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Analysis of errors in mathematics of the students completing elementary education

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Abstract

In spite of the voices to meet basic learning needs since the World Conference on Education for All in 1990, after passing 26 years, India still faces the problems of low performance in mathematics at elementary level of education, especially in the area of ability in mathematical problem solving. In the meantime RTE, 2009 guaranteed quality elementary education for all children of age group 6-14 years. A self made standardized achievement test in mathematics was used as a tool and 400 students of class IX from different government aided / government sponsored schools were used as sample. This paper aims at analyzing the errors done in mathematics after completing elementary level of education and attempts to reveal the cause of students' low achievement through analysis of the levels of their abilities, which are classified into the four stages. Comparison was made between students in Active delta area and Matured delta area and also between boys and girls students. The findings revealed that maximum error occurred at comprehension level for structured questions while the errors for multiple choice questions occurred at the transformation level and it was independent of gender and area. It is recommended that problems should be connected with daily life and solution through direct activity have to be entertained in the classroom. Same topic should be taught in various mode of teaching to enable students to understand the logic behind the method. To familiarize mathematical language mathematics should be interconnected with other subject, mathematics club, mathematics laboratory and mathematics library should be established in every school.

Keywords: Mathematics, achievement in mathematics, elementary education, analysis of errors, errors in mathematics, comparison among boys and girls students

1. Introduction

Mathematics is an important subject in secondary school because it is associated with more academic and career opportunities. Ironically, this subject is the basis for scientific, industrial and technological advancement of any country. But it is very sad to note that the performance by the elementary level of school education are not up to the mark and student's general impression is that it is a dreadful subject. Thus, mathematics learning and student's performance in mathematics receive considerable attention from educators, teachers and parents.

World Conference on Education for All in 1990 is one of the monumental landmarks in the educational development as it has led the world to work together towards realization of the ideal of universal primary education by appealing the importance of meeting basic learning needs in order for people to survive, to develop their full capacities to live and work in dignity, to participate fully in development, to improve the quality of their lives, to make informed decision, and to continue learning (UNESCO 1990) [4]. The importance of mathematical learning has repeatedly been emphasized by educators and politicians. Both teachers and parents have paid attention to students' performance in mathematics and their progress every year and they have also called for improving the students' overall performances and closing their achievement gaps.

1.1 Significance of the study

"Failure is the pillar of success" or "Mistakes are often the best teachers"- all over the world in many languages proverbs on errors can be found in many forms. Interesting, many of these proverb attribute a positive function to errors. This indicates the existence of a cumulative human experience in which errors can have positive effects.

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However, many people associate negative feelings with errors, which probably arise from the fact that errors are one of the most important measures to assess the performance of individual actions. Traditionally, mathematics education research has analyzed patterns underlying students' errors related to different mathematical concepts.

Errors can raise important issues for further explanation of mathematics, because errors make meaning to those who make them, it's important that errors be embraced in the teaching and learning of mathematics and not be overlooked, or just corrected. Errors "*provide evidence that the expected result has not been reached and that something else has to be done*".

For learners to develop misconception is a normal part of learning; all learners pick up misconception at some point, even those who got good teaching. For this reason teachers need to understand the type of errors that learners make and also understand why they make those errors. Understanding learners' errors can help teachers to develop teaching strategies that engage with learners' mistaken belief. Teachers can never exclusively prevent errors, so it is important that they can deal with them as they come up.

Data from classroom can help teachers develop method of looking deeply into learners needs and see how these learners needs can inform teachers learning needs. Teachers can deepen their understanding of learners' strength and misconception by looking collaboratively at their learners work and talking about it in meaningful ways. In looking learners work, teachers can get opening to understand their learners thinking, especially when learners make errors. One of the most important point is to identify the critical concepts needed by the learners. The purpose is to understand the thinking processes of the learners and to identify any misconception that could have contributed to the particular error. All possible rationale for the errors should be discussed. Analyzing what knowledge, skill and procedure are required to get the correct response for the question. It is important for teachers to understand the role that errors play in the teaching and learning of mathematics. The error analysis will help to handle errors that learners make in class as well as the errors they make in examination.

