuing this research, it was expected to make attention to the first and second indicators concept of understanding concept and ensuring the topic was suitable for applying the Discovery Learning model.

Acknowledgements

The highest appreciation is given to the students from one of schools in Padang which kindly allowed us to collect the data.

References


Mathematical Literacy: Teachers and Pre-Service Mathematics Teachers’ Perception

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Abstract

The low results of Indonesian students’ mathematical literacy assessment at international level needs to be responded through the implementation of evaluations, improvements, and changes for teachers and pre-service mathematics teachers. These changes are inseparable from their views on the field of study to be improve mathematical literacy. The aim of this research is to describe and map the perception of teachers and pre-service mathematics teachers toward mathematical literacy. Describing how the relationship between mathematical literacy and enhancement of students’ mathematics achievement is the goal of this research as well. This qualitative study used descriptive approach. The data were collected through open questionnaire with three groups of respondents. They were undergraduate students of mathematics education, postgraduate students of mathematics education and mathematics teachers. The result of the research showed that: 1). Teachers and pre-service mathematics teachers’ perceptions about mathematical literacy showed that it play an important role in understanding and using mathematics in various context to solve problems, 2). Teachers’ perceptions about mathematical literacy were better than pre-service mathematics teachers, 3). Teachers and pre-service mathematics teachers showed relatively similar thoughts in terms of relationship between mathematical literacy and the improvement of students’ mathematics learning. In this case, teachers and pre-service mathematics teachers agreed that mathematical literacy is more than just remembering basic facts, memorizing formulas, doing simple calculations and so on that have previously been indoctrinated in mathematics learning.

Keywords: mathematical literacy, teachers perception, pre-service mathematics teachers

Introduction

The education quality of a country is often used as a development sign for the country. The ability of students to solve mathematical problems and their applications in daily life are representations of good or bad the qualities of education, especially in the field of mathematics education for students. The field
of mathematics and science education are believed to play important part in country’s development. Thus, each country wants to improve its quality of mathematics and science education.

Currently, at least there are two international scale assessments that assess students’ mathematical abilities namely TIMSS (Trend in International Mathematics and Science Assessment) and PISA (Program for International Assessment). Based on these two international level assessments, Indonesian students’ mathematical abilities are almost below the international average. This indicated that education in Indonesia is poor compared to most of the participating countries.

According to the IEA assessment (the International Association for the Evaluation of Educational Achievement) which measures students’ abilities in the field of Mathematics and Science in 2015, Mullis, Martin, Foy, & Hooper (2016) stated that Indonesia is ranked 45 of 50 countries for mathematics with an average score of 397 points, while TIMSS average standard is 500 points. Meanwhile, the assessment by OECD (Organization for Economic Cooperation and Development) which measured mathematics literacy, science, and student reading in 2015 PISA (Program for International Assessment), Indonesia ranks 62 of 70 countries for mathematics literacy’ average score 386 points, while the average score set by PISA is 490 points.

PISA conducts assessments every three years since 2000 toward 15 year old students. The focus of PISA is to find out students’ literacy in reading, mathematics and science and emphasize the usefulness in everyday life. According to OECD (2018), mathematical literacy is the ability of a person to formulate, use, and interpret mathematics in a variety of contexts, which involves the use of mathematical reasoning abilities, concepts, procedures, facts, and tools to describe, explain, and make predictions about a case, which helps a person to recognize the usefulness of mathematics in everyday life, and as a basis for consideration and determination of decisions needed by the community.

Based on Abidin, Mulyati, & Yunansah (2017) in the PISA context, mathematical literacy is one of the important components needed in solving PISA’
problems, because PISA’ problems require the ability to apply mathematical concept in various ways and situation, and reasoning ability and give the reasons how the problems can be solved.

Considering the importance of mathematical literacy and ability especially for students, students must be equipped with the ability to explore, suspect and reason logically and use various mathematical methods effectively to solve problems with various circumstances and needed in real life. Therefore, it needs serious efforts to improve students’ mathematical literacy ability. Recalling that PISA’ result related to mathematical literacy are still not satisfactory, so the root causes of the problem need to be identified. The teachers have an extra task to help students develop their mathematical literacy skills. In other words, teacher knowledge and competence are also needed to support learning that refers to the development of students’ mathematical literacy.

Based on the problems, the purpose of this study was to describe and map teacher and pre-service mathematics’ teacher’ perceptions of mathematical literacy and their views on the relation between mathematical literacy and improving student’ mathematics learning.

**Research Methods**

This research is a descriptive study with a qualitative approach, in which this study describes the perceptions of teachers and pre-service mathematics teachers towards mathematical literacy. According to Bogdan and Taylor (Moleong, 2014) qualitative methodology is called a research procedure that produces descriptive data in the form of written or oral words from people and observed behavior. The research subjects were mathematics teachers and pre-service mathematics teachers and postgraduate students as many as 30 peoples.

We collected the data through questionnaires about the mathematical literacy perceptions of mathematics teachers and pre-service mathematics teachers, to find out and map their perceptions about mathematical literacy. According to Sugiyono (2017) “the questionnaire is a data collection technique that is done by giving a set of written questions or statements to the respondent to answer”. The
form of the questionnaire in this study was a semi-open questionnaire filled directly by respondents. Semi-open questionnaires are questionnaires which questions or statements are closed, followed by open questions.

Data analysis was carried out in three stages based on the Miles and Huberman model. First is data reduction, which means summarizing, choosing key things, focusing on important things, looking for themes and patterns, and removing unnecessary things. This aims to provide a clearer picture in accordance with research needs. Secondly, the presentation of data is in the form of organizing and arranging in a relationship pattern so that it is more easily understood and allows for conclusions to be drawn. Third, the conclusion is that which is based on the results of the analysis of data that has been collected previously.

**Result and Discussion**

This study is intended to obtain information about mathematics teacher and pre-service mathematics teachers perceptions about mathematical literacy. Where the subject consists of 10 people in each group of teachers, undergraduate students and postgraduate students, which is divided into several questions.

First about the knowledge by each group of teachers and pre-service mathematics teachers as shown in figure 1. Based on Figure 1, the analysis results of teacher and pre-service mathematics teacher knowledge on mathematical literacy showed that teacher knowledge was higher compared to undergraduate and postgraduate students, and even there were no teachers who answered maybe or did not know about mathematical literacy. While for postgraduate students there were some respondents who hesitant about their knowledge of mathematical literacy. Meanwhile, undergraduate students had no idea about mathematical literacy. This illustrated that knowledge of mathematical literacy of mathematics teachers is better than of pre-service mathematics teachers.
However, based on respondents' answers related to mathematical literacy knowledge, there were some opinions that inappropriate in looking at mathematical literacy. Like the answer from "GR2" subject, he argued that, "mathematical literacy is a systematic reading". Other answers come from the "GR9" subject which stated that "mathematical literacy is a reading activity before the learning processes". Meanwhile, there were also did not know about mathematical literacy, such as the opinions of "MS1" and "MS3" subjects who did not know about mathematical literacy and only learned about mathematical literacy from this research questionnaire.

The knowledge of mathematical literacy will direct teachers and pre-service mathematics teachers to apply literacy learning in classroom. So that the prior knowledge of teachers and pre-service mathematics' teachers regarding mathematical literacy can be used as guidelines and benchmarks when applying in learning. Therefore, the knowledge about mathematical literacy is very important to be possessed by the teachers and pre-service mathematics teachers when applying it in the classroom. Chapman (2012) states that teachers are expected to prepare real-world situations for students to make mathematical ideas that are
reasonable and acceptable to students. So that it can provide opportunities for students to recognize the relationship between mathematics and their lives.

Furthermore, regarding the views of teachers and pre-service mathematics teachers in looking at the relationship between mathematical literacy and students' mathematics learning. Results can be seen in figure 2.

![Figure 4 Graph of the views of teachers and pre-service mathematics teacher in mathematical literacy relationships with increased student learning](image)

Based on Figure 2, analysis results of the views of teachers and pre-service mathematics teacher in looking at the relationship between mathematical literacy and the improvement of students' mathematics learning, showed that the views of teachers and postgraduate students argued that there was a link between mathematical literacy and increased in mathematics student learning more than undergraduate students. On the other hand, overall none of the respondents argued that there was no relationship between mathematical literacy and increased student learning.

However, there are some of the respondents from teachers and pre-service mathematics teachers whether the undergraduate or postgraduate students who were by respondents 'answers to relationships between mathematical literacy and the improvement of students' mathematics learning. As according to “SG9” subject
which stated that "it is easier to explain when the child has read first". Another opinion from the “MS3” subject stated that "mathematical literacy is used to evaluate students' abilities"

Although the results showed that respondents did not believe there are relationship between mathematical literacy and improving students' mathematics learning, but in general the teacher and pre-service mathematics teacher response agree that there are links between the two. As stated by Lawrence & Calhoun (2013) that teachers need to show a link between the academic field and daily practice and integrate technology in it, so as to foster student skills in accordance with the demands of the 21st century.

The study about mathematical literacy is relatively new in Indonesia, where there have been many efforts made in order to improve literacy skills in schools. These efforts certainly cannot be separated from where the teacher knows about this mathematical literacy. Based on the information collected in this study, the teacher and pre-service mathematics teachers first encountered mathematical literacy notion from many things as shown in figure 3.

Based on Figure 3, it can be seen that the most answers come from teachers and postgraduate students, where they obtained the first knowledge about mathematical literacy from lecture material. Whereas for undergraduate students, generally recognized mathematical literacy from the internet.

For more details, the most teachers when they first recognized mathematical literacy came from lecture material. Then from the internet, seminars or workshops, training, mass media and friends. While for postgraduate students, most came from lecture material, and followed by internet, seminars or workshops and mass media. For undergraduate students, the first time they knew mathematical literacy from the internet. Then from lecture material, seminars and workshops, training, mass media and friends. However, from this undergraduate student group, there were several respondents who claimed that they never had learned about mathematical literacy, and even had it known through this research questionnaire.
Furthermore, there were several statements related to mathematical literacy such as mathematical literacy skills are important to be trained in mathematics learning, mathematical literacy skills are related to the context of everyday life, mathematical literacy skills can help students to interpret mathematics in various ways, mathematical literacy is related to the ability to read and write, and mathematical literacy can be developed by using appropriate learning methods. The results of these questions can be seen from Table 1.

Based on Table 1, it can be seen that generally teachers and pre-service mathematics teachers both provide students with positive responses regarding mathematical literacy links in mathematics learning. In general, it can be seen that teachers and pre-service mathematics teacher agree that mathematical literacy is more than just remembering basic facts, memorizing formulas, doing simple calculations and so on that have been indoctrinated in mathematics learning. And mathematical literacy is also closely related to ability to read and write, where this ability is the ability that is needed in everyday life and is the basis for all learning.
Table 9. Teachers and pre-service mathematics teacher’ perceptions related to mathematical literacy questions

<table>
<thead>
<tr>
<th>Number of questions</th>
<th>Teacher</th>
<th>Postgraduate student</th>
<th>Undergraduate student</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SA</td>
<td>A</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>60%</td>
<td>40%</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>50%</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>50%</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>30%</td>
<td>70%</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>40%</td>
<td>60%</td>
<td>-</td>
</tr>
</tbody>
</table>

SA : Strongly Agree  
A : Agree  
D : Disagree  
SD : Strongly Disagree  

So, in this case mathematical literacy can be said as an ability to express mathematical understanding and ideas as a result of the process of reading, interpreting, and interpreting the real situation that occurs into the scope of mathematics. So it is no wonder if Abidin et al. (2017) state that, "someone cannot be said to be a mathematical literate if he cannot apply his mathematical knowledge to solve problems in real life".

Conclusion

Based on the results of the discussion on the perceptions of mathematics teachers and pre-service mathematics teachers on mathematical literacy, it can be concluded that: 1). Mathematics teachers and pre-service mathematics teachers perceptions of mathematical literacy showed positive things, where mathematical literacy holds an important role in understanding and using mathematics in various contexts to solve problems. 2). In general, mathematics teacher's knowledge of mathematical literacy was better than the understanding of undergraduate and postgraduate students on mathematical literacy. Many factors influence this, there are the teacher has gained more experience related to mathematical literacy both in the implementation of the learning he did in the classroom and those obtained from
Mathematics teachers and pre-service mathematics teachers showed relatively similar thoughts in terms of the relationship between mathematical literacy and the improvement of students' mathematics learning.

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Utilization of Telegram Applications to Improve Student Achievement of Junior High School 2 Lahat in Mathematics Learning

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Abstract

The purpose of this study is (1) to describe the learning achievement of students who get mathematics learning using telegram applications, (2) describe the activities of students in mathematics learning that utilize telegram applications. The subjects of this study were 32 students of class IX.F SMP 2 Lahat in the 2018/2019 academic year. This research is a classroom action research consisting of two cycles, each cycle consisting of initial observation, planning, implementation, observation, and reflection. The results of the study describe (1) the use of telegram applications in mathematics learning can improve student achievement from an average of 71.88 to 78.13; Class completeness increased from 75.0% to 87.5%, (2) Student activities that seemed dominant in mathematics learning made use of telegram applications, among others students were more discussing, daring to ask questions, ready to express opinions and be able to work together. Learning utilizing telegram makes students activities increase, especially in terms of discussion. Discussion in the telegram group made students easier to understand, confident in answering questions and presenting their work. This mean learning using telegram can increase student activity. This shows that the use of telegram applications in mathematics learning can improve student achievement.

Keywords: mathematics learning, student achievement, telegram

Introduction

Information technology and the devices that support it develop very rapidly. This development resulted in a change of orientation in the field of work and social life (Wijaya, Sudjimat and Nyoto, 2016) so that each individual must be able to adjust to changes that occur in the 21st century. Only individuals have the ability to think critically, creativity, communication and collaboration are good who will be able to adjust and face the challenges of life in the 21st century.

Education plays an important role so that every individual has the ability and creativity. Education also facilitates that each individual has the skills and skills (Mulya, 2012). Furthermore, Permendikbud number 54 of 2013 emphasizes that students must have the attitude, knowledge and skills competencies outlined in the education process standard. In this process standard learning activities are
carried out with a scientific method known as the scientific approach which is observing, questioning, gathering information, associating and communicating. In the education and culture minister's regulation number 68 of 2013, mathematics is a compulsory subject at the junior high school level. Mathematics subjects given to one of the subjects that can develop students' creativity are mathematics because mathematics can develop the ability to organize logic and have a deductive mindset. This is in line with the National Council of Teachers of Mathematics (NCTM, 2009) which states one of the objectives of learning mathematics to develop the ability to think critically and creatively.

But the reality in classrooms shows that students still have difficulty understanding the mathematical concepts taught so that their critical and creative thinking skills do not match ideal expectations. Difficulties of students in understanding mathematics, the writer found in class IX.F of SMPN 2 Lahat in the 2018/2019 school year. During learning takes place students look passive, just listen and pay attention to the activities of the teacher explaining the teaching material so that it is less actively involved in the learning process. Even though the involvement of students in the learning process greatly influences their learning achievement (Susanto, 2016).

The results of interviews with students obtained information that only a few have learning resources in addition to mathematics textbooks borrowed from the school library. They think that the book they borrowed is less attractive and the explanation is too long. The opinions that are commonly shared by students state that they consider mathematics lessons unattractive, difficult and always delivered by the lecture method. Even though Ratih et al. (2013) stated that students will be very easily saturated if the learning process is delivered by the lecture method so that the motivation and learning achievement of students becomes low.

The learning process that is not fun for students results in them not understanding the lesson well, so their learning achievement is low. Based on this, the author discusses with fellow mathematics teachers trying to find ways to make the learning process interesting for students and the learning achievement of
students increases. The results of discussions with several fellow teachers and paying attention to previous learning activities, the author tries to do an ionization in learning activities by utilizing the telegram application.

Almost every country conducts research to utilize technology and digital media. Schrum (2013: 90) states digital media is a term to describe the technology in the late 20th century, including, internet, mobile telephone, interactive television, computer games, and virtual worlds. The technological changes that occur at this time will continue throughout the history of human life, thus forming the practice of daily activities and relationships. One application that is developed and can be used in laptops, computers and especially smartphones is a telegram application.

The use of smartphones is a challenge for educators to develop learning models. Smartphone as a communication and information tool is widely used by school-age children. Research conducted by Utama (2015) in Surabaya states that students also want to utilize the gadgets they have for learning. Previously, the research conducted by Novianto (2013) found that students had cognitive motives and social interaction motives to use the internet in learning. this shows that students are always open to learning that utilizes smartphones and the internet. One form of learning model that carries out internet-based learning or better known as e-learning is Blended Learning. The Blended Learning model is part of e-learning by combining online learning (internet) with offline (face-to-face) learning. Online learning on Blended Learning strives for learning by integrating technology so that it can improve the quality of learning. This can be realized by utilizing the telegram application.

The telegram is a new generation application that combines instant messaging with cloud files. The telegram can operate on cellphone operating systems (Android, iOS, Windows Phone) and desktop systems (Windows, OS X, Linux). Users can send files in the form of text, images, audio, videos, stickers and any file format (pdf, doc, zip, mp3, etc.).

Telegram Application features such as Reply, Mention, and Hashtag can provide opportunities to build collaborative learning environments, where
flexibility will be created in learning. According to Garrison (2004), the simple model of Blended Learning is "the integration of offline (face-to-face) learning experiences with online learning experiences" which aims to take advantage of text-based and asynchronous face-to-face situations. This causes offline learning with additional materials and online learning tasks, using a different learning management system. The advantages of telegram applications include:

1. Group coordination of up to 1000 members.
2. Chat synchronization on all devices.
3. Can send any type of document, has no limit on media size and chat.
4. Can set the message time with a timer.
5. Store cloud-based media so that it allows accessing messages from multiple devices.
6. Telegram messages are highly encrypted and can be deleted according to settings.
7. Send messages faster than other applications.
8. Telegram servers are spread all over the world for security and speed.
9. The telegram has an open API and free protocol for everyone.
10. Until now telegrams are available for free, without subscription fees and no advertisements.

