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Research Paper

Difficulties Faced by Secondary School Students in Learning Mathematics

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ABSTRACT

In the present scenario, students' mathematics performance is one of the major concerns in Mathematics education. Several students are facing difficulties while learning mathematics. This study was conducted to get a better picture of the areas of difficulty in mathematics as well as specific difficulties faced by secondary school students in learning mathematics. For this, the descriptive survey method was employed. The samples were randomly selected from 4 schools in Bhubaneswar, Odisha. A self-developed criterion-referenced test was administered, consisting of 25 items based on the NCERT class IX mathematics book. The collected data are analyzed by using the percentage of secured marks and quantitative descriptions. From this study, algebra was found to be the most difficult area than arithmetic and geometry. Around 71% of students were below the 50% criterion in the area of algebra. Among the specific difficulties, around 72% of students faced difficulty in basic mathematical calculations, around 83% of students were having difficulties in converting word problems into mathematical expressions and solving them accordingly, and around 69% of students were having difficulties in understanding the applications of the volume of solids. The findings of the study have great implications for school teachers, students, and also for teacher education programs to gain a better understanding and in-depth knowledge about the difficulties in mathematics and accordingly develop their capabilities to neutralize these difficulties.

Keywords: *Mathematics, Secondary Students, Specific Difficulties, Areas of Mathematics*

Mathematics is one of the most important subjects in the everyday life of human beings. Without the knowledge of it, we can say nothing is possible. Mathematics is also considered an important component of formal education from the ancient period to the present day. The subject of mathematics is beautiful and interesting because of its own symbols, language, terms, technology, etc. Students learn mathematics well only when they construct their own mathematical understanding, and this understanding requires them to examine, represent, transform, solve, apply, prove, and communicate.

The National Curriculum of Framework (NCF, 2005) defines the main goal of mathematics education is to develop children's abilities for mathematization. But in fact, difficulties make mathematics less desirable, feared, and boring for students. This can be seen from the

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students' poor results in mathematics. For this, educationists as well as states are facing the challenges with the problems of failure in the board examinations in mathematics.

A mathematical concept is a mental construct. These concepts are hierarchically related. These concepts can be acquired by associating the understanding gained from real-life experiences with the words. To understand mathematics, the role of Mathematical symbols and words is vital. Sometimes, the child may not be able to communicate his thoughts and concepts, not due to a lack of understanding of concepts, but due to a lack of vocabulary.

Need of Mathematics in Secondary School Curriculum

Mathematics is considered the gate and key to the Sciences. Neglecting mathematics creates injury to all knowledge since those who ignore it cannot know the other sciences or the things of the World.

The study of mathematics is a constituent of full life. It is quite necessary for the all-round development of the child. Modern science and technology stress the importance of mathematics in the school curriculum. Mathematics is the mother of all sciences. In the absence of mathematics, science cannot progress. It is due to the contribution of mathematics that man has moved even to the Moon. Mathematics does not mean merely a sum total of addition, subtraction, division, and multiplication. It is a mother discipline that forms a major part of human life. It is quite essential even for a layman and a shopkeeper. Hence, it occupies a strategic position in the school curriculum.

The place of mathematics in secondary schools cannot be undermined. It has to play its own part in shaping the future generation of the country. India, after independence, is striving hard to improve itself in all its commitments, whatever the sphere may be. Only individual and technological developments will extend their helping hand in making India an advanced country. To achieve this development, the knowledge of mathematics is essential. Proficiency in mathematics complements proficiency in science knowledge. The future of India should be shaped only in the Indian classrooms. To make Indians better citizens, the secondary school curriculum should be so formulated that proper importance is given to mathematics.

Background of the Study

The following are some of the earlier studies that have been taken to strengthen the current study.

