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Applying Guided Inquiry Learning Method with Contextual Approach to Improve Students' Ability of Mathematical Reasoning

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***Abstract*—This study aims to analyze the enhancement of students' mathematical reasoning ability through the application of guided inquiry learning model with a contextual approach. This research was carried out on 167 Indonesian students of grade 7 of Kendari City. The hypothesis test used two-way ANOVA, paired sample t-test and independent sample t-test. The result of this research are (1) the average of the improvement students' mathematical reasoning ability taught by using guided inquiry method with a contextual approach is significantly higher than that of direct learning method; (2) there is significant difference of influence between the application of guided inquiry learning method with contextual approach and direct learning method to students' mathematical reasoning ability in terms of students' learning motivation.**

Keywords—learning, guided inquiry, contextual, mathematical reasoning

I. INTRODUCTION

Education, in general, has a very important role for all children to face their future. Everyone can develop themselves through the learning process. Because of that, the Indonesian Government has composed rules about the rights and obligations of all citizens in getting an education. It is regulated in the Indonesian Constitution 1945 Article 31 which provides that every citizen has the right to obtain education and to have basic education and follow the Government rules and organizes a national education system. According to LAW Number 20 the Year 2003 [1], Indonesian education aims to develop the students' inner ability in order to become citizens who have good faith and pious to God Almighty, a great value of being good citizen, to be strong and well, being creative, to be independent, and to become democratic citizenships and become completely responsible for what they do. To make this reach the goal of Indonesian education, schooling does the learning process in various fields of study, one of which is the learning of mathematics.

Mathematics is a compulsory subject in educational systems throughout the world. Countries that ignore mathematics as a major priority will be left behind from the progress of all fields especially science and technology compared to other countries that provide a proper place for mathematics as an important subject. This is because mathematics is one of the science underlying the universal participation of the development of modern technology and has an important role in various disciplines and advancing the power of human thought. In accordance with the National Reseach Council (NRC) of the United States has stated that: "Mathematics is the key to opportunity" that has a similar meaning to mathematics is the key towards the success opportunities [2].

Mathematics and mathematical reasoning are two important concerns that cannot be separated. The students' reasoning ability is one of mathematical learning objectives in schooling, the students' way of thinking and practicing in drawing conclusions, developing the ability to solve problems, and developing the ability to convey information or communicate ideas through oral, written presentation, images, charts, maps, diagrams, and so forth. Moreover, the interaction of students and teachers in the learning of mathematics learners performed as a medium for learning explore, investigate conjectures, generalize and use a variety of ways to prove. The activity is an activity to develop reasoning skills [3].

To Indonesian students, mathematical reasoning is still considered to be difficult work to do. This supported the PISA and TIMSS survey results. The results of the survey Programme for International Student Assesment (PISA) in 2015, the average score of mathematics achievement of Indonesian students is 386 and ranked 63 out of 69 countries surveyed. Similarly, on the results of a survey of The Trend of International Mathematics and Science Study (TIMSS) in 2015, Indonesian students are only topped 64 of 65 participants [4]. Low results of TIMSS and PISA is caused by many factors. One contributing factors are the Indonesian students generally have not been able to solve problems with the characteristics of PISA and TIMMS contextual problems, demanding reasoning problems, problems for creativity, and argumentation in solution. One problem the TIMSS measures reasoning concerning with spatial dimension. The question asks how many books of a certain size will be contained in a box with a certain size. The results from TIMSS, the international average of 25% of the students answered correctly. Approximately 60% of students from the five countries of East Asia's best, in this case, Taiwan, Hong Kong, Korea, Japan, and Singapore can solve this problem. The next highest achievement was 36% in the Federation of Russia. As for the students of Indonesia only 11% of students who are able to answer the question the reasoning [5].

Indonesian students' mathematical reasoning ability is still at a low level of students mentioned above is questionable. Prior observations of the researchers in grade 7 Junior High School in Kendari City Indonesia found various obstacles that occur at school; for example, schools do not have enough educational utilities.Learning activities are still teacher-centered; students tend to be passive in the learning process. Most of the teachers are still using methods of lecture in delivering learning activities. learning activity conducted through listening to the lecture can be remembered by the students was only 20%, when learning activities were delivered through the vision act can be remembered by students of 50%, and when learning activity was performed by doing so, they will be remembered by students of 75%. The most frequent activity done by the teacher is usually with learning methods where the teacher gives the student listening activity materials. Then, the teacher explains the example, delivered question, do exercise, and students only look at what the teacher did [6].

