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AN OVERVIEW OF REASONING ABILITY IN MATHEMATICS AND MATHEMATICS ACHIEVEMENT OF STUDENTS IN TERTIARY INSTITUTION

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Abstract
The study's goal is to assess students who are enrolled in postsecondary mathematics in terms of their achievement and mathematical reasoning skills. Most experts think that for students to study mathematics, they must possess the ability to reason since solving problems in mathematics demands it. The achievement has a bearing on this since it is important for the school and the instructors to be aware of the academic performance of the pupils in various subject areas to track their progress. A student's accomplishments aid the instructor in determining their rank. The idea that mathematics is the most difficult subject has made learning the subject quite challenging. The ability of mathematics to reason is one significant component of mathematics that many overlook. Mathematical reasoning is crucial for success in the sciences, humanities, and other fields that rely on it. The current study examined math achievement and thinking skills. 228 students served as the study sample for this investigation. The design is expo facto. To direct the study, two research questions were established. According to the study, students' achievement is influenced by mathematical thinking. Additionally, female students outperform male students in math and courses closely related to mathematics.

Keywords: ability, achievement, mathematics, reasoning, students

Introduction
The study of sciences, technology, and other areas that need computations is based on mathematics, which has long been recognized as the mother of all sciences. Mathematics helps people build their critical thinking, creativity, and reasoning skills in addition to helping with calculations (Sujata, 2017, Onoshakpokaiye, 2021a). The transfer of students' past mathematical knowledge is only achievable with the development of higher-order thinking abilities. The study of higher-order thinking abilities might advance existing knowledge of the processes involved in the search for solutions in light of recommendations for greater emphasis on creativity, evidence development, and logical reasoning (Lester, 2013; Tularam, 2013, Tajudin & Chinnappan, 2017). The brain is trained and prepared for reasoning and critical thinking through mathematics. Our daily

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transactions require the use of mathematics. Since mathematics is useful in everything we do in our daily lives, no one can live without it. Mathematics is a fundamental subject in the system of education, as stated by George and Charles-Ogan (2019). Due to how prevalent it is in all academic domains and human endeavors, it is essential learning. They went on to state that improving students' computational and logical thinking skills is one of the aims of math teaching in all schools.

To succeed and perform better in math, science, and other courses that need computation, every student must acquire mathematical abilities. It takes experience from the teacher and properly planned training to close this gap, which makes teaching mathematics difficult, according to Onoshakpokaiye(2021b). It has become increasingly challenging for pupils to connect their informal knowledge to mathematical concepts taught in formal education. According to Hendriana, Prahmana, and Hidayat (2018), reasoning is a pattern of cognitive activity that involves drawing a conclusion or stating a new claim based on claims that have been accepted as true in the past. The analytical, inventive, and reasonable reasoning that emphasizes problem-solving ability is all based on a mathematical foundation and loves novelty (Lithner, 2008; Fathurrohman, Porter & Worthy, 2017, Hendriana et al, 2018). Reasoning is the ability to actively utilize one's intellect, the use of logic to confirm facts, and the construction of views based on either new or existing knowledge, according to Kanmani and Nagarathinam (2018). The purpose of the study is to find out whether a student's ability to reason mathematically influences their performance in math and math-related courses. It also examines the mathematical abilities of both male and female students.

Science and math student achievement is getting worse every day. Due to the mathematics or calculation required, the majority of children struggle academically. According to Maduabum and Odili (2006), some students struggle academically because they are uninterested in math. This can be a result of the students' incapacity to study mathematical ideas methodically and with critical thought. According to Ajani (2023) learning mathematics in school is meant to help kids improve their capacity to think, solve problems, and convey information or ideas orally or visually. Due to time constraints, it is regrettable that the majority of secondary school students struggle with mathematical reasoning and that teacher seldom provide the pupils extra attention (Hasanah & Surya, 2017). However, it is essential in the teaching of mathematics that all students are allowed to think critically, analytically, rationally, and creatively.

The few mathematics classes that are provided to students who are not mathematics majors cause some of their anxiety, which in turn has an indirect negative impact on their Grade Point Average (GPA). This might be a result of their capacity for mathematical reasoning. The fact that many students and teachers were not performing as expected may be due to their ignorance of the value of mathematical reasoning to achievement. The researcher needs to determine whether mathematical reasoning skill affects students' performance. Do males perform better than females in mathematics?

Purpose of the study

1. To investigate how math reasoning skills affect students' performance in diploma programs that offer math and math-related courses.
2. To assess the math performance of diploma students doing math and math-related courses, both male and female.

