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Investigating the Errors of Third Grade Elementary Male Students Performing Operations of Addition, Subtraction and Multiplication

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ABSTRACT

Ability to perform calculations is of the basic skills to successfully solve mathematical problems. Nevertheless, many students performing calculations have different errors. This study has aimed to identify the errors. Therefore, a boys' elementary was selected with cluster random sampling method from each region of education in Isfahan, and all third grade students of the elementary schools (n =242) were given a math test based on the content of textbooks, including 60 questions related to addition, subtraction and multiplication. After correcting students' papers, their errors in the calculations were identified. Their major errors were respectively as: lack of fluency on basic multiplication, subtraction of the smaller number from the larger number, regardless of the situation, ignoring the transferred number in operations of addition and multiplication, difficulty in understanding the concept of zero in operations of addition, subtraction and multiplication, addition in multiplication operations, difficulty in understanding the concept of number one in multiplication operations and ignoring the borrowed number in addition and subtraction operations.

KEYWORDS: basic operations, computational errors, addition, subtraction, multiplication and teaching mathematics

1. INTRODUCTION

The mathematical Association of America (MMA) in a meta-analysis of research findings related to successful learning of mathematics from preschool to eighth grade, agreed on the five major factors of success and skillfulness in mathematics that fluency in computation has-been one of them. The committee members have emphasized the implementation of mathematical procedures, such as addition, subtraction, multiplication and division of numbers flexibly, accurately, efficiently and appropriately (Kilpatric & Swafford, 2010).

According to Korn (2011), a person who is fluent in computation has basic math facts in its mind and is able to use basic math skills more effectively. Basic math facts usually refers to problems related to two conditions of addition and multiplication of single-digit, positive and correct numbers, along with the corresponding subtraction and division problems (e.g.: 3 + 7, 10-7; 3 × 7,21 ÷ 7). Fluency in calculations is the main base of kid's performance in advanced calculations. Start by addition encourages the kid to memorize the facts of 0+0 to 9+9. Children also memorize basic subtraction facts through solving single-digit problems whose overall answer is a positive integer, in the second grade the kid is expected to do addition and subtraction problems including numbers up to 100 (Blöte et al., 2001).

James (2011), on the acquisition of qualification in calculation suggests that a student's thought in calculations can act in four ways:

1. Mental calculations: the process of calculating without using pen and paper. This process is mostly about basic concepts of mathematics such as addition, multiplication, and so on. It is also used on finding and applying new strategies for doing calculations.
2. Estimation: that is intelligent guess of answer. This process is used in the measurement and calculation.
3. Written calculations: that is the use of numerical calculation to find the answer of problem. Mathematical calculations are known in math classes.
4. Calculator: that is the use of an electronic tool to perform calculations. Calculator quickly and accurately provides answers to the individual.

James (1390) notes that to do calculations, it is better to emphasize the useful methods and special skills.

Despite the importance of basic operations in success in mathematics, many students, for various reasons, commit errors when operating with the four basic operations, thus the obtained result will be wrong. The basic

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numerical and math skills for all children officially start of the preschool and kindergarten period. However, many children in first and second grades buckle updoing calculations fluently, that is a basis for more future progress in math skills, and (Arnold et al, 2002). Because of the importance of fluent basic operations in math achievement of students, some researchers have investigated these errors.

Wang (1996, quoted by Alborzi and Khoshbakht, 2007), have categorized a summary of the errors that have been reported by researchers for children mathematical calculations as the following:

1. The errors that are in a part of the problem. In this type of error the student only solves half of the problem given to it.
2. The errors caused by incorrect assignment and grouping. In this type of error the child does not detect when it should regroup or it may know correct grouping conditions, but it does not know the correct assignment.
3. The errors caused by wrong methods of calculation. In this type of error the children have not correctly learned mathematical methods. As the child add all the digits together instead of adding first the ones and then the tens.
4- The errors caused by the lack of fluency on the concept of zero.

Cox (1975), in a two-year study, has categorized and analyzed systematic errors of 700 students from the second grade to sixth grades. In this study it was found that 5 to 6% of children have systematic errors in addition, multiplication and division, while 13% of them had experienced systematic errors in subtraction. Greaber and Wallace (1977) in their sample reported systematic errors as 12% for addition, 40% for subtraction and 19% for division.

