THE EFFECT OF CONSTRUCTIVIST LEARNING USING SCIENTIFIC APPROACH ON MATHEMATICAL POWER AND CONCEPTUAL UNDERSTANDING OF ELEMENTARY SCHOOLS GRADE IV

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ABSTRACT

This study used a model of Concurrent Embedded with the aim of: (1) determine the difference between the conceptual understanding and mathematical power of students grade fourth who take the constructivist learning using scientific approach and direct learning, (2) determine the interaction between learning approaches and initial competence on the mathematical power and conceptual of understanding, and (3) describe the mathematical power of students grade fourth. This research was conducted in the fourth grade elementary school early 2015. Data competence and mathematical power obtained through tests, and analyzed using statistical tests Manova. Manova statistical analysis of the results showed that: (1) there is a power difference between the concepts of mathematics and understanding of students who take the scientifically-based constructivist learning and direct learning ($F = 5.550$; $p = 0.007 < 0.05$), and (2) there is an interaction between learning approaches and the beginning of the power of mathematics competence and understanding of the concept ($F = 3.497$; $p = 0.039 < 0.05$). Observations and interviews with students, shows that the construction of mathematical power of students have influenced the thinking of students in problem solving and contributes tremendous increase students' math skills. Researcher suggested that the learning of mathematics in schools using scientifically-based constructivist approach to improve the mathematical power of students and conceptual understanding.

Keywords: mathematical power, constructivist, scientific, initial competence

INTRODUCTION

Mathematics education reform issues on reasoning ability, critical and creative thinking skills have changed the paradigm of learning mathematics. Now, the purpose of learning mathematics is directed to the meaningful learning for students and can provide a good provision of adequate competence for further studies or to enter the workforce. Now the effort to reform mathematics is to portray the students to participate actively. That is the nature of the change of "transmission" to "participation". When students learn mathematics, the role of the student is the teacher construct knowledge together. Teachers gives problems, asking questions, hear students answers, probing questions and then wait for an answer from the students in the formation of knowledge or mathematical concepts expected. Hear the ideas of mathematics students is a very important aspect in learning constructivism "... to shift from 'telling and describing' to 'listening and questioning' and 'probing for understanding" (Maher & Alston, 1990).

Constructivism is a learning theory that describes the process of knowledge construction. Construction knowledge is an active, not a passive process (Ernest, 2004). Constructivists believe that knowledge should not only be stored into the minds of the students; but must be built by the students through active involvement in the learning process. Basically, constructivism emphasizes the importance of the context of teaching, students' prior knowledge and active interaction between the learner and the content will be studied.

According to Freudenthal (1991), when children learn mathematics separate from their daily experience that the child will quickly forget and not be able to apply mathematics. Researchers agree with constructivist ideology, that knowledge in this case is called the mathematical power is construction (formation) of students who know something (schemata). Knowledge or ability can't be transferred from the teacher to the student, because every student has his own scheme of what he knows is through experience. A student who is studying means to form knowledge actively and continuously (Suparno, 1996).

NCTM (1989; 2000) and Baroody (2000) states, the mathematical powers is the ability to explore, arrange allegations; and provide a reason logically; ability to solve non-routine problems; communicate ideas about mathematics and using mathematics as a means of communication; connecting ideas in mathematics, among mathematics, and other intellectual activities. Mathematical power of reasoning and communication capabilities include (Sumarmo, 2003) is a must-have capability of students to enable them to face the problems of mathematics in particular and everyday problems in general. Based on the opinion of mathematical power description, in this study the mathematical power is defined as a high level of mathematical ability to exploration (investigation), formulate a guess, reasoning, and communication in problem solving.

Basically every student can be seen to have the capability - including the ability of mathemacal power but the mathematical power level or degree students is different (Kusmaryono. I & Suyitno.H, 2015). According to the NCTM (2000) and Stranic & Kilpatric (1989) in learning to think mathematically, termed mathematical power same with high order thinking skills. The best thing is that students have the skills necessary to make choices and solve problems using logical reasoning. Non-routine problem solving is characterized as a high-level skills that can be obtained after mastering the skills to solve problems of the ordinary.