A student has to have a clear idea of the basis of mathematics when s/he is coming to secondary class from elementary class. Researchers have shown that students' mathematical base was not perfectly clear in the previous classes (Bourah, 2018; Singha et al, 2012). Lack of prior knowledge of the student created problems in studying mathematics (Acharya, 2017). Practical tools are the basis for constructing knowledge in mathematics. But due to a lack of practical exposure, students could not understand the practical applicability of the subject and lacked sufficient tools to make teaching mathematics interesting (Bourah, 2018; Poudel, 2015; Singha et al., 2012). According to Puri (2016), structural complexity and the less practical nature of mathematics were found to be the cause of problems.

Interest is the key factor in learning mathematics. Lack of interest, negative feelings toward mathematics, and poor study habits made it difficult to learn mathematics (Acharya, 2017; Ganal & Guiab, 2014). Each student should be motivated to participate in the class, which will create interest among them to learn mathematics. The result of some research (Poudel,

2015; Acharya, 2017) showed that a lack of student participation in the mathematics classroom, a lack of motivation, and counseling created a misunderstanding of studying mathematics among the students. Students think that Mathematics is much more complex to understand in comparison to other subjects. So, it needs more time to understand. Teachers also admitted that normal time periods are not sufficient to teach mathematics (Bourah, 2018; Puri, 2016).

Rationale of the Study

The students are suffering from various problems and they are facing the challenges of the Board examination being failure in mathematics. The complex nature and lack of practicality make mathematics more difficult (Singha et al., 2012). The National Council of Teachers of Mathematics (NCTM) says students struggle with mathematics due to poorly developed number sense, difficulty in representing mathematical concepts mentally, answering problems impulsively without inhibition, etc. These types of challenges instill fear among the students in mathematics. Due to this, for the first time in 2020, CBSE has introduced two different levels of mathematics examinations (Standard and Basic) for the class X students. Out of 19 lakh students, a total of 637,000 took the Basic paper, which means they don't wish to continue with mathematics in higher classes (Banachariya, 2020). So, this study tries to answer questions like, what are the difficult areas and specific problems students face while learning mathematics. Questions like this motivated to carry out this study among the secondary students in Bhubaneswar city of Odisha.

Research Questions

- Which are the difficult areas in mathematics for students at the secondary school level?
- What are the specific difficulties faced by students in learning mathematics?

Research Objectives

- To find out the areas of difficulty among students at the secondary school level mathematics.
- To identify the specific difficulties faced by students in learning secondary school-level mathematics.

METHODOLOGY

Population and Sample of the Study

Since the current study was based upon secondary school students and included both government and private schools, the population was selected from class IX students of both government and private schools in Bhubaneswar. For the current study, a total of 198 samples were selected from 2 government and 2 private schools.

Methods

The intention of this study was to know the difficult areas as well as specific problems that were creating difficulties for the secondary students in learning mathematics in the Bhubaneswar City of Odisha. So, for this, descriptive survey method was used.

Table 1: List of Schools

Sl. No.	Name of the School	Total Students
1	Kendriya Vidyalaya No. 4, Neeladri Vihar	45
2	Kendriya Vidyalaya No. 6, Pokhariput	58
3	MBS Public School, Bhauma Nagar	36
4	VEM School, Rasulgarh	59

Tools Used

A criterion-referenced test (CRT) was constructed with the help of the guide based on the NCERT class IX textbook. This test was constructed to provide a clear picture of the difficulties that were faced by the students while finding solutions to a mathematics problem.

Data Analysis

The collected data was analyzed as per the objectives of the study. For this, measures of central tendency, frequency, and percentage were used for analysis, and accordingly, interpretations were made. Also, the errors committed by students were analyzed from their answer sheets. So, the error analysis technique was carried out to identify the specific difficulties faced by the students.

FINDINGS

The findings of this study are given below.

Findings on Areas of Difficulty among Class IX Students at Secondary School Level Mathematics

The CRT was administered to 198 students of four different schools. The test had three areas as Algebra, Arithmetic, and Geometry. The full mark of the test was 50, and the distribution of marks among Algebra, Arithmetic, and Geometry was 19, 13, and 18, respectively. The area of difficulty was analyzed based on the marks scored by the students in the test. The criteria were set as "at or above 50%" and "below 50%". "Below 50%" criterion represented the students having more difficulties, and "at or above 50%" represented students having less difficulty. In each area, the students who scored 50% or above and below 50% were calculated through frequency count. Then the percentage of the students was calculated from the total number of students.