Figure 6. Telegram Application is Available on Playstore
When used as a learning media, the telegram is a transmission tool for distributing learning content. Learning content can be text, audio or video. The steps of the activity are as follows:

1. The teacher forms a learning group in the telegram application. Its members consist of several students. The teacher acts as a group admin.
2. Learning content is uploaded by the admin in the group that has been formed. When uploading content, learning objectives must be included.
3. Students can download learning content and can be learned anytime and anywhere. Learning activities take place independently and scheduled in class.
4. If there are things that have not been understood, questions can be asked in the group and discussed with other students with direction from the teacher.
5. Evaluation is carried out by learners by asking questions. Evaluation of groups both directly and in the form of files with include deadlines for gathering answers according to learning needs.

Students are quite familiar with social media applications so it is easy to do the communication process as part of learning. Thus, from the point of view of Blended Learning, social media provides an opportunity to support collaborative learning. The Telegram application can be accessed and used online easily, so online sessions not only provide additional material or separate tasks but to add new things, namely discussions for better face-to-face situation learning. With the use of the Telegram Application, students will produce unique interpretations and ideas and find their own ways of learning.

**Metodology**

Learning using telegram applications in class IX.F is in the form of Blended Learning. Blended Learning is learning that combines offline (face-to-
face) learning with online learning (telegram). The purpose of mixing offline and online learning is to support students' interpretation of concepts and understanding and use them as more varied learning resources. In this study, offline learning is done while in class or when learning takes place and online sessions when students and teachers use the Telegram Application outside the classroom. The Telegram application is used as a medium to stimulate students' motivation to learn and the media to discuss. Furthermore, this study will explore the role of Telegram applications as a medium of discussion in Blended Learning.

The subject of study are students IX.F SMPN 2 Lahat years lessons 2018 / 2019 amounting to 32 students. This research is a classroom action research on the Utilization of Telegram Applications to Improve Students' Achievement of SMPN 2 Lahat on Mathematics Learning material on the formation and form of roots. The study was conducted in 2 cycles consisting of problem identification, action planning, implementation, observation, evaluation and reflection. Face-to-face classroom action research was carried out on August 21, 2018 - September 12, 2018, on Monday and Wednesday, while the online discussion in the telegram group is held every Monday, Wednesday and Saturday every 16.00 -17.30. The research data was collected through observation, tests, and questionnaires.

Tests are carried out to determine student achievement in mathematics learning that uses the telegram. The test instrument adapted to the learning objectives of student achievement criteria is more than or equal to 70. if 85% of grade 9f students get a grade more than or equal to 70 then grade 9f is deemed to have achieved class completeness.

Observations in the classroom were carried out by two observing teachers using observation sheets. Observations were made to obtain student activity data during learning and during online sessions. The test is used to measure student learning outcomes after actions measured from the level of student learning completeness with the test tools compiled and developed by researchers. Questionnaire at the end of the study was given to students to find out the students' response to learning that uses telegram. Questionnaires were created using a 0-4 Likert scale.
Student activeness indicator in this study uses indicators of student activity according to Marhamah, Zulkardi, and Aisyah (2014) with offline and online modifications, namely: (1) Reading textbooks and worksheets, (2) Following learning well, (3) Writing (relevant to learning activity) (4). Discuss / ask questions between students and teachers (5), Discuss / ask questions with colleagues in groups / groups, (6) Work on questions, (7) Readiness of students to present their work, (8) Students reflect on learning, and (9) Reduced behaviour that is not relevant to KBM.

Irrelevant behaviours include irrelevant conversation, doing something that is irrelevant and daydreaming. Observation sheets are equipped with answer choices (5) always appear, (4) often appear), (3) sometimes appear, (2) rarely appear, (1) never appear. The highest score for each item is 5, so the maximum total score is 45. The average score of the observation results is calculated to be processed with criteria such as Table 1.

<table>
<thead>
<tr>
<th>Score</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very active</td>
<td>x &gt; 36</td>
</tr>
<tr>
<td>Active</td>
<td>27&lt; x ≤ 36</td>
</tr>
<tr>
<td>Less active</td>
<td>18&lt; x ≤ 27</td>
</tr>
<tr>
<td>Not active</td>
<td>x ≤ 18</td>
</tr>
</tbody>
</table>

Data obtained from observations and test results will be analyzed qualitatively, namely a data analysis where the findings are described in statements. A conclusion will be taken based on general trends.

**Result and Discussion**

The subject matter in cycle 1 is Powers of numbers, and root in cycle 2. Discussion activities are more active when using telegrams compared to offline sessions. This can be seen from the results of initial observations, which showed that students' activities were still small in participating in discussions. The
question-and-answer interaction only happened to a few offline students just like ordinary learning which only paid attention to the teacher's explanation. This shows that online sessions have a greater level of participation and help increase student activity in class.

Student activities in online sessions are more due to the habits of students who are accustomed to using messenger application groups. Students are not worried or shy in asking questions and answering good questions posed by students or teachers. By submitting writing in a group, it gives a perception that students can more easily manage writing before sending it in the group conversation. On the other hand, with the Telegram application feature both reply, mention helps students to minimize misunderstandings. Telegram discussions help students to get used to putting forward ideas so that there is an openness to each student.

Test results in cycle I and cycle can be seen in the figure 2.

![Figure 7. Average Value Of Students](image)

Figure 1 shows an increase in the average value of students, in the first cycle of 71.88 to 78.13 in the second cycle, an increase of 6.25. The percentage of class completeness also increased from 75.0% in the first cycle to 87.5 in the second cycle or increased by 12.5%. This shows that learning using telegram can
improve student learning achievement, both individual student achievement and class student achievement. This increase corresponds to the statements of Bruner (Surya, 2012) and Sudjana and Rivai (2011) that the use of telegram can increase students' learning interest to learn more so that there is an increase in student achievement. Telegram discussions make students dare to convey ideas, ideas or ask questions about mathematical concepts and pay attention to the opinions of other students.

Effectiveness is also seen from the results of observations of student activities. At the beginning of the first cycle, students were not yet active in discussing. Some students are also not ready to do the questions in front of the class. Some seemed doubtful about the results of their work. Likewise with the readiness of students to respond to the work of their colleagues. Students do not dare to refute or justify their colleague's answers. But at the end of the second cycle students have had the initiative to express ideas and answers, in discussions. Students also look ready to appear to present the results of their group work. In general, the development of student activities in each cycle is obtained from the observation of two observers seen in Figure 3.

![Figure 8. Student Activity](image-url)
The picture above shows that there was an increase in the average student activity score from a score of 29.5 with the active category in the first cycle to 36.17 with a very active category. The high average score of student activity is because students learn in groups both in class and when using telegrams. Telegram learning makes activities increase, especially in terms of discussion. Discussion in the telegram group made students easier to understand so that they were more confident in answering questions and presenting the results of their work in front of the class. This shows that learning using telegram can increase student activity.

**Conclusion**

The results of the study describe (1) the use of telegram applications in mathematics learning can improve student achievement from an average of 71.88 to 78.13; Class completeness increased from 75.0% to 87.5%, (2) Student activities that seemed dominant in mathematics learning made use of telegram applications, among others students were more discussing, daring to ask questions, ready to express opinions and be able to work together. This shows that the use of telegram applications in mathematics learning can improve student achievement.

**Reference**


Identification of Critical Thinking Abilities Using Ethnomathematics Problems

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Abstract

The Purpose of this study is to identify students' critical thinking abilities. This research is descriptive qualitative research. The subject of the research was 32 students of Yogyakarta Piyungan junior high school as many as 32 students. Data was collected using ethnomathematics problems and interviews. Data were analyzed based on five indicators of critical thinking ability, namely (1) the ability to provide simple explanations, (2) the ability to provide further explanation, (3) the ability to determine settlement strategies, and (4) the ability to make conclusions and (5) evaluations. The results of the study show that students' critical thinking ability have not been reached maximally. This is because there are indicators of evaluation capabilities that cannot be fulfilled by most students. Based on the results of student answers, only 25% of female students and 20.83% of male students were able to showed evaluation abilities.

Keywords: Critical Thinking, Problems, Ethnomathematics, Yogyakarta

Introduction

The 21st Century Partnership Learning Framework states that thinking skills are very important in this century. Considering the importance of these abilities, the Government of Republic Indonesia through Permendiknas Number 22 of 2006 which declared mathematics subjects need to be given to all students starting from elementary school so that they are able to have critical thinking skills (BSNP, 2006). These competencies are needed so that students can have the ability to obtain, manage, sort, review and utilize information to survive in a competitive situation and be ready to challenge (Widha, Sholihah, Martyanti, 2017; Syahbana A, 2012).
Critical thinking is cognitive skills that include the ability to interpret, analyze, evaluate, conclusions, explanations, and self-regulation (Faicon, 2010). Critical thinking is also a person's mental activity in collecting, categorizing, analyzing, and evaluating information or evidence in order to make a conclusion to solve a problem (Amir, 2015 & Lestari, 2014). Furthermore, Ennis grouped 12 critical thinking indicators into 5 major indicators, namely (1) the ability to provide simple explanations, (2) the ability to provide further explanation, (3) the ability to determine settlement strategies, and (4) the ability to make conclusions and (5) evaluations (Ennis, 1996; Costa, 1985).

Based on the school curriculum, one of the subjects that is able to facilitate students to develop critical thinking ability is mathematics. This is because mathematics has a material structure that is clear, coherent, logical so as to enable the development of students' thinking ability rationally, critically and objectively (Lestari, 2014 & Setiawan, 2012). Another reason, the concept of mathematical material can be applied in the context of everyday life. Students are asked to be able to make connections between mathematical problems with mathematical concepts and formulas to solve these problems, so students are required to think critically.

Mathematical problems are usually associated with questions that relate to everyday problems that are packed with story problems. This is because the question does not have a routine procedure that is known and uses an element of analysis in the use of certain rules / concepts used in the solution (Amir, 2015; Yanti, Prahmana, 2017).

In mathematics learning, students must be familiar with interacting with problem solving. Because with this, critical thinking abilities will develop. In addition, learning is not enough to only be able to facilitate the cognitive domain, but also facilitate other domains, such as the affective domain. It means to give meaning to mathematics with experience, the social life of students even touches the local culture and local wisdom. In this case we can associate mathematics with culture and local wisdom where students live. So that students understand how mathematics is adapted from a local culture. This concept is called
ethnomathematics. Through ethnomathematics, the teacher can facilitate the affective domain of students which is to foster a sense of love of students towards their culture as a form of a sense of nationalism (Richardo, 2016; & Marsigit, 2016).

Cognitive domains (critical thinking skills) and affective domains are very important for students, so teachers are always required to innovate in learning with models, strategies and methods capable of facilitating the domain. But, first identified the critical thinking skills of students so that the results are able to be a reference in determining the innovation of subsequent learning.

So in this study, researchers are interested in identifying students' critical thinking skills in solving ethnomathematical problems. Furthermore, the ethnomathematical problems in the context of Yogyakarta is the material of geometry. The results of this study are expected to be able to describe students' critical thinking skills through 5 indicators, namely the ability to provide simple explanations, the ability to provide further explanation, the ability to determine settlement strategies, and the ability to make conclusions and evaluations.

Method

This research is a descriptive qualitative research approach. The subject of this study was Piyungan junior high school students of class VII E totaling 32 students. Data was collected using ethnomathematics Problems and interviews. Before use, the instrument has been validated. Data were analyzed based on five indicators of critical thinking ability, namely (1) the ability to provide simple explanations, (2) the ability to provide further explanation, (3) the ability to determine settlement strategies, and (4) the ability to make conclusions and (5) evaluations.

Result and Discussion

Researchers have conducted research on class VII E with a total of 32 students with details of 8 male students and 24 female students. The students were given 5 questions of ethnomathematics problems in the context of Yogyakarta in the material of geometry that had been validated. Based on the results of student
answers and interviews, it was analyzed by classifying critical thinking abilities based on 5 indicators. The overall result can be seen in Table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Critical thinking Indicator</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>1</td>
<td>the ability to provide simple explanations</td>
<td>87.5%</td>
</tr>
<tr>
<td>2</td>
<td>the ability to provide further explanations</td>
<td>68.5%</td>
</tr>
<tr>
<td>3</td>
<td>the ability to determine settlement strategies</td>
<td>65%</td>
</tr>
<tr>
<td>4</td>
<td>the ability to make conclusions</td>
<td>62%</td>
</tr>
<tr>
<td>5</td>
<td>the ability to evaluations</td>
<td>20.83%</td>
</tr>
</tbody>
</table>

Based on the analysis in table 1, it was found that most male and female students were able to show the first indicator, the indicator was shown by being able to analyze and focus questions. Analyzing the question means that students are able to apply the subject of mathematics to their mathematical concepts and are able to write down information that is known from the problem. The ability to focus questions, it means students are able to correctly write down the information asked by the question.

Furthermore, male and female students were able to demonstrate critical thinking skills on the second indicator 68.5% and 79.17% respectively. This indicator can be seen from the ability of students to identify assumptions or choose mathematical concepts to answer questions. The third indicator is the ability of students to determine solutions or write answers based on coherent and logical steps. while the fourth indicator, students are able to find the right answer. The percentage of male and female students in the third indicator is 65% and 70.83%. Meanwhile, the fourth indicator of the percentage of male and female students is 62% and 65.17%.

The last indicator is the ability to evaluate. Only a few students have the ability to evaluate. This shows that the percentage of male and female students is only 20.83% and 25%. It is the ability to determine alternatives or other ways to solve problems. In this case the student's flexibility becomes an assessment. The flexibility aspect refers to the different ways given by students in solving problems,

Based on the explanation above, it was concluded that students' critical thinking skills were still very low. This is indicated by the fewer students who are able to show indicators of critical thinking from each step in solving problems. This condition is supported by the results of preliminary observations, that in the learning process the teachers have not familiarized and facilitated students to develop their critical thinking skills.

The last indicator is the most difficult indicator for male and female students to show. They do not have the ability to fluency in solving problems. this is a basic ability to develop the ability to think further, namely creative thinking. So, learning activities must go through problem solving with What’s another way. This is a way for teachers to develop creative thinking skills as well as critical thinking by providing problems through the answers they obtain. When students have found the answer, and examined the answer, the teacher can challenge students to find other ways to find the answer (Siswono, Novitasari, 2007). In this way, critical thinking skills can be maximized. Especially in the last indicator that is difficult for most students.

**Conclusion**

Based on the results and discussion, it can be concluded that students' critical thinking skills have not been reached maximally. Because there is a fifth indicator that is an evaluation that cannot be shown by most students both male and female. In class, the teacher must facilitate students through learning with what is another way. So that through learning, students' critical thinking skills can develop.

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Student Perceptions’ towards Mathematical Literacy

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Abstract
Mathematical literacy is one of the abilities that is important to be mastered by student in 21st century. Unfortunately, this term seems to be unfamiliar to some people. Mathematical literacy is the ability of individuals to use mathematics in various context. Based on the average PISA score, it is significant to discover student perceptions’ towards mathematical literacy. This is a descriptive-qualitative study using Miles and Huberman steps. It aims to describe the student perceptions’ of mathematical literacy. The sample of this study are of 20 students. It consist of 10 junior school students and 10 senior high school students (aged between 13-16 years old) towards mathematical literacy. Data were collected through interview of 20 students in three countries. The results shows that students who familiar with the term mathematics literacy is only 4 students (20%), while 16 other students did not know the term. From the students who knows the term, 1 of them responded that they knew it from their teachers, and 3 other students said that they found it on the internet, mass media, also from parents and friends. From the all of students, the many of students stated that the teacher and the textbook had familiarized themselves with exercises to solve contextual problems are 14 students (70%) and 6 students (30%). All students agreed that mathematics literacy is an important thing to be taught to students and they need to be trained to solve contextual problems that related to their daily life.

Keywords: perceptions, mathematical literacy, PISA

Introduction

Mathematics as a basic science has an important role in the development of science and technology, because mathematics is a means of thinking to develop the power of reasoning, ways of thinking logically, systematically and critically. Mathematics is a way to find answers to problems faced by humans and related to how to use information (Suharto, 2013). Mathematics cannot be separated from
everyday life, because almost every activity we do will be related to mathematical principles.

Mathematics is very important, so mathematics should be one of the lessons that must be mastered by every student who wants to succeed in their life. Problems faced by students in their lives are not just simple problems, but there will be a time when students will meet with more complex problems, so that the ability of students to interpret, formulate and answer these problems is needed. One way that is the answer to such a thing is that it takes a very important ability to be owned by the 21st century society today, namely mathematical literacy skills.

According to NCTM (2000), the competencies in mathematics learning are: mathematical problem solving abilities, mathematical communication abilities, mathematical reasoning abilities, mathematical connection abilities and mathematical representation abilities. The five of competencies are mathematical literacy (NCTM, Principles and Standards for School Mathematics, 2000). Evidently, both mathematical modelling and mathematical literacy place the functionality of mathematics in solving real-life situations at the centre of mathematical learning (Widjaja, W, 2011).

Mathematical literacy is translated as the ability to apply mathematics in everyday life. Mathematical literacy ability is one of the abilities assessed in PISA. Mathematical literacy skills based on the 2015 PISA framework assessment framework are defined as follows.

"Mathematical literacy is defined as students’ capacity to formulate, employ and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals in recognising the role that mathematics plays in the world and to make the well-founded judgements and decisions needed by constructive, engaged and reflective citizens" (OECD, 2016).

Mathematical literacy is the ability of individuals to formulate, use, and interpret mathematics in various contexts. In addition, mathematical literacy also includes mathematical reasoning and the use of concepts, procedures, facts and mathematical tools to describe, explain, and predict phenomena (Sari, 2015).
NCTM also defined mathematical literacy as an individual's ability to explore, to conjecture, and to reason logically as well as to use variety of mathematical methods effectively to solve problems (NCTM, Curriculum and evaluation standards for school mathematics, 1989). By becoming literate, their mathematical power should develop. Mathematical literacy help someone to understanding role and function mathematic in their life. Someone can using use it to make the right decisions as building, caring and thinking citizens (Wardhani, S, et al, 2011).

Based on the definition described above, it can be concluded that mathematical literacy is the capacity of individuals to formulate, use and interpret mathematics in various contexts. This includes mathematical reasoning and the use of concepts, procedures, facts, and mathematical tools to describe, explain, and predict phenomena. This leads individuals to recognize the role of mathematics in life and to make good judgments and constructive and reflective decisions needed by the population. In simple terms, mathematical literacy is the ability of individuals to formulate, use, and interpret mathematics in various life contexts.

