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Determination of Four Operation Symbol Errors of Primary School Students and Solution Suggestions*

Halil Önal, Assist. Prof. Dr., Corresponding Author
Burdur Mehmet Akif Ersoy University, Türkiye
halilonal@mehmetakif.edu.tr
Orcid ID: 0000-0001-6983-3842

Oktay Aydın, Assist. Prof. Dr.
Marmara University, Türkiye
oaydin@marmara.edu.tr
Orcid ID: 0000-0003-4927-7708

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Abstract

The aim of this study is to determine the symbol errors made by primary school first and second grade students in four operations content. The model of the research is a case study, one of the qualitative research methods. Study group, the sample consists of 327 students studying at the first and second grade levels of primary school, selected through criterion sampling, one of the purposive sampling methods. As a result of the analysis, within the category of symbol errors; "perceiving the minus (−) sign as a plus (+) sign", "perceiving the plus (+) sign as a minus (−) sign", "mistaking the equal (=) sign", "writing number symbols incorrectly", "using the operation line in the wrong place", "not using the operation line", "not using the operation symbol", "confusing the places of the operation symbols", "perceiving the multiplication (x) sign as a plus (+) sign", "perceiving the division (÷) sign as a minus (−) sign", "perceiving the plus (+) sign as a multiplication (x) sign", "perceiving the multiplication (x) sign as a division (÷) sign", "perceiving the minus (−) sign as a division (÷) sign" error types determined. Among these symbols errors, it was determined that the error of perceiving the minus (-) sign as plus (+) was made by the first-grade students at the highest rate. By the second-grade students, it was concluded that the error of perceiving the multiplication (x) sign as a plus (+) sign was made at the highest rate.

Keywords: Primary school, mathematics teaching, four operations, symbol, error

Introduction

At an early age, learning mathematics requires children to establish and recreate mathematical relationships in their own minds. Children need direct and concrete interaction with mathematical ideas. Continuous interaction is required between the child's mind and concrete experiences in the real world (Cockburn, 2005; Burns, 2007).

Children have a range of experiences that require them to use mathematical concepts before they start school. Activities and experiences, such as saying numbers in rhymes, forming patterns with objects, are clearly mathematical. Some mathematical concepts are more ingenious, such as sorting the washed laundry and setting the table (Mooney, Briggs, Fletcher, Hansen, & McCulloch, 2009). Children's early mathematical experiences are very important in terms of presenting images that they will carry with them as they grow up (Cotton, 2010, p.193). Primary school years are the years in which the foundations of many mathematical concepts are laid. Mathematical concepts are constructed as symbolic relational structures and encoded through signs and symbols that can be logically combined in mathematical operations (Steinbring, 2006). The results of teaching mathematics in the school years are fundamental and twofold. When using mathematical symbols first, it is important that they become confident users. Secondly, these symbols must be meaningful and integrated into mathematical knowledge (Anghileri, 2005).

Symbols have an important place in mathematics and generally provide order and management (NCTM, 2000; Adams, 2003; Esty, 2011; Bardini & Pierce, 2015). Symbols provide an extremely easy method to deal with quantities in calculation and problem solving in mathematics and give an opportunity to think about mathematical operations (Tall et al., 2001). Mathematical concepts are tightly bound to symbols that represent them. Mathematical symbols (1,2,3, +,−, x, ÷, <, >, %, etc.) are important tools used to convey mathematical knowledge. Children cannot begin to use symbols directly when learning math. The first use of the symbol begins after the discovery of the mathematical concept or relationship represented by this symbol. For example, people use the "+" symbol to represent addition and the "-" symbol to represent subtraction (Olkun & Toluk Uçar, 2012, p.9). Mathematical symbols (+, -, x, ÷, =, etc.) provide brevity in communication by providing a 'shorthand' for written work and then provide a form of representation that provides an algorithmic (pen and paper calculation) approach to written work (Anghileri, 2005). A symbol can represent a complex network of many links. Symbols for numbers, the symbol for addition, and the equals symbol have different meanings depending on the situation and shape in which they are used. To be suitable for these different contexts, many and extensive language support is needed. Such as; adding, counting, adding, decreasing (Haylock & Cockburn, 2014, pp.14-15).

