Improvement of College Students Mathematical Concept Understanding through DNR-based Instruction Models

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Abstract: Mathematical concept understanding is the basic ability that students must possess in learning mathematics. Mathematics that is abstract, having symbols which can be only understood in its field, makes mathematics complicated as felt by some students. The DNR-Based Instruction model with the principles of duality, necessity and repeated reasoning can improve students' ability to understand mathematical concepts. Therefore this study aims to determine the improvement in students' mathematical concept understanding through the DNR-Based Instruction model. Descriptive and n-gain analysis was used to analyze the results of students' work at pretest and posttest and then to discover the amount and qualification of the improvement in 54 students at a state university in North Maluku Indonesia. The results showed that there was an increase in students' mathematical concept understanding of 0.66 with moderate qualifications. The implication of this research is that learning mathematics by emphasizing on concept understanding is a way in which mathematics should be taught.

1 INTRODUCTION

Understanding mathematics is not only about remembering concepts (Godino, J. D, 1996), or being able to follow procedures (Idris, N, 2009). Understanding the mathematical concept is a deeper understanding and understanding of the basic nature of mathematics, from simple facts to mathematical proof which are all indicators of mathematical understanding (Hoosain, E., 2001). Understanding mathematical concepts is the basis for developing other mathematical abilities (Bakar, 2018b). Understanding mathematical concepts means knowing the concept in depth, being able to interpret, explain, prove and apply it in problem solving. The activities of understanding mathematics such as interpreting, concluding, proving, explaining, composing, predicting, applying, classifying, generalizing and solving problems are mental actions that are performed not only in this area of subject but also daily life (Bakar, 2018a).

Research related to understanding concepts has been widely carried out, for example by Bakar (2018b); Bakar (2018); Kieran (1994); Fuadi (2016) which broadly states that students' concept understanding is still low and it is still difficult for them to think deeply. Attorps (2006) stated that many college students experienced problems with mathematical concepts and symbols. The results of (Bakar, 2018a) research in the early semester students related to the basic concepts of mathematics show that most students make mistakes in interpreting the problem due to the lack of concept understanding and weak reasoning in understanding the problem.

The DNR-Based Instruction model, hereinafter referred to as DNR-BI, is considered to be able to improve students' ability to understand mathematical concepts because this learning model emphasizes on the intellectual needs of students in mathematics and how mathematics should be taught.

2 METHOD

This study aims to discover and describe the achievement and improvement of the mathematical concept understanding ability of students who obtain DNR-BI learning method. The subjects were fifty-four elementary pre-service student teachers at a state university in Ternate, North Maluku, Indonesia, who attended lectures on Basic

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Mathematical Concepts. The pre-test and post-test questions used were arranged based on the indicators of concept understanding. The indicators of understanding the mathematical concept are being able to associate a concept with other concepts, representing mathematical situations in various ways, and being able to determine a more appropriate representation. The four questions used in this article were questions that have been published in our previous article (See Bakar 2018a) but with a different analysis. The four questions are presented in Table 1 below:

Table 1: Problem description.

No.	Problems
1.	Mr. Amir bought five recreational park tickets for two adults and three children for Rp105,000.00 Meanwhile Pak Iksan bought three tickets for adults and five tickets for children at Rp165,000.00 State this situation in the most appropriate form you think (among SPLDV settlement methods) to determine the price of each recreational park ticket.
2.	A convenience store sells two types of rice. Rice type I and rice type II. The price of rice type I is Rp 10,000.00 and the price of rice type II is Rp. 13,000.00. The sales on that day were Rp. 2,935,000.00 and the amount of rice sold were as much as 250 litres. a. What kind of rice is the bestseller? Explain your reasons. b. Suppose that rice sold for 370 and sales were of Rp 4,450,000.00. How much is each type of rice sold?
3.	c. What conclusions are derived from these two problems?
4.	The circumference of an isosceles triangle is 20 cm. If the length of both feet added by 3 cm and the length of the base two times the original length then the circumference to be 34 cm. Represent your answers using more than two ways to get the lengths of all three sides of the isosceles triangle. A rectangular object with a circumference of 22 cm. If the length is made to three times the original length and width are made twice the original width, then the circumferences of the object become 58 cm. Find the area of the rectangle and explain the answers you get.

Analysis of achievement and improvement of students' mathematical concept ability using descriptive analysis and normalized gain formula developed by Harel, G (2001). The results of the normalized gain calculation were then interpreted using the classification stated by Hake, R. R. (1999). These interpretations and classifications are presented in Table 2 below:

Table 2: Normalized Gain Classification.

N-Gain Value (g)	Interpretation
$(\langle g \rangle) \geq 0,7$	High
$0,3 < (\langle g \rangle) < 0,7$	Medium
$(\langle g \rangle) \leq 0,3$	Low

3 RESULT

Descriptively data regarding the achievement ability to understand mathematical concepts of fifty-four students who received DNR-Based Instruction as a whole obtained an average of 78.055 with a standard deviation of 7.87 and a variation coefficient of 10.08%. This means that the contribution of lectures by using the DNR-Based Instruction model is better to establish students' understanding on mathematical concepts. In other words, students who are applied to the DNR-Based Instruction model in the Basic Mathematics Concept lecture get more benefits and get the opportunity to explore knowledge during lectures. For example, it was shown from the results of student's paperwork in solving the system problems of two variables in the form of story problems as shown in Figure 1:

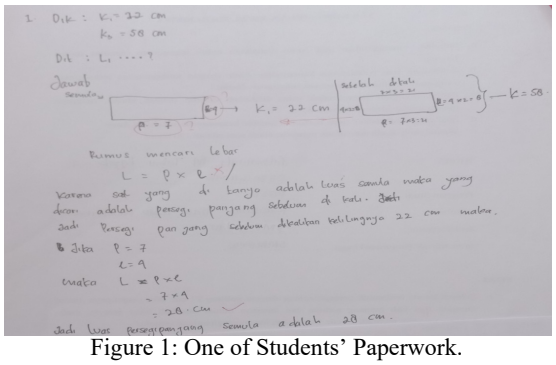

Figure 1: One of Students' Paperwork.