An international assessment by the Organization for Economic Cooperation and Development (OECD) related to mathematical literacy, science, and reading 15-year-old students in the 2015 Program for International Student Assessment (PISA) places Indonesia in the 63rd position of 70 countries in the field of mathematical literacy (OECD, 2016). One mastery of science that is a major aspect of PISA's international assessment is mathematics literacy. Mathematical literacy emphasizes the use of mathematics in everyday life. Mathematical skills require knowledge and disposition to think and act mathematically in applying certain mathematical principles to everyday problems and involve critical and related aspects of life (Beswick, 2008).

Mathematical literacy skills of Indonesian students in PISA are shown in Table 1. Based on the data in Table 1 above, it can be seen that Indonesian students' mathematical abilities have not been able to rank in the upper middle class and the scores achieved by Indonesia from year to year in PISA are still below the average score. The ratings and scores show that Indonesian students' mathematical literacy skills are still relatively low.
Table 1. Indonesian Student Mathematical Literacy Ability According to PISA

<table>
<thead>
<tr>
<th>Year</th>
<th>Rank/Number of countries</th>
<th>Score/Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>39/41</td>
<td>367/500</td>
</tr>
<tr>
<td>2003</td>
<td>38/40</td>
<td>360/500</td>
</tr>
<tr>
<td>2006</td>
<td>50/57</td>
<td>391/498</td>
</tr>
<tr>
<td>2009</td>
<td>61/65</td>
<td>371/496</td>
</tr>
<tr>
<td>2012</td>
<td>64/65</td>
<td>375/494</td>
</tr>
<tr>
<td>2015</td>
<td>62/70</td>
<td>386/490</td>
</tr>
</tbody>
</table>

Source: (Susanti, E & Syam, S. S, 2017)

Data shows the average score obtained, it is important to question how the student's perception of mathematical literacy is. Therefore, there needs to be an effort to see this. This study aims to describe students' perceptions of mathematical literacy. In the short term, students' perceptions of mathematical literacy can be used as a reference or criterion in implementing mathematics learning. In the long run, the results of this study can be used as a reference for further research that requires students' perceptions of mathematical literacy. Based on students' perceptions, further studies can be conducted on how the level of students' abilities in solving mathematical literacy problems and what are the factors causing the low mathematical literacy skills of students.

Research Method

This study is a descriptive study with a qualitative approach by using Miles and Huberman steps. The subjects in this study were 20 students consisting of junior and senior high school students in three countries aged between 13 and 16 years. Middle and high school students are 10 students each.

Data were collected through interview of 20 students in three countries by using semi-structured questionnaires. In the questionnaire there are two types of questions, namely open questions and closed questions. The presentation of questions from the two questionnaires was combined into one unit through the online form. Closed questionnaire requires students to answer questions by choosing one answer, namely: yes / already or not / not yet. While the open questionnaire requires students to write their opinions freely regarding questions or statements of students towards mathematical literacy. Questionnaire has been validated internally and tested to determine external validity and reliability.
Closed questionnaire data is processed quantitatively to obtain information on the percentage of student answers in each statement. While the open questionnaire data is used qualitatively data analysis techniques consisting of three activities that occur simultaneously, namely data reduction, data presentation and conclusion drawing. The thing that was done when the data reduction in this study was to summarize, choose the main things and discard unnecessary data and simplified and grouped based on the students' answers. The presentation of the data was carried out in the form of a brief description of the narrative text, and finally concluded. To introduce mathematical literacy, a problem was adapted from the PISA problem as follows.

Sebuah pabrik kue menyediakan dua jenis kue berbentuk cakram dengan ketebalan sama, tetapi ukuran berbeda. Permukaan kue yang kesil dan besar masing-masing berdiameter 10 cm dan 15 cm. Jika setiap kue yang kecil dan besar dijual masing-masing dengan harga Rp10.000, dan Rp15.000, manakah yang lebih menguntungkan, membeli tiga kue yang kecil atau dua kue yang besar?

(A cake factory provides two types of disc-shaped cakes with the same thickness, but different sizes. The surface of the cake is small and large, each with a diameter of 10 cm and 15 cm. If each small and large cake is sold for Rp.10,000 and Rp.15,000, which one is more profitable, buy three small cakes or two large cakes?)

Figure 1 Example of a PISA problem

From these questions students are asked to answer by giving reasons for their answers and writing down what might be difficult for them to answer. After all data has been collected, the entire data is then presented descriptively in order to get a picture of students' perceptions of mathematical literacy.

Result and Discussion

In this study students’ perceptions of mathematics literacy are shown by students' answers to questions in the questionnaire. The student's perspective is
seen from the answers to each question in the questionnaire. Of the 20 students, only 4 students had heard the term math literacy before, while 16 other students did not know the term. This means that only 20% of the total number of students who know the term mathematical literacy while 80% do not know the term mathematical literacy. Then from 4 students who know the term math literacy, there are 1 students who know the term from the teacher, 1 student knows it from the mass media, 1 student knows it from the internet, 1 student knows it from their parents and friends. Based on the answers of the 4 students, they stated that mathematical literacy is the ability of students to solve problems using numbers both by analyzing, formulating and implementing mathematics in life. The following is an example of students' answers to their opinions about what mathematics literacy means.

![Figure 2 Example of Student Answers – 1](image)

Furthermore, when a question is presented about the application of mathematical literacy skills, many students who answer three small cakes are more profitable than choosing 2 large cakes, there are 6 students with a percentage of 30% of the total students. While 14 students with a 70% percentage prefer 2 large cakes is more profitable than choosing 3 small cakes. Based on the answers chosen by students, 12 students stated that there were several reasons that might be the cause of the difficulties students answered. For example, because the same price causes students to doubt the problem solving, students feel that the two answer choices are correct, and the questions are confused or because the radius is known to be a number that has a number. While 8 other students did not find such reasons. The following is an example of a student's answer to his opinion about what might be difficult for him to answer a question.
Based on the sample questions given, all students (with a percentage of 100%) stated that the question could encourage them to apply the mathematics they learned in their daily lives. But in the next question students were asked to provide another example related to the application of mathematics in everyday life, there were 2 students who did not answer on the grounds that he did not know. While 18 other students submitted various answers related to this matter. The following is the material that students make as examples of the application of mathematics in everyday life.

Table 2. Percentage of Student Answers about Examples of Mathematical Material

<table>
<thead>
<tr>
<th>Material</th>
<th>Number of student</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Arithmetic</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>SPLDV or SPLTV</td>
<td>1</td>
<td>5.56</td>
</tr>
<tr>
<td>Algebra</td>
<td>1</td>
<td>5.56</td>
</tr>
<tr>
<td>Probability</td>
<td>1</td>
<td>5.56</td>
</tr>
<tr>
<td>Fraction</td>
<td>1</td>
<td>5.56</td>
</tr>
<tr>
<td>Compilation</td>
<td>1</td>
<td>5.56</td>
</tr>
<tr>
<td>Distance</td>
<td>1</td>
<td>5.56</td>
</tr>
<tr>
<td>Area and Volume</td>
<td>1</td>
<td>5.56</td>
</tr>
<tr>
<td>Measuring</td>
<td>1</td>
<td>5.56</td>
</tr>
<tr>
<td>Pythagoras</td>
<td>1</td>
<td>5.56</td>
</tr>
</tbody>
</table>

Based on Table 2 above, shows that 50% of the total number of students, namely 9 students provide examples related to social arithmetic, such as discounts, profits and losses. The material used by students as examples are social arithmetic, SPLDV or SPLTV, algebra, probability, fraction, compilation, distance, area and volume, measurement and Pythagoras, namely 1 student each.

Then in the next question related to the teacher and textbooks in school. Of the 20 students, 14 students with a percentage of 70% of the total students were of the opinion that the teacher had accustomed the practice to answering questions
whose context was related to daily life. Examples given by the teacher such as the system of linear equations two or three variables in its application to determine the price of goods of an object. But 6 other students (with a percentage of 30%) did not argue like that, because according to them that the teacher had not accustomed the practice to answering questions whose context was related to daily life. Furthermore, from 20 students, there were 6 students with a percentage of 30% of the total number of students who thought that the textbooks in school had familiarized themselves with the exercises to answer questions whose context was related to daily life.

In the last question about the importance of mathematics literacy, all students (with a percentage of 100%) agree that mathematics literacy is an important thing to be taught to students and students need to be accustomed to answering questions whose context relates to everyday life.

**Conclusion**

Mathematical literacy of students is considered to be an ability that must be owned by society in the 21st century today. With mathematics literacy, students are expected to be able to formulate, use, and interpret mathematics in various contexts. The term mathematical literacy itself may be foreign to students. Based on this study concluded that many students who know the term mathematics literacy are only 4 students with a percentage of 20%. While 16 other students did not know the term mathematical literacy. Of the many students who know this term, there are 1 students who know it from the teacher, and 3 students know from the internet, the mass media, parents and friends. This indicates that the teacher is indicated to have a great opportunity to introduce mathematics literacy to students. In addition, textbooks in schools were assessed by students who still did not train students as a whole, because there were still 14 students who thought that the textbook had not familiarized themselves with the exercises to answer questions whose context was related to daily life. Furthermore, all students (with a percentage of 100%) agree that mathematical literacy is an important thing to be taught to students and students need to be accustomed to answering questions
whose context relates to everyday life. Because with mathematical literacy that is used as a trained ability and to be owned by students to answer real problems related to everyday life. With the implementation of PISA type questions at school and balanced with guidance from the teacher, it is expected that it can also improve students' mathematics literacy skills themselves.

Reference


Analysis of Junior High School Students’ Problem Solving Difficulty of Math in Algebra

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Abstract

Problem solving is important in mathematics learning. However, there are still many students having difficulties in solving mathematical problems, especially algebra. So that is why that research is needed to describe dominant types of the difficulties students’ experience in solving mathematical problems in algebra. This study was a survey supported by the quantitative approach. The research subjects were students of class VIII junior high schools in Sleman district. The sample of 420 students from seven schools was classified into three categories: high, medium, and low established using stratified proportional random sampling technique. The data was collected through a test. The data analysis was done by using the quantitative descriptive analysis method that figured out the type of students’ difficulty. The results of the study are as follows. First, this dominant kind of difficulty experienced by junior high school students in solving mathematical problems in algebra was the encoding difficulty 86.4%, process skill difficulty 81.2%, transformation difficulty 44.8%, and comprehension difficulty 36.4%. For high category, students have relatively smaller difficulties in encoding, process skills, transformation, and comprehension than students do in the medium and low category. Second, students from the high, medium, and low category have the same difficulty in encoding. So, it needs an effort to overcome the problem solving difficulties in algebra by giving a more in-depth explanation, providing more intensive guidance to students in doing the exercises, giving examples of problems and solutions in algebra that are more varied.

Keywords: algebra, analysis, difficulty, problem, solving

Introduction

A problem solving is not just a topic, but a process that must exist and be applied in all contexts where concepts, principles and skills are learned. According to Permendikbud Number 65 of 2013 that in every core learning activity there should be problem solving that is adjusted to the competency characteristics and levels of education. This shows that mathematical problem solving is one of the important abilities developed and owned by students. Thus, problem solving is the main objective of all learning and mathematical activities.
According to NCTM (2000), problem solving is an integral part of mathematics learning meaning that problem solving cannot be separated from mathematics learning. Furthermore, Suherman (2003) said that problem solving is part of mathematics which is very important because in the learning process and its completion, students are likely to gain experience using the knowledge and skills that are already owned to be applied to non-routine problem solving.

The importance of this problem solving ability gives the effect to students to learn something new. Bell (1978) states that mathematical problem solving can help students develop their abilities, and can help in applying their abilities to various situations. The solving problems in mathematics is essential for the process of learning and completion because the students are possible to gain experience using the knowledge and skills that are already owned to be applied to new situations. Students have the opportunity to formulate, plan, implement, and review solutions that have been made.

Problem solving requires students to process and develop existing knowledge, allowing them to work with various processes, concepts, and strategies. This is in line with the opinion of Lubienski (2000) that problem solving is a tool for learning content and processes in mathematics. In that sense, problem solving is as an effort to help students apply what they learned which can be applicable for the real life as a benefit of learning mathematics.

Besides, a problem solving requires the teacher to provide opportunities for students to solve problems in learning mathematics. By providing questions that meet the criteria of problem solving, the teacher plays an important role in presenting the problem solving process in the learning of mathematics. The solving problem of students in learning mathematics will emerge along with the mathematical problems that students must solve. Therefore, to develop mathematical problem solving, it is necessary to know the strategies raised by students in the process of answering the problem solving.

Furthermore, In the process of solving problem, the students need more than one strategy (Posamentier & Krulik, 1998). In addition, strategies or tactics in problem solving are often referred to as heuristics (Larson, 1983). Heuristics is a
process to find solutions to a problem (Polya, 1973). Heuristics employs appropriate procedures or steps in solving problems. According to Schoenfeld (1985), in heuristics, there are activities such as painting pictures, using appropriate notation, using the relationship between problems with one another, reformulating, looking back, completing and examining the steps that have been used.

These problem solving strategies are expected to make students accustomed to solving problems. In learning process, the role of the teacher is to help and facilitate students in comprehension and implementing these mathematical problem solving strategies so that students do not experience further difficulties when they face mathematical problem solving. This is in line with the opinion of Miller & Mercer (Lerner, 2006), that the difficulties of learning mathematics in elementary schools will continue to secondary school, even they will affect the next adult life.

In the reality, there are no data or facts that can be used as evidence that the quality of mathematics education in Indonesia is good although Indonesia students' mathematics learning achievements are quite prominent individually, for example in International Mathematics Olimpiad (IMO), but not collectively. The results of a collective survey conducted by the Program for International Student Assessment (PISA) and Trends in the International Mathematics and Science Study (TIMSS) always put Indonesian students at the lowest rank.

The PISA program, measuring the Indonesia rank every three years, reports unfavorable results. For example, in 2006, Indonesia rank is 50th out of 57 countries with an average score of 391. In PISA 2009, Indonesia rank was 61st out of 65 with an average score of 371 (Kemdikbud, 2011). Whereas in 2012, Indonesia's ranking decreased, of which 65 Indonesian participants ranked 64th with an average score of 375 (OECD, 2014). The survey results that have been conducted by TIMSS every four years also place Indonesian’s students in the lower rank. This survey was carried out internationally regarding the mathematics achievement of eighth grade students of junior high school.

In addition, Mullis (2012) revealed the results of TIMSS achievements in 2007 and 2011 showed Indonesian students 'achievement in grade VIII SMP
respectively at 397 and 386 with an average score of 500. This situation shows that our students' mathematical abilities are still relatively low. Indeed, there are some factors causing Indonesian students' mathematical abilities are still low. One of the factors of this problem is the lack of training for students in solving problems. In addition, solving problems demands reasoning, argumentation, and creativity. Those are characteristic domains of TIMSS questions.

Mullis (2012) revealed that the assessment domain in TIMSS 2011 included content domains and cognitive domains. Content domains, namely numbers, algebra (algebra), geometry (geometry), data and opportunities (data and chance). The cognitive domain consists of knowledge (knowing), applying (reasoning), and reasoning. This is due, among other things, to the large number of test materials asked in TIMSS and PISA that our students rarely find, as a result students experience difficulties in solving mathematical problem solving problems. The difficulties experienced by students in solving mathematical problems can be caused by the difficulty of students in learning certain material.

Difficulties in solving mathematical problems are very common. Consequently, the students' achievement and mathematical problem solving skills will be disrupted if it is not addressed immediately. These difficulties must be defined, resolved, and determined with alternative solutions. According to Radatz (Blanco & Garrote, 2007), students' difficulties in solving mathematical problems are the results or products of previous mathematics learning experiences. Therefore, steps are needed to analyze and diagnose students' difficulties in solving mathematical problems. One of the difficulty analyzes used is an analysis of the difficulty of solving the Newman model of mathematical problems.

The Newman method is a method used to analyze students' errors in solving mathematical problems, especially verbal problems or story problems (Praktipong & Nakamura, 2006). In problem solving, there are many factors that influence the success of students to arrive at the correct answer. In this method, according to Praktipong & Nakamura (2006) the problem solving process needs to pay attention into two important things that can prevent students from getting the right answers, namely: (1) Problems in the smoothness of language and
comprehension of concepts related to simple reading and comprehension the
meaning of the problem. (2) Problems in the mathematical process consisting of
transformation, process skills, and coding of answers given by students.

The things above indicate that students must be able to interpret questions
in the context of mathematics before performing a mathematical process to obtain
the right answers. In general, the Newman procedure can be detailed as follows.

1. Reading level
   Reading errors occur when students are not able to mention
   information in the problem, which is reading keywords or symbols in
   the problem.

2. Comprehension level
   The comprehension level occurs if students do not master thoroughly
   what information contains in the problem.

3. Transformation level
   The transformation level occurs if students are not able to identify the
   operations or operating patterns needed to solve the problem.

4. Process Skill level
   The process skill level occurs if students do not know the procedures
   needed to accurately complete the operation.

5. Encoding level
   The encoding level occurs if students have found a solution to the
   problem, but are wrong in writing the final answer.

In addition, to student difficulties in solving mathematical problems in
TIMSS and PISA, it can also be seen from the results of the National Examination
(UN) report. Based on the average Junior High School Mathematics UN score in
Sleman Regency in the last three years, they also did not experience a significant
increase.
Table 1. The average Junior High School National Examination Mathematics Academic Year 2012-2015

<table>
<thead>
<tr>
<th>Level</th>
<th>National Examination Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>50,78</td>
</tr>
<tr>
<td>Yogyakarta Province</td>
<td>60,12</td>
</tr>
<tr>
<td>Sleman Regency</td>
<td>60,40</td>
</tr>
</tbody>
</table>


Furthermore, based on the results of the National Examination (UN) of Junior High Schools in Sleman Regency, Yogyakarta 2014/2015, it is seen that the percentage of mastery of mathematics questions is still low, especially in algebraic material. The ability tested was still far from the Minimum Completeness Criteria (KKM) of schools where there were 22 indicators that were still below the KKM from 40 indicators of mastery of the material being tested. This shows that students still have difficulties in solving problems, for example in the solving problems related to completing one variable estimation, only 48.51% of students are able to work on the items correctly, solving problems related to two linear equations of two variables in the experiment only 42.48% of students who are able to work on the items correctly, and solve extensive story problems only 41.08% of students are able to work on the items correctly. This proves that students have difficulty in learning mathematics, especially in algebraic material.