The first years of primary school usually consist of natural numbers and four operation questions with these numbers. Since mathematical concepts encountered in the set of natural numbers and other numbers are also encountered, teaching natural numbers and four operations with natural numbers are considered the basis for teaching other number sets (Olkun & Toluk Uçar, 2012, p.66). There are many children who can count flawlessly to 10, 50 or even 100 at an early age. In adults, for such a child, “This child is ready to add and subtract.” thought appears. Many studies have shown that this is wrong and that counting and processing requires more talent and skill (Altun, 2014, p.23). Understanding a mathematical subject is not a sudden event. It is a constantly evolving process that is reached at the end of the learning programme. Mathematics is a different process from perception in that it is about right and wrong answers. It is certain that wrong answers are a known difficulty (Barmby, Harries, & Higgins, 2010, p.48).

Student errors indicate “individual difficulties”. Errors: It shows that the student does not understand certain concepts, techniques, problems, and does not grasp it as "scientific" or "adult". Students learn erroneous concepts and processes in a similar way. Students look for commonalities between their first contact with a concept or process. With these they form an abstraction with certain common properties. They shape concepts and algorithms (Aschlock, 2002, p.9). Errors made by students are not random, except for basic facts and carelessness. The errors made are extremely consistent. Teachers see the same errors over and over for years. In most cases, children's errors are the result of applying an incorrect operation rather than a rule-based, correct algorithm. However, these wrong actions may make sense to the child, even if the logic is wrong (Burns, 2007, p.10). According to Leinwand (2009), almost all students make mathematical errors. Frequent logically based errors are commonly due to misunderstandings. Students may experience confusion in their efforts to understand new materials and concepts. Teachers should know that errors and confusion are a powerful learning opportunity. For the most part, teachers tend to focus on the correct answer in their math lessons. Instead of identifying the reasons that cause errors to occur, wrong answers are simply countered. Wrong answers are simply crossed out.

In mathematics, there is extensive use of keywords denoting the four operations (addition, subtraction, multiplication, division, equals) and mathematical symbols (+, −, x, ÷, =) which are representations of these words. As a result of this intensive use, the inability to distinguish between symbols can prevent learning (Baroody & Standifer, 1993; Patkın, 2011; Hansen, 2014). Students often have difficulties in attributing meaning to mathematical symbols (Adams, 2003; Anghileri, 2005; Powell, 2015; Powell & Driver, 2015). As a result, errors may occur. Errors also negatively affect students' next learning (Engelhardt, 1977; Ashlock, 2002; Spooner, 2002; Hansen, 2014; Ojose, 2015). When it comes to student error, knowing the situations that cause and produce that error is very important in terms of making sense of the error. To examine the errors of children performing mathematical operations; understanding their thoughts can contribute to teaching problems caused by teachers. If children are to understand the relationships that exist between numbers and the operations we use on numbers, it is essential that they understand what the teacher is saying and how this relates to the symbols they see on a page and use for calculations. It is important to identify the errors made by children to be able to overcome such difficulties and to provide appropriate assistance to children. Analysing student errors gives information about faulty problem-solving process, mathematical understanding and attitudes. If the errors are determined and the necessary feedback is not given to the students, the students' understanding of their errors may not emerge within the system and the students may not have the opportunity to correct their errors. For these reasons, it is thought that it is important to determine the symbol errors made by students especially in primary schools where the foundation of four operations is laid. The aim of this research is to determine the symbol errors made by primary school 1st and 2nd grade students in four operations.

Method

Research Model

The model of the research, in which it is aimed to determine the symbol errors made by primary school 1st and 2nd grade students in four operations, is a case study from qualitative research approaches. Qualitative research deals with how and why behaviour occurs. It describes how people interpret what they experience (Merriam, 2013, p.14). According to Creswell (2016), case study; it is a qualitative research approach in which the researcher examines one or more limited cases over time, using data collection tools containing multiple sources (observations, interviews, audio-visual, documents, reports) that define situations and themes depending on the situation. According to Yıldırım and Şimşek (2021), qualitative research is a type of research in which qualitative data collection methods such as observation, interview and document analysis are used, perceptions and events are monitored in the natural environment. Document analysis is also defined as the examination of written materials containing information about the case or cases that are aimed to be investigated. Document analysis was used as a data collection method in the research.