Indian society is division-riven and this provides a great challenge for quality and equality in education. Mathematics being a compulsory subject of study, access to quality mathematics education is every child's right. On the other hand, there is considerable research to suggest that teacher preconceptions, bias and behaviour, causes discrimination against children from the groups with low socioeconomic status, the so-called "*Scheduled Castes*" (SC) and "*Scheduled Tribes*" (ST). We have spoken of the missing millions among girls. The girls who do come to school are subject to social discrimination as well. In rural areas preconceptions such as mathematics being "*unnecessary*" for girls can be observed even among teachers.

The social context of Indian education is reflected in the sharp disparities between different social and economic groups, which are seen in school enrolment and completion rates. Thus, girls belonging to SC and ST communities among the rural and urban poor and the disadvantaged sections of religious and other ethnic minorities are educationally most vulnerable, and data confirm this.

Gender issue has become the talk of today's forum. Although the literacy rate is more among boys than girls, it is quite interesting to observe that girls are securing better

ranks than boys in almost all competitive examination.. Thus the present study is an attempt to find out the difference if any, in terms of errors in mathematics at the end of elementary education.

2. Objectives

This paper aims to

- Analyze the errors done by the students in the achievement test in mathematics at the end of elementary education.
- Compare the standard of performance between the boys and girls students in terms of committing mistakes in problem solving?
- Compare the level of achievement between the students of two areas namely active delta area and matured delta area.
- Investigate the causes behind those weaknesses and suggest some remedial measures for that causes.

In other words, the research questions are as follows:

1. At which level of problem solving do the students commit errors in mathematics?
2. Is there any difference between the boys and girls students in terms of committing mistakes in problem solving?
3. Is there any difference between the students of active delta area and matured delta in terms of committing error/s in mathematics?
4. What are the causes behind these errors / underachievement?

3. Method

3.1 Sample and Sampling Technique

Stratified random techniques were adopted for the study. 400 students were taken from nineteen schools. Out of these 210 students were boys and 190 were girls.

3.2 Tool

An Achievement test in mathematics for class VIII was made and standardized. The test was comprised of 40 items and the researcher found the reliability by split half method. Value of reliability by the method was 0.91 respectively. The test consisted of 40 items. Among these 40 items the author had tried to emphasize on the key elements in the areas of weakness where errors occurred. The author picked up five items and analyzed the errors committed on those items.

3.3 Collection of data

The author visited 19 schools and administered the achievement test in mathematics on 400 students of these schools and collected data from the students with' the help of the teachers of the respective schools.

4. Results

The researcher had administered the achievement test in the schools of rural area of South 24 Parganas in West Bengal. The total area was divided into two parts, one adjacent to the city tagged as matured delta area and another nonstop created area nearby to the ocean and far from the city, labelled as active delta area. The reason behind the division into two areas are Matured delta area is the extension of city, satellite city attached to the town, hazards of urbanization such as mobile, internet, cinema, drugs. On the other hand, in active delta area rural status present, surrounded by river, forest,

ocean, more virtual distance from city, demographic characteristics is totally different. There are many seasonal hazards like flood, cyclone, soil- erosion and struggle with forest life. Besides that, occupations of the people of the two areas are totally different. In active delta area all students have to go to the government aided / affiliated school because there exists hardly private school, but in matured delta area students having economically sound background go to private school (CBSE, ICSE, English medium) and so after social screening economically weak, deprived, demotivated students bound to go the government aided / affiliated / sponsored schools. Also students in matured delta area are dependent on private tutors who are low educated fellow.

From the result obtained, it can be said that the students have difficulties with application based problem where thinking power of reasoning, skill of computation with decimal fraction, deep understanding of underlying concept of mathematical procedure are required. The students faced difficulties in the problems of number system and arithmetic.

It was found that in five items mentioned below, the students have done mistakes largely on the whole part of the test, they were at the disqualified level of grade (below 25 % performance). So, the author analyzed the errors done in these five items only.

An identical impact about the weaknesses in those four items for both boys and girls students was seen. In all the

four items performances were in a disgraceful stage. The author had identified the weaknesses in four categories which were

Type 1: Lack of Knowledge to identify the problem, (*Simple recognition of words and symbols*)

Type 2: Lack of Understanding the method, (*Linguistic understanding of problems and Transformation from linguistic understanding to mathematical interpretation*)

Type 3: Lack of Power to apply (*Execution of mathematical processing*)

Type 4: Lack of Skill to compute or evaluate the answer to the problem (*Representation of results from mathematical processing*)

