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# Increasing Students' Mathematical Creative Thinking Abilities through Realistic Mathematics Education Using ICT and Deduction

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**Abstract**: Mathematics courses should be given to all students especially those in the elmentary school. It is vital to equip the students with the ability to think logically, analytically, systematically, critically, and creativelly as well as the ability to cooperate. Mathematics learning in the classroom is believed to be less able to increase mathematical creative thinking abilities among students, as shown in the International Student Assessment (PISA) results in 2009. Indonesia's Mathematics education ranked 59 out of 65 countries. Other results released by the Trends in Mathematics and Science Study (TIMMS) in 2007 showed Indonesian students obtaining an average score of 397, far below Singapore and Malaysia where both countries had both obtained the average scores of 593 and 474 respectively. Due to the above reasons, the need to carry out the research was felt necessary. In realistic mathematics education, students are required to create their own modeling, and develop existing knowledge, thus find new knowledge that will be useful in the learning process. This approach requires students to interact, both with the teacher and other students in order to enable them to exchange ideas and knowledge. In the process of doing that, it is hoped that the mathematical creative thinking abilities will be formed. Learning in this context is supported by the use of ICT as a learning media that displays a real-world context for students. Deductive approach will be used as the comparison group in this study. Based on the results of the processing and analysis of data, it is shown that the mathematical creative thinking abilities of students taught using the ICT-assisted approach to realistic mathematics education is different from students who were taught using the deductive approach. Students taught using the ICT-assisted realistic mathematics education have higher averages. In other words, realistic mathematics education in ICT-assisted is suggested to be better than the deductive approach in improving students' mathematical creative thinking abilities.

**Keywords**: realistic mathematics education, deductive approach, creative thinking, ICT

## 1. Introduction

Indonesian students' mathematics learning outcomes in the recent period has decreased. According to the National Exam Results Indonesian Ministry of National Education, the average value of the national exams for junior high school mathematics in 2013 was 6.1. It is lower than the acquisition in 2012, which was 7.54 (Kemendikbud, 2013).

In addition, the results of tests Trends in International Mathematics and Sciences Study (TIMSS) held the International Association for Evaluation of Educational Achievement (IEA) suggests that mathematical ability of the grade 8$^{th}$ of Junior High School in Indonesia is still quite alarmingly low, where it is ranked 38 from 45 countries (Mullis, 2012). The grade 8$^{th}$ ability of the Junior High School in Indonesia for completing non-routine problems (mathematical problem) is very weak, but relatively well in resolving questions on facts and procedures.

These facts indicate contradictory phenomenon. It raises the question of what approach to be taken to increase students' mathematical achievement. How should mathematical instruction be given in order to have a positive impact on the development of students who are being educated to face the future?

Mathematics learning outcomes are the ability to think creatively. These include the high order thinking skills. One of the lessons that can raise and improve the ability to think creatively is to provide mathematical learning. It is described in the standard curriculum unit for basic education and secondary mathematics which stated that Mathematics is needed in order to equip students with the ability to think, and build creative thinking (Peraturan Menteri Pendidikan, 2006).

Tthe study of mathematics in the classroom today is less able to raise and improve the ability to think creatively particularly mathematical creative thinking abilities of students. This happens because most teachers in Indonesia use the conventional or the traditional learning process. One example of traditional learning is learning through deductive approach (Ida, 2013).

Furthermore, interesting to note is the presence of discourse in mathematics learning paradigm revolution. This discourse is based on the conditions in which learning mathematics at this time is not just about counting activity. It is a human activity in living their everyday lives. According to Zamroni (2006), the development of science occurs when there is a paradigm revolution. For example in the development of mathematical knowledge, mathematics is stated as human activity, and that it is not just about numbers, but about life. This implies that learning mathematics is also learning about the meaning of life. This is consistent with one of the approaches in the learning of mathematics, namely realistic mathematics education.

Realistic mathematics education will facilitate students in planting concepts and enhance students' mathematical creative thinking abilities. This is where math is displayed into real figures that can be imagined. This is a realistic approach to mathematics learning of students involved in the learning process. They look at the learning process and create their very own models, thus encouraging creative thinking skills.

To increase the effectiveness of realistic mathematics teaching and learning approaches, teachers are advised to use the information and communications technologies (ICT). The use of ICT in the learning process uses a realistic mathematics education to help answer problems or issues in the learning process so that students can imagine within a realistic approach to learn Mathematics more effectively. In addition, the use of ICT can also increase the child's motivation to learn because it presents math in a more interesting way.