Study Group

The study group of the research was selected by criterion sampling, one of the purposeful sampling methods; in the 2015-2016 academic year, 162 students, 83 girls and 79 boys, are studying at the primary school first-grade level, and 84 girls and 81 boys are total 165 students studying at the second-grade level in primary school. According to Yıldırım and Şimşek (2021), the basic understanding in criterion sampling method is to study the situations that meet a predetermined set of criteria. As a criterion in the research, to be able to identify the different errors made by the students and to make an in-depth analysis, the students who make up the study group are in heterogeneous classes (good, medium, weak) in terms of mathematics achievement level, and the students are at different socio-economic (low, medium, high) levels instead of students with similar status. The schools to which the application will be made have been determined according to these criteria.

Data Collection Tool

In this research, mathematics textbooks of primary school 1st and 2nd grade students were used as data collection tool and document analysis was carried out. Primary school mathematics curriculum, teacher's guidebooks, student textbooks, supplementary workbooks, related literature were examined and the concepts in the four-operation symbols were tried to be determined. A data source has been created on how to evaluate student errors. The data source (symbol errors form) was created by obtaining expert opinions from 3 mathematics education experts and 3 classroom teachers, and the creation of categories and codes was ensured.

Data Collection Process

The research data were collected after obtaining the necessary permissions from the Istanbul Governorship Provincial Directorate of National Education. School administrators and teachers working in the schools where the application will be made by the researcher were informed about the right to study and process. The notebooks used by the students in the mathematics lesson were collected from the classes by the researcher in the lessons outside the mathematics lesson, photocopies and photographs were taken and distributed to the students in the classes again. In addition, the previous notebooks of the students who started to use the second notebook were requested by the classroom teachers and the data were collected.

Data Analysis

In the research, the data collected from the student notebook were analysed with the content analysis technique. Data analysis in qualitative research involves the preparation and organization of data for analysis, then coding the data and categorizing it by assembling the codes, and finally presenting the data in figures, tables or discussion (Creswell, 2016, p. 180). Content analysis is defined as a systematic, repeatable technique in which some words of a text are summarized with smaller content categories with coding based on certain rules (Büyüköztürk et al., 2012, p.240). Coding and analysing data is an analytical step. Organizing the coding hierarchically is part of the analysis process (Glesne, 2012). Frequency and percentage are generally used in the interpretation of the data obtained because of content analysis (Büyüköztürk et al., 2012, p.243). The analysed data were shown and interpreted by giving frequency and percentage values. While creating the categories and codes, the opinions of national and international literature, experts in the field of mathematics education and primary school first and second grade teachers were used. The number of students who made an error and the number of times the error was made were calculated and the percentage values were found. To ensure reliability, randomly selected samples from the student notebooks were analysed at different times and the same results were obtained.

The most useful method to increase reliability in qualitative research is member control (McMillan, 2000; Glesne, 2012). In this study, a second researcher was provided to encode the data and examine the encodings to ensure the reliability of the encoder while performing the content analysis. The data were re-coded by the second researcher independently of the first researcher, and the coding consistency value was determined as 91.33. As a result of the analysis, categories and codes were created for the four operation symbol errors, and the analysed data were digitized and tabulated. In addition, all the data obtained at the end of the research were reviewed by external controllers who were not familiar with the study and an objective evaluation was tried to be made.

Ethical Permits of Research

In this study, all the rules specified to be followed within the scope of "Higher Education Institutions Scientific Research and Publication Ethics Directive" were complied with. None of the actions specified under the heading "Actions Contrary to Scientific Research and Publication Ethics", which is the second part of the directive, have been taken.

Ethics Committee Permission Information:

Name of the committee that made the ethical evaluation = Istanbul Governorship Provincial Directorate of National Education Ethics Commission

Date of ethical review decision= 21.05.2015

Ethics assessment document issue number= 5252701

Findings

In this part of the study, in line with the data obtained by examining the student notebooks, the error types in the four operation symbol errors category of primary school first and second grade students; the frequency, percentage table and student error examples of how many students made the errors are presented. The frequency and percentage distribution of symbol errors of primary school first and second grade students is given in Table 1.