Table 1: The Students' Level of Errors in Questions

Types of Errors / Items	Type 1	Type 2	Type 3	Type 4
Item 17	4	77.5	0	18.5
Item 31	38.75	42	0	19.25
Item 32	26.75	25.25	12.75	35.25
Item 34	12.75	65	11.75	10.5
Item 35	21	39	25	19.5

Table 2: Comparison of Level of Errors in Questions between Boys and Girls

Types of Errors / Items	Girls				Boys			
	Type 1	Type 2	Type 3	Type 4	Type 1	Type 2	Type 3	Type 4
Item 17	2.85	78.09	0	19.04	5.26	76.84	0	17.89
Item 31	33.33	41.9	0	24.76	44.74	42.1	0	13.15
Item 32	27.5	21.25	27.5	33.75	16.25	27.5	20	36.25
Item 34	13.33	63.81	1.43	21.43	12.11	66.32	2.11	19.47
Item 35	25	28.75	30	16.25	6.25	47.5	22.5	23.75

Table 3: Level of Errors per Location (%)

Level of Errors per Location (%)	Type 1		Type 2		Type 3		Type 4	
	Active Delta Area	Matured Delta Area						
Item 17	1.25	5.83	76.87	77.92	0	0	21.58	9.58
Item 31	11.88	56.66	54.37	33.75	0	0	33.75	16.25
Item 32	6.89	40	29.38	39.16	8.75	15.42	55	5.42
Item 34	5	17.91	78.77	55.63	0.65	2.5	15.63	23.15
Item 35	25.12	27.92	23.12	32.92	26.25	20	25	19.16

5. Discussion

It can be said from table1 that maximum students have done errors of type 2 i.e. at understanding level and transforming mathematical problem into mathematical language.

In item 17, which was an application based problem on algebraic formula, the students had identified the problem but 77.5% students had failed to recognize the process to solve it. Noticeably those students who had identified the method were able to give correct since no big calculation was there. In item 31 which was an application based question on properties of triangle (geometry), the type 2 error was maximum. The problem lies in understanding of the method and transforming the problem into mathematical language and 38.75% students did not recognize the problem It also focused on the fact most of the students were afraid of geometry. Item 32 was problem solving

question on unitary method of arithmetic and it involved the operations on decimal numbers. Therefore in this item most of the students had identified and proceed but failed to give correct answer due to uncomfortable status to number system. A great awful order in understanding and operating with numbers subsist in number system domain. This was exposed in item 34. It was an objective type question on decimal numbers, also an item with difficulty level high. It was observed that most of the students were unable to find the correct and short process to solve the sum. In item 35, the problem being from weighed mean of arithmetic, the students got no way to proceed further after identifying problem. It also disclose the fact that students were not accustomed to the process of weighed mean, though all of them were familiar with average / mean method.

From the above table it can be said that there was no major divergence in doing mistakes in mathematics between boys and girls..

For qualitative analysis when the researcher talked to students, teachers and parents some problems related with the achievement test were revealed, that are discussed below:

Type 1: Lack of Knowledge to identify the problem

For those five items(item number 17,32,35,34 and 33 as mentioned in the chapter four), most of the students were totally confused with the problem, did not identify the problem and its method of solution. It was found that many of them were not familiar with the concept of unitary method and percentage. No systematic approach in writing or thinking, abrupt answer was written. Mistake was found done in subtraction of decimal numbers. They were confused with digits, not acquainted with decimal numbers and their operations, was not able to connect the problem with real-life situation. An abrupt attempt leads the student to get the price of 1 kg sugar Rs. 800. Most of the students had lack of ideas of place value in decimal numbers, No link between the two consequent lines of answer, no idea about what should be done in case of lesser quantity of product, if some data is given for higher quantity, also they had difficulties in the use of proper concept of unit. Conceptual error in case of using unit properly has been committed. Those students were not acquainted with the application of process of percentage or unitary method. They had no idea about when to divide or when to multiply in the process of unitary method, no idea of not using equal sign between two unequal numbers, totally lack of basic concept of arithmetic process. Those students were unaware of any properties relating to a triangle, not acquainted with the relation of an external angle with the two interior angles of a triangle. They possessed no sound knowledge in geometrical properties, even angle – sum property was unknown. Many students gave an absurd answer without doing any rough work. They were not familiar with weighted mean or average method, not aware with mathematical language. Difficulties in conversion of decimal numbers into fraction were untied.