Therefore, we need an analysis of the difficulties in solving mathematical problems in algebraic material to find out where the types of difficulties of students are dominant. Thus, it is necessary to do research on the analysis of the difficulties of solving mathematical problems of junior high school students in algebraic material. Therefore, this study aims to describe the type of difficulty that is predominantly experienced by junior high school students in solving mathematical problems in algebraic material.
Research Methods

This research is a survey research with quantitative descriptive approach conducted in Sleman Regency, Yogyakarta Special Province. The subjects of the study were eighth grade students of junior high schools in Sleman regency totaling 14,070 students from 110 schools. The research sample is seven school consisting of 420 students grouped into three categories, namely high, medium, and low, was determined by stratified proportional random sampling technique. Data collection is done using tests. Data analysis was carried out with quantitative descriptive analysis methods that provide an overview of the types of student difficulties. The steps of data analysis are carried out in the following stages. (1) Collect and formulate all the data obtained, (2) The data that has been collected then presented in the form of a brief description with narrative text. The data analysis in this study was also carried out in a descriptive analytical manner. The data analysis was carried out by organizing the test results, and (3) Conclusions were then drawn on the types of difficulties that were dominantly faced by students in solving teaching problems.

Results and Discussion

In this section, all data recorded through students' work on mathematical problem solving in algebra material that has been given to junior high students. They will be described. The description of the data is focused on students who experience difficulties in terms of the types of difficulties in solving mathematical problems with the Newman model. The types of difficulties in question are reading, comprehension, transformation, process skills and encoding.

At the reading level, researchers did not find students having difficulty reading the questions. So that this type of reading difficulty is not observed further. The location of the difficulty in question is on what material students experience difficulties in terms of mathematical problem solving steps which include comprehension, transformation, process skills and drawing encodings.

In this study, researcher collected information through diagnostic tests consisting of 5 items which were given to 420 students. After collecting all
student work results, the researcher corrected the results of the answers of students and the researcher obtains the data about the number of students who experienced difficulties in each step of solving problems such as difficulty comprehension, transformation, process skills and encoding. Furthermore, the data is described and analyzed. Students who experience difficulties if they get a score of 75 under the Minimum Passing Criteria (KKM).

Table 2. Types of Student Difficulties Based on Student Category in Solving Mathematical Problems

<table>
<thead>
<tr>
<th>Student Category</th>
<th>Level</th>
<th>High</th>
<th>Midle</th>
<th>Low</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>117</td>
<td>128</td>
<td>175</td>
<td>420</td>
</tr>
<tr>
<td>Comprehension</td>
<td>(%)</td>
<td>19</td>
<td>46</td>
<td>88</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16,2%</td>
<td>35,9%</td>
<td>50,3%</td>
<td>36,4%</td>
</tr>
<tr>
<td>Transformation</td>
<td>(%)</td>
<td>21</td>
<td>56</td>
<td>111</td>
<td>188</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17,9%</td>
<td>43,8%</td>
<td>63,4%</td>
<td>44,8%</td>
</tr>
<tr>
<td>Process skills</td>
<td>(%)</td>
<td>67</td>
<td>111</td>
<td>163</td>
<td>341</td>
</tr>
<tr>
<td></td>
<td></td>
<td>57,3%</td>
<td>86,7%</td>
<td>93,1%</td>
<td>81,2%</td>
</tr>
<tr>
<td>Encoding (%)</td>
<td></td>
<td>76</td>
<td>118</td>
<td>169</td>
<td>363</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65,0%</td>
<td>92,2%</td>
<td>96,6%</td>
<td>86,4%</td>
</tr>
</tbody>
</table>

From Table 2, it can be seen that in the high category, students who experienced comprehension difficulties were 16.2%, transformation difficulties 17.9%, process skills 57.3% and encodings 65.0%. In the medium category students who had difficulty comprehension as much as 35.9%, transformation difficulties as much as 43.8%, process skills difficulties as much as 86.7% and difficulties in drawing encodings as much as 92.2%. Judging from the table above students in the category of experiencing more than doubled compared to high category students in the comprehension and transformation section. Whereas for the low category students who experienced difficulties in the levels of
comprehension, transformation, process skills and drawing encodings were 50.3%, 63.4%, 93.1% and 96.6% respectively.

Based on the table shows students in the medium and low categories experience significant difficulties in comprehension, transformation, process skills and drawing encodings. In addition, from Table 2. also shows that the grouping of research samples based on the National Examination results is correct. This means that the results of the National Examination can be used as a benchmark for classifying schools in both high, medium and low categories.

This tendency indicates that when students experience difficulties in the initial step, it will have an impact on the next step in solving mathematical problems. This happens since every step in solving mathematics is systematic and interrelated with one another. This statement is in line with the research that has been done by Mahdayani (2014), which students' difficulties in solving mathematical problems are generally on problem solving steps. In addition, in the high category students experience difficulties in drawing encodings. This is known from the many high-category students who have difficulty drawing encodings as much as 65.0%. From these results, it certainly raises a question of why do many high-class students experience difficulties at this level. After a more in-depth search is known, that high category students consider the final results found to be the answer. So, they do not check the answers and the purpose of the questions.

From the table, it can also be obtained information that the type of student difficulty is dominant in the process skill step and the encodings are 81.2% and 86.4% respectively. Students in the high category experienced difficulties in comprehension, transformation, process skills and drawing encodings that were lower in percentage compared to students in the medium category or low category students. This can be used as an indication that student difficulties start with comprehension and transformation. In the transformation phase students are required to be able to identify the operations or operating patterns needed to solve problems. If students do not know the operation that must be used, the student is unable to solve it. The same thing was also revealed by Praktipong & Nakamura.
(2006) that the inability to determine and choose the right procedure in the transformation step will have an impact on the next step.

In the moderate category students, it is seen that the dominant type of difficulty is the type of process skill difficulty and encoding drawing. This shows that when students experience high difficulty in comprehension then in the transformation step, process skills, and encodings also experience high difficulties as well. From the table, information can also be obtained that the type of student difficulty is dominant in the process skill step and encodings are 81.2% and 86.4% respectively. In addition, students with high categories have difficulty in process skills and drawing encodings that are lower in percentage compared to students in the medium category or low category students. This can be an indication that high category students are able to solve mathematical problem solving problems based on creative thinking better than students in the medium and low category. This is in line with the findings of Wijaya (2014), that students who have difficulty comprehension, transformation difficulties, process skills difficulties, and encodings are correlated between students' difficulties and abilities.

Furthermore, to see in more detail where the difficulty of students in solving mathematical problems in algebraic material in terms of mathematical problem solving steps, the following will present a bar diagram of the type of difficulty solving mathematical problems of each item. Students are in high category and are experiencing difficulties in solving problems for item number 3 on the Two Variable Linear Equation System (SPLDV). This can be seen from the high percentage of difficulties from each mathematical problem solving step in item number 3. While the low category students have difficulty in solving problems for item number 5 on the Three Variable Linear Equation System (SPLTV). Because students experience difficulties in comprehension algebraic concepts and processes (Blanco & Garrote, 2007).

Based on the fact above, students' difficulties between one category and another in solving mathematical problems tend to vary. For example, item number 4 about SPLDV is considered easy for high category students, but not for students in the middle or low categories. This happens because item number 4 is a common
SPLDV problem compared to item number 3. Item number 3 is about solving the story problem of the Two-Variable Linear Equation System (SPLDV). SPLDV questions in the form of story questions make students difficult to understand the problem, do calculations and solve them. This problem requires an unusual way of solving problems, meaning students need to think critically and creatively in solving them. The problem is complex which does not only contain the concept of a linear system of two variables but the concept of comparison. The concept of comparison for most students is a hard concept. This is in line with the previous findings by Praktipong & Nakamura (2006), that there were 57.7% of students having difficulty comprehension the story problems related to computational calculation operations.

Whereas problem number 5 is about solving story problems with a system of linear equations three variables are presented in a form that students are not used to doing at school. It is not unusual here to mean that the problem given cannot be solved directly by applying a system of linear equations which are commonly found. Rather, more complex knowledge is needed, for example about equality and comparison. So that it requires effort to find solutions to problems in a reflective manner based on the experience he already has. This process involves the use of skills, strategies and theories in certain contexts that are integrated into meaningful new knowledge structures (Osta & Laban, 2008).

This is in accordance with the opinion of Hudojo (2003), that mathematical questions are divided into two, namely: (1) practice questions; and (2) problems. Practice questions are given when students learn mathematics. This problem trains students so that they are skilled or as an application of the meaning just taught. In contrast to practice questions, the problem requires students to use synthesis and analysis. To solve a problem, students must master the things that have been learned before that is about knowledge, skills and comprehension, but in this case he uses it in new situations. Comprehension and mastering the previous material and the creativity of students in processing some of the concepts they have will make it easier students in solving algebra problems.
The difficulty of students in solving problems related to SPLDV is in line with the low absorption of the UN. In 2014/2015 National Examination to solve story problems related to SPLDV, the absorption capacity of the National Examination was 46.14%. This is in line with the findings that students have difficulty solving problems related to SPLDV.

**Conclusions and Suggestions**

Based on the results of research and discussion, it can be concluded as follows. The dominant type of difficulty experienced by junior high school students in solving mathematical problems in algebraic material can be summarized as follows. The dominant type of difficulty experienced by junior high school students in solving mathematical problems in algebraic material is the difficulty of drawing conclusions 86.4%, process skills difficulties 81.2%, transformation difficulties 44.8%, and comprehension difficulties 36.4%.

For high category students have relatively smaller difficulties in drawing conclusions, process skills, transformation, and understanding than students in the medium and low category. Second, students from the high, medium, and low category have the same difficulty in the conclusion. So it needs an effort to overcome the problem solving difficulties in algebra by giving a more in-depth explanation that is by providing more intensive guidance to students in working on questions and giving examples of problems and solutions in algebra that are more varied.

Based on the conclusions above, the researchers suggest the following. To the junior high school students to multiply the exercises on mathematical problem solving problems, especially in the Algebra material in the form of story problems. In addition, students are also expected to realize and understand the types of difficulties that cause difficulties in solving mathematical problems, especially in the transformation and process skills and find alternative solutions as an effort to overcome these difficulties in order to obtain optimal results.

To the mathematics teacher, to make improvements in the planning, implementation and evaluation of learning. Planning learning should use learning
tools that contain problem solving. In the implementation of learning, the teacher should use learning models that are able to improve students' abilities in solving mathematical problems, such as the problem based learning model. Whereas in the evaluation of learning, teachers are advised to use non-routine problem solving problems. In addition, because many students experience difficulties ranging from transformation, process skills, and conclusions, teachers are expected to familiarize students in solving problems in various ways, calculating systematically and carefully and familiarizing students to check the purpose of the questions in the questions.

To academics, especially in the fields of mathematics and mathematics education, to be able to carry out advanced research to improve the quality of mathematics education in schools to find solutions to improve students' mathematical problem solving skills in sharing material and how to solve mathematical problem solving by paying attention to the types of difficulties often faced by students.

References


Improving Mathematics Learning Outcomes of Social Arithmetic Using Simulation Methods Assisted by Images Media

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Abstract

This study was encouraged by the low social arithmetic learning outcomes of grade VII students in SMP Negeri 4 Tengaran Satu Atap. The aim of this study was to determine whether there was an improvement in the learning activities and outcomes of social arithmetic by using simulation method assisted by images media. To achieve this objective, classroom action research was conducted in 2 cycles where each cycle consisted of: plan, action, observation, and reflection. Simulation method is an instructional scenario where the learners are placed in a “world” defined by the teacher. The teacher controlled the parameters of this “world” and used it to achieve the desired instructional results. Students experienced the reality of the scenario and gathered meaning from it. The simulations in this research were buying and selling activity. The image media used was in the form of product images required in the simulations. The research subjects were grade VII A students, as many as 20 students. Data collection methods used were observations and tests for each cycle, which were later analyzed descriptively and comparatively. The indicators in this study showed were >75% of all students were active during the learning and >75% of students reached or exceeded the minimum score criterion (KKM) of 75. From the research result, it is evident that there was an increase in students’ activities aspect, moving from 73% to 88%. And it was recorded that there was an increase of the classroom learning outcome average, moving from 69.76 to 71.43 in cycle I and to 77.89 in cycle II.

Keywords: activity, images media, learning outcomes, simulations, social arithmetic

Introduction

Mathematics is an important knowledge. All aspects in life can’t be separated from mathematics since everyone uses mathematics in all spheres of life. For example, in astronomy, medic, civil engineering, architecture, insurance, and in the field of management, cannot be separated from the role of mathematics. One example of the role of mathematics in medic is dosimetry, where calculus really essential here. Dosimetry is a branch of radiotherapy associated with the use of X-rays. As for students, through learning mathematics they will be able to develop the ability to think logically, critically, analytically, creatively, and productively which is very necessary in the life of the 21st century today. In fact, most of the
students considered that Mathematics is difficult subjects. Many students already feel resistant and avoids mathematics even before they actually learn it (Wijaya, 2012: 2).

Based on the experience of teaching Mathematics, one of the topic that is considered difficult is social arithmetic. In the curriculum of KTSP, social arithmetic is included in Grade VII materials. In this topic, students are expected to understand how to determine the selling price, the buying price, the profit-loss in trade, discounts, gross, tare and net, single interest, and taxes.

According to the guidance of KTSP of SMP Negeri 4 Tengaran Satu Atap mentioned that Minimum Criterion Score (KKM) for Mathematics subjects is 75. However, based on the record of teacher's score in the previous academic year from 21 students in VIIA class, there are 9 students (42.85%) who have not reached the KKM. Some of the difficulties faced by students are: (1) students have difficulties in performing numerical counting operations involved percent, (2) students have difficulty in calculating the amount of discount / rebate. That is why, it would be important for teachers to improve students' understanding of learning materials.

Therefore, it is the time for Math teachers to present the material in an interesting and non-boring way. According to Rahman (2013: 55) teachers not only need to master the material to be taught, but also master the various methods of learning applied in the classroom. Rahman explained that teacher should be able to choose the right method or approach to make fun learning in every opportunity, because basically there is no best method or approach. Teachers should provide opportunities for students to take part actively in the classroom. By using activities that makes students participate actively, it will reduce boredom because students will be able to absorb and understand learning well if they are totally involved in fun activities (Hamid, 2014: 35). Simulation methods is one of methods that can make students actively involved and fun for social arithmetic topic. Through the buying and selling simulation, the students will really feel the atmosphere directly in determining the selling and purchasing price, giving the discount, etc in interesting circumstance of simulation.
Looking at the phenomenon occurs recently, students assumed that exciting
activities are just outside of lesson time. It is because they feel burdened when they
are learning in the classroom. Especially for certain subjects that they think as
boring subjects. Related to this, there are interesting words from Melvin L.
Silberman who adopted the wise words of Confucius stated that "what I heard I
forgot, what I saw I remembered, what I did I understood" (Asmani, 2014: 25). It
has meaning that if students in the classroom only hear the various exposures and
explanations, then they are easy to forget, because they are not brought into the
reality of what they have heard.

The use of media while teaching is also an important thing to support the
effectiveness of teaching and learning activities. Using media of learning, teachers
can build more interactive communication with students and it will eliminate
boredom. In addition, with examples explored through the instructional media can
also stimulate students' learning spirit. Most importantly, by using the right media
will make learning atmosphere more fun and not monotonous so that learning
goals can be achieved. Media learning does not have to be sophisticated and
expensive, teachers can use the one that easy to use and cheap. One of the example
is the images media. Media images are cheaper and easier to use. Not only easy in
usage but also easy to provide. Using the images media can help students to
visualize materials taught by the teacher.

Based on the problems above, the authors raise the problem formulation as
follows: "Whether there was any significant increasing in the activity and learning
outcomes of social arithmetic topic by using simulation method assisted by images
media for students of grade VIIA in SMP Negeri 4 Tengaran Satu Atap First
Semester of the year 2017/2018?"

The purpose of this research is to increase the activity and math learning
outcomes in social arithmetic topic by using the simulation method assisted by
image media on VII A students of SMP Negeri 4 Tengaran Satu Atap first

The expected benefits of this classroom action research are: (1) The
students are able to improve skills, knowledge and experience in practice, (2) To
give students meaningful learning, (3) To give students comprehension how to apply simulation method in mathematics classroom.

**Literature Review**

**Learning Activity**

Learning activities are activities or actions both physical and mental performed by individuals to build knowledge and skills for themselves in learning activities. Learning activities will make learning more effective. Teachers are not only able to convey or transfer knowledge and skills but also bring students actively participate in learning. According to Paul B. Diedrich (Sardiman, 2006: 101), stated that student activities are classified into: (1) Visual activities (reading, demonstrations, experiments), (2) Oral activities (stating, formulating, asking, giving suggestion, giving opinion) (3) Listening activities (listening to conversation), (4) Writing activities (writing stories, essays) (5) Motor activities (experimenting, constructing, repairing models, playing), (6) Mental activities (responding, remembering, problems solving, and analyzing), and (7) Emotional activities (interested, bored, excited, passionate, courageous, calm, nervous)

Learning activities can be divided into criteria based on the score level. According to Suharsimi Arikunto (2006: 210), the criteria of learning activities can be classified as Table. 1 below.

<table>
<thead>
<tr>
<th>No</th>
<th>Percentage (%)</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>More than 75</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>56 – 75</td>
<td>Pretty good</td>
</tr>
<tr>
<td>3</td>
<td>40 – 55</td>
<td>Not so good</td>
</tr>
<tr>
<td>4</td>
<td>Less than 40</td>
<td>Bad</td>
</tr>
</tbody>
</table>

Student activities to be observed in this research are:

1) Student activity on the initial activity.
   a) Students prepare books and stationery.
   b) Students show an enthusiastic attitude to follow the lesson.
   c) Students listen and pay attention to the explanation by the teachers.
2) Student activity on core activities
   a) Students are enthusiastic to perform buying-selling simulations activities in accordance with their respective roles
   b) Students finish the Worksheet (LK) provided
   c) Students carry out the discussions on each group
   d) Students present the results of the discussion
   e) Students pay attention to the presentation and give response

3) Student activity at the end of learning
   a) Students record the conclusions derived from the learning activity
   b) Students accomplish the quiz / evaluation enthusiastically

Using the observation sheet, the teacher is assisted by colleagues to make observations during the learning process to get data about student learning activities.