Wallace (1984), in a sample of 140 students strong of the third, fifth and eighth grades, reported the most common computational errors of students as the lack of fluency on the basic facts of addition and multiplication, failure to understand place value and counting; and difficulty in subtraction and grouping.

In a study by Kilian et al (1980), 97% of errors were related to the procedures or calculations. The researchers have noted incorrect patterns and mistakes in the Multiplication table.

Mckillip (1981) in his study focused on the exercises that students aged 9 and 13 years completed for national assessment of education advancement. He reported that 74% of students aged 9 years did correct two-digit divisions but without using the algorithm. Only 19% had done two-digit divisions correctly using the algorithm. In the age of 13 years, about 70% had done three-digit divisions using algorithm. In this study, the most important category of errors was the category that has had the label of "unclassified".

Brown and Burton (1977) also investigating the answers of 1325 students in fourth, fifth and sixth grades observed that about 40% have applied incorrect algorithms. Most of the errors were related to borrowing, especially when there was a zero.

In a more extensive study that has been related to the mathematical literacy assessment of elementary students during 2009 to 2010, a number of common errors of students were identified which are considerable. Some of the errors associated with the four operations were: weakness in multiplying by zero and one and dividing by one, revert the operationof8÷8=64, subtract and multiply where they should divide ,incorrect manipulation of numbers in subtraction: e.g.70-19=69, that the errors were common (EMLA, 2010-2011).

Some mathematical problems are single, that means the child has only defect in the arithmetic skills. However, others are associated with other skills available in other areas of learning similar to language (Selikowitz, 2002, quoted by Alborzi and Khoshbakht, 2007). Selikowitz (2002, quoted by prior) argues that single arithmetic problems occur in these areas: 1. mathematics understanding, 2.operationalactions, 3.the ability to add, subtract, multiply or divide,4. chain memory, remember the order of operations required to solve the problem, 5. chain organization, the ability to distinguish the order of numbers, 6.verbal expression of mathematics, 7. abstract symbolizing, the ability to understand the form of numbers with symbols, 8. hearing-visual ability, link the number to written symbol, 9. clustering and grouping, 10.objective mathematical manipulation, estimating the size and number of real objects,11.quantity maintenance,12.one-to-one correspondence formation, 13.graphical representation of numbers, 14.interpretation of processing signals, read and understand the arithmetic symbols.

Wadlington & Wadlington (2008) have suggested that analysis of error patterns in the calculation is an important tool in the assessment, according to the authors, the proper classification of the error patterns depends on the ability of students, however some patterns are common and include the following items. Nevertheless, these error patterns are not only limited to the items: 1. Basic facts error, 2. wrong operation, 3. steps error (chain), 4.unordered numbers (by not writing them under each other), 5.grouping error,6.solution error, 7.wrong copy 8.reading error, 9.random error, accelerate the review of errors before students repeat and practice them, is important.

According to Bryant (2005): Students who do mathematical calculations with difficulty, have problem in some or most of the following skills:

Distinguish signs and their meanings (i.e. +, -, ×, >, =, <, %).

Easily remind the answers of mathematical tasks operations, i.e. 3+4=? 9×9=? 15-8=?

Pass the basic (easier) counting methods towards more complex methods in calculating the answer of math problems. For example, a student who uses the basic counting method one by one, to add 2 things with other 4 things, starts from 1 and counts all those things to reach 6. A student who uses a more complex batch counting method, to add 4 and 2, starts from 4 and counting 2 other will reach the answer 6.

Understand commutative property (i.e.3+4=7 and 4+3=7)

Solve multi-digit calculations that require deduction (subtraction) and transfer (addition).

Sloppy write the numbers when transcribing problems from the textbook or board

Ignore the points that can be found in mathematical problems.

Forget the steps of solving different calculations

Research has shown that fluency in calculations will be obtained by transforming a division problem like18 ÷ 3 =?, into a corresponding multiplication problem 3 ×? = 18 which is stored in memory, you (De Brauwer & Fias, 2009). The researchers confirmed the idea that solving mathematical problems with more than three or more operations require multiple processing steps (Geary & Widaman, 1992). Depending on the complexity of the problem, it can be divided into several parts easier to be solved.

