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IMPORTANCE OF MATHEMATICS– ASSESSMENT OF SKILL OF REASONING

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Abstract

The purpose of this research paper was to analyse importance of mathematics to measure the reasoning skills of mathematics students using a test instrument developed from mathematics routine and non-routine task. The study used research and development method. Development of the instrument and measurement of mathematical reasoning skills using procedure: items preparation, expert validation, field testing, and data analysis. The field testing involves students of Government Degree College Siddipet. The data analyzed through studying the students' task solving, the transcripts of their work, after interview the test, identifying the specific task solving situations, and the arguments were supporting the strategy choice and strategy implementation. Result of research shows that student mathematical reasoning can be measured using the instrument test develop from the routine task and non-routine task. This present research study is the reasoning skills of mathematics students into two categories, imitative reasoning, and creative reasoning. Reasoning skills of mathematics students grouping results can be used by various interested institutions to evaluate the test using in mathematics instruction.

Keywords: Mathematics Reasoning, Reasoning Skills, Imitative Reasoning, Creative Reasoning, Routine Task, Non-Routine Task Initiative Reasoning.

Introduction

Statement of the problem

“No passion so effectively robs the mind of all its powers of acting, Mathematical reasoning as few.”

Prof. Edmund Burke

A familiar Statesman, Economist,
Mathematician & Philosopher from UK.

Mathematics is a study of measurements, numbers, and space, which is one of the first sciences that human work to develop because of its great importance and benefit. The origin of the word "mathematics" in Greek, which means tendencies to learn, and there are many branches of mathematics in science, that are related to the numbers, including the geometric forms, algebra, and others.

Mathematics plays a vital role in all aspects of life, whether in everyday matters such as time tracking, driving, cooking, or jobs such as accounting, finance, banking, engineering, and software. These functions require a strong mathematical background, and scientific experiments by scientists need mathematical techniques. They are a language to describe scientists' work and achievements.

As for mathematical inventions, they are numerous throughout the ages. Some of them were tangible, such as counting and measuring devices. Some of them are not as tangible as methods of thinking and solving. The symbols that express numbers are also one of the most important mathematical inventions.

Mathematics helps in analytical thinking. While solving math problems, data are collected, disassembled and then interconnected to solve them.

- Mathematics helps to develop the ability to think.
- It helps explain how things work.
- It helps to develop wisdom.
- It increases the speed of intuitive.
- It helps to make the child smarter.
- Money can be collected in mathematics when used as a profession.
- It is important in a constantly evolving world.
- It provides the child with an opportunity to get to the world.



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Mathematics in Our Everyday Life

Mathematics is the pillar of organized life for the present day. Without numbers and mathematical evidence, we cannot resolve many issues in our daily lives. There are times, measurements, rates, wages, tenders, discounts, claims, supplies, jobs, stocks, contracts, taxes, money exchange, consumption, etc., and in the absence of these sports data, we have to face confusion and chaos.

Thus, mathematics has become the companion of man and his helper since the beginning of human existence on earth. When man first wanted to answer questions such as "How many?" he invented math. Then algebra was invented to facilitate calculations, measurements, analysis, and engineering.

The science of trigonometry emerged when humans wanted to locate high mountains and stars. Therefore, the knowledge of this article arose and developed when human felt the need and mathematics are necessary for the long planning of life and also the daily planning of any individual. Mathematical rapprochement is necessary for any process, so if anyone wants to reach the height of his life, he should not fail to believe in the role of mathematics in his life, starting with the ordinary citizen. Every day has a daily interest in mathematics. Mathematics is deeply related to the natural phenomenon, the way to solve many secrets of nature.

Mathematics is necessary to understand the other branches of knowledge. All depend on mathematics in one way or another. There is no science, art, or specialty except mathematics was the key to it. The discipline and mastery of any other science or art are very much related to the size of mathematics.

