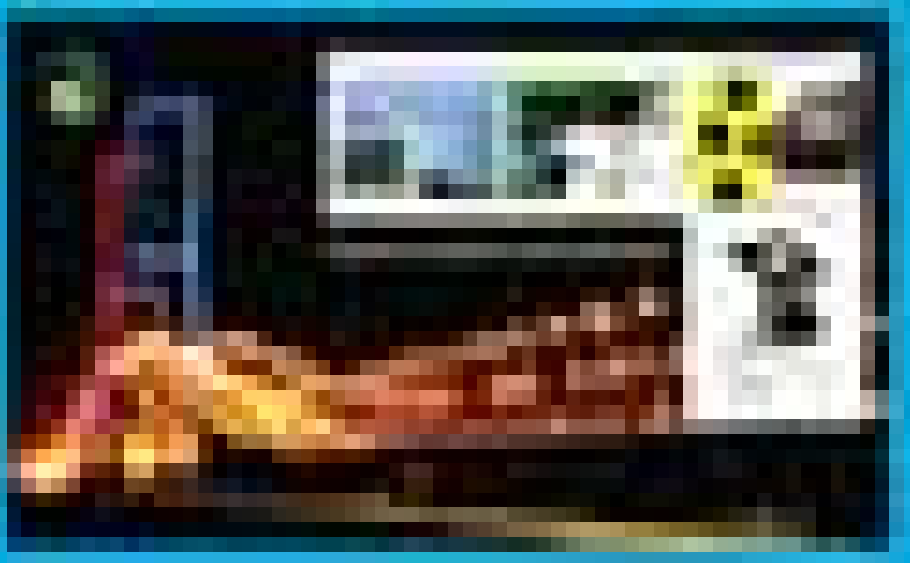

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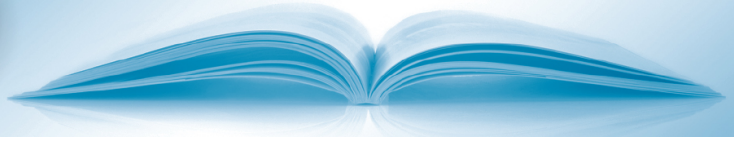

Preface: 2nd International Conference on Mathematics – Pure, Applied and Computation

As a follow up on the first edition of International Conference on Mathematics: Pure, Applied and Computation (ICoMPAC) which was held in 2015, the second edition of ICoMPAC was jointly organized by the Department of Mathematics in Faculty of Mathematics and Natural Sciences, Institut Teknologi Sepuluh Nopember (Indonesia) and by the Science Program (Mathematics) in Faculty of Industrial Science and Technology, Universiti Malaysia Pahang (Malaysia). The aim of this conference is to provide a forum for researchers, educators, students and practitioners to exchange ideas, to communicate and discuss research findings and new advancement in mathematics, and to explore possible avenues to foster academic and student exchange, as well as scientific activities. The conference will be a venue to communicate and discuss on mathematical problems faced by the industries. The topics of the conference comprise: Pure, Applied, Computation, Education and related fields. This conference was held on November 23rd, 2016 in Pullman Hotel, Surabaya. The scientific program consisted of plenary and regular presentations. Preceding the conference, we organized two one-day workshops on applied mathematics and computer science. This year's Conference is themed, "Empowering Engineering using Mathematics".

There were 90 papers presented at the conference. The authors were from Indonesia, Malaysia, Japan, Saudi Arabia, Ethiopia, Germany, United Arab Emirates, Hungary, Pakistan, Taiwan and United Kingdom. It is a unique opportunity for all of us to meet and reunite with colleagues from some areas of Mathematics and its applications. There were 1 keynote speaker and 3 invited speakers covering the different areas of the conference. The keynote speaker was Prof. Dr. Ir. Heru Setiawan, M.Eng (Institut Teknologi Sepuluh Nopember, Indonesia). The invited speakers were Endah Rokhmati Merdika Putri, Ph.D (Institut Teknologi Sepuluh Nopember, Indonesia), Prof. Hsing-Kuo Kenneth Pao (National Taiwan University of Science and Technology, Taiwan) and Dr. Frits Van Beckum (University of Twente, The Netherlands).