Table 2: Areas of difficulty among class IX students at secondary school level Mathematics

Area	Percentage of Students at or Above 50%	Percentage of Students Below 50%
Arithmetic	54%	46%
Algebra	29%	71%
Geometry	40%	60%

From the above table, Algebra was found to be the most difficult area among the class IX students as 71% of students were "below 50%" criterion. The students also perceived the same thing that most of the contents in Algebra are difficult to learn at the secondary level (Yasoda, 2003). Algebra is basically concerned with constants and variables that constituent polynomial. But a majority of the students are facing problems to understand the polynomials and doing necessary calculations using them.

Findings on Specific Difficulties Faced by Class IX Students in Learning Mathematics

After finding out the difficult areas, then it was intended to identify the specific difficulties in each area faced by the students. Area-wise criteria had been set to identify the difficulties. As the focus was to find the specific difficulties, those students having problems in each criterion were taken into consideration. Then the percentage of students facing problems in each criterion had been calculated from the total students.

Specific difficulties faced by students in Arithmetic

Total of six criteria had been set to identify the difficulties faced by students of class IX in Arithmetic. In each criterion, students having problems were chosen through frequency count and then the percentage was calculated.

Table 3: Specific difficulties faced by class IX students in Arithmetic

Area	Criteria	Percentage of Students Having Difficulties
Arithmetic	1. Rationalizing the denominator	31%
	2. Finding rational numbers between two rational numbers	36%
	3. Addition and subtraction of rational and irrational numbers	41%
	4. Decimal expansions of rational and irrational numbers	49%
	5. Calculating cubes, cube roots, and square roots	52%
	6. Basic arithmetic operations	72%

The above table revealed that 72% of students faced difficulties in basic arithmetic operations such as addition, subtraction, multiplication and division. These operations are basic things in Mathematics and most of the students faced problems in these only whereas 31% of students faced difficulties in rationalizing the denominator of an irrational number.

Specific difficulties faced by students in Algebra

To identify the specific difficulties in Algebra, seven criteria had been set. Then students having difficulties in these criteria were calculated using frequency count. Then, the percentage was calculated and put in table 4.

Table 4: Specific difficulties faced by class IX students in Algebra

Area	Criteria	Percentage of Students Having Difficulties
Algebra	1. Finding solutions to linear equations	24%
	2. Factorizing quadratic equations	53%
	3. Finding zeros of polynomials	58%
	4. Application of identity	63%
	5. Finding the degree of polynomials	70%
	6. Factorization by applying the identity	80%
	7. Solving word problems using variables	83%

The above table revealed that 83% of students were having difficulties in converting word problems into mathematical expressions and solving accordingly. For students, factorization

of the polynomial was a little bit easy but when it was instructed to use the suitable identity for factorizing, then it became tough for them and faced difficult to solve. Students found the least difficulty in finding the solutions to linear equations in algebra.

Specific difficulties faced by students in Geometry

To identify the difficulties faced by the students of class IX, eight criteria had been set in the geometry section. The percentage of students facing difficulties in these criteria had been calculated and put in table 5.

Table 5: Specific difficulties faced by class IX students in Geometry

Area	Criteria	Percentage of Students Having Difficulties
Geometry	1. Properties of the cyclic quadrilateral	11%
	2. Application of the angle sum property	19%
	3. Application of surface area	25%
	4. Application of the properties of a square	47%
	5. Relation between a circle and non-collinear points	47%
	6. Application of Heron's formula	54%
	7. Understanding the application of the volume of solids	69%
	8. Conditions for parallel lines	69%

The above table revealed that 69% students faced difficulties in writing the conditions for two lines to be parallel and understanding the application of volume of solids. This had been taught in earlier classes still they faced problems. Only 4.34% of students faced difficulty in stating the properties of a cyclic quadrilateral.