The Most Important Uses of Mathematics

I think it is impossible to limit the uses of mathematics in everyday life so we will suffice with some of them:

- Can you use any entertainment game without using numbers?
- Can you practice any sport without using numbers to learn if you are a winner or a loser?
- Can you do your work without using the numbers? If you are a teacher, collect your students' marks or a doctor, estimate the amount of medicine for the patient or an engineer, estimate the amount of raw material to be added to complete the work or even a leader in a battle.
- Can you enter the store without using the numbers?
- Can prayers be organized without the use of numbers, and what is left of the time for the next prayer?
- And much more, whatever you try, you cannot get rid of the use of this important science.

The importance of mathematics is that it is a method based on research and analysis, to reach the desired results, and is used for calculation and presentation of data; not only the use of this science in a particular field but the use of all areas of life and different sciences.

The Importance of Mathematics to Individuals

Mathematics is one of the most important sciences that cannot be dispensed with, and the individual's need for mathematics is no less than the need of society. When studying an individual or a person of mathematics, this will develop his thinking and scientific tendencies. Mathematics also works to express the most accurate and objective, and it helps us to manage time and planning things, economics and others. Mathematics is an innate approach to research and analysis to reach a solution to mathematical problems. Mathematics is a basic subject taught at all stages. It cannot be dispensed with. Some of the important roles of mathematics in society are:

The importance of mathematics in scientific studies: The conduct of studies and scientific research requires many skills in sports, which help in the development of studies and progress, for example, the study of physics or chemistry depends heavily on mathematics, including mathematical skills and mathematical matters, and lies the role of mathematics in the accuracy of conducting social research through the statistics branch.

The importance of mathematics in the development of social values: It helps mathematics in the development and refinement of personality, through the organization and accuracy, research and investigation and study, and helps to detect.

The importance of mathematics in cultural development: Like other sciences, mathematics influences civilization's development. Cultural development depends on the achievements of scientists and innovators, especially athletes. No one neglects the role of Arab and Muslim scientists in the development of civilizations. A great mathematician, Muhammad ibn Musa al-Khwarizmi who created the theory of algebra and laws of arithmetic that helped develop modern science and technology.



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Mathematics is a subject directly related to human life. The subject has emerged from humans' observation of the world (Tanujaya, Prahmana, and Mumu, 2017). Since ancient time, mathematics guided human beings in tackling real-world problems, providing powerful tools for the development of sciences. Nowadays, mathematics still plays a crucial role in almost every branch of science and technology (Miao and Reynolds, 2018). The importance of mathematics makes it essential that children be well educated on the subject. Therefore, students who study mathematics need to know how to learn mathematics appropriately.

Learning mathematics is somewhat different from learning other subjects. The student who studied mathematics must think and learn mathematics by/for themselves, must think mathematically, and have to feel free to explore the intended knowledge independently with minimal formal teaching input. Mathematical thinking is different from doing mathematics. Students need to explore their thinking abilities when learning mathematics. On the other hand, mathematics instruction that teaches and supports students' thinking skills in Government Degree College, Siddipet of Telangana State. Impact of the situation can be seen from the low mathematics achievement of Indonesian students. Indonesian students are always ranked low on various international tests.

Mathematics instruction, as well as other instruction in education, is an attempt to humanize human beings. Therefore, it must be a successful instruction. The success of mathematics instruction can be measured by various indicators, one of which is through the student learning outcomes. A successful educational system should focus on student learning outcomes and provides the support necessary for every student to achieve them. The students' mathematics learning outcome is a form of mathematical concepts understanding that is very important in mathematical instruction, that needs to be known by the teacher as well as by the students themselves, using assessment

Assessment, especially classroom assessment, is not only designed to determine the rank and grade of students but more importantly, to get other functions in the learning process. The assessment has traditionally been used to evaluate student's accomplishment and content area of curriculums. However, new approaches to mathematics instruction have expanded the role of the assessment to include supervising student improvement and making instructional decisions. The teachers can find out the information in a variety of classroom assessments that range from observations and discussions to test, tasks, and projects, from self-assessment and homework to oral presentations.