Table 1. *Frequency and percentage distribution of primary school 1st and 2nd grade students regarding symbol errors*

Symbol Errors	f1	%	f2	%
Perceiving the minus (−) sign as a plus (+) sign	26	16,05	9	5,45
Perceiving the plus (+) sign as a minus (−) sign	19	11,73	7	4,24
Mistaking the equal (=) sign	15	9,26	7	4,24
Writing number symbols incorrectly	14	8,64	6	3,64
Using the operation line in the wrong place	13	8,02	5	3,03
Not using the operation line	12	7,41	5	3,03
Not using the operation symbol	11	6,79	4	2,42
Confusing the places of the operation symbols	8	4,94	3	1,82
Perceiving the multiplication (x) sign as a plus (+) sign	0	0,00	22	13,33
Perceiving the division (÷) sign as a minus (−) sign	0	0,00	17	10,30
Perceiving the plus (+) sign as a multiplication (x) sign	0	0,00	5	3,03
Perceiving the multiplication (x) sign as a division (÷) sign	0	0,00	8	4,85
Perceiving the minus (−) sign as a division (÷) sign	0	0,00	6	3,64

When Table 1 is examined, there are error types related to the symbol errors made by primary school first and second grade students in four operations. It is seen that the error type "perceiving the minus (−) sign as a plus (+) sign", which is included in the category of symbol errors, is the error type made with the highest rate by 26 first-grade students, 9 second-grade students and 35 students in total. At the same time, it is seen that the error type "perceiving the minus (−) sign as a plus (+) sign" is the error type with the highest load value among the first classes. This type of error was "perceiving the plus (+) sign as a minus (−) sign" by 19 students, "mistaking the equal (=) sign" by 15 students, "writing number symbols incorrectly" by 14 students, "using the operation line in the wrong place" by 13 students, "not using the operation line" made by 12 students, and "not using the operation symbol" made by 11 students are followed. Considering the error frequencies made by 2nd grade students; it is seen that the error type "perceiving the multiplication (x) sign as a plus (+) sign" is the error with the highest load value made by 22 second-grade students. This error type is respectively; "perceiving the division (÷) sign as a minus (−) sign" made by 17 students, "perceiving the minus (−) sign as a plus (+) sign" made by 9 students, "perceiving the multiplication (x) sign as a division (÷) sign" made by 8 students, made by 7 students each; "perceiving the plus (+) sign as a minus (−) sign" and "mistaking the equal (=) sign" were done by 6 students each; "writing number symbols incorrectly" and "perceiving the minus (−) sign as a division (÷) sign", done by 5 students each; the error of "using the operation line in the wrong place", "not using the operation line" and "perceiving the plus (+) sign as a multiplication (x) sign", "confusing the places of the operation symbols" made by 3 students and having the lowest load value among the second-grade students species are observed. Below, the error types included in the symbol errors category are explained in detail with examples.

It is seen that the error type "perceiving the minus (–) sign as a plus (+) sign" in the category of symbol errors was made by 26 first-grade students, 9 second-grade students and a total of 35 students, with the highest rate of error in the category of symbol errors. Children perform addition in operations where the minus (–) sign, which represents subtraction, is used. It can be said that such a misunderstanding occurred because the teaching of four operations in children started with the teaching of addition. This type of error is encountered in second-grade students as the addition operation in subtraction operations that require decimal decay. Examples of errors made by students and visuals of student answers are given in Figure 1.

$\begin{array}{r} 6 \\ -3 \\ \hline 9 \end{array}$ $\begin{array}{r} 22 \\ -\ 7 \\ \hline 29 \end{array}$ $5 - 2 = 7$ $13 - 5 = 18$

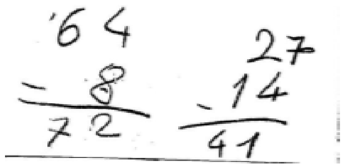

Figure 1. Error examples of student perceiving minus (–) sign as plus (+) sign

It is seen that the error type "perceiving the plus (+) sign as a minus (–) sign", which is included in the category of symbol errors, was made by 26 students in total, 19 first-grade and 7 second-grade students. In addition, operations where the plus sign is used, the child perceives the plus (+) sign as a (-) sign and performs subtraction. It can be said that one of the reasons why first-grade students make this error may be that they have just started teaching subtraction. This type of error made by second grade students is usually encountered in the operations that will occur in the hand and that the child must carry the hand. The child may have preferred the easier process to lighten the processing load. Examples of errors made by students and visuals of student answers are given in Figure 2.