For example, someone who is fluent is calculations (5 × 5) +6 could easily solve the problem (5×5) + 6 through the reading of result of 5 × 5 from memory and then adding 6. But someone who is not fluent in computing often makes the problem as computable parts: 5 + 5 + 5 + 5 + 5+6. Solving the problem in such case reduces both speed and accuracy. Experts of field of mathematical functions suggest that a pattern of memory recovery that depends on the stored math recovery from long-term memory is considered as the most effective method for solving simple arithmetic problems (Geary & Widaman, 1992).

In Iran, a researcher in its search has faced a research that has examined computational problems of addition type in a sample consisting of 448 third grade elementary male and female students in Shiraz city. Researchers (Alborzi and Khoshbakht, 2007), showed that third grade students had the most difficulty in doing the addition operation together with hundreds transfer, as well as the least problem in addition with the concept of zero. Also in all types of addition, the male students amount of errors was more that female ones. The students had more errors in doing addition operation in horizontal method than vertical.

Although calculations are not as the goal by nature, but skillfulness and fluency to do them, due to their critical role in mathematics and finding answers to problems, are important. That is why the identification of students' computational errors can help teachers and parents to plan and remove them. Jordan et al (2009) state that fluency is important in math calculations because they it may predict the mathematical ability in the future.

Therefore, the assessment of calculations ability to identify mathematical defects of children at risk in order to plan for initial intervention is beneficial. According Picus et al (1975), an important aspect of a teacher's job is to check that how the student has obtained incorrect answer. Accurate check of errors may show error patterns that are logical for children but not for us. The present research has been also conducted in this regard.

2. METHOD

Method of the research: The descriptive method has been used in this study.

The study population includes all third grade elementary students in Isfahan.

Sample: an elementary boy school was selected in cluster random sampling method from each of the six areas of education of Isfahan. The final sample has consisted of all third grade students of the elementary schools (n=242).

Tools: a math test measuring tools consisted of 60 questions related to the types of addition (20 items), subtraction (20 items) and multiplication (20 items) which were prepared based on the content of math book of third grade according to the two-dimensional table of the parts profiles of the book and two third grade teachers' approval (content validity). The test reliability coefficient was calculated 0.81 using Bisection method. Since the third grade elementary students read the division restrictively, in the test, questions relating to the division have not been used.

Implementation: according to the long duration of the test questions, it was divided into three parts and implemented in three times. After the implementation, students' worksheets were corrected and any errors observed were. At the end, the observed errors were listed in order of frequency and percentage.

RESULTS

Table 1 shows the errors of third grade students doing the four basic operations, in order of the frequency and percentage.

Table 1: the errors of third grade students doing the operations of addition, subtraction and multiplication, in order of the frequency and percentage

Row	Frequency	Type of error	Percentage
1	68	Lack of fluency on basic multiplication	17.48
2	53	Subtract a larger number from a smaller number regardless of the location	13.63
3	45	Ignore the transferred number in addition and multiplication operations	11.57
4	44	Difficulty in understanding the concept of zero in operations of addition, subtraction and multiplication	11.31
5	41	Addition in multiplication operation	10.54
6	34	Difficulty in understanding the concept of one in multiplication operation	8.74
7	33	Ignore the borrowed number in addition and multiplication operations	8.48
8	29	Ignore the transferred number in addition and multiplication operations	4.88
9	15	Addition of columns regardless of their place values	3.90
10	13	Mistake in putting the numbers right under each other in multiplication operation	3.34
11	13	Leave multiplication operation unfinished	3.34
12	8	Add the transferred number by the upper number of tens and hundreds column and then multiply the number by the lower number in multiplication operation	2.05
13	3	Multiplication in addition operation	0.77
Total	**389**		**100**