The assessment has various purposes, such as providing student grades, system monitoring, student placement, determining interventions, improving teaching and learning, or offering individual feedback to students and their parents. The assessment is also a process of gathering the information that accurately reflects how well a student is achieving the curriculum expectations in a subject. The result of learning evaluation by the teacher can also be used by students to support their success of learning. The assessment can help students monitor their studying. When students know what is expected of them, through feedback and grading criteria, they are better able to keep track of their mastery of the material. The assessment should be an integral part of the learning process. Thus, there are some purposes of mathematics classroom assessment, although the primary purpose of the assessment is basically to improve the achievement of student learning.

Assessment and Skill of Reasoning

The mathematics classroom assessment is a primary instrument for supporting and monitoring student progress toward mathematics standard. Teachers should know about their students' problems while learning their progress, and the level of formality they are operating at so that they can adapt their teaching strategies to meet the students' needs. Thus, practical assessment in mathematics requires more than a look at the answers students give. The teachers need to analyze their processes and get the student to communicate mathematical thinking. The ability to think mathematically is the most crucial aspect of learning mathematics.

In order to evaluate the thinking ability of students who study mathematics, it is necessary to know the components in students' thinking skills, especially students who study mathematics. According to Breen and O'Shea, one level of mathematics learning outcomes is the students' reasoning ability. The reasoning is one mathematical thinking skills in addition to conjecturing, proving, making connections, abstraction, generalization, and specialization. Being able to reason is essential to understanding mathematics.

Mathematics reasoning is the process of making sense of and understanding mathematical ideas and concepts inherent to procedures, the line of thought adopted to produce assertions and reach conclusions, and can be defined as five interrelated processes of mathematical thinking, categorized as sense-making, conjecturing, convincing, reflecting, and generalizing, Conjecturing is forming an opinion or supposition about on the basis of incomplete information. Convincing is causing to believe firmly in the truth

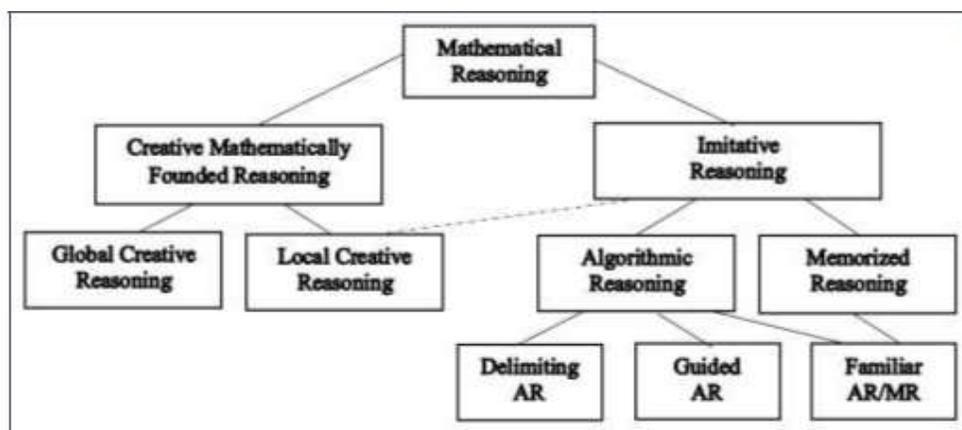
of something, reflecting is thinking profoundly or carefully about, while generalizing is make a general or broad statement by inferring from specific cases or make (something) more widespread or prevalent.

Students use reasoning when they engage in mathematical argumentation, is a process that involves making and justifying mathematical claims. Argumentation is the substantiation, the part of the reasoning that aims at convincing oneself or someone else that the reasoning is appropriate. The students tend to note patterns, structure, or regularities in both real-world situations and symbolic objects. They ask if those patterns are accidental or if they occur for a reason, and they conjecture and prove. It is, therefore, essential for a mathematics teacher to have an instrument to measure mathematics students' reasoning skills.

Mathematical Reasoning

Students' thinking skills in mathematics reasoning possess two categories: Imitative Reasoning, and Creative Mathematically founded Reasoning (CMR). Imitative reasoning is also known as Memorized Reasoning (MR) and Algorithmic Reasoning (AR). Imitative reasoning is students reasoning that often suitable in routine tasks. The MR strategy choice is founded on recalling, by memory, an answer, and the strategy implementation consist only of writing it down. The AR strategy choice is to recall an algorithm, which is a sequence of rules for solving a particular task type whereas the three following conditions define CMR, i.e., novelty, plausibility, and mathematical foundation. Thus, there are five levels of mathematical reasoning skills.