## 2. Theory

### *2.1. Student's Mathematical Creative Thinking*

Creativity is the ability to produce a composition, product, or idea of what is essentially an unknown author. It can imagine activities which include formation of new patterns and combined information derived from previous experiences. This will result in a new situation and not only covers the establishment of sheer fantasy (Hurlock, 1992). Students' creative thinking ability can be measured by the fulfillment of indicators of the ability to think creatively. Indicators according to Torrance includes smooth/fluent thinking, flexibility, originality/novelty and detail/elaboration (Munandar, 2009).

Associated with the learning of mathematics, mathematical creative thinking abilities of students can be seen from (1) students' fluency constraint answers associated with math problems and address issues related to the math correctly, systematic and relevant, (2) diversity completing math problems and can change resolution existing mathematics to different problem-solving (3) find and give new ways of relating to the completion of math problems and (4) describe in detail how to go into details or how to solve the mathematical problem, which detail can be sentences, graphs and images.

There are levels in mathematical creative thinking abilities according to Siswono (2008): (1) a person is very creative (level 4) if he/she was able to demonstrate proficiency/fluency, flexibility and novelty or just show flexibility and novelty in solving problems or asking, (2) a person is creative (level 3) if he/she was able to show proficiency/fluency and novelty or shows fluency and flexibility in solving a problem, (3) a person is creative enough (level 2) if he/she was able to show it or show flexibility novelty alone, (4) a person said to be less creative when he/she was only able to demonstrate proficiency/fluency only in solving mathematical problems, and (5) the last level or level 0, which is classified as not creative.

### *2.1.1. Realistic Mathematics Education ICT Assisted*

"Mathematic is a human activity", said Hans Freudenthal. This statement is the basis of Realistic Mathematics Education (RME). Realistic mathematical theory was first introduced and developed in the Netherlands in 1970 by the Freudenthal Institute which stated that mathematics should be associated with reality and mathematics is a human activity (Suharta, 2005). In Indonesia, the implementation of realistic mathematics (PMRI/Indonesia Realistic Mathematics Education) is still relatively new. PMRI has been tried in some elementary school (SDN/MIN) in Indonesia and so far it has shown good results for the advancement of mathematics learning activities, one of which as admitted by Ratini (2005), third grade teacher MIN Yogyakarta II states that through learning fractions with PMRI approach, students can understand math, art and creativity thrive soul. To the level of Junior High School or junior secondary school there is no programme devoted to applying realistic mathematics learning, but efforts in that direction have been tried by IndoMath with training programs for junior high school teachers (Hadi, Plomp, Suryanto, 2001).

This realistic mathematical approach emphasizes the importance of pupils known real context and the construction of mathematical knowledge by the student himself. The context of real-world problems is the main part of mathematics (Tarigan, 2006). Real or realistic is not just something real and concrete for students but can be a context that can be imagined by the students. In realistic mathematics education, there are three main principles. According to Gravemeijer, there are Guided re-invention, Didactical Phenomenology and Self-delevoped Model (Supinah, 2008).

Realistic mathematics education has some characteristics that differentiate it from other approaches. Treffer (Wijaya, 2012) formulates five main characteristics of realistic mathematics approach, namely (1) the use of context, (2) use the model for progressive mathematics process, (3) utilization of construction student outcomes, (4) interactivity and (5) linkages. The use of context of realistic mathematics learning is the first step in building and finding a math concept through mathematical process. The mathematical process comes from horizontally to vertically mathematical process. Mathematics in the horizontal process starts from the issue - a matter of context, then students define for themselves the language and symbols on its own. Vertical mathematics is a process that occurs within the system itself, which include mathematical concepts such as the use of multiplication, division, addition or subtraction.

In mathematics realistic education students are involved in the learning process of making models by the students themselves. The use of models in realistic mathematics education serves as a bridge of mathematics from the informal to formal mathematics or the bridge between horizontal mathematical processes to vertical. Realistic mathematics learning approach feature either active interaction with students or student interaction with student teachers. Teachers' interaction with students in the learning process can be seen in the presence of a teacher asking some questions to the students. Student's questions can also lead to students' interaction among students. "Linkages" means that in realistic mathematics education, mathematics should be interconnected to other subjects, so that the subject of mathematics learning is integral and intact. To understand these characteristics, teachers should know that the mathematical terms are interrelated.