Mathematical reasoning is reasoning about and with the object of mathematics. The statement can be interpreted that mathematical reasoning is reasoning about mathematical objects. The mathematical object, in this case, is the branch of mathematics that are studied such as algebra, geometry, statistics and so on [7]. Students, in learning mathematics, needed reasoning abilities,because students'ways of thinking developed in mathematics always involve critical thinking, systematic thought, logical, and creative thinking [8]. The ability of reasoning is very important to understand mathematics [9]. Reasoning and proof are fundamental aspects of mathematics [10]. Further, mathematical reasoning ability is very important in mathematical understanding, ideas, free to estimate the solution, and apply mathematical expression in the context of the relevant mathematical, and understand that the math that's meaningful in their life [11].

Nowadays learning the process with the condition of interactive and communicative learning involves the active participation of students in learning. To be able to reach the standards of learning, a teacher should be able to create an atmosphere of learning that allows students to actively learn by constructing knowledge, discovering and developing their own knowledge. Because of the teaching of mathematics is not just putting together a sequence of information, but need to review its relevance for usability and the interests of students in life. By studying mathematics students are expected to resolve the issue, students are able to discover and develop ideas that emerge in the minds of the students independently.

One of the alternative learning method used is a guided inquiry learning method. The guided inquiry learning method is a learning method that involves students actively in the learning process and also motivates students intrinsically. In the guided inquiry learning method, the role of the teacher is only as a facilitator. In this learning method students are required and trained to be able to think for themselves, as well as summarize their own on the subject matter based on the data provided by teachers, help and serve answers questions of students who have difficulties. In the guided inquiry method the role of students is quite heavy because learning is no longer centered on the teacher but on the students. In this learning method students are encouraged to think for themselves, so that in finding the general principles based on materials or data provided by teachers [12]

The application of contextual learning can contribute to improving alternative thinking ability of mathematics students, and ultimately it will improve student learning mathematics achievement. The application of mathematical learning, contextual learning in mathematics is possible because the topics taught in the Junior Secondary School is generally still largely be linked to everyday life. Although students of Junior Secondary School was already at the stage of formal operations, the change of the operational phase to concrete operational stage formal does not take place suddenly but gradually. Therefore, the students of Junior Secondary School at the age of 12-16their thinking process has not been entirely abstract in nature, so it still takes real objects in his education [13]

The integration of guided inquiry learning method which contains a contextual approach helps students in solving mathematics problems independently. The existence of contextual problems presented in the inquiry stage of learning makes students able to construct their own mathematical reasoning, contextual problems presented in the learning make students closer to the mathematical problems in the life of everyday students.

The students' motivation in education has always been the thing that caught our attention. Due to the fact that students' motivation is seen as one of the factors that are very dominant to contribute to the success of the purpose of education. Although it is recognized that the student's talents and intellectual ability are the main basis of the attempt to achieve educational achievement, but they are not going to be a lot of meaning when students as an individual do not have good motivation to learn. Students with high intellectual ability will only be wasted when they do not have any desire to make good learning habits and utilize the advantages of it [14].

The focus of this research is mathematical reasoning ability towards Junior Secondary School students grades 7 in Kendari City Indonesia through the application of the inquiry learning method with a contextual approach. The existence of the learning motivation variables in this research is controlling the influence of other variables that affect the execution of inquiry learning method with a contextual approach.

II. RESEARCH METHOD

This was experimental research; we were applying a guided inquiry method of contextual approach and direct learning model. Our research subject were 167 students of grade 7 of Junior Secondary School 20 Kendari City Indonesia academic year 2016/2017 covering 6 parallel classes. We selected two of six parallel classes based on certain consideration; one class was going to be an experimental group,the other class is the control group. In the experimental group, students were taught by applying guided inquiry method. The other group was taught by applying direct instructional approach.

In general, the direct instructional approach, known as the traditional approach to learning is focused on mastery of content, with less emphasis on the development of skills and the nurturing of inquiring attitudes. The current system of education is teacher-centered, with the teacher focused on

giving out information about "what is known." Students are the receivers of information, and the teacher is the dispenser. Much of the assessment of the learner is focused on the importance of "one right answer." Traditional education is more concerned with preparation for the next grade level and in-school success than with helping a student learn to learn throughout life.

Traditional classrooms tend to be closed systems where information is filtered through layers to students. In general, the use of resources is limited to what is available in the classroom or within the school. Use of technology is focused on learning about the technology rather than its application to enhanced learning. Lesson plans are used to organize the various steps in the learning process for the whole-class approach. On-target questions that would tend to cause deviations from the plan are met with, "We will get to that later."