Figure 1.



Overview of mathematics reasoning of mathematics students in the framework

Furthermore, studies have shown that many teacher-made task display a heavy focus on Imitative Reasoning only. Likewise, the assignment compiled by mathematics teachers in Manokwari, and the assignment in the textbooks they use, are generally routine task in the range C1 - C3, which can be grouped in the matter of Imitative Reasoning.

How can the teacher measure students' reasoning skills if the task available are only in the group of imitative reasoning? Therefore, in order to measure mathematical reasoning skill of students in Indonesia, especially in West Papua, it is necessary to develop the non-routine test. The non-routine test can be developed from various tests in mathematics textbooks or the mathematics Olympiad. So, the purpose of this research was to measure the reasoning skills of mathematics students using test instrument developed from mathematics routine and non-routine task.

Materials and Methods

The method used in this study is research and development (R&D). R&D is a research method to achieve new knowledge that it might use to create new technology, products, services, or systems. Thus, the results of this research are a test of mathematics instrument to measure the ability of reasoning skills of mathematics students, especially for high school students and first-level of university students. The instrument test used as a reference for developing similar test instruments.

The research, development of test instrument, was conducted in four steps, i.e., item preparation (modification task), expert validation, measurement of student reasoning skills (field testing), and data analysis. Test instrument development was started by compile some types of mathematics task from some sources. The task consists of familiar and unfamiliar problems for students. The



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familiar problems were taken from the mathematics textbook, while the unfamiliar problems are a task from mathematics Olympics and modified from both types of tests. The familiar tasks are also known as routine tasks, while unfamiliar tasks referred to as non-routine tasks.

The instrument tests development continued with item analyzed by experts to determine the familiarity level of the items. The experts also conducted an analysis of the readability and social desirability of the item. Each expert had discussed with an others expert to then deducing their decision. The expert analysis results were used by the researcher to compose some new test instruments. The analysis conducted by these experts is an effort to increase the validity of the instrument. The experts' judgement of instrument items is referred to as content validity. Content validity according to Rusticus, refers to the degree to which an instrument is relevant to, and representative of, the targeted construct it is designed to measure.

The measurement of reasoning skills involves 20 students from final year and 30 students from mathematics first Year, the Government Degree College Siddipet of Telangana State, Data analysis in this study consists of two phases. The first thing was to interpret the reasoning skills of mathematics students by studying the students' task solving, using transcripts of their work and the interview. The second phase of data analysis was to identify the crucial task solving situations, and the arguments supporting the strategy choice and strategy implementation. Based on the characteristics of these argumentations, each solution attempt was classified as comprising one of the reasoning types in the framework.

Results and Discussion

In classroom activities when solved the task, the students provided a complex reaction in working solving a non-routine problem of mathematics. Several responses revealed how students have difficulty in solving the non-routine task. Majority students, however, expressed the view that despite some difficulty of the subject, they were able to accomplish and provide solutions to the problems. There are three cases of solutions to the student.

The students can answer the task correctly. However, the answer presented does not show a detailed completion process. The answer given is the result of remembering what the teacher teaches. The students memorize how to get the answer. This remembering activity belongs to a low level of reasoning. The students tend not to use mathematical reasoning skills when solving the task. According to Bieda et al., students use reasoning when they engage in mathematical argumentation. When solving this type of task, students do not fully use their reasoning skills. They do not show arguments that should appear in their answers. The students' reasoning abilities do not appear in their responses.

Research Analysis

The students' mathematical reasoning ability in this group classified into two groups: memorized reasoning and algorithm reasoning. The answers given by the first group of students are the result of the process of memorization, while in the second group of students, the answers were obtained using the learned procedure — these two groups of students classified into imitative reasoning. Imitative reasoning, according to Bergqvist, can be described as a type of reasoning built on copying task solutions. They found the way of solutions from a textbook example or through remembering an algorithm or an answer. Some observations show a connection between a narrow focus on imitative reasoning and students' difficulties when learning mathematics.