DISCUSSION AND CONCLUSION

The above study revealed that most secondary school faced difficulties in learning mathematics, especially in the area of algebra. The arising difficulties in algebra might be for its unique language with the use of variables and constants. Polynomials are composed of variables and constants. Major students faced problems in understanding the polynomials and writing the constants and variables in their corresponding places. Pramesti and Retnawati (2019) revealed that the cause of students' error in algebra include at least three things, namely understanding the problem, understanding the meaning of variables, and operating the algebraic form. Solving word problems was one of the hardest things among students. This difficulty was highly affected by the language used in algebra (Tiwari & Fatima, 2019). Apart from language, there were certainly other factors such as problems in reading text or questions, misinterpreting the problem and the students having difficulty in understanding the problem so they couldn't interpret it in symbolic form (Novriani & Surya, 2017). Identities play a major role in Mathematics, in which students also faced problems. From the study, it was found that factorization became comparatively easy for the students but when it was instructed to apply the suitable identity to factorize then it became more difficult for them. Yasoda (2003) had also found that students were facing problems relating to mathematical formulae in understanding, remembering, deriving and selecting suitably while solving the problems. Overall, the difficulties in learning algebra were due to the negative attitudes of students toward solving algebraic problems (Julius et al., 2018).

Arithmetic is also an important area in Mathematics. It is the study of numbers, especially the properties of the traditional operations such as addition, subtraction, multiplication, and division on them. From the study, it was found that the majority of the students were facing problems in these four operations while using decimal numbers, rational and irrational numbers. They were having confusion about using positive and negative signs appropriately in given problems. Some students even failed to work with fractional numbers. Some were having problems applying the BODMAS rule also. These difficulties of students might be due to a lack of pre-requisite knowledge in previous classes. Studies showed that students' mathematical base was not perfectly clear in previous classes (Bourah, 2018; Singha et al, 2012). A number of students were facing difficulties to discriminate between rational and irrational numbers if the decimal expansion was given. The majority of students faced difficulty to find the square root of a given number by applying the long division method. These were the basic difficulties that made mathematics uninteresting.

The study identified some difficulties in the area of geometry also. The majority of the students were facing problems to define the conditions for two lines to be parallel. Though there are several conditions still they were unable to state any two. This might be due to a lack of clear understanding of parallel lines and angles between them formed through the transverse. Recognizing angles like corresponding angle, alternate interior angle, vertical opposite angle, etc. was a problem for some of the students. Most of the students were having a big confusion between surface area and volume of solids. Khan (2019) revealed that most of the students faced difficulties in understanding, remembering, deriving and selecting the formulae properly in content areas like surface area and volume of solids in geometry. It might be due to the dogmatic method of teaching adopted by the teacher in the classroom. Therefore, the students found it difficult to understand the particular mathematical formula, and its application and were unable to recall it. Visualization and drawing are the two basic parts of geometry and most students faced the same difficulties. It might be due to the lack of teaching materials and inappropriate teaching methods (Sah, 2016). Another mistake done by them was forgetting to write the units in the mensuration part.

EDUCATIONAL IMPLICATIONS

The above study seems to have important implications for understanding the difficulties encountered by the students which are briefly described below.

For Schools

Students' learning in mathematics with deeper understanding may not take place in the classroom due to the above-said difficulties. After knowing these difficulties, the school should plan and prepare a well-structured classroom with the availability of such mathematical instruments to avoid these problems and transact accordingly.

For Teachers

Students' in-depth learning is highly concerned with teachers. The findings of this study will aware the teacher of the difficult areas as well as specific difficulties faced by the students. Accordingly, teachers should develop the knowledge of the subject matter, and pedagogical content knowledge during the teaching-learning process to address these difficulties.

For Students

Like the teachers, the findings are also useful for students. It will help the students to gain in-depth knowledge in the concerned area.

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