Journal of Education and Learning (EduLearn)
Vol. 17, No. 4, November 2023, pp. 598~603
ISSN: 2089-9823 DOI: 10.11591/edulearn.v17i4.20632

Misapprehension of mathematics among teachers, parents, and elementary school students

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Article Info

Article history:

Received Jul 14, 2022
Revised Aug 24, 2023
Accepted Sep 16, 2023

Keywords:

Elementary school
Learning mathematic
Mathematic misconceptions
Misapprehension
Misconceptions

ABSTRACT

Early mathematicians viewed mathematics as a beautiful and ethereal art form. However, the pupils in school appear to have no idea of this beauty. Misconceptions about mathematics among students, parents, and instructors are thought to be one of the root causes of the problem. Mathematical misconceptions and myths among instructors, parents, and students were examined in this study. These findings were obtained using a descriptive qualitative method of investigation. Research participants included elementary school pupils and their parents from East Java, Indonesia as well as 10 instructors, 10 students, and 10 parents. Random selection was used to pick the respondents. The results of this study showed that teachers, parents, and students have a wide range of misconceptions about mathematics. Among the misconceptions that occur among students, teachers and parents are: i) The conception of mathematics; ii) The aim of learning mathematics is only to train students to count and memorize formulas; iii) Mathematical ability is a genetic talent and only people who have talent will be proficient in mathematics; and iv) Mathematics is a non-applicable. The consequences of widespread misconceptions about mathematics among teachers, parents, and students are detrimental to the learning process and hinder the development of strong mathematical skills.

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1. INTRODUCTION

There is a good reason why math is taught from preschool on up to college level in most formal educational settings. As a means of developing logical reasoning and mental discipline, mathematics has been found to be helpful [1]. In mathematics, one is able to develop the capacity to formulate hypotheses, conduct experiments, gather evidence, and make conclusions [2]. If you teach arithmetic correctly, you may expect not only excellent scientists, but also competent human resources to emerge. People will be able to think critically, methodically, and creatively [3].

Unfortunately, instead of being interested and enthusiastic about becoming an expert in the field, most students associate mathematics with negative feelings and unpleasant things [4]–[6]. Not a few also categorize mathematics as a difficult and disliked subject [7], [8]. Several studies have even confirmed that

students' dislike of mathematics continues to their next education level [9]. Finally, the feelings of dislike and/or anxiety about mathematics have an impact on students' performance in this subject [10], [11].

Feelings of discomfort and pressure when dealing with math problems, or more generally when dealing with numbers, is known as mathematics anxiety [12]–[14]. Feelings like this can happen not only in academic situations, but also in daily life practice [15]–[17]. People with mathematics anxiety have a tendency to avoid everything about mathematics, including the field of work related to mathematics.

Based on the results of a survey conducted by the Rise Program, there was a decline in the ability of Indonesian children in mathematics. This research was conducted from 2000 to 2014. In this survey, 4th grade students were asked to work on math problems from 3rd grade or lower grades. The results were surprising. In 2000, the percentage of students who answered correctly was 60%, while in 2014 there were only 46% of students who answered correctly [18].

The low mathematical ability of students in Indonesia is also confirmed by research conducted by the Trends in International Mathematics and Science Study or TIMSS and Program for International Student Assessment or PISA. The results of research conducted by the two institutions expose how low the mathematics ability of students in Indonesia is [19]. In several years of implementation, Indonesian's position has not improved.

There are several reasons why every child should have good math skills [20]. First, math is a good brain exercise. Problem solving skills that are trained in mathematics lessons will be needed by a person throughout his life. Second, mathematics is needed in almost all types of occupations. Every job requires at least one to have good basic math. Third, mathematics is useful in everyday life [21]. A person may not like math, but he cannot argue that math has been around all his life. From waking up in the morning to going back to sleep at night. Teaching mathematics well will not only create scientists, but also good citizens [3].

The low mathematical ability and mathematical attitude of students is an accumulation of many factors. One of them is the existence of misapprehension about elementary and important things related to mathematics. This has implications for mathematical attitudes which in the end also has an impact on performance in mathematics learning. This study aims to analyze the myths and misapprehension that develop among teachers, parents and students about mathematics. Among the many myths and misconception about mathematics, some of them have been widely accepted and seem to be true or are called misapprehension.