However, at the time of the interview, the students can generally show how to solve the problem. An example on the issue is to determine the value of the multiplication of two integers. All students can quickly answer the question. However, they could not elaborate on how they got the answer. Some of them using distributive law of addition to solves the problems. Others can answer after the researchers helped them explore the concept they have learned. The concept is known through memorization, not through understanding the concept well.

Therefore, mathematics task should present in the form of open questions. The kind of tasks can develop students' mathematics reasoning skills because inquiring about mathematics concepts, more specifically about the concept of multiplication. Since elementary school, students are generally required to memorize the results of multiples of two integers, without knowing how to get it. This situation enforces mathematics teachers to teach the concept of multiplication correctly. Experts classified these types of questions as open-ended questions. The question is a problem whose solution solves in various approaches. The questions require more thought and more than a simple one-word answer. This type of problem causes students to think about solving the problem.

The researcher plays a crucial function in developing students' reasoning abilities. Student reasoning ability can be done in various ways, one of which is through habituation in learning. Students should be accustomed early to be able to solve mathematical



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questions that require thinking skills. Therefore, the questions contained in various mathematics textbooks should be developed and modified by the teachers before being used in mathematics learning. Mathematics instruction has characteristics that are not the same as the characteristics of other lessons. Therefore, example and practice problems used in the instruction of mathematics should use HOTS questions. The used of HOTS questions in learning mathematics can improve students' thinking skills well. Students who have excellent thinking skills will able to solve problems both problems in school, as well as problems in daily life, now and later on.

students' answers are varied, depending on the known mathematical concepts, their ability to remember the concepts that have been mastered, and how to use the mathematical concepts. The variety of students' answers shows the diversity of their mathematical reasoning skills.

In this case, only a small percentage group of students can solve the task correctly. Others are generally confused about how to answer the question. They have no idea how to solve it. They have never done such a mathematics problem. They are not accustomed to working on problems that are not routine, so they have no idea how to answer it. So, the types of problems are classified as a non-routine task.

A non-routine task is a complicated question that could be solved in several procedures, but typically do not have an immediately apparent approach for solving it. Student requires some degree of creativity or originality to solves the problem. The types of problems focus on developing students' mathematical reasoning and fostering the understanding that mathematics is a creative subject matter. Solving the non-routine problems in mathematics intensifies their study habit, actualizes their creative skill, improves their strategic thinking skill, and develops their focus and mental discipline. Conversely, the task discourages them because it is highly challenging, mentally, and physically exhausting, and, lastly, their experience with the teacher is frustrating.

Summing Up and Suggestions

In the group of students who answered correctly, their answers were quite diverse. There are several versions of solutions performed by students. The diversity of answers occurs because of the variety of concepts used in answering the problems. The ability of students to use the various concepts that have been learned is crucial in answering these tasks. In this case, students who answered correctly are classified as students who have good mathematics reasoning ability. In the first group, the students were able to solve the task because they had worked on a similar task. They use algorithms and basic techniques that have been studied to answer the various exam.

Furthermore, in the second group of students, they have never worked on that type of task. They develop their reasoning skills, using various concepts that have been studied. Both groups of students can be categorized as students who have creative mathematically founded reasoning. Creative mathematically founded reasoning is a product of creative mathematical thinking. Creativity is not primarily correlated to geniality or superior thinking, but the creation of a new and reasonably well-founded task answer. Almost all students cannot answer the task questions correctly. The main reason given by students is that this type of task never been taught before; they have no idea. The last tasks are classified as a non-routine task. These kinds of problems are hardly used in routine mathematics learning activities, so students do not know how to solve them.

Student's mathematical reasoning can be measured using the instrument test developed from the routine and non-routine task. The result of the measurement shows that there are two kinds of mathematics students' reasoning can be grouped into two, that is students who memorize, and using the algorithm, classified as students who have imitative reasoning, while the students who develop the concept, and creates the procedure to solve mathematical problems as creative reasoning students. The results of these measurements can also be used to perform the detection of errors in the learning of a mathematical concept, to improve the quality of mathematics instruction.

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