We know that the success of the conference depends ultimately on the many people who have worked with us in planning and organizing this conference, in particular for the review process and preparing the technical programs. Recognition should belong to the Local Organizing Committee members who have all worked extremely hard for the details of important aspects of the conference programs. Last but not least, we would like to thank American Institute of Physics (AIP), for the cooperation for publishing papers in this conference to their proceedings.

Dieky Adzkiya
Chairman of ICoMPAC 2016

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Development of probabilistic thinking-oriented learning tools for probability materials at junior high school students

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Development of Probabilistic Thinking-Oriented Learning Tools for Probability Materials at Junior High School Students

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Abstract. This research is a developmental research of probabilistic thinking-oriented learning tools for probability materials at ninth grade students. This study is aimed to produce a good probabilistic thinking-oriented learning tools. The subjects were IX-A students of MTs Model Bangkalan. The stages of this development research used 4-D development model which has been modified into define, design and develop. Teaching learning tools consist of lesson plan, students' worksheet, learning teaching media and students' achievement test. The research instrument used was a sheet of learning tools validation, a sheet of teachers' activities, a sheet of students' activities, students' response questionnaire and students' achievement test. The result of those instruments were analyzed descriptively to answer research objectives. The result was teaching learning tools in which oriented to probabilistic thinking of probability at ninth grade students which has been valid. Since teaching and learning tools have been revised based on validation, and after experiment in class produced that teachers' ability in managing class was effective, students' activities were good, students' responses to the learning tools were positive and the validity, sensitivity and reliability category toward achievement test. In summary, this teaching learning tools can be used by teacher to teach probability for develop students' probabilistic thinking.

INTRODUCTION

Probability is an important part of human life. Starting from a simple question, "Is it going to rain today?" Until a complicated question, "will the volcano erupt?". This is an example of a situation which may occur. Furthermore, to respond this situation, then a person is expected to think probabilistically.

Probabilistic thinking is a cognitive activity associated with a context which contains uncertainty element. Hence, probabilistic thinking is different with the other mathematical thinking which contain deterministic context. While in globalization era, one is not enough to be able to do deterministic thinking, but one must also be able to do probabilistic thinking. This phenomenon occurs because probabilistic thinking is not only solving the certain situation but also the uncertain one. This is happened because [1] stated that a probabilistic reasoning implies to reason under uncertainty. This reasoning takes in consideration two important components: the variability of the result and randomness. Furthermore [1] stated that the outcome is randomly "selected"; it means that there is no correlation between the outcome and what was happened before. In fact, randomness is uncertain, independent, without correlation, and it cannot be predicted with certainty.

If discuss about probabilistic thinking, so closely connected with material of mathematics that is probability. It is caused [2] stated that probability is an old mathematical discipline dealing with calculating probability of various events. Then [3] stated that probability is defined as the quantification of chance and one of the mathematical components of probability is randomness. This is in line with [4] stated that probability is defined as the quantification of chance, and requires the recognition of randomness and the application of proportional thinking. More specifically, the integration of a range of concepts is required for appropriate probability reasoning. [4] stated

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that probability was value which be given (estimate) of outcomes that occur in random situations. Therefore, probability is always associated with three events are certainty event, impossible event and possible event. Interpretation of these events is a number; 0 is interpretation of impossible event, 1 is interpretation of certain event and between 0 to 1 are interpretation of possible event. However, certainty event, impossible event and possible event could also be interpreted with words like; never, surely, sometimes, always or often. These interpretation is caused by students' reasoning. Students' reasoning is affected by beliefs and individual experiences, intuitive strategies, context relevant to individual, cultural context [5]. If students' reasoning is different, then level of students' probabilistic thinking is also different. [6] made characterization of students' probabilistic thinking; prestructural probabilistic thinking, unistructural probabilistic thinking, multistructural probabilistic thinking, and relational probabilistic thinking. Description of prestructural probabilistic thinking showed that student thinking is irrelevant, non-mathematical, or personalized, description of unistructural probabilistic thinking showed that student thinking is quantitative and non-proportional, description of multistructural probabilistic thinking showed that student thinking is quantitative and proportional, and description of relational probabilistic thinking showed that student thinking shows an interconnection of probabilistic ideas.