Indonesian education curriculum in 2006 implicitly require elementary school to high school students has a strong mathematics. **Why mathematical power is important? M**athematical power is part of a high-level thinking skills, has become the focus of development in the 21st century in mathematics education (NCTM, 2000). Given the importance of the ability of higher- order thinking is needed by our young people for the challenges of the 21st century (Griffin, McGaw & Care. 2012), therefore develop students' mathematical power starts from the level of young people has become an important goal of the present study mathematics (Diezmann & English, 2001; Phillips & Anderson, 1993; NCTM, 1989)

Results of research conducted by Sudrajat (2013) and Wardani (2002) reported that the mathematical power (reasoning and communication aspects) elementary school and high school students have not reached optimal results. On the other hand Sumarmo (2003) in his research said the power of mathematical reasoning and communication include: the ability to be owned by the students to enable them to face the problems of mathematics in particular and everyday problems are generally still low.

Based on the initial research that has been conducted by researchers about the mathematical power description of the construction of the fourth grade students in elementary Sultan Agung Semarang through interviews, observation and recording of documents in the field, researchers assumed that mathematical powers students to contribute positively to the achievement of learning mathematics (Kusmaryono. I & Suyitno. H, 2015). One alternative actions that can be done to improve student math is through the application of scientific -based constructivist learning mathematics. Alternative choice of action is based on some opinions about the importance of linking the real life experiences of children with mathematical ideas in the classroom (Soedjadi, 2000; Price, 1996; Zamroni, 2000).

Scientific learning is learning that adopt scientists in building knowledge through scientific method. The learning model is needed that allows created scientific thinking skills, developing "sense of inquiry " and creative thinking abilities of students. The learning model is needed that is able to generate the ability to learn (Joyce & Weil : 1992), not only acquired some knowledge, skills, and attitudes, but more important is how the knowledge , skills , and attitudes acquired learners (Zamroni, 2000 & Semiawan, 1998). Scientific Learning is not only looking at the end result of learning as the estuary, but the learning process is considered very important (Yanti, 2014). Therefore emphasizes the scientific learning process skills. This model emphasizes the search process knowledge of the transfer of knowledge, the student is seen as a subject of study that needs to be actively involved in the learning process, the teacher is just a facilitator who guides and coordinates the activities of learning (Yanti, 2014). In this model, students are invited to conduct the search process knowledge with respect to the subject matter through the various activities carried out by the process of science as scientists (scientist) in conducting scientific investigations, so the students are directed to find out for yourself the facts, concepts, and new values necessary for life. The focus of the learning process aimed at developing students' skills in knowledge process, find and develop their own facts, concepts , and values required (Semiawan: 1992). This model also included the discovery of the meaning, organization , and structure of the idea, so that gradually the students learn how to organize and conduct research.

Learning with understanding the concept is often the subject of study is very broad and deep in educational research. Dahar (1988) states that learning concept is the result of education. The ability to understand the concept of a foundation for thinking and resolve problems or issues. Concepts that will give a theorem or formula. Concepts or theorems that can be applied to other situations, the need for skills in using concepts or these theorems. The concept is the foundation for higher-level thinking processes or can mean that students understand the concept properly will be able to generalize and transfer knowledge than students who simply memorize definitions. Learning math can work, in addition to the factors specified learning approach, students' competency factors varying allow receipt of material differences in each student. This will result in differences in the ability of mathematical power of students and conceptual understanding (I Nyoman Dharma, I Wayan Sadra & Sariyasa, 2013).