Type 2: Lack of Understanding the method

Again in many cases the student has identified the problem and diagnosed the method, tabulated it in a mathematical language, but the student committed an error in formation of table of rule of three or without writing table directly applied the method of percentage with unitary method committed mistake. Totally lack of basic concept of arithmetic process was found. General (conventional) language proficiency influences the ability to comprehend word problems and the speed with which these problems are comprehended and solved . The student was acquainted with the given type of problem but did not understand the right method appropriate to the sum.

Type 3: Lack of Power to apply

The student had identified the problem as well as the method appropriate for it, wrote the correct table of rule of three but the student committed an error in formation of ratio and proportion by given data. That is, due to conceptual misunderstanding of hidden underlying correct concept of directly proportionate quantities or inversely proportionate quantities could not proceed in right way to

complete the sum. Transformation of mathematical language into mathematical process was not familiar; behavior problems such as absenteeism are associated with lower achievement and this type of error.

Type 4: Lack of Power of Skill to compute/evaluate the answer to the problem

In this type the students had identified the problem, formed the table and diagnosed the method of solution in a correct way and had applied the process in a correct way, but at the time of evaluating the answer mistake was done i.e., mistake has been done at the time of calculation. That was due to absolute lack of concentration. Also difficulties in handling the operations on fraction and decimal fraction were major grounds behind making the scheduled answer to the problem.

The student identified and understood both the problem and the consequent method but mistake was found in the last stage due to lack of practice. In these cases, home environment and the number of siblings are associated with achievement in mathematics. The findings through NAS, 2014 for class VIII by NCERT also shore up the same result.

Item 34 was a very short type question on decimal numbers and fractions. This was also an application type question for which concentration and quick power of recognition skills are required. Only 20.5% students had given correct answers. Most of the students did not identify the problem and its method of solution. 65% students gave wrong answers by choosing wrong options given in the item in the test without showing any rough work.

The author talked with few students of matured delta area, they expressed their opinions and it was revealed from their conversation that they have no home guidance, dependent on tuition, tutors had secondary level schooling who are unable to teach the real method, concept, values etc. But, students of active delta area are very much dependent on school teachers who are qualified. Students' achievement in mathematics for those two areas was shown elaborately in the previous chapter. It can be said that there stands very significant difference between the achievements of students of Active Delta Area and students of Matured Delta Area signifying that students of Active Delta Area have very much better achievements than the students of Matured Delta Area in mathematics.

Discussion with students, teachers, parents revealed the hidden causes behind success which focused the criteria: geographical location of their area, struggling in daily life, inconvenience in communication, lesser availability of information technology, agricultural dependence, good relationship between students and teacher, cooperative attitude of parents towards teachers, nature friendly mindset, strong bonding of peer feelings, more acquaintances with calculation, more practical knowledge in weight, unit, volume, area, parental occupation namely fishermen, farmer etc. The students of active delta area learn informally many mathematical fundamentals like area, perimeter, concept of unit, weight through their daily life activities.

While collecting data the investigator informally discuss with some students about their daily life. The researcher talked with Anshu (*student completing of class VIII*) who helps his father in agriculture every day. He is 15 years old. At the time of ploughing he has to measure the area for dividing the whole area into different parts for growing different types of crops. Then he assists in watering the

field. After growing is completed, he helps in weighing the crops to store it in jute bag. Then at the time of selling he has to estimate the price and reckoning the approximate result of the total value of the crops.

Another student named Halim goes with his father for fishing in the sea. He helps to keep the direction and speed of the boat. At the young age of 14, he gets hold of risky practice of crossing the sea. After catching fish he gives a hand to assess and balance in weighing for selling. In this way, like Anshu and Halim many students of that are bountiful to great effort to their families. As a result they become skilled in calculation, computation, weighing, measuring the land, maintaining speed and direction. These activities facilitate to breed their cognitive domain as well as affective and psychomotor domain also. This work value allows them to work on their own and make decision, also to service to others and work with co-workers in a friendly non-competitive environment. Again the researcher observed that they have to come school by walking or cycling. These help them to keep an eye on the distance, time and speed also. In this manner they perceive the functional ideas of mathematical principles and formulae which guide the way to go ahead in mathematics learning and achievement. The present study has drawn attention to the reality that academic achievement in mathematics is influenced by the physical and educational environment of

the home. That result was carried by the findings of the study in India and outside India in addition in twenty years back and in recent studies also. As for example, it can be said that in India. It is found that the students of lower socio-economic comparison with those students who have high socio-economic status because the students of the low socio-economic status get more opportunity of calculation in their day to day life. They have to go to market and they make transactions and hence they become experts in the mathematical calculations and applications. It proves the validity of the reasons behind the achievement of the students with the findings of thirty six years old study. Also the recent findings could be shown here for the relevance of the present study.