Based on mathematics curriculum in Indonesia, probability is firstly introduced at the junior high school level. This means junior high school students especially ninth grade students, are not only required to be able to think about deterministic context, but junior high school students began to be prosecuted for probabilistic thinking. Students are required to be able to predict possibility of what will be happen and be able to predict how probability of an event if an experiment is performed. For example, if there is one coin or a dice is thrown, then students can predict likelihood which may occur, and calculate probability of picture on coin and 5 dots on the dice. This is a simple example to develop students' probabilistic thinking.

The teaching learning process of probability is different with teaching learning process of other math materials. If teaching learning process of other math materials can be said meaningful learning even without using an experiment, but teaching learning process of probability can't be said meaningful learning without using an experiment. Based on research results of [7] stated that the importance of the demonstration and concrete experience with teaching probability contents and established that children better understood more difficult concepts if they actively participated in the corresponding demonstrations. This is in line with [8] stated that concrete experiments made on the topic of probability Increased students' achievement and helped learning to take place at conceptual level. So teaching learning process of probability, should be done with concrete experiments and students actively participate in a demonstration. [9] stated that personal engagement, sensory experience with the manipulative, oral argument on what happens to the disks, motivation to win and experimentation intervened between the two Conditions and lead young children in higher estimations about uncertain events within a contextualized problem situation.

METHOD

This type of research paper was developmental research with quantitative descriptive approach, hence analysis technique used descriptive statistical analysis [10]. Development research was conducted to produce a good probabilistic thinking-oriented learning tools of probability materials at ninth grade junior high school. Teaching-learning tools consist of lesson plan, students' worksheet, learning teaching media (spinner) and students' achievement test.

Stage of development teaching learning tools consist of (1) define stage was aimed to establish and define requisites of teaching learning by doing front-end analysis, learner analysis, concept analysis, task analysis, and formulate specifying instructional objectives, (2) design stage was aimed to produce teaching learning tools design which oriented probabilistic thinking. Result of this stage was called first draft. Activities in this stage include media selection, format selection, initial design, (3) develop stage was aimed to produce a final draft; teaching learning draft was revised based on input of experts (validator) and data from developmental testing.

Activities of develop stage were (1) expert validation was conducted by experts as professor of mathematics education to get feedback or suggestions for teaching learning tools perfection. These validation results were analyzed and used as consideration in revising first draft. Teaching learning tools that have been revised based on results of validation referred to second draft, (2) developmental testing was aimed to obtain direct feedback from field to teaching learning tools that have been prepared. Developmental testing results were analyzed and used as consideration in revising second draft. Second draft that have been revised was called final draft.

Subject of Developmental Testing

Developmental testing was conducted in ninth grade MTs Model Bangkalan. The subject were IX-A students of MTs Model Bangkalan.

Design of Developmental Testing

Design of developmental testing was one group pretest-posttest design. This model used twice data collection (pretest and posttest) on subject of research.

Analysis Technique

Analysis of Validation Data

First draft which has been validated by validator was valid if average score was categorized as good or excellent. The average score category follows: $1.00 \leq$ average ≤ 1.50: very no good, $1.50 <$ average ≤ 2.50: no good, $2.50 <$ average ≤ 3.50: good, $3.50 <$ average ≤ 4.00: excellent.

Thus the analysis results that do not meet with good or excellent categories will be taken into consideration to revise teaching learning tools that have been tested.