Early mathematical competence is an ability that can be the basis for receiving new knowledge. Early mathematical competence is the foundation and base for the formation of a new concept in learning. A learning process can be said to be significant if a student has been able to associate the concepts that exist in his mind well . Of the linkage process, it was discovered a new knowledge that can be used in life. Ausubel (Depdiknas: 2006) states that prior knowledge of students will determine whether or not a meaningful learning process. That is why teachers have to check, improve and enhance the students ' prior knowledge before discussing the new material. Dochy’s Research (1996) concerning the competence of the initial finding that the initial competence students contribute significantly to the post-test scores or learning out comes. Learning orientation at the beginning of the competence will have an impact on the process and the acquisition of adequate learning outcomes. Early competence of students is very important to know before learning to do. Competence early role as the foundation of students to follow learning to higher level. Initial competency will describe the mathematical ability of students before the beginning of the learning is done. Therefore, students need to be directed learning through a process of gradual gradually from simple concepts to the understanding of more complex. Until finally the students understand, understand, control and able to apply them in solving problems of everyday life.

METHODOLOGY

This research method is a combination method of quantitative and qualitative (concurrent embedded). The population was fourth grade students at Semarang Sultan Agung elementary school in 2015, amounting to 96 students. Samples were taken by using cluster random sampling technique. Samples of the experimental group and the control group each consisted of 24 students. Interviews were conducted with selected students, to obtain information on the opinions and reasons in mathematics problem solving.

Prior to testing the hypothesis that the research data should qualify analysis includes a data distribution normality test, homogeneity of variance test, and test multikolinierity overall. Test normality of data distribution using the Kolmogorov - Smirnov statistic and Shapiro - Wilks test while the homogeneity of variance using Levene statistic, multicolinierity test the dependent variable using product moment correlation and test homogeneity of variance - covariance using Box 's test. Then the data were analyzed using descriptive and 2 × 2 factorial Manova. All hypothesis testing was done at the 5% significance level with SPSS 20.0 for Windows PC.

The research data is data balanced understanding of the concept and power of mathematics scores were collected through the test form of essay test. Data post test understanding of the concept and power of mathematics were analyzed using descriptive statistics and statistical tests Manova . In this study proposed two hypotheses.

Hypothesis 1 can be formulated as follows

$$H_{0(1)} : \begin{bmatrix} \mu_{A1} & Y_1 \\ \mu_{A1} & Y_2 \end{bmatrix} = \begin{bmatrix} \mu_{A2} & Y_1 \\ \mu_{A2} & Y_2 \end{bmatrix}$$

$$H_{a(1)} : \begin{bmatrix} \mu_{A1} & Y_1 \\ \mu_{A1} & Y_2 \end{bmatrix} \neq \begin{bmatrix} \mu_{A2} & Y_1 \\ \mu_{A2} & Y_2 \end{bmatrix}$$

Hypothesis 1 :
(Ho): There is no difference in understanding of the concept and mathematical power among the students who follow the scientifically-based constructivist learning than students who take the Direct Learning in terms of students' initial competence.
(Ha): There are differences in understanding of the concept and mathematical power among the students who follow the scientifically-based constructivist learning than students who take the Direct Learning in terms of students initial competency.

Hypothesis 2 can be formulated as follows

$$H_{0(2)} : INT.AXB = 0$$

$$H_{a(2)} : INT.AXB \neq 0$$

Hypothesis 2 :
(Ho): There is no interaction between scientific-based constructivist learning approach based scientific with an initial competence (high and low) on the ability of understanding of the concept and power of mathematics.
(Ha): There is an interaction between the scientific-based constructivist learning approach with an initial competence (high and low) on the ability of understanding of the concept and mathematical powers.

Specification: A: Learning Approach; A1 : Constructivist Approach; A2 : Direct Learning Approach; B: Preliminary Competence; B1: High initial Competence; B2: Low initial Competence Low; Y1: Mathematical Power, and Y2: Conceptual of mathematics Understanding.

RESEARCH FINDING

Based on the results of descriptive statistics can be seen that the average score of students' mathematical power constructivist approach based scientific group = 65.42, higher than students group Direct Learning approach the average score = 63.75. The average score students' understanding of the concept of group constructivist approach based scientific = 73.33 is higher than the group Direct Learning approach which had an average score = 63.33. In other words, that learning through constructivist approach based scientific is superior compared with the Direct Learning approach in achieving mathematical power and conceptual understanding.

