Enhancing mathematical connection ability of mathematics education student through inquiry-based learning

A D Handayani¹,²*, T Herman³, S Fatimah² and I Setyowidodo¹

¹Universitas Nusantara PGRI Kediri, Kediri, Indonesia
²Department of Mathematics Education, Postgraduate School, Universitas Pendidikan Indonesia, Bandung, Indonesia

*Corresponding author’s email: apriliadwi@unpkediri.ac.id

Abstract. As a pre-service mathematics teacher, the student of mathematics education is required to have high order thinking skills. A part of high order thinking skills is the ability of a mathematical connection. The purpose of this study is to analyse the improvement of student’s mathematical connection ability as a result of the implementation of inquiry-based learning. This research is a quasi-experimental research involving two classes. The first class as the experimental group which get Inquiry learning and the second group is the control group which get the conventional learning. The sample of this research is students who take the course of Numerical Method. The data have been obtained and then analysed by using t-test. The results of this study show that the ability of mathematical connections of students in the class that using inquiry-based learning is better than the students in the class that using conventional learning.

1. Introduction
Among the goals of school mathematics are [1]: 1). Obtaining mathematical concepts and skills needed in everyday life and continuous learning in mathematics and related disciplines; 2). Recognizing and using ideas in mathematics and between mathematics and other disciplines. Connections inside and outside mathematics are an important part of the school mathematics curriculum. The teacher must provide students with opportunities to experience connections in the mathematics they learn. This is possible through the relationship between conceptual knowledge and procedural knowledge, connections between mathematical topics and equivalent representations of the same concept. Mathematics is built on itself in a way that is not the same as other sciences [2]. Each topic developed in antiquity continues on the development of relevant mathematics today, namely the knowledge that arises for new knowledge, problems that cause new problems. One of the goals in teaching the concept of mathematics is to give students the sensitivity of how an idea fits in a large building called mathematics. Connection training between math topics is one way to achieve this goal. Teachers facilitate children to recognize and use connections between mathematical ideas [3]. This statement is consistent with the development of global mathematics education.

Mathematics learning in class lacks reasoning and tends to routine problem activities so that students are less accustomed to solving non-routine problems and teaching of mathematics results in students only working procedurally and understanding mathematics without reasoning [4]. Mathematical reasoning can be developed through the application of learning that trains students to explore ideas and construct knowledge independently, both individually and in groups. Learning is
nuanced in exploration, inquiry, discovery, or problem solving. One learning that has the character of fostering the ability to think creatively is inquiry learning. Inquiry learning methods lead students to be more active as a participation in the learning process [5]. In this case, it can called student centered learning. This learning method enhances students' ability to analyze, synthesize, evaluate and correlate concepts contained in learning with other disciplines and daily life, so it causing the topics that they are studied more relevant [6].

Goos, Stillman, & Vale argue, inquiry learning in mathematics results in a deeper and more flexible understanding [4]. Various new constructivist-based studies advocate learning mathematics through inquiry and asking teachers to engage students to reason and solve problems. The activities of teachers and students in inquiry learning supported by habits of individual thinking and self-monitoring, and the encouragement of teachers in the inquiry process can develop students' mathematical thinking.

Inquiry comes from English "inquiry" which can be interpreted as a process ask and find out answers to scientific questions asked. Question scientific is a question that can directing investigation activities to the object of question. In other words inquiry is a teaching method student-centered who encourage students to investigate problems and find new information. Principles Inquiry Learning are: 1) Oriented Intellectual Development. The main purpose of the inquiry strategy is development thinking ability, 2) Interaction. The learning process is basically a process of interaction, good interaction between students and student interactions with teachers, even interactions between students with the environment, 3) Asking questions, The role of the teacher must be done in using this strategy is the teacher as "questioner" Develop students' critical attitude with always questioning all phenomena which exists, 4) Learning to Think Learning is a process of thinking that is a process develop the potential of the entire brain in a way optimal, 5) Openness. Meaningful learning is learning that provides various possibility as a hypothesis the truth must be proven. In an open manner.