$\begin{array}{r} 8 \\ +3 \\ \hline 5 \end{array}$ $\begin{array}{r} 17 \\ +\ 4 \\ \hline 13 \end{array}$ $5 + 3 = 2$ $26 + 4 = 22$

Figure 2. Error examples of student perceiving plus (+) sign as minus (–) sign

It is seen that the error type "perceiving the multiplication (x) sign as a plus (+) sign" in the category of symbol errors was made by 22 second-grade students. At the same time, it is seen that this type of error has the highest load value among the second-grade students in the category of symbol errors. The child performs addition in operations in which the multiplication (x) sign, which represents multiplication, is used. This error may have been made because of the repeated addition of multiplication. Students may have made this error because the teachers emphasized the repetitive addition of multiplication during the lesson. Examples of errors made by students and visuals of student answers are given in Figure 3.

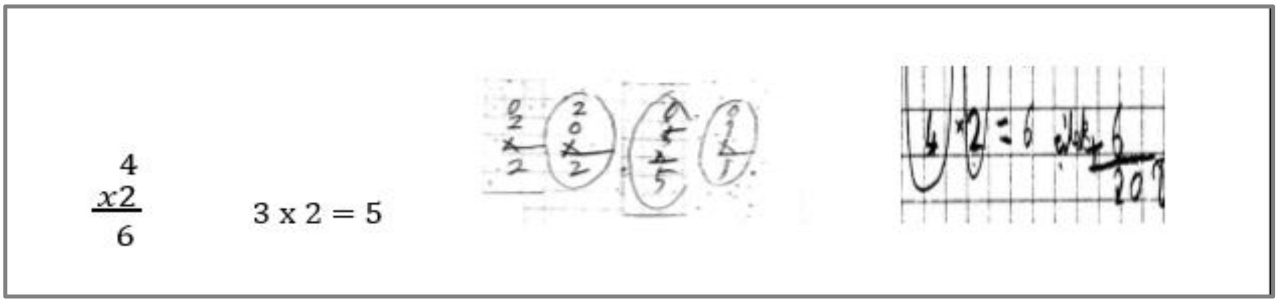

Figure 3. Error examples of student perceiving multiplication (x) sign as plus (+) sign

It is seen that the error code of “mistaking the equal (=) sign” in the category of symbol errors was made by 15 first-grade and 7 second-grade students. Students have difficulties when they use the equal sign in horizontal operations. The child who writes the result of the operation under the operation line in vertical operations cannot understand the equal sign in horizontal operations. Especially not given in the transaction; students make errors when they are added, subtracted, multiplied or divided. Examples of errors made by students and visuals of student answers are given in Figure 4.

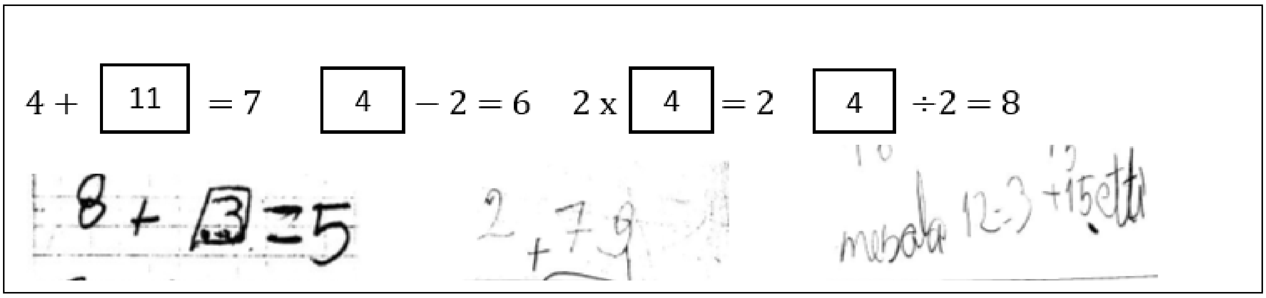

Figure 4. Error examples of student mistaking the equal (=) sign

It was determined that 13 first-grade and 5 second-grade students made the error type "using the operation line in the wrong place", which is included in the category of symbol errors. While students should write the process line on the result section in vertical operations; it is placed between the numbers, below the result. Examples of errors made by students and visuals of student answers are given in Figure 5.