Research questions

To direct the study, the following research questions were posed:

1. Does a student's ability for mathematic reasoning affect their performance in math and math-related courses?
2. Is there a gender difference among diploma students doing math and math-related courses in terms of math achievement?

Reasoning ability in mathematics

According to Sumarmo (2014) in Saleh, Prahmana, Isa & Murni (2018), the reasoning is the method of getting to an orderly conclusion based on relevant data and sources. A student commonly finds ways to suggest answers to these problems and draw a trustworthy conclusion because there are so many challenges to be overcome. This is typically done through mathematical reasoning by carefully examining all relevant data or arguments. For this particular reason, a student's mathematical thinking skills must be taught through a carefully thought-out school curriculum. Sujata (2017) states that reasoning is a type of thinking distinct from ordinary thinking since it entails a series of symbolic actions intended to solve an issue. Sujata (2017) quoted Garrett (1986) who claimed that logic is sequential thinking, which is goal-or purpose-driven.

The instruction of mathematics and teaching mathematical logic are two closely associated tasks that cannot be dissociated since the subject is understood by reasoning and mathematical reasoning is taught through studying mathematics (Ayal, Kusuma, Sabandar & Dahlan, 2016). This demonstrates that mathematical reasoning is a crucial aspect of mathematics since students may answer math problems using their mathematical reasoning. Because thinking is an illustration of mathematical reasoning skills, it is crucial to take this into account when learning mathematics. Mathematics is the only subject that has a significant impact on reasoning rather than memory. Since mathematics is the basis of reasoning and critical thinking skills, mathematics reasoning has a significant impact on children. The ability to think mathematically is one of the crucial skills that contribute to the creation of one's mindset, according to Hendriana et al. (2018). According to Ali (2017), mathematics is a discipline that requires problem-solving abilities. According to Kanmani and Nagarathinam (2018), it is crucial to develop students' mathematical reasoning abilities to provide them with the ability to employ both critical thinking and mathematical skills. Students who are developing their mathematical reasoning can perceive that mathematics is important and makes sense, which aids in their understanding of the subject.

The capacity to work with numbers, calculations, patterns, and logical and scientific thought is known as logical-mathematical intelligence (Lestari, 2019). Reasoning and learning mathematics go hand in hand. Because mathematical reasoning may be understood by understanding mathematical material, and mathematical material can be understood by understanding mathematical

reasoning, the two concepts cannot be separated (Baig & Halai 2006). When attempting to comprehend mathematics or solve mathematical problems, reasoning is the primary and constant method utilized (Napitupulu, 2017). With mathematical reasoning skills, students learn or acquire methods for selecting issues, creating, analyzing, describing, proposing solutions, drawing logical inferences, and determining how the solutions to these problems might be used in academic contexts. To adapt to various life situations and to assess any problems we may run into more critically, comprehensively, and logically, mathematics reasoning skills are necessary for everyday life (Hendriana et al, 2018). Mathematical reasoning ability, according to Saleh, Prahmana, Isa, and Murni (2018), may be characterized as students' capacity to assess the necessity or sufficiency of the facts and any relationships between the arguments and information given to draw reliable conclusions.

According to Oringanji (2013), mathematics helps students become more capable of handling a variety of difficulties, both within and outside of the classroom. For quantitative thinking, mathematics serves as both the foundation and the only language (Fayose & Loyd, 2015). Students that possess mathematical reasoning skills are better able to critically, thoroughly, and logically analyze any problems (Hendriana et al, 2018). Because of this, it helps students, especially those studying disciplines connected to the sciences and mathematics, solve some challenges they might run into while learning. It supports the learning process for the students, allowing them to succeed in their academic endeavors. Given that math contains computations that tax the brain, it is essential for the appropriate development of the students' reasoning, critical thinking, and creative abilities. To close the gap between fundamental skills and higher-order thinking, mathematical reasoning is crucial (Saleh, Prahmana, Isa & Murni, 2018).

According to Kanmani and Nagarathinam (2018), students who respond to mathematics can imitate problem solutions and judge if they make sense. These students are aware of the importance of and how to apply reasoning as a core idea in mathematics. In the area of enhancing students' mathematical reasoning abilities, emphasis should be made on the significance of mathematics as a potent tool for reasoning ability development. The teacher must foster students' mathematical reasoning skills so they can evaluate, approach issues in mathematics, persevere and defend the results if they want students to feel confident and rely on mathematics (Kanmani & Nagarathinam, 2018). Our daily actions require the ability to reason mathematically. They help us pick between options, categorize situations into good and negative ones, and determine how to approach and solve problems (Kanmani & Nagarathinam, 2018).