Test the hypothesis in this study conducted by statistical methods using a 2 x 2 factorial Manova using SPSS 20.0 for Windows. Manova 2 x 2 factorial multivariate analysis intends to examine the influence of each independent variable on the dependent variables simultaneously. Results of the analysis of hypothesis testing can be presented as in Table 1 Multivariate Tests.

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.987	1602.231[b]	2.000	43.000	.000
	Wilks' Lambda	.013	1602.231[b]	2.000	43.000	.000
	Hotelling's Trace	74.522	1602.231[b]	2.000	43.000	.000
	Roy's Largest Root	74.522	1602.231[b]	2.000	43.000	.000
approach	Pillai's Trace	.205	5.550[b]	2.000	43.000	.007
	Wilks' Lambda	.795	5.550[b]	2.000	43.000	.007
	Hotelling's Trace	.258	5.550[b]	2.000	43.000	.007
	Roy's Largest Root	.258	5.550[b]	2.000	43.000	.007
Initial competence	Pillai's Trace	.446	17.301[b]	2.000	43.000	.000
	Wilks' Lambda	.554	17.301[b]	2.000	43.000	.000
	Hotelling's Trace	.805	17.301[b]	2.000	43.000	.000
	Roy's Largest Root	.805	17.301[b]	2.000	43.000	.000
approach * initial competence	Pillai's Trace	.140	3.497[b]	2.000	43.000	.039
	Wilks' Lambda	.860	3.497[b]	2.000	43.000	.039
	Hotelling's Trace	.163	3.497[b]	2.000	43.000	.039
	Roy's Largest Root	.163	3.497[b]	2.000	43.000	.039

a. Design: Intercept + approach + initial competence + approach * initial competence

b. Exact statistic

Manova analysis results (Table. 1) shows that the significance for Pillae Trace, Wilk Lambda, Hotelling Trace, Roy's Largest Root. Has significance smaller than 0.05. That is, the price of F for Pillae Trace,

Wilks Lambda, Hotelling Trace, Roy's Largest Root are all significant. So the null hypothesis [Ho (1)] is rejected, it means that there is a difference (learning outcomes) of mathematical power and understanding of the concept among the students who follow the constructivist learning approach based on scientific and learning of students who take the Direct Learning approach in terms of students' competencies in mathematics fourth grade students of Sultan Agung Semarang. Results of the study after a test Manova statistics show that there are differences in the understanding of mathematical concepts and significant power between groups of students who studied with constructivist approach based scientific and a group of students who studied with Direct Learning approach, which has a value of Fhit = 5.550 > Ftab = 2.66 with a significance level of 0.007 where $p < 0.05$. This may imply that the achievement of mathematical power and conceptual understanding of students in the constructivist approach based on scientific is better than Direct Learning approach. Based on the analysis Manova in Table 1 shows that the price of F hit (F count) = 3,497 > Ftab = 2.66 to Pillai 's Trace, Wilks ' lambda, Hotelling 's Trace, and Roy 's Largest Root is $0.039 < 0.05$. This means that all values Pillai 's Trace, Wilks ' lambda, Hotelling 's Trace, and Roy 's Largest Root is significant. Thus, the null hypothesis [Ho (2)] is rejected, it means that there is an interaction between learning approaches (Constructivist and Direct Learning) with initial competence (high and low) on the ability of understanding of the concept and mathematical power.