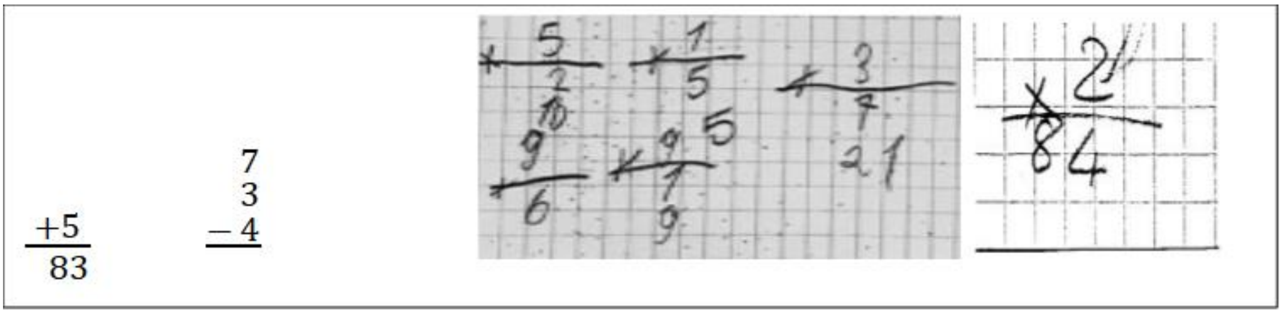

Figure 5. Error examples of students using the operation line in the wrong place

It is seen that the error code of "confusing the places of the operation symbols", which is included in the category of symbol errors, was made by 8 first-grade students and 3 second-grade students. While students should place the trade symbol in the upper left corner of the action line, they can place the trade symbol on the top right of the action line or below the action line. Examples of errors made by students and visuals of student answers are given in Figure 6.

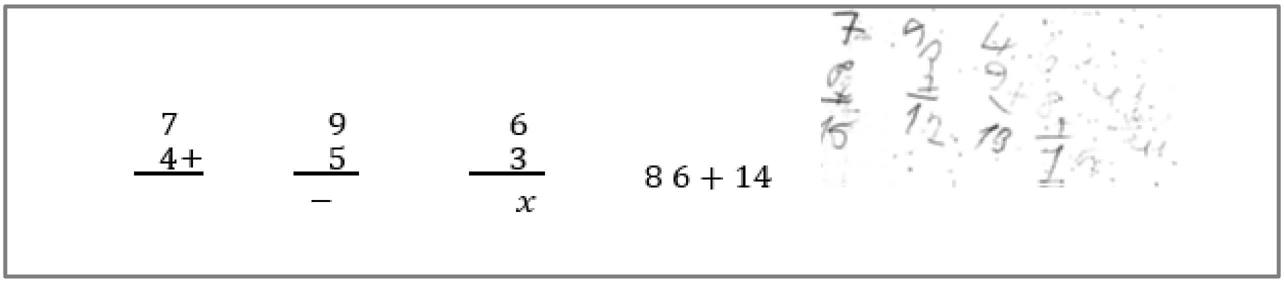

Figure 6. Error examples of students confusing the places of the operation symbols

Another type of error made by students is "writing number symbols incorrectly", which is in the category of symbol errors. It is seen that this type of error was made by 14 first-grade and 6 second-grade students. Students who make such errors write the number symbols in reverse and confuse the numbers with each other. In particular, the numbers 2 and 5, 3 and 8, 1 and 7, 6 and 9 are confused with each other. Examples of errors made by students and visuals of student answers are given in Figure 7.