Simulation Method

According to English-Indonesian dictionary Echols and Shadily, simulation means duplication or imitation work. Simulate means to imitate, pretend or act as if. Simulations are the instructional scenarios where the learner is placed in a "world" defined by the teacher. They represent a reality within which students interact. The teacher controls the parameters of this "world" and uses it to achieve the desired instructional results. Not only that, students were expected to experience the reality of the scenario and gather meaning from it.

A simulation is a form of experiential learning. It is a strategy that fits well with the principles of Student-Centered and constructivist teaching learning. Sandra de Young in Nursalim and Efendi (2008) states there are three types of simulations:

1) Simulation exercise
   It is a learning method, which provides a presentation of real-life situations that can be controlled. Students have the right to manipulate situations in order to improve students' understanding the situation
better. This type of simulations, may include: simulations using audio visual and live simulated patient.

2) Simulation game, a play role where student reach the purpose of learning through the game.

3) Role playing
   It is one of learning methods of by using drama. Students spontaneously demonstrate a role and interact each other as the issues and relationships created.

Stages in the simulation as a learning model applied in the classroom are:

a) Orientation stage, the activities of this stage are:
   1) Present various simulation topics and concepts to be integrated in the simulation.
   2) Explain the principles of simulation and games.
   3) Provide a technical description for the implementation of simulation.

b) Stage of Participant Training. The activities of this stage are:
   1) Plan scenarios (contains rules, roles of each actor, procedure, system, record, decision forms to be made, and formulate goals to be achieved).
   2) Conduct a short experiment of an episode

c) Stage of Simulation Process:
   1) Implement the activities of games and arrangement of activities.
   2) Gain feedback and evaluation from the performance and observation results.
   3) Clarify the wrong conception.
   4) Continue the simulation activities

d) Maturation stage in the form of:
   1) Summarize the events to be observed and the perceptions develop during the simulation.
   2) Make a summary of the difficulties or constraints encountered
   3) Analyze the simulation process.
4) Compare simulation activities to actual reality.
5) Relate the simulation process with lessons.
6) Assess and redesign the simulation refers to the summary notes as well as the analysis during the simulation process.

Simulation method is one of the methods in learning that can be applied in mathematics classroom. Many benefits that can be taken through the implementation of this method. One of them is to provide an opportunity for students to understand the concept of mathematics better and its implementation in everyday life. In addition, this method trains students to work together and helps each other in solving problems. The interaction between students during the simulation makes the learning more fun and enjoyable.

Simulations encourage the use of critical and evaluative thinking. Since they are ambiguous or open-ended, they will encourage students to contemplate the implications of a scenario. The situation feels real and hence leads them to engage more interaction of the learners.

Simulations also promote achievement concept through experiential practice. They help students to understand the nuances of a concept. In fact, students often find them deeply engaging more than other activities, as they experience the activity first-hand, rather than hearing about it or seeing it.

By considering the benefits, the implementation of this method brings hope to improve the acquisition of mathematics learning outcomes in social arithmetic topics on first semester of the VII A students of SMP Negeri 4 Tengaran Satu Atap academic year 2017-2018.

Images Media

Learning media is an integral part of learning activities. Learning media can help teachers to facilitate teaching and learning activities so that the learning process will be easier, clarify learning materials with a variety of concrete examples, facilitate interaction and provide opportunities for students to practice.

In today's classrooms, teachers need every resource they get to attract the attention of their students. As students are being constantly visually stimulated, the
use of imagery can be a very useful and effective tool. Images allow students to tap into their inherent creative nature, while promoting attention to detail, critical thinking, and creativity. It also allows students to process deep and complex issues in abstract, and stimulate mentally. Image media is one of cheap and easy learning media. Image media is a media that comes from the reproduction of an original form in two dimensions, in the form of photographs or paintings. In this study, the image media used was the product images to be used during the sale and purchase simulation.

**Research Methods**

Before conducting the Classroom Action Research through simulation method, mathematics learning outcomes of the students are low. In order to improve students' mathematics learning outcomes, researchers will apply simulation methods on social arithmetic topic. The research will be conducted through 2 cycles. In cycle I, learning is conducted through the simulation practice of buying and selling which involves calculation of selling price-purchasing price, profit-loss, and profit-loss percentage. By using guidance and direction from the teachers, students work in groups to simulate buying and selling practices. In other words, students are divided into their roles, some will act as sellers and some as buyers.

In the second cycle, learning carried out through selling and buying simulation which involve the calculation of discounts. As the second cycle action is the improvement on the action in cycle I, the second cycle action is expected to improve the math learning outcomes in social arithmetic topic through the simulation method assisted by images media to the VII A students of SMP Negeri 4 Tengaran Satu Atap in the first semester for academic year 2017-2018.
According to the framework of thought above, it can be formulated hypothesis of action as follows: It assumed through the use of simulation method assisted by images media on VII A students of SMP Negeri 4 Tengaran Satu Atap first semester academic year 2017/2018 can increase the activity and math learning outcomes of social arithmetic topic.

The subjects of the study were the students of VII A SMP Negeri 4 Tengaran Satu Atap Tengaran, Semarang Regency, Central Java. The number of students are 20 students, consist of 5 girls and 15 boys. This research was conducted in the first semester of the 2017/2018 academic year, which covers the preparation, implementation and preparation of the report from July to December.

This research is a Classroom Action Research with a design adapted from Kemmis & Mc. Taggart 1988 (Doni, 2014: 338), the classroom action research flows as shown in the following figure.

**Figure 1. Framework of Thought Diagram**

INITIAL CONDITION

Mathematical learning Social arithmetic topic without using simulation methods

Low learning outcomes. Less than the KKM

ACTION

Mathematical learning Social arithmetic topic is carried out using simulation methods assisted with image media

Cycle I

FINAL CONDITION

Guessed through the use of simulation methods assisted by images media can improve learning outcomes of Mathematics social Arithmetic topic

Cycle II
According to the diagram above, this research will be conducted in two cycles. The cycle means a series of activities start from planning, preparation, implementation, to the evaluation (Suyadi, 2010: 65). Data sources in this study were taken from the subject of research called primary data that is the score obtained from Teacher’s files and the score obtained after the action giving in cycle I and cycle II. While the secondary data source obtained from observation / observation during the learning.

The instrument of data collection used in this research was test and non-test method. The test is a tool or procedure in which individual behavioral samples are obtained, evaluated, and scored using standard methods (Masrukan, 2013: 3). The method used is achievement test method or test result of learning / achievement. Types of tests used was formative tests, in the form of essays.descriptions consist of the test of cycle I and cycle II. While the non-test instruments used were the observation sheet and diary / journal.

Validation of data is required to obtain valid data. For the quantitative data in the form of written test scores was conducted theoretical validation by examining the instruments and grids that have been made. While for qualitative data validation is done through triangulation of source and method. In this
research, quantitative data analysis in the form of test scores is done by using comparative descriptive analysis which is comparing between the value of initial condition or pre cycle, cycle I and cycle II.

While the qualitative data of observation result using qualitative description analysis based on observation and reflection result of each cycle. Every action in the teaching and learning process observed using assessment instruments. This classroom action research worked with the following indicators:

1. Process Indicators

Indicator of process in this research was the increase of student activity that was > 75% students actively involved during learning by using simulation method assisted by images media.

The criteria of student learning activities were:

a) Good: if student learning activity reaches more than 75%
b) Pretty enough: if student learning activity reaches between 56 - 75%
c) Not good: if student learning activity reaches between 40 - 55%
d) Bad: if student learning activities reach less than 40%.

2. Outcome Indicators

Indicator result of this research was the improvement of learning outcomes shown by 75% or more reach the minimum criteria (KKM) that was 75.

**Results and Discussion**

**Pre Cycle Condition**

The existing scores shows that the learning outcomes of VIIA students are low, especially in the topic of social arithmetic. The low average score and the high number of students in class VII A who obtained scores under the Minimum Completion Criteria (KKM = 75) became a reference for improving student learning outcomes. The average score of students' daily tests is 69.76 and students who have not completed are 9 students (42.85%). This can be seen in the following table:
Table 2. Initial Condition

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lowest score</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>Highest score</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>Range</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>Average</td>
<td>69.76</td>
</tr>
<tr>
<td>5</td>
<td>Complete percentage</td>
<td>57.15 %</td>
</tr>
<tr>
<td>6</td>
<td>Incomplete percentage</td>
<td>42.85 %</td>
</tr>
</tbody>
</table>

The low student learning outcomes are possible because it is influenced by the low level of understanding. Since the lecturing method still dominates the past learning activities, so the students become less active to participate in the learning process. Consequently, the students find many obstacles in knowledge transfer that makes learning process runs less effectively.

Cycle I

From the observations the researcher found that:

1) Teachers only provided scenarios and asked students to comprehend their own understanding without additional explanation on how the students to carry out the simulation of buying and selling, so the students did not understand the main thing in doing the simulation.

2) There were students who did not understand the instructions

3) Students were not brave enough to present the results, so the teacher should give examples and encourage them.

The things that need to be improved for the next cycle were:

1) Teachers should give more detailed explanation on how the students in carried out the simulation of buying and selling. Clear instructions will help students to practice the simulation.

2) Teacher should motivate the students to focus on performing the simulation activities.

3) Teacher encourage and motivate the students to present the things they acquired during the simulation.
Observation data from the observer can be seen on the following table:

**Table 3. Observation data in cycle I**

<table>
<thead>
<tr>
<th>No.</th>
<th>Aspect</th>
<th>1st Observer</th>
<th></th>
<th>2nd Observer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Percentage</td>
<td>Value</td>
<td>Percentage</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Initial Activity</td>
<td>8</td>
<td>16%</td>
<td>11</td>
<td>22%</td>
</tr>
<tr>
<td>2.</td>
<td>Core Activity</td>
<td>18</td>
<td>36%</td>
<td>17</td>
<td>34%</td>
</tr>
<tr>
<td>3.</td>
<td>Final Activity</td>
<td>10</td>
<td>20%</td>
<td>9</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36</td>
<td>72%</td>
<td>37</td>
<td>74%</td>
</tr>
</tbody>
</table>

From Table 3, it is shown that the average percentage of student activity was 73% (pretty good category). To reach at least 75% (good category), student activity in cycle II needs to improve more than the activity in cycle II. While the students learning outcomes on the implementation of cycle I is shown in the following table:

**Table 4. Student learning outcomes in cycle I**

<table>
<thead>
<tr>
<th>No</th>
<th>Students Score</th>
<th>Frequency</th>
<th>Percentage (%)</th>
<th>Complete / Not Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35 – 44</td>
<td>-</td>
<td>-</td>
<td>Not Yet Completed</td>
</tr>
<tr>
<td>2</td>
<td>45 – 54</td>
<td>1</td>
<td>5%</td>
<td>Not Yet Completed</td>
</tr>
<tr>
<td>3</td>
<td>55 – 64</td>
<td>5</td>
<td>25%</td>
<td>Not Yet Completed</td>
</tr>
<tr>
<td>4</td>
<td>65 – 74</td>
<td>2</td>
<td>10%</td>
<td>Not Yet Completed</td>
</tr>
<tr>
<td>5</td>
<td>75 – 84</td>
<td>9</td>
<td>45%</td>
<td>Completed</td>
</tr>
<tr>
<td>6</td>
<td>85 – 100</td>
<td>3</td>
<td>15%</td>
<td>Completed</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>20</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Average 71.43
Highest Score 90
Lowest Score 55

From the table above, it can be seen that from 20 students of VIIA class, there were 12 students (60%) were completed learning and 8 students (40%) were not completed yet. The average score was 71.43 with 90 as the highest score and 55 as the lowest score.
Cycle II

Based on observations made by the observer, was found the following points:

1) Teacher already gave previous explanation at the beginning for students to carry out buying and selling simulation, so that students understood the main thing and the purpose of the activity.

2) Students performed their role well during the simulation. Both buyer and seller knew the each role they play.

3) Students were brave enough to present the results in front of the class.

Observation data from observer in cycle II is presented in the following table:

Table 5. Observation data in cycle II

<table>
<thead>
<tr>
<th>No</th>
<th>Aspect</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Observer</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Observer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score</td>
<td>Percentage</td>
<td>Score</td>
</tr>
<tr>
<td>1</td>
<td>Initial Activity</td>
<td>12</td>
<td>24 %</td>
</tr>
<tr>
<td>2</td>
<td>Core Activity</td>
<td>23</td>
<td>46 %</td>
</tr>
<tr>
<td>3</td>
<td>Final Activity</td>
<td>10</td>
<td>20 %</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>45</td>
<td>90 %</td>
</tr>
</tbody>
</table>

From the table above, can be seen that the percentage of student activity on 1<sup>st</sup> observer was 90% and the 2<sup>nd</sup> observer was 86% so the average was 88%. It means there were an improvement of student’s activity from cycle I to cycle II.

Table 6. Student Results in Cycle II

<table>
<thead>
<tr>
<th>No</th>
<th>Score</th>
<th>Frequency</th>
<th>Percentage</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35 – 44</td>
<td>-</td>
<td>-</td>
<td>Not yet completed</td>
</tr>
<tr>
<td>2</td>
<td>45 – 54</td>
<td>-</td>
<td>-</td>
<td>Not yet completed</td>
</tr>
<tr>
<td>3</td>
<td>55 – 64</td>
<td>3</td>
<td>15 %</td>
<td>Not yet completed</td>
</tr>
<tr>
<td>4</td>
<td>65 – 74</td>
<td>2</td>
<td>10 %</td>
<td>Not yet completed</td>
</tr>
<tr>
<td>5</td>
<td>75 – 84</td>
<td>8</td>
<td>40 %</td>
<td>Completed</td>
</tr>
<tr>
<td>6</td>
<td>85 – 100</td>
<td>7</td>
<td>35 %</td>
<td>Completed</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>20</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>77.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Highest score</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lowest score</td>
<td>60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the table above, the average score was 77.89 with 60 as lowest score and 100 as the highest score.
From 20 students, there were 15 students (75%) are able to reach the minimum score criteria (KKM), and the average score is more than 75. So that the implementation of learning in cycle II declared successful.

In general, the results of this study were presented in the following graph:

Figure 3. Students Activity Chart

Figure 4. Learning Outcomes Chart
From the diagram above, it appears that there was an increase number for the lowest score, highest score, average and completeness in each cycle. Although this increase was not striking but quite significant.

**Conclusions and Suggestions**

The conclusions obtained from this research were:

1. By using the simulation method assisted by images media has improved student’s activity of mathematics social arithmetic topic in grade VIIA students of SMP Negeri 4 Tengaran Satu Atap, Semarang. It developed from 73% in cycle I to 88% in cycle II.

2. By using the simulation method assisted by images media has improved student learning outcomes of Mathematics social arithmetic topic in grade VIIA students of SMP Negeri 4 Tengaran Satu Atap, Semarang. In pre cycle condition, the average score was 69.76 with 57.15% completeness. In the first cycle has increased to 71.43 with 60% completeness. Then, in the second cycle has increased more to 77.89 with 75% completeness.

**Suggestion**

1. Teachers should use appropriate methods or approaches for learning activities so that the learning process become more fun and interesting for students. Simulation method can be applied in teaching social arithmetic material, as it can improve student activity and learning outcomes.

2. Students should always keep their enthusiasm to learn, actively participate in the classroom and pay attention to the teacher for getting better understanding.

3. School is supposed to facilitate teachers in applying various methods and approaches to teach, so that learning process will be more meaningful and enjoyable.
References


Profiling STEM Learning Readiness Based on Teacher Attitude toward STEM

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Abstract
STEM (Science, Technology, Engineering and mathematics) education is still new in Indonesia. Integrating STEM learning is not always easy for both teachers and students. To integrate STEM in learning, various aspects need to be well prepared. Teachers have a strategic role in achieving successful learning and improving the quality of education. To find out the teacher's readiness for STEM, it can be interpreted through the teacher's attitude towards STEM education. This survey research aims to describe the readiness of mathematics senior high school teachers in implementing STEM education through the teachers’ attitude towards STEM. The sample consisted of 88 math teachers from 20 provinces in Indonesia who were willing to fill out an online survey. The teacher's attitude towards STEM is seen from beliefs, knowledge, feelings, and tendencies of action. This study applies quantitative and qualitative approaches. The research shows that 16.3% of respondents have a positive attitude towards STEM, 71.3% of respondents are fair and 12.5% are poor. Dominated by the "fair" category, this study shows that most teachers are not ready to integrate STEM in schools. But they expressed interest in STEM training. A follow-up program is needed to improve teacher readiness in STEM Education.

Keywords: STEM, teacher attitude, quality of education

Introduction
STEM education is being developed throughout the world to face the challenges of the 21st century when the technology develops rapidly. The development of technology has led to new versions of business forms such as online stores, online transportation, and various practical online facilities. As a result, varied new jobs emerged; many types of work were forced to be replaced by practical machines that were more efficient. As a consequence, the quality of human resources must be improved so not to be excluded.

STEM education means integrating science, technology, engineering, and mathematics in teaching and learning in all school level (Gonzalez & Kuenzi,
Commonly, technology and techniques in STEM learning are ignored. Technology in this case does not mean asking students to use hi tech tools, but more than it, they are expected to explore the system and find out how it works. (Vasquez, Sneider, & Comer, 2013).

The main goal of STEM Education is students have good STEM literacy, they do not have to be very reliable in the STEM field. STEM literacy means the ability to identify effective science, technology, engineering, and mathematics, and good knowledge and understanding of concepts in decisions making (Vasquez, Sneider, & Comer, 2013). Integrated STEM does not always have to involve all four disciplines of STEM. In K-12, engineering is becoming more prevalent and provides great problem solving opportunities for students to learn about mathematics, science, and technology through the engineering design process (Stohlmann, Moore & Roehrig, 2012).

In Indonesia the application of STEM in learning is developed continuously. The curriculum is formulated to compensate the needs of educational output. The 2013 curriculum mandates that students should be educated to have 21st century skills by combining character qualities, competencies, and basic literacy. In the domain of competence, students are trained to solve complex problems by thinking critically, creatively, in a communicative and collaborative way. Although STEM learning is not explicitly stated in the regulations of 2013 curriculum, the 2013 curriculum objectives for the establishment of 21st century skills indicate the need for STEM implementation in classroom learning. STEM learning is appropriate because it adopts learning which is close to everyday life.