In this context recommendation on Proposed New Education Policy 2016 by National Commission for Protection of Child Rights (NCPCR) can be included here: "Children, especially in rural areas, demonstrate great learning skills through their curiosity, exploration, experiments, and innovations with locally available material. However, their activity based learning is severely challenged in the classrooms which centre on textbooks, information and examinations. The worst sufferer in this situation is science, the subject of explorations, discoveries and innovations."

Table 5: Causes behind errors

Types of error	Causes behind errors
Lack of Knowledge to identify the problem	<ul style="list-style-type: none"> ➢ Absenteeism in classroom ➢ Math phobia / math anxiety ➢ The students' previous knowledge is not clear.
Lack of Understanding the method and transforming the problem into mathematical language.	<ul style="list-style-type: none"> ➢ The students do not have appropriate acquaintance with the method of the problem and mathematical language. ➢ The students may be short of sufficient realization for conversion verbal statement to mathematical statement
Lack of Power to apply	<ul style="list-style-type: none"> ➢ The students do not have adequate comprehension to identify mathematical logic behind the method. ➢ The students may have scarcity to application based problem in every group of mathematics.
Lack of Power of Skill to compute/evaluate the answer to the problem	<ul style="list-style-type: none"> ➢ The students may be deficient in an adequate amount of practices to crack accurate answer. ➢ The students may have the problems with operations on decimal number. ➢ The students do not have ample proficiency recognize geometrical figure and associated properties.

As stated above, this paper results clearly showed poor performers had linguistic and conceptual comprehension problem. This is why Thai language teachers and mathematics teachers should collaborate in considering their appropriate teaching methods. In case of mathematics, the teachers should give clear explanation about mathematical concept to ensure that each student understands it. Students have different comprehension levels, and therefore, some activities may be employed to support poor performers' understanding through working with good performers. And they learn how to interpret the mathematical problems from their peers.

Learners also seem to have difficulties with analytic concepts. The research also show that misconceptions are a result of poor understanding of the basic themes of arithmetic unitary method, percentage For some of these findings certain analytic concepts should be developed early in the elementary course.

To ensure students are actively engaged, teachers should adhere to the following guidelines:

- Create a safe environment where students feel comfortable

- Establish clear procedures and routines
- Provide both challenge and support
- Use carefully assigned and well-managed cooperative groups
- Make frequent real life connections
- Use an integrated curriculum
- Provide engaging educational experiences those are relevant to students
- Present activities where students produce and share products

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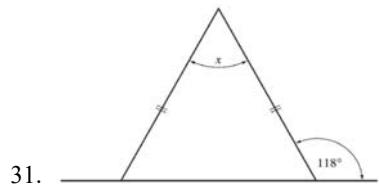
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7. Appendix

17. Which of the following can be represented in the form $a^3 - b^3$? 1

- (A) $x^3 + y^3 + 3x + 3y$
- (B) $x^3 + 2x^2 + 3x + 1$
- (C) $x^3 + 3x^2 + 3x - 2$
- (D) $x^3 + 3x^2 + 3x - 7$



The triangle above is isosceles. Find the value of x° . 1

32. If 24 carat gold is 100% pure, then how much pure gold does 22 carat gold contain?

2

33. Sayan bought 2 kg sugar and 5 kg rice with total Rs. 184.75. If 1 kg of sugar costs Rs. 39.50, then what is the price of 1 kg rice? 3

34. How many decimals lie between $\frac{2}{5}$ and $\frac{9}{10}$ among 0.40, 0.56, 0.91, 0.99, 0.75, and 0.09?

2

- (A) 1
- (B) 2
- (C) 3
- (D) 4

35. The average daily income of 6 workers in Rajesh Babu's factory is Rs. 400. Among the 6 workers, 2 men are clerks. The daily income of other workers is given below. What is the daily income of each clerk? 2

Worker	Daily income(in Rs)
Owner	600
Manager	500
Accountant	400
Storekeeper	200
Clerk	?