The inquiry approach is more focused on using and learning content as a means to develop information-processing and problem-solving skills. The system is more student-centered, with the teacher as a facilitator of learning. There is more emphasis on "how we come to know" and less on "what we know." Students are more involved in the construction of knowledge through active involvement. The more interested and engaged students are by a subject or project, the easier it will be for them to construct in-depth knowledge of it. Learning becomes almost effortless when something fascinates students and reflects their interests and goals.

Inquiry classrooms are open systems where students are encouraged to search and make use of resources beyond the classroom and the school. Teachers who use inquiry can use technology to connect students appropriately with local and world communities which are rich sources of learning and learning materials. They replace lesson plans with facilitated learning plans that account for slight deviations while still keeping an important learning outcome in focus. They meet on-target questions with, "How do you suggest we investigate that question?"

Another issue regarding inquiry-based learning has to do with a misconception about when to make an inquiry. The inquiry is not only done in laboratory or group work - it can also be done in lectures that provoke students to think and question. Teachers often discount the fact that when they are giving talks or lectures to students, the students, if engaged, are applying to listen and observing skills - using their senses. If teachers focus more on "how we come to know" by presenting evidence and information and encouraging student questioning, then talks can even become powerful inquiry models for students. Collaborative meaning-making can take place through discourse.

After the learning process students were tested to obtain their score of grade 7 mathematical reasoning ability academic year 2016/2017, the test consisted of 7 essay questions. We also collected students' learning motivation data. The observer was assigned to check and collect data on the activity of both teacher and students during the learning process. The students' learning motivation data was obtained by applying a number of questions regarding it. There were 50 reliable and valid statements to measure students' learning motivation.

III. Result and Discussion

Before conducting research, we first developed a learning plan and research instruments. The learning plan included student worksheets, and topics covered. The research instrument included the students' mathematical reasoning ability and students' learning motivation questionnaire. The learning plan and the questionnaire then were being validated by experts, some lecturers, and some teachers.The students' mathematical reasoning abilities were declared as valid by both lecturers and teachers. The learning motivation questionnaire has been tried out in schools, and its reliability is 0.918.

Descriptive data of the students' ability of mathematical reasoning of both experiment group and control group based on student learning motivation category classification is presented in Table 1.

TABLE I. Students' Mathematical Reasoning Abilities of Both Groups Learning Method based on Each Category of Learning Motivation

Learning Motivation Category	**Statistics**	**The Learning Model**					
		Guided Inquiry			**Direct Learning**		
		Pretest	***Posttest***	***N-Gain***	***Pretest***	***Posttest***	***N-Gain***
High	N	7	7	7	7	7	7
	Average	42.86	74.49	0.55	45.71	60.12	0.27
	Std. Dev	6.99	6.56	0.11	12.39	11.75	0.08
Moderate	N	7	7	7	7	7	7
	Average	30.71	58.33	0.39	37.86	52.38	0.23
	Std. Dev	9.32	6.36	0.11	10.35	8.28	0.12
Low	N	7	7	7	7	7	7
	Average	17.86	45.24	0.33	16.43	32.14	0.19
	Std. Dev	6.99	6.56	0.06	8.99	9.84	0.07

Each mean of N-gain students' mathematical reasoning abilities of the two learning methods based on students' learning motivation categories is presented in the following figur

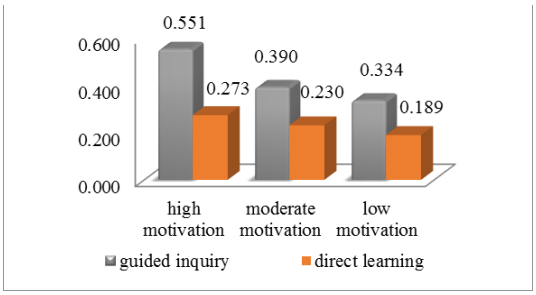

Fig. 1. The means of N-gain of Students' Mathematical Reasoning ability of both Treatment Groups

The improvement of students' mathematical reasoning abilities can be determined by conducting paired sample t-test and analyzed by using the SPSS program at 0.05 significance level. The results of the students' mathematical reasoning ability enhancement test on an experimental group taught by learning method of guided inquiry with a contextual approach are presented in Table 2. Statistical hypothesis testing is:

$$H_0 : \mu_1 \leq 0, \text{ vs. } H_1 : \mu_1 > 0$$

The test criteria are:

- If $\frac{\text{Sig.}}{2} < \alpha$ then H_0 is rejected
- If $\frac{\text{Sig.}}{2} \geq \alpha$ then H_0 is accepted

TABLE II. HYPOTHESIS TEST OF STUDENTS' MATHEMATICAL REASONING ABILITY GROUP TAUGHT GUIDED INQUIRY LEARNING METHOD WITH CONTEXTUAL APPROACH

		Paired Sample Test			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair	Posttest - Pretest	28.8486	7.96955	1.73910	16.588	20	.000

Based on Table 2, the results show that the increment of the ability of mathematical reasoning by using paired sample t-test, we get the value of $\frac{\text{Sig.}}{2} = 0.00 < 0.05 = \alpha$. So H_0 is rejected. That is, there is an increment in students' mathematical reasoning abilities after being taught by applying guided inquiry learning method with a contextual approach.