Student literacy in Indonesia in the fields of science, math, and reading which is the main component of STEM is still low, the causes include the low quality of human resources both teachers and education personnel, lack of quality and quantity of educational facilities, and the low quality of teaching and learning processes (Permanasari, 2016). Teacher is an important concern in the development of quality Indonesian resources through education. A very inspiring slogan "teaching is the one profession that creates all other professions" further
awakens the importance of the teaching profession in improving human resources. Professional teachers act as agents of change for students. In its role as a learning agent, professional teachers will broaden their knowledge, skills and motivation so as to bring changes to the classroom learning in order to elevate student learning achievement (Yoon, et al, 2008).

The implementation of STEM Education does not always run easily, even when teacher has received STEM material. A description of teacher's readiness for STEM can be found in the attitudes of teachers, who are considered able to interpret learning practices. Gregoire & Pintó (in Thibaut, et al, 2017) argue that the level of change in STEM instructional practices will be determined by changes in teacher attitude towards STEM teaching. Therefore, this attitude must be taken into account. To concern with this important role, this study will see the profile of teacher readiness trough their attitude toward STEM education.

**Theoretical Background**

**How Teachers Support STEM Education**

STEM-based learning is a new challenge for teachers. As an important educational asset because of its role in transferring knowledge, skills, and values of life, teachers are expected to continue learning to be able to prepare their students for the 21st century. Concerning this statement, a lot of research has been conducted to see that teachers have a relation to student achievement, that the quality of mathematics and science teachers positively affects on student achievement (Gonzalez & Kuenzi, 2012).

With all the possible benefits of integrated STEM education, it is important to ensure how teachers can effectively teach integrated STEM education. Teachers need preparation and support of integrated STEM. To effectively develop teachers in STEM education, Stohlmann, Moore & Roehrig (2012) recommend models of support, teaching, efficacy, and materials (s.t.e.m.) for teachers for a long time. See the Figure 1 to find the considering activity of s.t.e.m model.
STEM is an interdisciplinary approach, certainly not easily accepted by students. Not only strong content knowledge, teachers also need pedagogical knowledge to encourage student build their knowledge. Berlin & White (in Stohlmann, Moore & Roehrig, 2012) provide recommendations on how teachers should approach student knowledge:

1) build on students’ prior knowledge;
2) organize knowledge around big ideas, concepts, or themes;
3) develop student knowledge to involve interrelationships of concepts and processes;
4) understand that knowledge is situation or context specific;
5) enable knowledge to be advanced through social discourse;
6) understand that knowledge is socially constructed over time.
In STEM education, the cooperation of various subject teachers is needed, for example, the topic of the solar system will involve a multidisciplinary approach from science teachers, art teachers, math teachers, English teachers and social studies teachers (Vasquez, Sneider, & Comer, 2013). Teachers need more time to discuss curriculum planning, modify their schedules, and find relevant media.

**Teacher attitude**

Attitude is a mental and neural readiness organized through experience that affects a person's response to all objects and situations that are interconnected (Gable, 1986). Attitudes start from feelings (likes or dislikes) associated with a person's tendency to respond to an object, attitude can be formed so that the meaning of an attitude extends to the behavior or action that is influenced by the object (Majid, 2015).

Krech and Ballachey (1962) further divide the aspect of attitudes into (1) cognition, an attitude component that is consistently obtained through individual trust or trust in objects, (2) Feelings, related to emotional relationships from individuals to objects, and (3) the tendency of action which is the tendency to act. Douglass, Fishbein, Ajzen (1977) also mention “attitude should be worked out in conceptual distinctions among belief, attitude, behavioral intention, and behavior itself, and through assumption of spécifique causal linkages and séquences among the four.

Donaghue (in Thibaut, et al, 2017) argue that attitude bring over teachers in their actual classroom practices and play a fundamental role in the acceptance of new approaches, techniques, and activities. Teachers may have positive acceptance or a pessimistic view of the readiness of students, teaching material, and learning activity for STEM, or even for the development of STEM education itself. This is the attitude of the teachers towards STEM education. Based on the references above, attitude can affect the owner to respond and take action. Good attitude produces a positive response and presents good actions. There are not many studies addresses the attitudes of Indonesian teachers towards STEM
education, in relation to the incessant development of STEM education. Do teachers in Indonesia have positive views about STEM? Are Indonesian teachers convinced that STEM is indeed needed to equip students to face the 21st century? This study will try to measure the attitudes of teachers towards STEM as a picture of their readiness to implement STEM in learning.

Regarding the argument of Krech and Ballachev (1962) as stated above the research instruments of Teacher's Attitudes toward STEM must be concerned with the cognitive domain which includes beliefs, affective aspects which include emotions or feelings that arise, and conative aspects which include the teacher's tendency to act.

**Methodology**

This study applies quantitative and qualitative approaches where data is obtained from online surveys on July until September 2019. Respondents, who voluntarily filled out the survey, were selected only for secondary mathematics teachers. Some other respondents were ignored. Finally, there were 80 secondary school math teachers came from 20 provinces. The questionnaire consisted of 10 closed statements and 2 open questionnaires. Questionnaire on teacher's attitude towards STEM Education using a Likert scale with grades 1-4. From the quantitative data can be presented a decryption of teacher attitude toward STEM and from qualitative data will be concluded opinions about the implementation of STEM. The next step is change the score obtained into qualitative values using a criteria as shown in Table 1.

<table>
<thead>
<tr>
<th>Score</th>
<th>Qualitative Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X \geq \text{Mean}+1\text{Sd}$</td>
<td>High</td>
</tr>
<tr>
<td>$\text{Mean}-1\text{Sd} \leq X &lt; \text{Mean}+1\text{Sd}$</td>
<td>Fair</td>
</tr>
<tr>
<td>$X&lt; \text{Mean}-1\text{Sd}$</td>
<td>Poor</td>
</tr>
</tbody>
</table>

$x=$score, $\text{mean}= rate$, $\text{Sd}=\text{standard deviation}$ (Azwar, 2013)
Results

Description of the data is used as information about the readiness of high school mathematics teachers to implement STEM seen from the teacher's attitude towards STEM education. Table 2 shows that in general the attitude of teachers towards STEM Education is in the fair category, this attitude is owned by 71.3% of respondents. While 16.3% of the study sample were in the high category and 12.5% of them were in the low category.

Table 2 Result of The Trachers’ Attitude Toward STEM Education

<table>
<thead>
<tr>
<th>Category</th>
<th>Range</th>
<th>Sum</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>$x &gt; 31.14$</td>
<td>13</td>
<td>16.3%</td>
</tr>
<tr>
<td>Fair</td>
<td>$21.14 &lt; x \leq 31.14$</td>
<td>57</td>
<td>71.3%</td>
</tr>
<tr>
<td>Poor</td>
<td>$x &lt; 21.14$</td>
<td>10</td>
<td>12.5%</td>
</tr>
<tr>
<td>Rate</td>
<td>26.14</td>
<td></td>
<td>Fair</td>
</tr>
</tbody>
</table>

Teacher attitude toward STEM is shown in three indicators as follows: beliefs, feelings, and action tendency. In more detail, Figure 2 able to show the score position obtained by each indicator compared to the maximum value of 4. The figure 2 shows the position of each score’s indicators. Beliefs, feelings, and action tendency gain a medium score and categorized as fair. There are no indicators reaching the highest category as expected.

Figure 2. Indicator scores of teacher attitude toward STEM
From the Figure 2, can be explained in more detail:

1. In belief indicators, many respondents understand that STEM education is useful for students and mathematics lessons support the implementation of STEM, but some consider that STEM learning takes a long time to be conducted, and they find some difficulties in implementing STEM Education. For the teacher's belief in knowledge, some teachers feel that they have not mastered the STEM learning, and only a few teachers have begun to develop literacy related to technology and engineering.

2. In the indicator of feeling, some teachers argue that the government has not given full support to STEM education, and they are not sure about the readiness of their students to receive STEM education.

3. In the indicator of action tendency, there is lack of teachers' willingness to form team work with different subject teachers to support the STEM.

From the respondents' input, it can be summarized what they have done in supporting STEM includes strengthening literacy and learning technology through online (33%), but 24% have not done personal development. Most respondents (62%) require STEM-related training, respondents expect various institutions, including PPPPTK Mathematics, to support the success of STEM education. Respondents from remote areas expect for easy Internet access.

**Discussion and conclusion**

As mentioned in previous introduction, Gregoire and Pinto (in Thibaut, et al., 2017) argue that teachers attitude toward STEM will be determined level of change in STEM instructional practices. Positive attitude toward STEM will encourage teachers to give their best efforts in teaching and learning STEM. If teachers have positive attitude toward STEM, they will improve learning and teaching in a class and will encourage students to have better competency in STEM literacy. Furthermore the teachers will motivate students and inspire...
positive attitudes to their students. However, from the research we obtain there is low level teacher readiness for STEM education which can be seen from the teacher attitude which is mostly in the fair category. This can be interpreted in general that the teacher is not really ready to apply STEM education.

It needs more effort from teachers and the government to improve the attitude towards STEM. Teachers are expected to be one who carry out continuous personal development (CPD) both independently and in groups and improve the culture of literacy.

Furthermore, it is known that many teachers are already interested in developing themselves in supporting the implementation of STEM, this is certainly a valuable opportunity by providing opportunities for STEM training. Indonesia is a vast area, it is expected that the training that will be carried out can be evenly distributed, including the areas having lack Internet access.

From this study, several things that need to be considered to improve teacher attitudes towards STEM education are as follows.

1. Develop literacy in terms of technology, engineering, science, mathematics and other literacy.
2. Teachers carry out individual and group self-development to support STEM.
3. The government provides more opportunities in STEM training.

**Limitation and suggestion for future research**

This study is considered to be too narrow as the number of respondents does not represent Indonesian teachers widely. In subsequent studies, research can be carried out on the attitudes of teachers to STEM education by sampling that more represent the conditions in Indonesia. In addition, research can be conducted to determine the structure of the program which is effective and appropriate for STEM teacher mathematics training.
References


Developing Learning Module Based On Differentiated Instruction

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Abstract

This study aims at developing learning modules based on a differentiated instruction for the Department of Informatics, Universitas Darussalam Gontor. This material is about equalities and inequalities of absolute value. This research is a development research adopting Borg and Gall development procedures limited to 7 stages namely information collecting, planning, development, preliminary field testing, revisions, main field testing, and revisions of a product as suggested by main field test result. The development of this product uses a differentiated instruction approach based on differences in student ability levels. Expert validation was carried out by 5 mathematicians (mathematics lecturers). The results of the expert validation indicate that the module is feasible to use in which its score is 84%. The practicality and effectiveness were assessed by the observer using some instruments including a lesson plan, feasibility observation sheet, student’s questionnaire. The product testing was conducted in calculus subject for the Department of Informatics. The score of the student response on the questionnaire was 82.67% which mean student responses are positive and modules were feasible to use for Calculus course. The product feasibility and student response show that the module based on differentiated instruction is valid and feasible to use as teaching aid in Calculus course.

**Keywords:** development, differentiated instruction, a learning module

Introduction

Education works as a means for character building and gives considerable contribution for the development of a country. No doubt that human resource is a key role in the achievement of a good education. Many developing countries have established and well-structured education system by giving a major investment in it. However, this accomplishment cannot be achieved if several factors have not been met. It is not only determined by the learning process but also the learning method as well. Furthermore, one of the most substantial factors in learning method is the teaching materials.
As mentioned before, the teaching materials are quite complex. There are several substances that support the learning process as well. One of them is called module. A module is systematically composed by some contents, methods, and evaluations. A well-composed module must be able to facilitate the student comprehension according to the student learning level.

There are several definitions about module prior to this research. A module is a printed learning material about which the student doing self-learning (Susilo, Siswandari, & Bandi, 2016). This self-learning style is the characteristic of a module as well according to (Lasmiyati & Harta, 2014). Consisting of a well-planned experience learning, module is designed to assist the student understanding of a lesson and its evaluation. (Tjiptiany, As’ari, & Muksar, 2016) proposed a learning module based on inquiry approach. It was stated that the proposed module accommodated the teacher and student to display their ideas. In addition to that, the module enabled the student to improve their skills by solving the problems by dealing with the evaluation and competency test materials independently. In order to achieve that purpose, the module was adapted to the students characteristics.

Module is a structured program based on a relevant qualification framework. When composing this module, it is highly required a student-centered learning approach. In addition, this composition did not only focus on the content and model but also on the learning quality.

Learning Calculus is quite demanding especially for the student of the department of informatics. In recent observations, the learning activities barely reach the learning purpose. This is occurred because of the teaching material that unable to accommodate by differentiating the students learning level capabilities.

Universitas Darussalam Gontor is an Islamic boarding university in which more than 80 % of the students come from Darussalam Gontor Islamic Boarding School. In an Islamic boarding school, the majority of the lessons are non-scientific. Obviously, when the students start learning in a department, in which based on science, they barely understand the content of a science course. For instance, in a math course, every student faces a difficult circumstance. In a recent
The survey conducted by the Department of Informatics Universitas Darussalam Gontor resulted that the mathematical ability of the students are classified into three levels, such as: low, middle, and high. In the learning process, the low-level students tend to be passive and barely understand the given materials. By this condition, the gap between high-level and low-level students was getting higher for the learning results. Based on this outcome, a comprehensive module is developed to optimize the student math learning performances.

The differences in which every student has affected significantly on the student achievement. The students are able to discover a creative and innovative way to solve a problem. Furthermore, this learning style has taught them a lifetime learning. This research is intended to develop a learning module based on differentiated instruction (DI) for the Calculus course particularly in the topic of equality and inequality of the absolute value. DI is a learning approach about which the material instructions, processes, and evaluation are set to be distinguished to each student according to their learning level.

The curriculum, content, and purpose of a course is delivered equally to every student. However, their learning end point, the deep of understanding is unique as well as the instructed assignment. When teachers differentiate instruction according to student existing interest, such students are motivated to connect what is being taught with things they already value (Joseph, Thomas, Simonette, & Ramsook, 2013).

In DI method, the student thinking competency is crucial. It must be stimulated throughout all learning activities in which incorporate both deductive and inductive reinvention. For example: a peer group discussion of the same level students can be helpful to enhance this ability. Finally, the evaluation is given at the end of the discussion.

In this decade, many research studies have been conducted in the topic of DI. Having a research on student as a subject, six years later, (Borja, Soto, & Sanchez, 2015) studied the understanding of lecturer on using the DI method. The result showed that the DI method has considerable impact on the student learning progress. (Ditasona, 2017) stated that learning using DI approach is able to
improve the student mathematical logic ability. In another research, (Iskandar, 2016) mentioned that DI is significantly influencing the increase of the mathematical problem solving ability as well.

In this research, the DI approach can bring positive learning experience to students. Instead of being treated equally on learning to a particular course, the students are set into a certain learning level environment. By this condition, the students are able to optimize their learning skill. However, the DI concept is not that simple. Skilful teachers, well-planned materials, and implementation play important roles in order to achieve the learning purposes (Dixon, Yssel, McConnell, & Hardin, 2014).

**Research Methods**

This research may be categorized as a research and development (R&D) where the developed product is learning module based on DI. The development of this module used Borg and Gall development procedures limited to 7 stages. These stages are organized as follows: (1) Literature study and information gathering which include student capability analysis, concept analysis, and arrangement of the material concept map. (2) Planning which includes determining the learning tool for development and selecting the module format. (3) Development which include developing the learning tool, composing the research instruments, and the expert validation sheets. (4) First implementation was conducted using a questionnaire for low-scale subjects, about 10 students, to measure the module feasibility and readability. (5) Second implementation was the revision of the first implementation. (6) Field implementation was conducted in order to implement the lesson plan. (7) And the last one was the revision of the field implementation.

Expert validation is using a validation sheet to determine the feasibility of the module that develops. Questions in the validation sheet were about format, illustration, language, and content. The validation data is analyzed both quantitatively and qualitatively. The qualitative data are recommendation, comments, and critics in writing taken from the expert teams. And the quantitative data are validated scores and responses from students. The score assessment
consisted of five categories: very bad (1 score), bad (2 score), quite good (3 score), good (4 score), and very good (5 score). A learning tool is considered as valid when each result belongs to a category which has score greater than or equal to 3.

This DI steps are consisted as follows: before delivering a lecture, a pretest is conducted in order to determine the student learning level. The pretest results are categorized into three groups: low, mid, and high. The classification of student learning level was determined based on the average value and standard deviation from the pretest results. Each level is limited by maximum and minimum threshold. The minimum is formulated as:

$$b_{\text{min}} = \bar{X} - \frac{1}{2} SD$$  \hspace{1cm} (1)

and the maximum value is formulated as:

$$b_{\text{max}} = \bar{X} + \frac{1}{2} SD$$  \hspace{1cm} (2)

where $b_{\text{min}}, b_{\text{max}}$ are minimum and maximum threshold respectively. $\bar{X}$ and $SD$ are the average score and standard deviation respectively.

Once the minimum and maximum value are determined, the intervals for classification are determined as in Table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Interval</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$x &lt; b_{\text{min}}$</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>$b_{\text{min}} \leq x \leq b_{\text{max}}$</td>
<td>Middle</td>
</tr>
<tr>
<td>3</td>
<td>$x &gt; b_{\text{max}}$</td>
<td>High</td>
</tr>
</tbody>
</table>

where $x$ is the student pretest score.

The practicality aspect of using module is using questionnaire response (QR). These used five Likert’s scale. The QR consist four indicators, namely readability, interest, renew ability, and relevance to students’ abilities. The QR was analyzed using quantitative descriptive analysis in the average form and grouped for each indicator. To find out the quality of modules in each indicator and overall percentage conversion is done into qualitative data with a scale of five. Changing the percentage score to scale five is based on table 2.
Table 2. The Percentage Score to Scale Five

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1</td>
<td>Very Less</td>
</tr>
<tr>
<td>1.01 – 2</td>
<td>Less</td>
</tr>
<tr>
<td>2.01 – 3</td>
<td>enough</td>
</tr>
<tr>
<td>3.01 – 4</td>
<td>Good</td>
</tr>
<tr>
<td>4.01 – 5</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

The average score obtained by each indicator is concluded descriptively to describe the feasibility of the module. Modules are said to be feasible if each indicator includes a good or very good category. In addition, the feasibility of the module is also determined by the average score of the total questionnaire that was considered positive when percentages that are greater than 80%.