2. RESEARCH METHOD

This research falls under the category of qualitative research that is descriptive. The purpose of this study was for the researchers to attempt to get an understanding of the attitudes and behaviors about mathematics and the learning of mathematics held by mathematics instructors, parents, and primary school pupils. In this particular study, there were a total of 30 participants: 10 instructors of mathematics, 10 parents, and 10 primary school pupils. All of the courses originated from seven different primary schools in the province of East Java, Indonesia and these schools were chosen on purpose. In-depth interviews served as the method of data gathering for this particular research project. The approach of the interview was carried out in person and consisted of seven fundamental questions that were asked in accordance with established indications.

3. RESULTS AND DISCUSSION

3.1. The perception of teachers, parents and students about the definition of mathematics

Mathematics is a branch of the natural sciences that is covered in a variety of curricula, ranging from preschool all the way up to university [22]. Despite this, there are a great deal of misconceptions and misunderstandings around mathematics that have been extensively cultivated across society. Some of them have even gained widespread acceptance while being misunderstood. The question "what is mathematics?" is one that leads to a lot of misunderstandings concerning mathematics. The responses to these few questions will demonstrate how individuals understand the concept of mathematics. The manner in which individuals define mathematics has repercussions for the impressions and perspectives they have towards mathematics [23].

The teachers, parents and students who were respondents in this study seemed to agree that mathematics is the science of numbers and counting, of course, this opinion is not entirely wrong. Although that is not entirely correct either. Three words that almost always appear in the question "what is mathematics?" are numbers, counting and formulas. This gives an illustration that respondents think that mathematics is a science related to numbers, counting and formulas; however, is it true according to experts?

The experts are not unanimous in defining mathematics. There are some differences among experts about what mathematics is. Even so, defining mathematics as the science of numbers, counting and a

collection of formulas is not correct. According to Devlin [24], that definition was obsolete 2500 years ago. By the mid-1600s, when Newton and Leibniz discovered calculus, the definition of mathematics had become the study of numbers, forms, motion, change, and space. Along with the development of mathematics along with the variety of studies, the definition of mathematics has changed. In the late 19th century, mathematics was defined as the study of numbers, forms, motion, change, and space. The latest definition as stated by Devlin, mathematics is the science of patterns. Patterns in mathematics manifest in number lines, communication and reasoning, patterns of movement and change, shape, symmetry and position patterns. The simplification of mathematics definition as the science of numbers, counting and a collection of formulas is inversely proportional to the way previous scientists view mathematics. Mathematicians regard mathematics as something beautiful and sublime. Previous researchers for example, they called mathematics as the queen of science [25]–[27] because of the great contribution of mathematics to the development of other fields of science. Meanwhile, Galileo even called mathematics as the language of God when he wrote the universe [28]. The notion that mathematics is just the science of numbers, counting exercises and a collection of formulas makes the beauty and majesty of mathematics invisible. This makes the students lack the motivation and passion to master, or even become experts, in the field of mathematics.

3.2. The goals of learning mathematics

Learning objectives are specific statements about behavior or performance which are a description of the expected learning outcomes. Learning objectives are an important element in learning design because they are the starting point as well as the point of departure for learning activities [29], [30]. Objectives that are clearly formulated can be used to evaluate the success of the learning process. For teachers, learning objectives can be used as a basis for designing learning systems. The choice of materials, methods, strategies, media and learning resources really depends on the learning objectives that are believed to be. As for students, the learning objectives will be their motivation and will guide students as independent learners [31].

The elementary school teachers who were respondents in this study were asked the question, “what abilities do you expect students to achieve from learning mathematics?” Teachers expect students to have problem solving skills. Although, there is also teacher who expect students to have the skills to apply formulas and be good at arithmetic. Meanwhile, parents and students were asked, “what is the purpose of learning mathematics?” Predictably, the answer of parents and students to these questions is to have numeracy skills. So, what exactly is the ability or attitude change expected from learning mathematics?

Mathematics is taught in schools with a very important mission [32], [33]. Broadly speaking, the purpose of teaching mathematics in schools can be classified into two, formal and material goals. Formally, mathematics is taught with the aim of organizing reasoning and shaping students’ personalities. While materially students are expected to have the ability to solve problems and apply mathematics in various situations [34], [35]. In different sources, the objectives of learning mathematics which are set by the National Council of Teachers of Mathematics (NCTM) [36] are: i) Practicing thinking and reasoning in drawing conclusions; ii) Developing creative activities that involve imagination, intuition, and discovery; iii) Developing problem-solving skills; and iv) Developing the ability to convey information and to communicate ideas.