Mathematics reasoning ability and achievement

Numerous studies have demonstrated that young children who receive instruction in mathematical reasoning are more self-assured, have a deeper understanding of how these skills may be applied in a variety of contexts, and are also more willing to take risks to learn what works and what doesn't (Saleh, Prahmana, Isa & Murni, 2018). Rastogi (1983) claimed in Sujata (2017) that the ability to think mathematically is one element that contributes to low mathematics success. Regarding success in math and other subjects that use math or entail computations, it is quite important. Numerous studies on the relationship between

mathematical aptitude and success have found a strong correlation (Sumangala, 1995 cited in Sujata, 2017). The evidence of a causal link between logical reasoning and mathematical aptitude in primary school students is provided by Nunes et al. (2007). But logical competency was outlined as the application of logical concepts to mathematics, such as understanding one-to-one and one-to-many correspondences, additive composition, and the inverse relationship between addition and subtraction.

Mukherjee's (2012) study of students in the tenth grade to examine the link between academic achievement and students' study habits, personalities, and scholastic aptitude found that reasoning and numerical aptitude had a substantial impact on student's academic success in mathematics. Additionally, it was shown that the best indicators of students' academic progress were their capacity for reasoning and numeracy. Research by Muthumanichan (1992) that indicated a positive association between business performance and reasoning skills was cited by Sujata (2017). According to Saleh, Prahmana, Isa, and Murni (2018), students may understand the problem and have sufficient information to conclude activities of reasoning growth. Ashima, Bhandari, and Rashpalkaur performed a study on the influence of aptitude on the justification of senior secondary students' mathematical success, which was quoted in Kanmani and Nagarathinam(2018). No appreciable disparities in thinking skills between male and female senior secondary pupils were found, according to their research.

In their study on reasoning skills among higher secondary students, Kanimozhi and Ganesan (2017) found a correlation between mathematical achievement and reasoning skills that were positive. Additionally, there was no discernible difference in thinking ability between males and females. A study was conducted by Brunner, Krauss, and Kunter(2007) to look at how German students performed on mathematics-related items. According to their research, the boys outperform the girls in terms of specialized mathematics ability, while the females somewhat outperform the boys in terms of reasoning ability.

Method

An expo-facto design was used in this study to look into the mathematical reasoning skills of diploma students doing math and math-related courses. All the 228 students-133 females and 95 males—who were diploma students taking math and math-related courses at Delta State University in Abraka, Nigeria, made up the study's sample. The diploma program is two years course at completion they are awarded a diploma certificate. The mathematics results of the students were collected and used as the instrument for the study. The results of the students of various units (math and science courses) served as the study's data source. To compare student grades in mathematics and their overall academic performance, the mathematics grades of the students and their Cumulative Grade Point Averages (CGPA) were gathered which also help the researcher to determine their reasoning ability. Simple percentages were used to provide answers to the research questions.

4.50-5.00(Distinction), 3.50-4.49(Credit), 2.40-3.49(Merit), and 1.00-2.39(Pass) are the different grade levels.

Research question 1

Does a student's ability for mathematics reasoning affect their performance in math and math-related courses?

Table 1. Students' mathematics scores and their respective grades in the result

Grades	Students who scored 50% and above	Students who scored below 50%	Total	Percentage
Distinction	-	-	-	-
Credit	38(63.33%)	22(36.67%)	60	100
Merit	26(31.70%)	56(68.29%)	82	100
Pass	22(25.58%)	64(74.41%)	86	100
Total	86	142	**228**	

In Table 1, of the 60 students who received credits, 38 students had scores of 50% or above, while 22 students received scores of 50% or below (63.33% and (36.67%), respectively. In the second row, there were 82 students with Merit grades; 26 of them received 50% or more, while 56 received less than 50%, translating to percentages of (31.70) and (68.29), respectively. There were 86 students in the third row who received Pass marks; of them, 22 students received 50% or more and 64 students received less than 50%.

Research question 2

Is there a gender difference among diploma students doing math and math-related courses in terms of math achievement?

Table 2. Mathematics scores of both male and female students and their percentages

Gender	Students who scored 50% and above	Students who scored below 50%	Total
Female	53(39.84%)	80(60.15%)	133
Male	33(34.74%)	62(65.26%)	95
Total	86	142	**228**

Out of 133 female students, 53 achieved a 50% or higher grade in Table 2, while 80 achieved a 50% or lower grade, with percentages of 39.84 and 60.15, respectively. Out of 95 male students, 33 had scores of 50 or above, while 62 received scores below 50%, with percentages of 34.74 and 65.26, respectively.