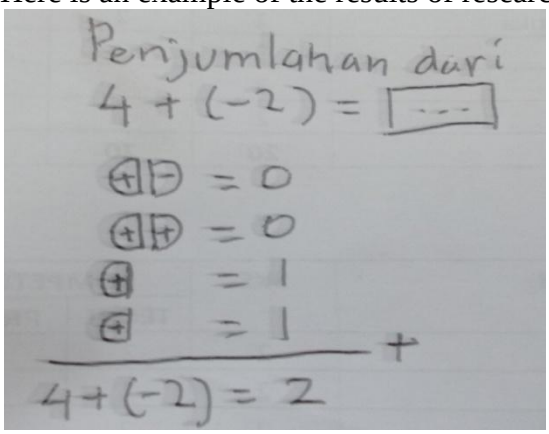
DISCUSSION

The following discussion is why the achievement of understanding of the concept and mathematical power students in the constructivist approach based on scientific is better than Direct Learning approach. As it is known that in the process of learning the scientific –based constructivist approach always starts by providing contextual and real problems to be completed by students in a way that they are able (informally) either in groups or independently.

The next process is the discussion (groups and classes) and teachers can facilitate by providing questions conceptual and procedural so provoke students to generate activity metacognition, creative thinking and higher order thinking. This method is suited to classroom conditions that have been set up in small groups. In the process of discussion the teacher as mediator and facilitator, so that in turn the problem can be resolved formally by the student correctly.

Development concept originated from intuition students and students using each strategy in acquiring a concept. Constructivist approach based scientific gives students greater opportunities to develop students' ability in accordance with their respective experiences. Learning with constructivist approach based scientific gives better results in achieving the mathematical power and students' understanding of mathematical concepts.

Here is an example of the results of research interviews with students (Shofiyyah) :



Excerpts of the interview:
Teacher : Shofiyya , why are you doing solving this problem, not the same as was done by your friend?
Shofiyyah : for me , it is easier
Teacher: What 's the meaning of the image circle ?
Shofiyyah : this is called manic-manicpositive and manic - manic negative , if paired result is zero (0)
Teacher : wow , good idea.

Figure 1. Examples of Students Work 1

The results of interviews conducted by the students, to one aspect of the mathematical power (reasoning), that students understand the math as to what they thinks, they do their own knowledge construction, not what is thought by the teacher. Many students better understand mathematics through pictures and other visuals of the need to memorize formulas without meaning. Based on the results of student work can be seen that some students have been able to quickly see patterns and regularities of small incidents (specializing) and then the suspect with alleged (conjecturing) strong generalization small incidents (Kusmaryono.I & Suyitno. H, 2015). Marjolijn.P, et.al. (2009), confirmed that the suspect the true reason is the mathematical thinking process using Mathematical Power.

In the case of this study, there are some students are very heavy for making idea, because initial competence as a form of learning experience of students is still low. So that these students experience barriers in the process of knowledge construction. By the time the students have problems teachers provide assistance (scaffolding process) to students to learn. Scaffolding is giving some assistance to students during the stage - the early stages of learning, then reduce aid and provide an opportunity to take over greater responsibility as he can do (Slavin, 2005). Assistance in the form of guidance, encouragement, warning, describes the problem into solving steps, provide examples, and other measures that allow students to learn independently. The interaction between early learning approach with due competence in the classroom, the students were initially high competence, does not necessarily indicate a better learning motivation on learning with a constructivist approach or Direct Learning approach compared with the competence of student motivation initially low. These findings also indicate, that constructivist learning based scientific can be implemented for all students to pay attention to the background of the initial competence (high or low).

CONCLUSION

Based on the description of discussion above, the research conclusions obtained as follows. First, there are differences in the ability of mathematical power and conceptual understanding between groups of students who studied with constructivist approach based scientific and a group of students who study the direct approach of learning in terms of students' competence. Secondly, there is an interaction between learning approach with an initial competence to the understanding of the concept and power of mathematics. Third, In line with the constructivist ideology, it is said that students understand the math in his own way and in a way that varies according to learning abilities possessed before, it is this which has led to the mathematical power difference between the two groups of student learning. Results of this

study are supported by previous studies showing that the construction of mathematical power students influence the thinking of students in problem solving The end of this discussion, it is believed that the learning of mathematics using constructivist approach based scientific can improve students' mathematical power and conceptual understanding.

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