With regard to the abilities that are expected to exist in students from the results of learning mathematics, in the treasures of mathematics it is known as mathematical proficiency. A common attribute possessed by someone who is proficient in mathematics [37], [38]. Mathematical proficiency (mathematical skills) consists of five components that are intertwined and dependent on each other. The components of the mathematical skills are: i) Conceptual understanding; ii) Smooth procedures; iii) Strategic competence; iv) Adaptive reasoning; and v) Productive disposition. Mathematical skills as proposed by NCTM [39] has also been adapted by the Ministry of Education and Culture as a mathematics learning goal, as stated in the 2022 prototype curriculum Number 028/H/KU/2021.

Given how important educational goals are to the success and achievement of student learning outcomes, serious efforts are needed to socialize them to teachers, parents and students. The purpose of learning mathematics is not only so that students have numeracy skills and memorize formulas, but also practice reasoning skills and draw conclusions. Mathematics must be understood not only as the science of numbers, but the science of patterns of reasoning.

3.3. Is there really a math gene?

Those who have difficulty in learning mathematics try to justify by saying that mathematics is genetic. Only those who are born carrying the math genes can become experts in the field of mathematics. They view mathematics as an elite subject that few people understand [40]. There are several big names in mathematics who are believed to have been born with the math gene, so no matter how hard other people try they will never reach that person’s level because they do not have the math gene.

The belief that mathematics is genetic also occurs in teachers, parents and students who are respondents in this study. They believe that innate talent influences students' success in mathematics far more than persistence and effort. Teachers feel that often students who perform well in mathematics are not the students who study and practice the most. Parents who have children with moderate or even poor math skills find a justification that what happens to their children is fate. Meanwhile, parents who have children with superior mathematical abilities believe that this is because their children were born with gifts.

This perspective will not only harm children with ordinary math skills, but also those who are good at math. The statement "It's ok—Not everyone can be good at math" becomes a kind of mantra that will discourage the students to try and practice. As for children with good math skills, accusations that they are good at math because of gifts will discourage them. That what they achieved was not the result of hard work, but God's grace.

In fact, there is no biological or neurological evidence for the existence of mathematical genes as many believe [41]. This statement is also emphasized by Boaler and Greeno [42], according to them there is no math gene and all students can study mathematics to the highest level. The belief that a person achieves the best level in mathematics if s/he has the math genes is a very destructive idea. It inhibits students' persistence, confidence and effort in learning mathematics.

3.4. Mathematics is not applicable

Another misapprehension about mathematics is the belief that the only useful mathematics lessons in everyday life are addition, subtraction, multiplication and division operations. One does not need to study mathematics outside the four operations because it is considered not applicable in life. The benefits of studying mathematics that are so complex are limited to school exams.

Naturally, that opinion is wrong. In fact, in some universities there are two choices of majors in mathematics, pure and applied. Applied mathematics is a branch of mathematics that deals with the application of mathematical techniques to various other disciplines [43]. Even so, applied mathematics can also be seen as a slice of mathematics with other fields.

The assumption that mathematics is not applicable is actually caused by the abstract way of teaching teachers. They teach mathematics not using concrete examples or what students can imagine. This kind of teaching method is not in accordance with the child's developmental stage. Based on the theory of stages of cognitive development by Jean Piaget [44], [45], children who are in the age range 7–11/12 years, are in the concrete operational stage. When teachers teach mathematics without the help of concrete objects, or objects that can be imagined, children will have difficulty. Likewise with textbooks and student workbooks that have not provided the opportunity to construct their own knowledge. The material in the student worksheets (LKS) is presented briefly without giving an explanation to students about the process of finding the concept. Teachers should precede mathematics learning by showing the benefits or applications of the mathematics to be studied.

In fact, mathematics is in everyone's daily life. A fact that cannot be denied by anyone, even those who do not like math. The concepts of distance, time, size, pattern, geometry, comparison are a few examples of mathematical applications in everyday life. Everyone from various professions needs at least good basic math skills [46], [47].

4. CONCLUSION

The results showed that there were several myths and misapprehension about mathematics among teachers, parents and students. Some of the myths and misapprehension about mathematics have been around for a long time and have been widely accepted so that they are misunderstood. Among the misapprehension about mathematics among teachers, parents and students are: i) The definition of mathematics as the science of numbers and counting; ii) The purpose of learning mathematics is simply to train students' counting and memorizing formulas; iii) Mathematical ability is a talent genetics and only people who have talent will be proficient in mathematics; and iv) Mathematics is not applicable. Mathematics is considered just an abstract concept that cannot be implemented in daily activities. These myths and misapprehension among teachers, parents and students have implications for the non-optimal learning of mathematics and the low enthusiasm of students to master mathematics. For this reason, efforts are needed from various parties in an effort to show the beauty of mathematics, its urgency in life and the contribution of mathematics to the development of advanced scientific and technological efforts.

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