Result and Discussion

In this research, a learning module based on student learning level using DI has been proposed for the Equality and Inequality Absolute Value topic in Calculus course. The learning level is based on the student pretest results. The pretest is conducted prior to the module development for understanding the student characteristics. The first-stage average result of the student capability is 71.64 with the standard deviation equals to 13.96. From these values, it can be determined the maximum and minimum threshold for each interval. The maximum and minimum values are 64.65 and 78.60 respectively. The classification results are shown in Table 3.

Table 3. First-stage Student Capability Categories

<table>
<thead>
<tr>
<th>Interval</th>
<th>Categories</th>
<th>N(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x &lt; 64.65$</td>
<td>Low</td>
<td>7</td>
</tr>
<tr>
<td>$65.65 \leq x \leq 78.60$</td>
<td>Mid</td>
<td>7</td>
</tr>
<tr>
<td>$x &gt; 78.60$</td>
<td>High</td>
<td>10</td>
</tr>
</tbody>
</table>

where $x$ is the score and N(S) is the number of students.

From the pre-test results, it was known that the students of Informatics Department can be classified into three categories: high, mid, and low. According to these categories, three type modules are proposed. Each module represents each level categories. For a convenient use, the low, mid, and high modules were
labelled as 01, 02, and 03 respectively. Thus, the students will not aware of this classification.

Materials and curriculum are arranged equal for every student level. However, the depth of materials was unique. The depth, in this term, refers to the question difficulty, learning activity, and learning evaluation. The proposed modules are validated by five mathematics educator experts. The validation covers four aspects in learning tool: format, illustration, language, and content.

Table 4. Validation Score Summary

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Score</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>4</td>
<td>Good</td>
</tr>
<tr>
<td>Illustration</td>
<td>5</td>
<td>Very Good</td>
</tr>
<tr>
<td>Language</td>
<td>4</td>
<td>Good</td>
</tr>
<tr>
<td>Content</td>
<td>4</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Average Score</strong></td>
<td><strong>4.2</strong></td>
<td><strong>Good</strong></td>
</tr>
</tbody>
</table>

As shown in Table 4, the average score of all categories is equals to 4.2. In other words, if the maximum score of 5 then the average score is equals to 84% as well. Therefore, the proposed modules satisfy the feasibility study for all scoring aspects with the mark as good. The further step is the field implementation.

The product experiment was tested twice: the first and field implementation. The first test is carried out with 10 students in semester 3 who have taken the Calculus class. The students were asked to read and learn the modules. The first trial was not delivered in a class. However, the students was prepared to read and self-learn the module. This process was observed by the researcher. Assuming that the students, who have passed the calculus class, have understanding in the selected topic. In this first trial, the module was assessed from the aspects of readability and message acceptance.

Then, they filled the QR. The QR consist four indicator, namely satisfaction, renewability, attention, and relevance to skills with five categories. The results of the analysis of student responses to modules are presented in table 5.
### Table 5. Result of the Analysis of Student Responses

<table>
<thead>
<tr>
<th>Student Response Indicator</th>
<th>Score</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>4.1</td>
<td>Very Good</td>
</tr>
<tr>
<td>Renewability</td>
<td>4.18</td>
<td>Very Good</td>
</tr>
<tr>
<td>Attention</td>
<td>4.15</td>
<td>Very Good</td>
</tr>
<tr>
<td>Relevance to Skills</td>
<td>4.1</td>
<td>Very Good</td>
</tr>
<tr>
<td><strong>Average Score</strong></td>
<td><strong>4.13</strong></td>
<td><strong>Very Good</strong></td>
</tr>
</tbody>
</table>

It is known from the first test that the total average QR score is 4.13 which means that it is in a very good category. On the four indicators shows that the average score of each indicator includes a very good category. The percentage of the average questionnaire response was 82.67%, which mean student responses are positive and modules were feasible to use for Calculus course. In spite of the fact that the result was good, there is a mistake. It is the mistyped words in the module type 01 learning activity 3 in the question guide. Hence, the module 01 is revised.

Once the first work done, the next step is the field implementation. There are two components in this test. The researcher acted as the lecturer while the colleague as the observer. Different from the first test, the respondents are the students from semester 1 who are on-going taking the Calculus course. In order to conduct this test, a learning method called Team Assisted Individualism was incorporated.

In addition, an observation is used to see the practically and effectiveness the module. The observation sheet for learning implementation is used with the intention of measuring the effectiveness and delivery of the module. The student activities were monitored by using student activity observation sheet. Given the observation sheet results, all of the learning steps have been accomplished and complied with the lesson plan (RPP). In addition to that, the score from the observation sheet is 84 % means that the students are interested in using the module based on DI.

After the lesson was delivered, all of the students are asked to fill the QR about the DI module. The result is remarkable. With the 85.06% of average score, which mean student responses are positive and modules were feasible to use for Calculus course. Put it differently, the students are positive with the DI module.
According to the students, this module can be referred as a learning material for Calculus.

Based on the both validation and field experiments results, it can be drawn into conclusion that the proposed DI module is feasible enough for the Calculus teaching materials. This learning tool is expected to accommodate the students’ needs as a reference. The level capability of every student is unique. Having considered the distinction, a learning approach must be developed. The DI does not solely mean to treat all students equally. Instead, by giving them an adaptive learning which is related to the learning level. As an illustration, the high-level students are given the harder task than other levels.

**Conclusion**

In this research, a learning module based on DI has been developed. In addition to that, a learning tool, which compatible with the proposed module, has been developed as well. Both learning tool and module have been approved as valid and feasible for implementation because of the expert team validation. The questionnaire results, from the first and field trial results, showed that the students felt about this module is new and easy. The students were interested in learning Calculus by using this DI module as well. According to students, this module can be used as reference in Calculus and accommodates them to solve question independently.

In future work, there are some recommendations that must be considered:
(1) Highly recommended to the lecturer to utilize this module as their reference in Calculus course. (2) Since this current research scope is solely taken place in department of informatics of Universitas Darussalam Gontor, hoping that this module can be applied to other universities as well.
References


Mathematics Learning Video: Practical or not?

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**Abstract**

Media are ones of the necessary components in the learning process. One of the alternative media that can be used in learning mathematics is video. The practicality of using video becomes important as it affects students and teachers in mathematics learning process. It brings either convenience or distress. This study aims to describe the response of teachers and students about the use of video in learning mathematics whether it is practical or not. Data were collected from observation, questionnaires and interviews which were analyzed using qualitative methods. Participants in the use of mathematics learning video involved 33 students from public school in Surakarta. The results showed that the mathematics learning video proved to be practically used in mathematics learning process. Several factors that influence the practicality of using mathematics learning video include: availability of facilities and student learning styles.

**Keywords:** mathematics, video, practicality

**Introduction**

Nowadays, learning mathematics through videos is being the way of learning because of the rapid internet access at home, school, and smartphones. Schneps, et al. (2010) said that video can be used effectively to enhance learning as an impact of an “explosion” in online courses and a rapidly changing comprehension. In order to successfully support various pedagogical strategies, we can use video in a variety of ways. In the context of problem-based learning, video can be used to present a problem to trigger students problem-solving; to provide information related to the topic; or to present the solutions of the problem in the end of the process (Rasi and Poikela, 2016). The content of the videos might be academic in nature or material that is supplementary to academic content, such as a news or film. They can be used in supporting of both practical and conceptual teaching (Kay, 2012) through formats: the video lecture, video tutorial, short-knowledge video, and “how-to” example-based video-modelling.
The use of video by the teachers could improve students’ practicum experience at schools but this required efficient and effective access to appropriate video material (Lane & Brown, 2007). Students are showing an increasing attraction to be more independently in control of their learning process and to create “personalized learning environments” in and outside of the classroom (Rasi and Poikela, 2016). Video provides that opportunity for students to take control over their learning, both the flexibility over when it’s watched but also as a tool to create video material as part of their learning.

**Literature Review**

The media are ones of the necessary components in the learning process. The media is an intermediary or messenger from the sender to the recipient of the message (Arsyad: 2017). Media is a tool that is physically used to convey the contents of teaching materials which include tape recorders, cassettes, videos, films, slides, pictures, graphics, photographs and computers (Gagne: 1987). Video is one of the alternative media that can be used in the learning process. Riyana (2007) defines video as a media that presents audio and visuals containing learning messages in the form of concepts, principles, procedures, and application concepts to help students to understand the learning material. Mathematics is one of the materials given by teachers in various levels of education from primary to high school. Therefore, videos which are deliberately designed to support the process of learning mathematics are called mathematics learning videos.

Mayer’s “cognitive theory of multimedia learning” is heavily being draws by researchers as a framework through which to understand the processes involved and ways in which video may assist or hinder learning (Clark and Mayer, 2016). The theory relies on three principles. Firstly, there are two different channels for processing visual/pictorial material and for processing auditory/verbal material. Secondly, each channel has a limited capacity and can deal with only a few pieces of information at a time. Thirdly, active processing is required for learning to occur. The three steps of selecting, organizing and integrating information across the dual channels works as follows: learners select relevant sounds, words, and
images to be processed, and they organize the selected sounds and images into a “mental model” of the material they are learning. Learners then integrate a mental model of new material integrated with their prior knowledge. “Meaningful learning” occurs through suitable engagement in all three of these processes. In order to have a learning process, we need to have not just stored knowledge in our long-term memory but be able to retrieve and apply it (Clark and Mayer, 2016). There are further theories of learning multimedia in the next section.

Schreiber et al. (2010) states the benefits of video in enhancing learning according to these theories. The visual and auditory nature of video stimulate the dual processing channels to enhance learning; the limitations of the working memory are eased by the ability to pause, rewind and repeatedly watch video; and finally, video provides opportunities for interacting with interesting material, through attentive engagement with video content, which can be organizing and integrated with previous comprehension. Conversely, Castro-Alonso et al. (2018) note that transient forms of information can cause heavier cognitive load given the need to process current images while retaining and integrating those that have disappeared.

For students who had lacked computer skills, they will find the difficulties of using the video, such as the authentication required to negotiate the firewall (Lane & Brown, 2007). Some instructors may be hesitant to allocate their time to develop video lectures and integrate them into a course. This may be a particularly difficult issue when teaching-oriented or technological activities are not rewarded by the school or the social culture of the school (David Brecht, 2012). The use of the video had improved students’ ability to make links between theory and classroom practice (Lane & Brown, 2007). Besides the practicality of the video must be important aspect to be noticed. Practicality aspect according to Nieveen, et al (1999: 127) refers to two things: the practitioner or expert can state that developed instructional videos benefit our users, and the instructional video easily applied in the field. Finally, the practicality of using video becomes important that causes students and teachers to be easy or difficult in mathematics learning process.
Methods

This study uses a qualitative approach with phenomenology type. The use of phenomenology type aims to describe the phenomena that appear in the study. Video-based learning that is endemic due to high internet usage both at home and at school certainly gets its own response in saving students and teachers. In order to be focused and in-depth research, this study will discuss the practicality of using video whether it is easier for students to learn mathematics or not.

Participants in the use of mathematics learning videos involved 33 students from public schools in Surakarta. Data were collected from questionnaires and interviews. Questionnaire is used to find out students' opinions about using mathematics learning videos consisting of 10 statement items with a 5 scale. The data obtained were analyzed by the following steps:

1. Input the data.
2. Calculate the mean score by the formula:
   \[
   \bar{x} = \frac{\sum x}{n},
   \]
   where: \(\bar{x}\) is the score mean, \(\sum x\) is the sum of the score, and \(n\) is the total of the student.
3. Convert the mean score into the criteria of practicality based on the Table 1.

<table>
<thead>
<tr>
<th>Score</th>
<th>Practicallity level</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\bar{x} &gt; 4.20)</td>
<td>Excelent</td>
</tr>
<tr>
<td>(3.40 &lt; \bar{x} \leq 4.20)</td>
<td>Good</td>
</tr>
<tr>
<td>(2.60 &lt; \bar{x} \leq 3.40)</td>
<td>Fair</td>
</tr>
<tr>
<td>(1.80 &lt; \bar{x} \leq 2.60)</td>
<td>Poor</td>
</tr>
<tr>
<td>(\bar{x} \leq 1.80)</td>
<td>Very Poor</td>
</tr>
</tbody>
</table>

4. Mathematics learning video is said to be practical when the mean score had a good category.
Interviews are used to describe students' perceptions of video use in mathematics learning. Data were analyzed using qualitative methods according to Creswell (2014) as follows:

1. Process and prepare data for analysis.
2. Read the entire data.
3. Start coding all data.
4. Apply the coding process to describe the settings, participants, categories, and themes that will be analyzed.
5. Show how these descriptions and themes will be presented again in a narrative or qualitative report.
6. Make interpretation of qualitative data.

**Results and Discussion**

This study examines how learning videos can be used as an alternative media whether they are practical or not to use. The research activity took place on 10th September 2018. Before the questionnaire was distributed, students first carried out mathematics learning by using video as a learning medium. Then students were asked to fill out the practicality questionnaire for the use of learning videos. The result of this study is shown below.

**Table 1. Students' response toward the mathematics learning video practicality**

<table>
<thead>
<tr>
<th>Number</th>
<th>Aspect</th>
<th>Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Usability for student</td>
<td>3.81</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>Convenience to be applied on learning</td>
<td>3.46</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td><strong>Mean</strong></td>
<td><strong>3.63</strong></td>
<td><strong>Good</strong></td>
</tr>
</tbody>
</table>

Based on the Table 1. the practicality questionnaire obtained data that the video is classified as practically used with a mean of 3.63 in the good category. Students feel happy because it is easy to understand the concept of probability through examples of questions presented. This is in line to Nieveen, et al (1999) which states that learning media are easily applied in the field.
In addition, students were asked to answer some open questions related to the practicality of using mathematics learning videos. From the students' answers, the following data are obtained: 1) eight out of thirty-three students have never used video to learn mathematics, 2) one in thirty-three students does not have a supporting device for learning mathematics using video, and 3) thirty one of thirty-three students find it easy to learn mathematics. Various students’ answers related to the ease of learning mathematics because video use can be categorized in two aspects, namely material content and video content. Students feel easy to learn because the content of the material is short, clear, and complete, including concepts, sample questions and discussion of questions. Interesting and interactive video content also makes it easy for students to learn. Choosing the right layout, letters, colors, voice and music can reduce the redundancy in learning.

Some other things that influence the ease of learning are the availability of facilities and student learning styles. Based on the data obtained by most students, they already had supporting facilities that can be used to play videos in the form of cellphones and laptops. In addition, based on the observation, facilities at the school are sufficient to do video-based learning with the availability of projectors, speakers and screens in each class. Of the thirty-three students, there were two people who felt learning difficulties in mathematics because they preferred to read rather than see and listen to videos.

**Conclusion**

In general, students give a positive response to the use of mathematics learning videos. The video learning mathematics presented is in good category so it can be said to be practical to use. The facilities provided by the school strongly support video-based learning. In addition, each student also has a device that supports the use of mathematics learning videos. As a result, the students can easily access mathematics learning videos. So that the availability of facilities is one of the factors of practicality in using mathematics learning videos. Another factor that influences the practicality of video is student learning styles. Students who have auditory and visual learning types are easier to understand mathematics
with the help of mathematics learning video media. On the contrary, students who are not of such type are difficult to learn mathematics using video. These are some of the findings obtained in this study which can generally contribute to the innovation research of mathematics learning with video as an alternative learning media.

References


Improving 21st Century Skill by Implementing STEM Assisted Maket Board in Ratio and Proportion

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Abstract

The common students skill in 21st centuries is critical thinking, creative, collaboration, and communication. All of those skills should be do in the daily learning activities where students are active in building their knowledge. The real situation in six grader students of SDN 7 Lembang wasn’t that, the student’s mathematic conceptual understanding in low rate. The ratio and proportion material are still abstract and difficult for student to understand. The learning process still teacher centred approach. The STEM education can be a solution to solving that problem. By implementing STEM assisted maket board media, students are encouraging to become a problem solver, innovator, and logical thinker. Maket board media use to build the ratio and proportion concept material real. This research using Classroom Action Research design that implemented in two cycle with 30 six grader students in SDN 7 Lembang. The research result shows that there is improvement in 21st century skill in cycle I as 65.67% rate (medium category) that improved on cycle II to 83.75% (high category). The result of student’s learning outcomes in every cycle shows that student’s mathematical conceptual understanding are improves. By the research result, we can concluding that the implementation of STEM assisted maket board media in ratio and proportion can improving student’s 21st century skill such as critical thinking, creative, collaboration, and communication that build in one learning activities.

Keywords: 21st century skill, maket board, ratio and proportion, STEM.

Introduction

Now a day we are living in 21st centuries where all things commonly connected in all around the world. This are become a challenging in educational world especially in mathematical world. To preparing the students 21st centuries skills especially in mathematics, it can’t stand alone. We need to integrating math with other subject to improving the 21st centuries skills. This how we need STEM that knowing as science, technology, engineering, and mathematics to be integrated in learning activities

In the fact, the mathematics learning process in SDN 7 Lembang shows that students still facing the math subject as difficult things to learn, they also found any difficulties in learning ratio and proportion matter. The learning process
still teacher centred, teacher explain the math matter and students just sitting down to listening and then doing the exercise. This causing math become bored for the students and of course math are not make any meaning for the students mind.

To solving that problem, writer need to make a class room action research by using STEM assisted maket board media in ratio and proportion to improving the students 21\textsuperscript{st} centuries skills in grade six SDN 7 Lembang West Bandung District West Java Province.

**Focused Problem**
- How the implementation of STEM assisted maket board media to improving the students 21\textsuperscript{st} centuries skill in ratio and proportion matter?
- Is that STEM assisted maket board media can improving students 21\textsuperscript{st} centuries skill in ratio and proportion matter?
- Is that STEM assisted maket board media can improving students learning outcomes in ratio and proportion matter?