Steps for applying the method inquiry in this study is as following: a) Ask questions or Problem, b) Planning a solution problem, c) Collecting data, d) Data analysis, e) Make conclusions. The five steps are applied at each meeting with the different discussion. The activities carried out by students in each meeting are preceded by presenting problems to students to be discussed together with their group friends. Problems presented to students vary at each meeting. The next step is to plan problem solving. Students discuss with group friends to predict problem solving and then they seek information from various books to complement their expectations. After getting various sources of information related to the material they learned then they did data analysis. In this case the students solve the problem according to the plan they have made before. After completing the problem, they made conclusions from what they had learned together in the group. At the end of each meeting, each group is given the opportunity to take turns to convey the answer. In the inquiry activity carried out in this study, each student gets a Student Activity Sheet that has been prepared based on the indicators in inquiry learning. The steps presented in the student activity sheet are adjusted to each stage of inquiry learning and adapted to the objectives of the study, namely to develop students' mathematical connection ability.

Inquiry learning is one of the learning based on understanding constructivist mathematics learning. Mathematics is only a tool for thinking, the main focus of learning mathematics is to empower students to think about constructing mathematical knowledge that has been discovered by previous experts [7].

The approach to mathematics learning is the way in which teachers carry out learning so that the concepts presented can be adapted by students [7]. There are two types of approaches in mathematics learning, namely methodological approaches and material approaches. While the learning method is a way of presenting material that is still general, for example a teacher presents material with dominant delivery orally and occasionally there is a question and answer. Every teacher can do such lecture methods according to their respective fields.

Inquiry learning has several advantages [8]: 1) in fact the sciences were obtained through discovery, 2). That finding something by yourself can increase motivation, want to conduct further studies on the subject of study, 3) something obtained can be more durable and if forgotten, more likely to trace it again.
Several principles in inquiry learning including the following [9]: 1) Oriented on intellectual development. The criteria for success of inquiry learning are determined by the extent to which students move to find and find something, not to what extent students can master the subject matter. So, the material presented with inquiry learning is material that can be found by students independently. 2) Principles of interaction. In this principle, in inquiry learning, the teacher is not a source of learning, but as an environmental regulator or contractor regulator. With teacher direction, students learn to develop their thinking skills through their interactions. 3) The principle of asking. The role of the teacher in inquiry learning is as a questioner, so students try to answer the teacher's questions. The efforts of students in answering teacher's questions are part of the thinking process. 4) The principle of learning to think. Learning not only remembers a number of facts, but learning is a process of thinking (learning how to think), which is the process of developing the potential of the whole brain. 5) Openness principle. In learning, students go through the process of trying various possibilities. Students need to get the freedom to try according to their reasoning abilities and logic. Whereas the teacher is tasked with providing a draft for students to develop hypotheses and openly prove the truth of the proposed hypothesis.

Based on the description of the background of the problem above, the formulation of the problem in this study is are the mathematical connection abilities of students who take inquiry learning better than students who take conventional learning in terms of: (a) all the student; (b) students' initial mathematical ability category?

2. Methods
This research is a type of quasi-experimental research involving two research groups. The first group is a class that teaches with Inquiry learning as an experimental class, the second group is a class that receives conventional learning as a control class.

The research design used in this study is the pretest-posttest control group design (Pretest Posttest control group design), combining 2 x 3 factorial designs with two types of learning.

Population is an area of generalization consisting of objects / subjects that have certain qualities and characteristics applied by researchers to be studied and then drawn conclusions. The populations of this study were students of Mathematics Education Program in a university in Kediri. While the sample of this study were two classes of Mathematics Education Study Program students who took numerical analysis courses

3. Results and Discussion
The data in this study were obtained from two types of instruments, namely instruments in the form of tests and non-tests. The instrument in the form of a test consists of a series of test questions that are used to measure students' initial mathematical abilities, and mathematical connection abilities. While non-test instruments are the observation of Teacher and student activities.