Analysis of Teachers' Ability in Managing Class Data

Teachers' ability in managing class was said effective if score of every aspect in LP was considered minimal 3. Thus the analysis results that do not full fill the good or excellent categories will be taken into consideration to revise teaching-learning tools that have been tested.

Analysis of Students' Activities Data

Students' activities data during teaching learning activities was analyzed using percentages, namely:

$$\text{percentages of students' activities} = \frac{\text{Frequency of every observation aspect}}{\text{Total frequency of all observation aspects}} \times 100\%$$

Students' activities were said to be effective in teaching learning, if least six aspects of student activities for each meeting performed effective limits criteria with tolerance limit was 10% from ideal time. If Students' activities do not fulfill the effective limits criteria, they will be taken into consideration to revise teaching learning tools that have been tested.

Analysis of Students' Response Data

Students' response data was obtained through questionnaire and analyzed using percentages. Student's response was said to be positive if students' answer to statement for every response aspects was obtained by percentage $\geq 80\%$. Meanwhile, if percentage which was obtained less than 80%, then teaching learning will be considered for revision.

Validity Testing of Achievement Test

One technique was used to determine validity of achievement test was correlate scores which be obtained on each item with total score. Product moment correlation formula was used, namely:

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)(N\sum Y^2 - (\sum Y)^2)}}$$

In this study, a test item was valid if it was categorized high or very high. While validity of test items were categorized low and very low, will be revised.

Sensitivity Testing of Achievement Test

Sensitivity testing of achievement test was a measure to know how test items can distinguish level of students' abilities before and after receiving learning. To determine sensitivity testing of test items used formula:

$$S = \frac{\sum S_{ea} - \sum S_{eb}}{N(skor_{max} - skor_{min})}$$

In this study, a test item was sensitive if its sensitive score was $S \geq 0{,}30$. While sensitive score of test items were $S < 0{,}30$, will be revised.

Reliability Testing of Achievement Test

The formula to analyze reliability of achievement test was formula that corresponds to narrative test (essay), namely alpha formula as follows:

$$r_{11}(\alpha) = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum {\sigma_i}^2}{{\sigma_t}^2}\right)$$

In this study, a test item was reliable if it was categorized high or very high. While reliability of test items were categorized low and very low, will be revised.

A good teaching learning tools were considered from teachers' ability in managing class was effective, students' activities were good, students' responses to teaching learning tools were positive and the validity, sensitivity and reliability category toward achievement test. In this developmental testing, all comments and suggestions from teacher, students and observers were recorded as an input to revise second draft devices into final draft. If developmental testing results showed second draft has not fulfilled a good criterion, then second draft was revised to be draft II (j) ($j \geq 1$). Draft II (j) was tested again in one class (different with class of first developmental testing) and one class were drawn randomly.

RESULT

Based on 4-D developmental model which has been modified, the following is result of teaching learning tools development.

Description of Define Stage

Front-End Analysis

Front-end analysis was done to examine basic problems, then looked for an alternative solution. This activity was done by selecting relevant approaches and assess materials/teaching learning resources that suitable with problems.

In this stage researcher found that in 2015/2016 academic year, MTs Model Bangkalan done 2013 curriculum. However, teaching learning process in ninth grade of MTs Model Bangkalan not yet fully applied scientific approach and student centered learning. That was still transition from teacher centered learning to student centered learning. Teacher was still visible guiding students to learn. This happens because in MTs Model Bangkalan was still implementing 2013 curriculum 1 year ago. Students were not familiar with scientific approach implemention in the classroom. This was evident in answering questions and asked, often a good intelligent students dominated while less intelligent students tend to be passive. Also in try stage, teacher gave more clues than provided opportunity for students to develop their ability to solve problems. students tend to be less active in teaching learning process.