ICT (information and communication technologies) has two aspects: communication technology and information technology. This includes information technology hardware and software to perform a task such as capturing, processing, transmit, store, retrieve, manipulate or display data. Communication technology is related to data processing and data transferring from one device to another. Information and communication technologies have strong links between information technology and information processing systems. Communication technology aims to send information that have been processed (Rusman et al, 2011: 83). Microsoft power point is used in this ICT-assisted learning of realistic mathematics education. Power point is used to display the contextual issues related to real life, so hopefully the students may be interested to resolve the problem.

### *2.1.2. Deductive Approach*

This approach is characterized by a presentation given at the beginning of the learning where teachers provide definitions and terms. Deductive approach (Sagala, 2005) is a process of reasoning approach which starts from the general to special circumstances. This approach begins with the present rules, where the general principle is followed by giving an example or a specific example of the application of topics that have been submitted. The general principles then move into

specific circumstances. Step by step deductive approach as follows: (1) The teacher explains the material to be delivered, (2) Teacher gives examples of questions from material that has been described, (3) Teachers provide an opportunity for learners to record the material that has been described and provide an opportunity to ask the teacher and occasionally ask about the material that has been presented to the students. (4) The teacher then provide tasks to the learners.

## 3. Research Methodology

This study uses a Quasi Experiment design. Data sources in this study were students of VIII-5 class as the class were taught by a realistic mathematics education ICT assisted (experimental class), and students of VIII-3 class as a class taught by a deductive approach (control class) in SMPN 106 SSN Jakarta registered in the first semester of 2012/2013 academic year. Experimental class totaled 33 students and a control class with 34 students. Data is collected using a written test with a test item instrument description. It is to measure the ability of students to think creatively in mathematics.

## 4. Data Analysis

To analyze the data obtained in the study used statistical test using t-test, but previously performed tests of normality and homogeneity test as a condition of doing data analysis. (1) normality test is used to determine whether the sample used normally or not, so it can determine the types of statistics that will be used later. Normality test used in this study is the Lilliefors test, (2) homogeneity test is to show that the variance of the samples to be compared were not significantly different. Testing homogeneity in this study used the Fisher test, (3) t-test was performed to determine which hypothesis after the data were normally distributed and homogeneous.

## 5. Results

### *5.1. Validity*

Out of the 12 obtained about the creative mathematical thinking, nine were valid and three were not valid.

### *5.2. Reliability*

Reliability calculation with regards to the mathematical creative thinking ability showed $r_{result} = 0.766$ where it has a value greater than $r_{table} = 0.361$. Thus, it can be concluded that the matter of mathematical creative thinking abilities of students in the subject of two-variable linear equation system is reliable and fit for use as a research instrument.

### *5.3. Data Descriptions*

#### *5.3.1. Data Classes Taught by Realistic Mathematic Education Approach ICT Assisted*

The research data obtained from the mathematical creative thinking abilities test among students in the experimental class taught classes with a realistic approach to mathematics instruction on the subject of ICT assisted linear equations system of two variables. Of the tests that have been done scores ranged between 6 to 27, with the average score of 12.39; median of 11.668; modes of 10.664, and the standard deviation of 5.178.

#### *5.3.2. Data Classes Taught by Deductive Approach*

The research data obtained from tests of mathematical creative thinking abilities of students in the control class is a class that is taught by a deductive approach on the subject of two-variable system of linear equations. Of the tests that have been done, obtained scores ranged from 1 to 17, with the average score of 7.588; median 6.875; modes of 5.50, and a standard deviation of 3.978.

*5.4. Test Result Analysis Data Requirements*

*5.4.1. Normality Test*

Having tested the test, results obtained Lilliefors $L_{result}$ = 0.1380 <0.1542 = $L_{table}$ (class of realistic mathematics education ICT assisted) and $L_{result}$ = 0.1260 <0.1519 = $L_{table}$. Thus, it can be concluded that both classes have a normal distribution.

*5.4.2. Homogeneity Test*

The homogeneity of two classes will be tested using the Fisher test. Results obtained are as the following $F_{result}$ = 1.694 and $F_{table\ (0.95)}$ = 0.556 and $F_{table(0,05)}$ = 1.798. As $F_{0,\ 95\ (32.33)}$ = 0.556 <1.694 = $F_{result}$ <1.798 = $F_{0,\ 05\ (32.33)}$ it can be concluded that both sets of respondents has the same conditions or homogeneous variance.