In this study, the instrument in the form of a question to measure students' initial mathematical abilities was given at the beginning of the study, before the experimental class was treated with inquiry learning. The instrument is the test of mathematical connections is given at the end of the treatment to determine the effect of inquiry learning assisted by Matlab software to improve the ability of mathematical connection abilities. While non-test instruments are the observation of Teacher and student activities that used to get the information about activities teacher and student in Inquiry learning.

The process of preparing the tests carried out is to compile a question box which includes the material, the measured ability, indicators and the number of items. Then proceed with compiling questions and key answers and scoring rules for each item. After the questions are arranged, further consideration is given to the weighers to validate the content and advance validation of this test. Face validity is to find out the language / editorial clarity and image. Content validity is to find out the suitability of the material, the objectives to be achieved, the aspects measured, and the level of difficulty of the problem. The validators of this instrument were 5 people, that expert in mathematics and mathematics education.
After the test questions were revised according to the results of the consideration and suggestions from the validator as well as input from the promoter team, the tests were then tested. Test instrument testing aims to find out, validity, reliability, and level of difficulty of the problem. For non-test instruments, the trial was conducted to determine the weight of each item in the mathematical thinking scale and its validity.

From research that has been done quantitatively, Quantitative data is obtained from the results of the mathematical connection ability test. Further step is the data that has been obtained is analysed for generalization purposes. Data analysis used is using t-test.

Before the statistical test is carried out, a prerequisite test is performed, namely the normality test and the homogeneity test of the data group variants. This test is carried out with the aim that conclusions about the population based on the sample are closer to the truth. Normality test and homogeneity test using Kolmogorov Smirnov test and Levene test.

The results of this study show that the mathematical connection ability of students that teach by using inquiry learning is better than students that teach by conventional learning, both in terms of the overall students and based on students' initial mathematical abilities.

4. Conclusion
The results of this study show that the mathematical connection ability of students teach by using inquiry learning is better than students that teach conventional learning, both in terms of the overall students and based on students’ initial mathematical abilities.

5. References
[1] Berinderjeet K and Lam T T 2012 Reasoning, Communication and Connections in Mathematics. Yearbook 2012 Association of Mathematics Educators
[2] Marchisotto E A 1991 Connections in Mathematics: An Introduction to Fibonacci via Pythagoras. California State University, Northridge http://www.fq.math.ca/
[3] NCATE/NCTM Program Standards 2003 Programs for Initial Preparation of Mathematics Teachers http://www.math.uri.edu/
[4] Yuwono S I and Muksar M 2013 Penerapan Pembelajaran Inkuiri Untuk Meningkatkan Penalaran Matematika Siswa Kelas VII-4 SMP Negeri 4 Balikpapan. Makalah disajikan dalam KNPM V di Universitas Negeri Malang
[5] Stefanos G et all. 2000 Using Guided Inquiry in Teaching Mathematical Concepts. Illionis Mathematics Teacher–Fall http://www.abourcherif.com/
[6] A D Handayani, et al. 2018. Journal of Physics: Conference Series. Inquiry Based Learning: a Student Centered Learning to Develop Mathematical Habits of Mind.
[7] Suherman E et al. 2003Strategi Pembelajaran Matematika Kontemporer (Bandung: Jurusan Pendidikan Matematika, FMIPA UPI)
[8] Ruseffendi E T 2006 Pengantar kepada Membantu Guru Mengembangkan Kompetensinya dalam Pengajaran Matematika untuk Meningkatkan CBSA (Bandung: Tarsito)
[9] Sanjaya W 2008 Strategi Pembelajaran Berorientasi Standar Proses Pendidikan (Jakarta: Kencana Prenada Media Group)

Acknowledgments
We thank you very much to Mr. Tatang Herman and Mrs. Siti Fatimah, lecturers Universitas Pendidikan Indonesia who has supported the continuity of the process to write this paper. Thank the government who have been assisted by BPPS scholarship and doctoral grant to facilitate the author in completing the study.