Based on above, it was needded learning alternative which student centered learning and teacher's role as facilitator. One student centered learning was teaching learning process which be oriented probabilistic thinking on

probability material. Implementation of teaching learning process which be oriented probabilistic thinking was required teaching learning tools. While teaching learning tools which was used in schools was not adequate to implement this teaching learning process, so necessary to develop an teaching learning tools to support implementation of teaching learning process.

In addition, researcher also found that teaching learning tools was available and used by mathematics teacher in MTs Model Bangkalan not suitable with teaching learning which be oriented probabilistic thinking. Students also did not have worksheet which could allow students actively in teaching learning with scientific approach. So that, it was needed conceived and developed teaching learning tools and to support implementation of teaching learning process which be oriented probabilistic thinking. Thus, this study developed teaching learning tools such as lesson plans, worksheets, learning media and achievement tests.

Learner Analysis

Learner analysis was aimed to study characteristics of ninth grade students in MTs Model Bangkalan. Analysis results were used to design and develop teaching learning tools. Method of documentation and interviews with teacher were used to produce descriptive about learner; (1) Students' ability in MTs Model Bangkalan was various. Therefore, in accepting material of subject required a relatively long time, (2) Students age of ninth grade in MTs Model Bangkalan were range 13-15 years. This indicated that students were on formal development stage. In this stage, student was already capable to abstract thinking and logical thinking by using "possibility" thinking pattern. Students have scientific thinking models with type hipothetico-inductive and deductive, so they could made conclusions, interpret and generate hypotheses, (3) Ninth grade students in MTs Model Bangkalan got probability material in eight grade, based on 2013 curriculum. So that probability material in eight grade as a prerequisite material to study probability in ninth grade, (4) Division of classes in MTs Model Bangkalan was heterogeneous based on academic ability.

Based on learner analysis above, researcher provided teaching learning that could accommodate heterogeneity based on students' academic ability of students, as well as experiments carried out by a group to develop probabilistic thinking of each individual and develop communication in group discussions. One appropriate teaching learning was teaching learning which was oriented probabilistic thinking.

Concept Analysis

Concept analysis was aimed to identify main parts which were taught and arranged systematically. Probability material consists of (1) sample space, (2) empirical probability, and (3) theoritical probability.

Task Analysis

Task analysis examined type of tasks related with probability which must be solved by students. Results of task analysis were (1) determine sample space, (2) Determine empirical probability of an event, (3) solving problems in daily life associated with empirical probability, (4) Determine theoritical probability of an event, and (5) solving problems in daily life associated with theoritical probability.

Formulate Specifying Instructional Objectives

Formulate specifying instructional objectives was aimed to formulate indicators of achievement test based on material and task analysis. Results of formulate specifying instructional objectives activities were (1) students could explain definition of sample space, (2) students could determine sample space of an experiment, (3) students could determine empirical probability of an event, (4) students could apply principles of empirical probability to solve problems in daily life, (5) students could determine theoritical probability of an event, and (6) students could apply principles of theoritical probability to solve problems in daily life.

Description of Design Stage

Media Selection

The balls in box, spinner and dice were the probabilistic thinking-oriented learning tools. Balls in box and dice are available in stores, however spinners must be developed by researchers. The following picture of spinner in this study.

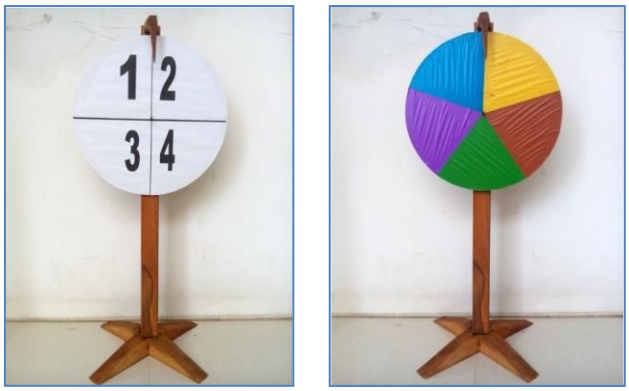

FIGURE 1. Spinner Media

Format Selection

Format of lesson plan which was used according to lesson plan format in 2013 curriculum. Lesson plan consisted standards of competence, main competence, basic competence, indicators, learning objectives, learning materials, learning method and learning activities.