*5.5. Hypothesis Testing Results*

Research hypothesis was formulated stating that there is a difference between students who were taught realistic mathematics education and deductive approach to mathematical creative thinking abilities. Proposed hypotheses were tested using t-test. And the values obtained from the list-t distribution with significance level $\alpha = 0.05$ and degrees of freedom (df) = 65 to test the two parties, in the $t_{table}$ = 1.9983 = -1.9983. With testing criteria receive $H_0$ if $t_{result}$ between -1.9983 and 1.9983. The calculation shows that t is not among the criteria of acceptance of $H_0$ is t = 4.2650> -1.9983 = $t_{table}$ or t = 4.2650> 1, 9983 = $t_{tabel}$ which indicates that $H_0$ is rejected. Rejection of $H_0$ indicates that there are differences in mathematical creative thinking abilities among students who were taught using the deductive and the ICT method.

## 6. Results

Realistic ICT assisted mathematics education can make a difference in mathematical creative thinking abilities of students. Learning process through realistic mathematics education displays mathematics in the real world context. Mathematical learning becomes meaningful because students who are guided and motivated by teachers can find for themselves the mathematical concepts through the exploration of the real world. As students are included in the learning process, they were able to make generalization and construction of knowledge to complete the problem given. The learning process encourage enhancement of students' mathematical creative thinking abilities. The use of ICT in teaching realistic mathematics approach also made learning more effective because ICT is used to help illustrate mathematical problems.

Interaction is one of the characteristics of realistic mathematics education approach assisted ICT. Here students are encouraged to exchange their imaginations and ideas. Through construction and reconstruction, students will be more creative in answering math problems. The use of real-world context and orientation which changes from the teacher focused to the students' learning processes provides a positive impact in improving students' mathematical creative thinking abilities.

## References


Hadi, S., Plomp, T., & Suryanto. (2001). *Introducing Realistic Mathematics Education to Junior Highschool Mathematics Teachers in Indonesia*. (accessed 30th March 2007, from http://www.math.uoc.gr/~ ictm2/ Proceedings/ pap279.pdf).

Hurlock, Elizabeth B. (1992). *Perkembangan Anak.* Jakarta: Erlangga.

Kemendikbud. (2013). *Hasil UN SMP-Sederajat Tahun Ajaran 2012-2013.* Jakarta: Kemendikbud.

Mullis, Ina V.S., *et.al.* (2012). *TIMMS 2011 International Results in Mathematics.* Chestnut Hill: TIMSS and PIRLS

Munandar, Utami. (2009). *Pengembangan Kreativitas Anak Berbakat.* Jakarta : Renika Cipta.

Ratini. (2005). *Pembelajaran Pecahan dengan PMRI Lebih Bermakna*. Buletin PMRI (Pendidikan Matematika Realistik Indonesia). Edisi VI – Februari 2005.

Sagala, Syaiful. (2005). *Konsep dan Makna Pembelajaran.* Bandung: CV Alvabeta

Siswono, Tatag Yuli Eko. (2008). *Model Pembelajaran Matematika Berbasis Pengajuan Dan Pemecahan Masalah Untuk Meningkatkan Kemampuan Berpikir Kreatif.* Unesa University Press.

Suharta, I.G.P. (2005). *Matematika Realistik Apa dan Bagaimana*. Jurnal Pendidikan dan Kebudayaan Edisi 38, Pusat Data dan Informasi Pendidikan, Balitbang – Depdiknas

Supinah. (2008). *Pembelajaran Matematika SD dengan Pendekatan Kontekstual dalam Melaksanakan KTSP*. Yogyakarta: Pusat Pengembangan Pendidikan dan Tenaga Kependidikan Matematika.
Tarigan, Daitin. (2006). *Pembelajaran Matematika Realistik*, Jakarta: Departemen Pendidikan Nasional.
Wijaya, Ariyadi, (2012). *Pendidikan Matematika Realistik.* Yogyakarta: Graha Ilmu.
Zamroni. (2006). *Pergeseran Paradigma Pembelajaran Matematika Sekolah*. Makalah Direktorat Profesi Pendidik. Direktorat Jenderal Penajaminan Mutu Pendidik dan Tenaga Kependidikan.