Overall, the results of test in increasing students' (primary school teacher candidates) understanding towards mathematical concepts descriptively showed that pre-test score of 36, 38 and post-test of 78.055 with an ideal maximum score of 100 and obtained normalized gain of 0.66 based on Hake normalized gain classification, in Table 1 is categorized as medium.

4 DISCUSSION

The level of the students' achievement and improvement in understanding mathematical concepts who obtain DNR-Based Instruction learning in solving problems related to a two-variable liner equation system with an average of 78.055 and a standard deviation of 7.87 with an n-gain of 0.66 with a medium increase category shows that learning by using the DNR-Based Instruction model has a positive effect on achieving and improving students' mathematical concepts understanding. The high contribution of the DNR-Based Instruction learning models is because the DNR-Based Instruction model has the principles of duality, necessity and repeated reasoning (Harel 2008a) which emphasizes the mastery of content and student's intellectual needs. Duality principle considers that mathematics understanding and thinking method, which is called as Ways of Understanding (WoU) and Ways of Thinking (WoT) (Harel 2008b). This principle requires learning mathematics not only in mastering concepts, theorems, evidence, rules etc., but it also directs learner to master the way of thinking.

Furthermore, the necessity principle states that students will be interested in teacher's teaching if they find a necessity on the teaching materials. Therefore, the DNR-Based Instruction model highly regards on meeting student's intellectual needs (Harel 2010) Presenting and marking student's intellectual needs are indeed difficult to do, but it does not mean that it is improbable. There will be differences in teaching methods or approach between teachers who have the knowledge of teaching and mastering math content with teachers who do not have that knowledge. The principle of repeated reasoning considers that repetition in mathematic learning activities will improve student's concept/knowledge of mathematics. However repeated reasoning is different with working on repeated examples. Repeated reasoning emphasizes on thinking method (Harel; 2001). Thus the DNR-Based instruction model is a learning model that strongly emphasizes the aspects of mastering mathematical concepts, not on the psychological aspects.

5 CONCLUSION

Achievement and improvement of students' understanding towards mathematical concepts can be improved through the DNR-Based Instruction model, with an average achievement of 78.055. Improvement value is categorized under the average category.

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REFERENCES

Godino, J. D., 1996. Mathematical Concepts, Their Meanings, and Understanding. In *Proceedings of XX Conference of the International Group for the Psychology of Mathematics Education*. V.2, pp. 417 – 425. Universidad de Valencia.

Idris, N., 2009. Enhancing Students' Understanding in Calculus through Writing *International Electronic Journal of Mathematics Education* 4 1

Hoosain, E., 2001. What Does It Mean to Understand Mathematics?, *Humanistic Mathematics Network Journal*, 25, 9

Bakar, 2018b. Mathematical Concept Understanding, Reasoning, and Disposition Ability Improvement on Students of Elementary Teacher Education

Program through DNR- Based Instruction Model - Disertation

Bakar, 2018a. The association between conceptual understanding and reasoning ability in mathematics: An analysis of DNR-based instruction models. *IOP Conf. Series: Journal of Physics: Conf. Series 1088 2018 012107. Doi 10.1088/1742-6596/1088/012107*

Bakar, 2018. Learning Obstacles on Linear Aquation concept in *Junior High school Students: Analysis of Intellectual Need of DNR-Based Instructions. (in reviuw) IOP Conf, series*: Journal Physics

Kieran, C., 1994. Doing and seeing things differently: A 25-year retrospective of mathematics education research on learning. "*Journal for Research in Mathematics Education* 25 583-687

Fuadi, R., Johar, R., & Munzir, S., 2016. Improving the ability of Mathematical Understanding and Reasoning through Contextual Approach Juornal Didaktika Matematika 3 1

Attorps, I., 2006. Mathematics Teachers' Conception about Equations. Thesis. University of Helsinki, Fakulty of Behaviour Sciences Department of Applied Education

Harel, G. 2001. The development of mathematical induction as a proof scheme: A model for DNR-Based instruction. In S. Campbell & R. Zaskis (Eds.), Learning and teaching number theory. In C. Maher (Ed.), *Journal of Mathematical Behavior*. New Jersey, Ablex Publishing Corporation, 185–212.

Hake, R. R. 1999. *Analyzing Change/Gain Score. Departement of Physics.* Woodland Hills USA: Indiana University.

Harel, G., 2008a. DNR perspective on mathematics curriculum and instruction, Part II: With reference to teacher's knowledge base. *Zentralblatt f¨ur Didaktik der Mathematik*, 40, 893– 907.

Harel, G., 2008. What is mathematics? A Pedagogical answer to a philosophical question. In R. B. Gold & R. Simons (Eds.), Proof and other dilemmas: Mathematics and philosophy (pp. 265–290). Washington, DC: Mathematical Association of America

Harel, G., 2013. Intellectual Need, in Keith R. Leatham. Vital Direction for Mathematics Education Research (pp. 119- 151). New York Springer.

Harel, G., 2007. The DNR System as a Conceptual Framework for Curriculum Development and Instruction. In R. Lesh, J. Kaput & E. Hamilton (Eds.), *Foundations for the Future in Mathematics Education*. Erlbaum.