The results of the increment of the ability of mathematical reasoning in the control group are presented in Table 3. The statistical hypothesis tested as follows:

$$H_0 : \mu_2 \leq 0, \text{ vs. } H_1 : \mu_2 > 0$$

The criteria for test $\alpha = 0.05$:

- If $\frac{\text{Sig.}}{2} < \alpha$ then H_0 is rejected
- If $\frac{\text{Sig.}}{2} \geq \alpha$ then H_0 is accepted

TABLE III. IMPROVEMENT TEST OF MATHEMATICAL REASONING COMPETENCE OF CONTROL GROUP

		Paired Sample Test			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	Posttest - Pretest	14.8814	6.15878	1.34396	11.073	20	.000

Based on the results of the test output of mathematical reasoning ability enhancement by using a paired sample t-test presented in Table. 3, the value of $\frac{\text{Sig.}}{2}$ is 0.00 and is smaller than 0.05, so H_0 rejected. That is, there is an increase in students' mathematical reasoning abilities after being taught by direct learning model.

Hypothesis testing of the difference between the improvement of the ability of mathematical reasoning group taught inquiry guided inquiry method with the contextual approach and another group taught by direct learning model is done by t-test statistic. The summary of the t-test results of both groups of data is also presented in Table 4. Statistical hypothesis used as follows:

$$H_0 : \mu_1 \leq \mu_2 \text{vs. } H_1 : \mu_1 > \mu_2$$

Criteria test is:

- If $\frac{\text{Sig.}}{2} < \alpha$ then H_0 is rejected
- If $\frac{\text{Sig.}}{2} \geq \alpha$ then H_0 is accepted

Table 4 shows that the value $\frac{\text{Sig.}}{2}$ is 0.000 and is smaller than 0.05 significance level specified so that Ho is rejected.That is, the enhancement of students 'mathematical reasoning abilities taught by guided inquiry learning method with a contextual approach is better than the increment of students' mathematical reasoning which is taught by direct learning method.

Furthermore, to know the difference between the two of students' mathematical reasoning abilities in terms of student learning motivation presented in Table 5.

TABLE IV. HYPOTHESIS TESTING OF DIFFERENCES IN IMPROVEMENT OF MATHEMATICAL REASONING ABILITY WITH N-GAIN AGAINST BOTH TREATMENT GROUP

Independent Samples Test							
		Levene's Test for Equality of Variances		**t-test for Equality of Means**			
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**
Value_N Gain	Equal variances assumed	2.061	.159	5.498	40	.000	0.19476

TABLE V. HYPOTHESIS TESTING THE DIFFERENCE OF STUDENTS' N-GAIN OF MATHEMATICAL REASONING ABILITY INCREASED BETWEEN THE TWO LEARNING METHOD IN TERMS OF STUDENT LEARNING MOTIVATION

Sources	Sum Of Squares	df	The Average Quadratic	F	Sig.
Corrected Model	0.961	5	0.192	9.239	0.000
Intersection	4.515	1	4.515	501.489	0.000
Motivation	0.166	2	0.083	9.203	0.001
Class	0.398	1	0.398	44.243	0.000
Motivation * Class	0.037	2	0.019	2.068	0.141
Error	0.324	36	0.009		
Total	0.925	42			

Table 5 informs us that the value of F is 44.243 and sig.value is 0.000. The value of Sig.<α = 0.05, so Ho is rejected. That is, there is a significant difference of the influence between the application of inquiry learning method with the contextual approach and the application of direct learning method to students' mathematical reasoning abilities in terms of student learning motivation. Based on the motivation row we obtained the value of sig. equals 0.001. Because of the value of Sig. < α = 0.05, then Ho is rejected. This means that there is the influence of learning motivation of mathematical reasoning ability against the students. Next on the row is the motivation of * class retrieved that the value of sig. is 1.41. Because of the value of sig. > α = 0.05, so there is no interaction between learning motivation and learning methods against mathematical reasoning abilities of students