**21\textsuperscript{st} Century Skill**

The 4 C skill in 21\textsuperscript{st} centuries skill (NEA, 2012) are:
1. Critical thinking and problem solving
2. Creativity and innovation
3. Communication

**STEM**

STEM education rise by the unsatisfied with the traditional approach in mathematics and science in the United States. Science and mathematics still focused on memorizing skill and less of improving students interest in career and study on STEM area (NRC, 2014). According to Brown (2011) STEM is meta discipline in school level where science, technology, engineering, and mathematics integrated as one dynamic unity. In the implementation, STEM has a various way to be implemented. But the integrated pattern is suggested to be implemented because it’s not changing the curriculum. The integrated approach in STEM implemented as students like learn one object. The integration can be
doing by the two subjects minimum. The implementation of STEM also depends on teacher creativity to make STEM education effective. STEM teacher’s effectiveness in engaging students by demonstrating the importance and relevance of STEM subjects in the real world and engaging captivating STEM outreach partners not only supports students learning but also enhance their opportunities to develop their knowledge and skills (Aslam, 2018). Kelley (2013) also say that in STEM learning, teacher need to be active participants in their learning as they develop knowledge, skills, and dispositions related to students, learning, curriculum, pedagogy, and assessment.

Maket Board Media

Maket board media is a media that used in the implementation of STEM in ratio and proportion matter. It’s like the miniature of a living land that peoples have to live. Students should build the the maket by thinking first about the housing needs, land area, green area, parking area, and sports area. Students should designing the housing land with a limited land but lots of peoples to live. To showing the housing, students making the space figure that consist of rectangle prism and triangle prism. Every space figure has its own width that should be counting by the ratio of housing need and peoples. The maket board become the challenging things for students to think creative, collaborative with their group, critical thinking in designing and solving the problem, and of course communicate the maket their made and explaining why they choose that way to solving the problem.

RESEARCH METHOD

This research using class room action research method (CAR). CAR needs to repairing the learning quality in the class room. This way as what Hopkins (2011) that CAR is an action that doing by the teacher to repair and or developing how teacher’s teaching. The kind of research using CAR that conducted to spiral model that developed by Kemmis and Taggart, that was action that been doing recur and continuous. This mean that in a long way expected a higher outcome in changes and result. The research has four stages in every cycle, such as: planning,
acting, observing, and reflecting. The stages spiral cycle can be shown by this picture:

![Picture 1. Spiral Flow Kemmis and Taggart (Denzin & Lincoln, 2007:278)](image)

This research planned in two cycles where each cycle consists of three learning activities. The first and second learning activities is the implementation of lesson plans and the third is cycle evaluation. The research plan is:

**Table 1. Research Plan Design**

<table>
<thead>
<tr>
<th>No</th>
<th>Cycle</th>
<th>Learning Activities</th>
<th>Discussion</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>First (I)</td>
<td>1</td>
<td>Drawing the webs of rectangle prism and triangle prism</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>First (I)</td>
<td>2</td>
<td>Building the space figures of rectangle prism and triangle prism</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>First (I)</td>
<td>3</td>
<td>Cycle I evaluation</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Second (II)</td>
<td>4</td>
<td>Finding the ratio and proportion of width area and its populations</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Second (II)</td>
<td>5</td>
<td>Building the maket board of housing land by counting its ratio and proportion of width area and its populations</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Second (II)</td>
<td>6</td>
<td>Cycle II evaluation</td>
<td></td>
</tr>
</tbody>
</table>
RESEARCH OUTCOMES

CYCLE I

The research data explanation in cycle I that consist of three acts where first and second acts are the implementation of STEM education and the third act is cycle evaluation.

**In the first act**, learning activities do in 2x35 minutes or 70 minutes that decides in pre, core, and closing act. In this first act, students drawing the webs of rectangle prism and triangle prism. The making of rectangle prism should be in a same measurement as 12.5 cm x 10 cm x 8 cm. this important because the rectangle prism would be used in building the maket in next cycle. Students made collaboration with their class mates in group how to drawing the webs correctly, they’re share their ideas each other. Every webs their made are different, its shows that students creativity is improving in this activity. When each group showing their works in front of the class, other group that not agree are arguing why, its shows that students critical thinking skill are arise. And of course, when student presenting their works, arguing each other, they’re learn how to make a good communications skill.

**The second act**, the learning activities do in 2x35 minutes. Students build the rectangle prism and the triangle prism. This way do by cutting the webs that they’re made before in first act. Students doing these activities by the stages of STEM in improving the 21st centuries skill. The science core shown when students the right matter in making the webs. The right matter is a strong matter but environment friendly by using the recycle hard paper. The technology and engineering show when the students using their own tools and their own way in built the space figures. The mathematics shown when they’re measuring the width and ensuring that the build their made are rectangle prism as it’s characterize. The collaboration, critical thinking, creative, and communicative skill shows during student doing the activities.

**The third act**, teacher giving the cycle evaluation that do in 35 minutes. Students answering the question that teacher gave to them.
**CYCLE II**

The research data explanation in cycle II that consist of three acts where first and second acts are the implementation of STEM education and the third act is cycle evaluation.

**First act**, the learning activities do in 2x35 minutes. Students finding the ratio and proportion of width area and its population by teacher guide. First of all, teacher show the table data of West Bandung Regency’s population in 4 years. Students then solving the problem in the question of their work sheet about the growth population and how if the populations are uncontrolled but the width area to live are limited. In the group, students discussing to solve that problem by collaboration and sharing their ideas by their critical thinking skill. They should be creative in solving the problem. Students then presenting what their idea in front the class and communicate their idea with their friends.

**Second act**, this activity take2x35 minutes. Students building the maket board of housing land by counting the ratio and proportion of its width area and its populations. Students should solving problem as: *based on Indonesian policy about the population, the ideal housing is 10 m² per people. So, if there is 45 peoples to living in that area, how many building the architect need if one building takes 12.5cm x 10cm. (maket’s scale 1:100. Then student should arrange the building because the housing area is limited. Students also think about the green area, sports area, and parking area to be placed in the maket board. In this activity, students should be creative, collaborative, has an critical thinking skill, and has a good communication skill.

**Third act**, the activity was cycle evaluation in 35 minutes. Students answering the question in the sheet that teacher gave to them.

**DISCUSSION**

The implementation that was do in cycle I and cycle II shows the improvement in student activities, students creative and critical thinking skill, student communication and collaboration skill. The research are also improving the students learning outcomes.
### CONCLUSIONS AND ADVISES

**Conclusions**

By the research, we can concluding that:

- The implementation of STEM assisted maket board media can improving the students 21st centuries skill in ratio and proportion matter.
- STEM assisted maket board media can improving students 21st centuries in ratio and proportion matter.
- STEM assisted maket board media can improving students learning outcomes in ratio and proportion matter.

**Advises**

- It’s takes a long time to implementing STEM as project, so teacher should plan the activities as well.
- So many things can be implemented in STEM, don’t afraid of improving teachers creativity to dig the subject matter that can be integrated in STEM.

### REFERENCE


The Increase in Students’ Geometry Score upon the Implementation of Ethnomathematical Perspective in Contextual Teaching and Learning of Math

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Abstract

A pilot study conducted in SD Negeri Wonolelo, Wonosobo, showed that there are two major problems in the teaching-learning process of Math, especially the geometry. The two problems are (1) the implementation of conventional or lecturing method and (2) the non-optimum students’ score, below the passing grade of 70. This interests the researcher to implement a teaching model which is intended to make school mathematics more culturally relevant and meaningful for students and encourage students to make a link between their knowledge and their daily lives. This research was aimed to describe the increase in students’ geometry score upon the implementation of ethnomathematical perspective in Contextual Teaching and Learning (CTL) of math to the sixth graders of SD Negeri Wonolelo, Wonosobo. The ethnomathematical perspective in this research set out the Wonosobo local culture as a reference in geometry lesson planning and assessment. This research adopted the Classroom Action Research (CAR). The subjects of this research were to total 22 sixth grade students of SD Negeri Wonolelo, Wonosobo, in the academic year 2018/2018. The data collection technique included observing, testing, documenting, and note-taking. This research used descriptive statistics as a means of data analysis, which then indicated that (1) the treatment leads to the increase in students’ geometry score, with the average score of 67.50 during the Cycle I and the average score of 76.81 during the Cycle II. (2) the students found ethnomathematical perspective in CTL interesting and it enables them to explore a deeper understanding of their local culture.

Keywords: students’ achievement, geometry, surface area, contextual teaching and learning, ethnomathematics.

Introduction

Mathematics or Math plays an important role in many educational settings. Prihandoko (in Widyastuti et al, 2016:2) claimed, “Mathematics is a basic tool used when studying any other science.” Math is also closely related to daily human activities. How important Math is that it is taught in schools, from elementary school until university level.

A pretest in geometry was conducted and the result showed that, in general, the students’ score were below the minimum score set by the school, that is 70. Among 22 students in sixth grade, only 6 students (approximately 27% of
The research subjects passed the pretest, with the average score of the class was 59.09.

The students’ non-optimum score is hypothetically due to the fact that the teacher did not enable students to make connection between concepts in Math and their daily activities since the teacher presumed that it might be confusing and take much time. Besides, instead of giving the students a chance to explore and develop Math concepts, the teacher simply instructed them to memorize the concepts. The teacher was less likely to engage the students in the classroom organization so that they were unable to improve their knowledge and creativity in order to gain further understanding. Eventually, the memorized concepts of Math were only used during classroom-based exercises. Accordingly, the students learn not to overcome the Math concepts but to simply memorize them. They had not got accustomed to applying Math concepts to their daily activities.

Rosa & Orey (2011: 35) describes ethnomathematics as the mathematical practices of identifiable cultural groups and may be regarded as the study of mathematical ideas found in any culture. In this article, ethnomathematics is regarded as the field which presents mathematical concepts of the school curriculum in a way in which these concepts are related to the students’ cultural background, which the teaching-learning materials and assessment are referred to.

The professional role of teachers in the teaching-learning activities needs a continuous improvement in order to establish an intensive and supportive, yet varied, classroom interactions. The teacher’s role is not only teaching but also preparing the students to be educated and civilized. For this reason, the teacher’s part is considerably dominant in building the students’ mentality, attitude and character. Teachers are responsible for managing the classroom; therefore, what occurs in classroom, either directly or indirectly concerned about the students, becomes the teacher’s duty.

According to the description above, there is a need for a more contextual method in the way Math is taught so that students are able to apply Math concepts in everyday life. Implementing the ethnomathematical perspective in Contextual Teaching and Learning (CTL) in Math is one of the possible alternatives. CTL
connects the learning materials with the students’ real-world and help them to make use of their knowledge in daily life. Thus, CTL makes it easier for students to comprehend Math concepts being taught. The deeper understanding the students get of such concepts, the better result they will achieve.

DIKNAS (2002) implies that in Contextual Teaching and Learning model, there are seven phases in learning process; those are 1) constructivism, 2) inquiry, 3) questioning, 4) learning community, 5) modelling, 6) reflection, and 7) authentic assessments.

This research was directed by the question “Does the implementation of ethnomathematical perspective in Contextual Teaching and Learning of Math lead to the increase in the geometry score achieved by the sixth grade students of SD Negeri Wonolelo?” As previously mentioned, this research was aimed to describe the increase in students’ achievement upon treatment.

**Methods**

This experiment was started on September 13\textsuperscript{th} 2018 in SD Negeri Wonolelo, covering Math subject in the sixth grade curriculum in the academic year 2018/2019. The classroom action research was adopted as the research framework. Mulyasa (2009) claimed that classroom action research is used as a way of improving the learning process and outcomes of a group students.

The subjects of this experiment were 22 sixth graders of SD Negeri Wonolelo. Included in the experiment tools are syllabus, lesson plan, and student worksheet while the data collection instruments are assessment sheet and, in addition, photographs.

The data was collected using the assessment sheet and analysed using descriptive statistics with the purpose of elaborating the increase in students’ Math score. The classroom action research in this experiment used the design developed by Kemmis & McTaggart (1998). The learning process in Math class of sixth grade was held in two cycles following a spiral model comprising four steps, proposed by Kemmis & McTaggart: planning, action, observation, and reflection, as can be seen in Table 1.
Table 1. Math Schedule

<table>
<thead>
<tr>
<th>No.</th>
<th>Day, Date</th>
<th>Grade</th>
<th>Learning Materials</th>
<th>Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Thursday, September 13th 2018</td>
<td>VI</td>
<td>Characterization of Rectangle and Square</td>
<td>I</td>
</tr>
<tr>
<td>2.</td>
<td>Friday, September 14th 2018</td>
<td></td>
<td>Rectangle Formulae: Area</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Thursday, September 20th 2018</td>
<td>VI</td>
<td>Characterization and Formulae of Triangle</td>
<td>II</td>
</tr>
<tr>
<td>4.</td>
<td>Friday, September 21st 2018</td>
<td></td>
<td>Characterization, Special Cases, and Formulae of Trapezoid</td>
<td></td>
</tr>
</tbody>
</table>

Findings and Discussion

During this step, the researcher prepared instruments to use in the experiment, namely syllabus, lesson plan, student worksheet, and assessment sheet for Cycle I and Cycle II, which was used as the data collection instruments. At this step, the sixth grade students of SD Negeri Wonolelo was also considered as the subjects of the experiment. In this experiment, the teaching-learning process was held in two cycles. Each cycle covered three meetings; two meetings for classroom discussion and one meeting for assessment.

The classroom organization during this experiment was started in a constructive way, that is the teacher started with preparing the students, checking attendance list, and offering questions to brainstorm the students basic knowledge of the field, and interrelating the students responses with the materials.

The constructive phase was then followed by the inquiry phase (DIKNAS, 2002). The classroom was then divided into five groups. Each group consisted of four to five student. Each group worked on the student worksheet on a topic according to the schedule. In the first meeting, the students discussed and worked on Characterization of Rectangle and Square. As a means of adopting the ethnomathematical perspective in CTL, the students were invited to talk about Sagon, one of the local Wonosobo food that is in square shape, as can be seen in Figure 1.
The next phase in CTL is questioning (DIKNAS, 2002). The students were given time to ask questions if they had found any difficulties during the group discussion. In the learning community phase, a number of students represented their groups and delivered a presentation concerning the group discussion results. The groups took turn presenting while the teacher’s role was to guide and facilitate the learning activity. When it came to the modeling phase, the students were given a test in the form of short essay composition. The following activity was about reflection, where the teacher invited the students to revisit of what had been discussed, draw conclusion, and make connection between the findings and their daily experiences. Moreover, the teacher also suggested the students to implements what had been studied in their everyday life. The final phase in CTL was authentic assessment, in which the students worked individually on a quiz.

The students’ Math score was collected using the assessment sheet, containing four Math problems as follows:

1. A rectangular stole usually worn by a Jaran Kepang dancer has the total surface area 6800 cm². If the length of the stole is 170 cm, what is the width?
2. One of the outfits worn by a Lengger dancer is a stagen. It is a rectangular fabric worn on the dancer’s belly. If the length of the stagen is 3.8 m and the width is 14 cm, what is the total surface area of the stagen?

Upon completion of the two cycles, the students’ Math score was obtained and calculated. The increase in the students’ score can be seen in Table 2.

Table 2. The Increase in Students’ Math Score

<table>
<thead>
<tr>
<th>Data</th>
<th>Number of Students</th>
<th>Average Score</th>
<th>Expected Increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>22</td>
<td>59,09</td>
<td>-</td>
</tr>
<tr>
<td>Students’ Score:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle I</td>
<td>22</td>
<td>67,50</td>
<td>8,41%</td>
</tr>
<tr>
<td>Students’ Score:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle II</td>
<td>22</td>
<td>76,81</td>
<td>17,72%</td>
</tr>
</tbody>
</table>

The data presented in Table 2 shows that in Cycle I the students gained average score of 67,50. It is also showed that the students gained the average score of 59,09 in the pretest. The students’ score increased as much as 8,41% upon treatment (Cycle I) whereas the the students’ score increased as much as 17,72% upon treatment (Cycle II) with average score of 76,81, compared to that of the pretest. It can be concluded that there is an expected growth in the students’ score upon implementation of ethnomathematical perspective in CTL.

The number of students passing the minimum score set also increased, as shown in Table 3.

Table 3. The Increase in the Number of Students Passing the Minimum Score

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Cycle I</th>
<th>Cycle II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Students</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Students Passing</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Students Failing</td>
<td>16</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Overall Achievement Percentage</td>
<td>27,2%</td>
<td>45,4%</td>
<td>72,7%</td>
</tr>
<tr>
<td>Overall Achievement Criteria</td>
<td>Failing</td>
<td>Failing</td>
<td>Passing</td>
</tr>
</tbody>
</table>
As many as 10 students passed the minimum score set during the Cycle I whereas 12 students did not pass. Compared to the pretest, 6 students passed the minimum score set while 16 students failed. In classroom assessment of Cycle I, the overall achievement percentage obtained was 45.4%, compared to that of the pretest: 27.2%. This indicates that there was an expected increase in the students’ score upon implementation of ethnomathematical perspective in CTL.

Moreover, in classroom assessment of Cycle II the overall achievement percentage obtained was 72.7% and 16 out of 22 students passed the minimum score set. It can be concluded that the students generally succeeded since more than 70% of the students passed.

This research adopted the action research framework with the purpose of measuring the increase in students’ geometry score upon implementation of ethnomathematical perspective in CTL. Generally, this experimental research was going well although there were some obstacles during the experiment.

During the Cycle I, there were a number of obstacles as follows:

1. The classroom became rather noisy since the students had never been organized using this scheme. Some students were confused and rather selective to the group members. Some preferred to in the same group with their closest friends.
2. The students lack of knowledge about innovation, presentation, and the way of asking questions.
3. Some students are less careful in the way they perceive questions so that the made mistakes in providing responses.
4. The teacher invited the students to do presentation but most of them were too shy. This is hypothetically due to the fact that they haven’t got accustomed to such activity for, perhaps, they were usually passive during the lesson.
During the Cycle II, the obstacles encountered during the Cycle I were able to overcome.

1. The students showed a more positive attitude and less selective to their group members.

2. The researcher’s guidance and motivation for the students enabled them to participate more in the teaching-learning activities, as shown by the larger percentage in each cycle.

3. The teacher allocated more time for the students to examine and respond to each question.

4. There was a reward given to students who were no longer shy or afraid of doing a classroom presentation.

**Conclusion**

Upon the two cycles of the experiment, it can be concluded that:

1. The implementation of ethnomathematical perspective in contextual teaching and learning of Math leads to the increase in students’ score, especially in geometry. The expected increase can be seen in the results of classroom assessment, from the average score of 67.50 in the Cycle I to 76.81 in the Cycle II. In addition, the overall achievement percentage in the Cycle I 45.4% turned to 72.7% in the Cycle II.

2. The students found the ethnomathematical perspective interesting during the experiment. This perspective also enables them to explore a deeper understanding of their local culture.

**References**