Learning content refers to material analysis results, task analysis results, and specifying instructional objectives which have been formulated in define stage. Through application of teaching learning which be oriented probabilistic thinking was expected students were become more active.

Learning resources which will be developed consist of student worksheet, and achievement test. Students' worksheets were made interesting with variety of colors so that students were interested. In addition, there were preliminary as motivation matter will be easier for students to remember material. Tasks were given in worksheets guided students to conduct experiments and some questions related experiments have been conducted, as well as exercises.

Initial Design

This step produced three lesson plans, three Students' worksheets, spinner and achievement test. The test was administered in the form of essay to measure students' cognitive abilities. Achievement test was classified benchmark tests, it would be used to measure achievement of basic competencies which have been formulated.

Description of Development Stage

Expert Validation

Based on results of validation were performed by 3 validator, obtained an assessment of lesson plans, worksheets, learning media and achievement test which have been developed in good and excellent categories. However, there were suggestions and comments from validator, so research did some revisions and improvements to first draft thus resulting second draft, such as (1) there was no phrase "note results of experiments in the following table", (2) phrase "explain definition of sample space by using your words", was replaced with phrase "write definition of sample space by using your words", (3) phrase "explain definition of sample space elements by using

your words ", was replaced with phrase "write definition of sample space elements by using your words", (4) phrase "please complete the following table" was replaced by phrase " note results of experiments in the following table", and (5) phrase "Can you distinguish empirical probability and theoretical probability?", was replaced with phrase "based on the above activities, write definition of empirical probability by using your words".

Developmental Testing

After teaching learning tools were validated, then result of validation was called second draft. Second draft was used to developmental testing. Developmental testing was started from July 23 to August 6, 2016. Developmental testing was aimed to look suitability of time needed by teacher to teach probability material by using teaching learning which be oriented probabilistic thinking. Data of developmental testing were analyzed to be taken into consideration in revising second draft.

Teachers' ability in managing class. Observation results of teachers' ability in managing class by teaching learning model which be oriented probabilistic thinking were effective because observation results on any observation aspect during three meetings were in good or excellent category.

Students' activities. Observation results of students' activities in three meetings were expressed as a percentage. observation aspects of students' activity consists of attention to teacher's explanation and give question; gathering with their group members and receiving worksheet; viewing questions in worksheet and media which has been provided; answering questions from teacher and asking if there are things that are not understood; conducting experiments by using ball, spinner, dice or coins; discussing results of the experiments which have been conducted with each group; solving problems in worksheet are related to concepts; some groups present their work in front of class and other students give feedback; some groups receive awards and other groups provide uploase; summarizing and note if there are things which are considered important; behavior is irrelevant. Based on results of descriptive analysis showed that all observation aspects were within tolerance effectiveness. Based on student activities criteria, so that students' activities were said to be active.

Students' response. Table 3 showed students' feelings to teaching learning components. It showed that most students were like with material, worksheet, learning ambience in class and teachers' technique by using teaching learning which be oriented probabilistic thinking.

TABLE 1. Students' Feelings to Teaching Learning Components

Teaching Learning Components	Like (%)	Unlike (%)
Material	96,7	3,33
Worksheet	80	20
Learning ambience in class	96,7	3,33
Teachers' technique	100	0

Students' interest to follow teaching learning process showed that 90% from number of students in class were interest and 10% from number of students in class were uninterest. So, students' opinion at worksheet showed that 80% from number of students in class said that language on worksheet can be understood. And 20% from number of students in class said that language on worksheet can not be understood. Students' opinion about worksheet performance showed that 80% from number of students in class said that worksheet performance was interest. Then students' opinion about media performance showed that 96,7% from number of students in class said that media performance was interest.