3. DISCUSSION AND CONCLUSION

The results show that students involve numerous and various errors doing calculations with operations of addition, subtraction and multiplication, but some of the errors like lack of fluency on the basic multiplication, subtract the smaller number from the larger number regardless of the location, ignore the transferred number in operations of addition and multiplication, difficulty in understanding the concept of zero in addition, subtraction and multiplication operations, addition in multiplication operation, difficulty in understanding the concept of number one in multiplication operation, and ignore the borrowed number in operations of addition and subtraction are more common. Although the errors arise from various sources, but one of the main reasons is inadequate or incorrect training. If the student uses incorrect or weak calculation methods in terms of speed and accuracy to do calculations with no attention and consideration, the errors will be repeated and become as the main habits in doing calculations over time. In such cases the replacement of unsuitable formed methods becomes more difficult. Therefore, it's necessary in the same early years, to identify, analyze and remove computational error patterns. It should be noted that some of the students who have difficulty in performing arithmetic operations may often have the mathematical inability or failure. A child with disability in learning math may often meet the problem in learning basic skills, which rooted in memory and cognitive issues, during primary education of math. For example, research studies have shown students who learn basic math operations with difficulties, compared to students who are skillful in this case, over a two-year period, unexpectedly could not achieve suitable progress in terms of doing basic math operations, in specified time conditions (Bryant, 2005). According to Geary (2004, quoted by prior), it seems this problem has persisted and considered as the features of memorial or cognitive problems. Therefore, it is better to check and diagnose students' computational errors at the early steps so that if there are deep or abnormal problems, individual or special educational program can be designed or referred to specialists. As Jordan et al (2009) has also stated that the assessment of calculations ability to detect children's math defects who are at risk in order to plan for early interventions is beneficial. Analyzing students' error patterns, teachers can provide a basis for more useful training. Considering the importance of doing accurate and fast calculations on the growth, progress and future of students' mathematics, it is necessary that teachers use various and innovative teaching methods to meet the computational problems and students' fluency in calculations. Encourage students to explain underlying concepts and processes of their calculations, when they practice in the classroom is an important way of making calculations fluent (Baroody, 2003, quoted by Korn, 2011).The teacher can ask the student to describe explain it has done. That is how it has added, multiplied or divided. If when the students are explaining, the teacher finds out the wrong methods applied by them, it may note the methods and teach them more effective methods. Secondary or derivative addition technique is of such methods. Students usually learn the sum of some addition before others and memorize them, for

example, they learn the addition of 6 + 6 and 10 + 10 earlier and better than the addition of 10+ 9 and 6 + 7. Students could be taught to use the first type addition that is called secondary addition to do the second type addition. Numerical composition is related to each other. The relationship identification and the advantage of using it can make learning the numerical composition easier and cause it to be less forgotten so that the students' errors will be also reduced (Kilpatric & Swafford, 2011). According to these authors, the relationship between addition and subtraction, division and multiplication, can be used to make learning subtraction and division simple for students. For example, to calculate 13-8, we can search for a number adding by 8, number 13 is obtained. For many female students, it is easier to learn subtraction by addition.

Doing operations in a useful order in the multi-stage operations is of other items that should be taught to students. That is, first they solve the expression inside parentheses and then perform other operations.

Also practical, objective and visual methods, as well as educational help to better understand mathematical concepts generally and calculations and cause the better strengthening of basic facts in memory. However, you should not rely solely on the education of the fast computation techniques. To achieve better results and improve the level of mathematical knowledge and develop skillfulness in mathematics, teachers should combine training to quickly and accurately perform calculations with the component of understanding. Some teachers separate these two or consider the mas separate skills. According to Kilpatric & Swafford (2011), in school mathematics the creation of computational skills and understanding are considered to be competitors. However, putting skill against understanding creates an inappropriate opposition. Understanding makes learning the skills easier and at the same time learning procedures strengthens understanding mathematics and expands it. Blani (2007) also states in the same issue that: Elementary school pupil was taking a course of computational skills as preliminary training. The skills were considered the most important factor in teaching arithmetic. It was assumed that understand why a rule is applied is not required (p. 1). This misunderstanding leads to train students that may do calculations but without understanding them. Use of such mechanical methods will not help the advancement of students' mathematics. Calculations as other aspects of mathematics must be taught in a meaningful context.

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