Findings and Discussion

According to Table 1 above, 63.33% of the students who received credit had scores of 50 or above. The fact that the pupils performed well (earned credit marks) points to the possibility that their good mathematical reasoning abilities had a role in their achievement. Using Table 1 above as a reference, we also discovered that 22 pupils (or 36.67%) received scores below 50, which may be a result of their shaky mathematical thinking. Only 26 pupils (31.70%) had high mathematical reasoning ability, while 56 students (68.29%) had low mathematical reasoning ability, according to merit marks. There were 64 pupils with poor math aptitude under pass grades, 38 students with excellent math aptitude under credit grades, and 22 students with pass grades.

Table 1 above shows that among students with excellent mathematical ability, the majority of them achieved highly (getting credit grades); 38 of the students received credit grades, which is a significant number compared to other grades (merit and pass) which is supported by Hendriana et al (2018) who stated that students with better mathematical reasoning skills are better able to critically and logically analyze any problems. According to Table 1, only 22 students with scores below 50 earned credit, which may be a result of their poor mathematical reasoning skills. Additionally, according to Table 1, students with scores under 50 are more in the passing grade, indicating that their mathematical reasoning skills are not strong. It can be concluded that students' mathematical reasoning ability contributes to their achievement in mathematics and mathematics-related courses. Because 64 of them obtained scores below 50, indicating that these students' mathematical reasoning abilities are low. This finding is consistent with the findings of Kanimozhi and Ganesan (2017), who found a correlation between mathematical achievement and reasoning ability.

Due to their mathematical reasoning skills, more students (38), as opposed to just 22 students, received credit grades under the credit system. Although those who scored above 50 are less than those with low mathematics ability for merit grades, when we thoroughly examined the table, we found that students with little mathematical reasoning ability slant towards the pass grades. Fewer students obtained 50 or higher compared to those that scored below 50 in the passing grades.

The majority of the passed students' scores were below 50, indicating that their mathematical reasoning was weak. This is in line with Rastogi (1983) in Sujata (2017), who claims that one factor contributing to students' poor mathematical achievement is weak mathematical reasoning ability. Twenty-two (22) students had high mathematical aptitude, as evidenced by their scores above 50. We can also notice that 64 students with scores below 50% obtained tests whereas 38 students with scores over 50% received credit marks by comparing the credit and pass grades. This implies that students' success is influenced by their capacity for mathematical thought. Students with scores below 50 may be more likely to receive passing marks since they have weaker mathematical thinking abilities. It can be concluded that mathematical reasoning skill affects or contributes to students' achievement in mathematics and mathematics-related courses. Since mathematics is the foundation of reasoning, a student's ability to reason in that subject will be impacted if it is not developed.

According to Table 2, 53 female students had grades above 50%, while 80 female students received grades below 50%. 33 male students scored 50% and above, while 62 fell below it. Comparing the percentages of male and female students, it can be seen that students who achieved a score of 50 or above were 53 (39.94%) for girls and 33 (34.74%) for boys. Girls who received a score below 50% were 80 (60.15%), while boys received 62 (65.76%). In mathematics and courses connected to mathematics, it can be concluded based on the proportions of both boys and girls that females do better than males.

Table 2 shows that 80 of the female students scored below 50%, whereas 53 of them did better. For male students, 33 students received scores greater than 50%, while 62 students received scores below 50%. Comparing the percentages of male and female students, it can be seen that students who scored above 50 were

53 (39.94%) among girls and 33 (34.74%) among boys. The number of females who received a score below 50% was 80 (60.15%), whilst the number of males was 62 (65.76%). According to the percentages of both males and females, it can be concluded that females outperform males in mathematics and courses connected to mathematics which is contrary to the study conducted by Brunner, Krauss, and Kunter (2007), according to them the boys outperform the girls in terms of specialized mathematics ability, while the females somewhat outperform the boys in terms of reasoning ability.

Conclusion

Since no student can thrive in mathematics without it, developing the learner's mathematical reasoning skills is extremely important. Due to their weak mathematical skills, many students frequently have trouble solving mathematical issues. To help their students acquire better reasoning ability, teachers must motivate them and carefully prepare their lectures. From the study, we discover that the majority of the students with excellent mathematical abilities achieved better. While students with low mathematical reasoning skills achieve poorly in math which suggests that mathematical reasoning ability influences students' achievement in math. The study found that female students do better in mathematics and courses connected to mathematics and that students' achievement is influenced by their ability to think mathematically.

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