Based on above data, it showed that students' answers to statement on questionnaire were positive for every response's aspect. So that, it showed that students' response to teaching learning tools which be oriented probabilistic thinking was positive.

Validity testing. Achievement test data was analyzed for look validity, sensitivity, and reliability. Result of validity calculation of each test items by using product moment correlation formula presented in the following table.

TABLE 2. Validity of test items

Number	1	2	3	4	5
R_{xy}	0,481	0,484	0,442	0,565	0,76
Validity	enough	enough	enough	enough	high

Based on validity criteria showed that each test items considered valid.

Sensitivity testing. Result of sensitivity calculation of each test items by using sensitivity index formula presented in the following table.

TABLE 3. Sensitivity of test items

Number	1	2	3	4	5
S	0,414	0,457	0,431	0,621	0,819
sensitivity	sensitive	sensitive	sensitive	sensitive	sensitive

Based on sensitivity criteria, all test items were categorized as good.

Reliability testing. Based on reliability calculation by using Alpha formula, obtained reliability coefficient of 0.426. It means that reliability of achievement test was categorized enough.

Based on description analysis results of developmental testing, it was concluded teaching learning tools which be oriented probabilistic thinking were valid, because of teacher's ability in managing class was effective, students' activities in class were good and students' response to teaching learning tools was also positive and the validity, sensitivity and reliability category toward achievement test.

DISCUSSION

Based on descriptive analysis results, it could be concluded that probabilistic thinking-oriented learning tools which have been developed, could be used as an alternative to teach probability material in ninth grade. This was as the result of learning application by using probabilistic thinking-oriented learning tools categorized as effective. Effectiveness of teaching learning was caused by teachers' ability in managing class was effective, students' activities were good, students' responses to teaching learning tools were positive and the validity, sensitivity and reliability category toward achievement test.

Every observation aspects of teachers' ability in managing class during three meetings were good and or excellent category. It was happened because steps of teaching learning which be oriented probabilistic thinking was easy to be done. Even, it was supported by discussion between researcher and teacher in MTS Model before implementing teaching learning and how to guide students in experimental activities.

Based on descriptive analysis results of students' activities, it showed that students' activities in teaching learning were good. Meanwhile teaching learning which be oriented probabilistic thinking could to be students active and reduced teachers' dominance in teaching learning process. This is in line [4] stated that "concrete experiments helped learning to take place at conceptual level". So with reducing teachers' dominance in explaining material, it made students have more time to discuss in their group and provided opportunities for students to predict an event may to occur through experiment activity by using media learning. Overall students' activity showed that teaching learning which be oriented probabilistic thinking was student centered learning. So that students were actively involved in learning. It was seen from percentage of students' activities during teaching learning process.

Based on descriptive analysis results showed that students' response to teaching learning was positive. It could be looked that most students were like with material, worksheet, learning ambience in class and teachers' technique by using teaching learning which be oriented probabilistic thinking, students' interest to follow teaching learning process, students' opinion showed that language on worksheet can be understood, Students' opinion that worksheet and media performances were interest.

Based on descriptive analysis results showed that achievement test was valid, sensitive and reliable. It indicated that questions of achievement test could measure probabilistic thinking ability of junior high school students in solving probability.

CONCLUSION

Probabilistic thinking-oriented learning tools for probability materials were designed based on the analysis at this stage of definition. Moreover, the results of designed learning tools were validated by three validators. Consequently, revisions were made based on feedback from the validators. After that, the learning tools were tested to IX students of junior high school. The trial results suggest that the ability of teachers to manage learning by using learning tools were good, the activity of students in participating in learning was good and the students' response to the learning device was also positive and fulfill the category of valid, reliable and sensitive to learning about the test results. In conclusion, the learning tools can be used as an alternative for teachers / practitioners to send in pursuit of material probability of using this learning tool, to develop students' probabilistic thinking.

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