IV. DISCUSSION

The implementation learning approach in the classroom applied by the teacher influences the activity of students' learning process during the class. Implementation of conventional learning method puts teachers as the model of and the center of the activities of the learning process, and as the only source of knowledge. The conventional learning method reduces students' involvement in learning activities. Empirically, students become lazy, are not interested in paying attention to the material studied, feel bored, are not happy in learning mathematics, and do not understand the mathematics in depth, so the subject will be quickly forgotten and the process of learning will not be meaningful learning. Students feel that learning is to follow the directions of the teacher, doesn't need to be creative, and students are assuming that the more important thing is that all topics that being delivered by the teacher are being mastered. Learning process done like this is less challenging and does not interesting, cannot develop students' way of thinking. As a consequent, students are not able to solve the problems that are more challenging and difficult that requires higher-order thinking skill like mathematical reasoning.

To help students to overcome their problem with their mathematical reasoning is not easy to do, so it is needed to take learning method that becomes a bridge to facilitate students to develop the ability of mathematical reasoning. The learning method,here, is a guided inquiry learning method with a contextual approach, because this learning method can foster students' motivation to learn mathematics so as to improve the ability of mathematical reasoning.

The result of data analysis both from descriptive analysis and inferential analysis indicate that there is an influence of the application of guided inquiry learning method with a contextual approach to improving students' mathematical reasoning ability. The comparison of the gain of students' mathematical reasoning ability of the two treatment groups through inferential statistical test was also obtained that there is a significant difference of influence between the guided inquiry learning method with contextual approach and the direct learning method to the improvement of students' mathematical reasoning ability both from the whole students and from the motivation student learning. It can be seen from the average score of n-Gain of the two groups which concluded that the average n-Gain mathematical reasoning ability of the student's group whose learning using guided inquiry model has a contextual approach is higher than the average n-Gain score of the student group learning using direct learning model.

The guided inquiry learning method with a contextual approach is a learning method within the scope of a constructivism philosophy of education that focuses on the students' discovery process with their new knowledge or new concepts. Phases in guided inquiry learning with contextual approaches enable students to participate actively and have high confidence in discovering and communicating new ideas, knowledge or concepts they found. By using a contextual approach, students can easily construct mathematical problems. The ease of construction of knowledge because of the mathematical problems encountered is very closely related to the daily life of the students so that students can gain meaningful learning of mathematics topics.

The guided inquiry is a learning method that can be applied to train students' skills in carrying out the investigation process to collect facts so that students are able to construct conclusions independently to answer the teacher-proposed research question [15]. The guided inquiry learning method with a contextual approach in learning

mathematics aims to create an atmosphere of learning so that students gain experience in finding something new through the learning process. The guided inquiry models can improve students' cognitive because students are encouraged to conduct experimental activities [16].

Students deeply felt the effects of the application of guided inquiry learning method with a contextual approach, especially the influence of the method towards the students' mathematical reasoning. In the beginning, students encounter themselves that they could not analyze mathematical problems, predict the solution of mathematical problems given, make a mathematical analogy, and declare generalization of mathematical problems. By applying guided inquiry method with a contextual approach, gradually, mathematical reasoning problem faced by the student can be overcome. Because of that, students could increase their mathematical reasoning ability.As class activities going on, the guided inquiry learning method with contextual orientation allowed students to be trained to reason mathematically so as to enable them to acquire new knowledge, obtain new ideas and experiences meaningful learning.

The guided inquiry learning method with a contextual approach brings students to be active when solving mathematics problems provided by the teacher so that their activities can develop students good learning motive. Students who have good learning motivation will do more and faster learning activities compared to students who have less motivation to learn. Students who have high motivation will also carry out their learning activities with full confidence and responsibility compared to students who have low learning motivation so that they will achieve optimal learning outcomes. The existence of variable of learning motivation in this study controls other factors that can affect students 'mathematical deployment ability and the results of this study indicate that motivational factors greatly influence the improvement of students' mathematical abilities. Therefore, students who have high learning motivation have a greater chance to get better learning outcomes than students who have low learning motivation.

V. CONCLUSION

Based on the results, the conclusion as follows: (a) students' mathematical reasoning abilities increased after being taught by applying guided inquiry learning method with contextual approach, (b) students' mathematical reasoning ability increased after being taught by direct learning method, (c) the average gain of students' mathematical reasoning abilities taught by guided inquiry learning method with a contextual approach is higher than the average gain of students' mathematical reasoning ability taught by direct learning method, (d) There is a significant difference of effect of students' mathematical reasoning ability between group taught by guided inquiry learning method with contextual approach and group taught by direct learning method when it is being differentiated in terms of learning motivation.

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