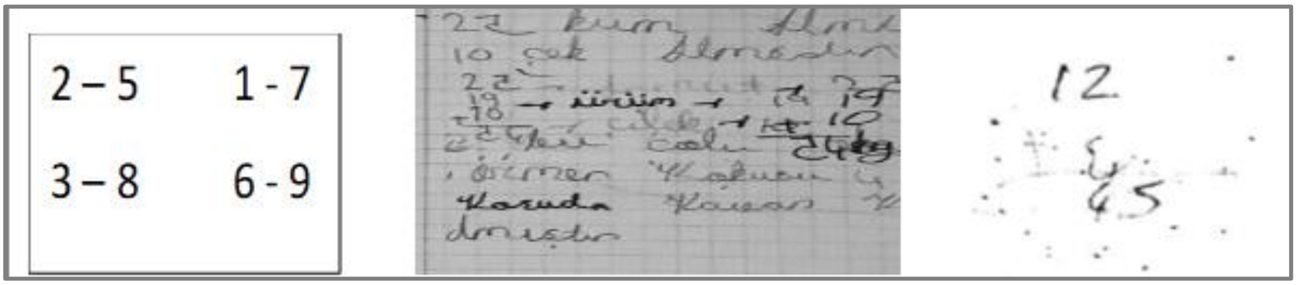

Figure 7. Error examples of students writing number symbols incorrectly

It was determined that the "not using the operation line" error type in the category of symbol errors was made by 12 first-grade students. Students who make such errors cannot use the operation line, but they can only use the operation symbol. Examples of errors made by students and visuals of student answers are given in Figure 8.

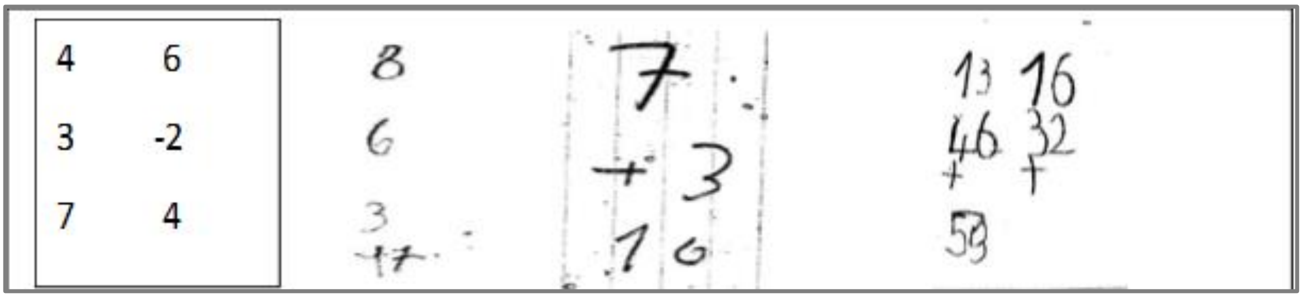

Figure 8. Error examples of students not using the operation line

It is seen that the error type "not using the operation symbol" in the category of symbol errors was made by 11 first-grade and 4 second-grade students. Students perform operations without writing the operation symbol. In sequential calculations that require the same operation, students may be ignoring the operation symbol after a certain point in time. Examples of errors made by students and visuals of student answers are given in Figure 9.

$$\begin{array}{r} 8 \\ 5 \\ \hline 13 \end{array} \qquad \begin{array}{r} 9 \\ 4 \\ \hline 5 \end{array} \qquad \begin{array}{r} 3 \\ 2 \\ \hline 6 \end{array} \qquad 8\ 2 = 4$$

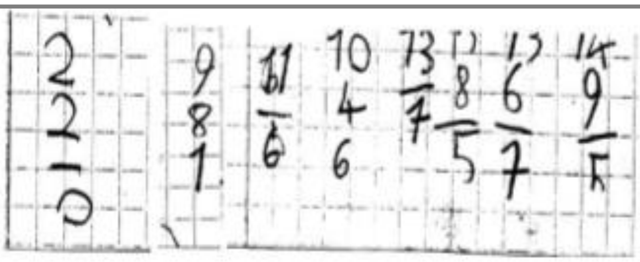

Figure 9. Error examples of students not using the operation symbol

It is seen that the error type "perceiving the plus (+) sign as a multiplication (x) sign" in the category of symbol errors was made by 5 second grade students. Children perceive the (+) sign, which represents addition, as a multiplication sign (x), and perform multiplication. Instead of addition, it performs multiplication. Examples of errors made by students and visuals of student answers are given in Figure 10.

$$\begin{array}{r} 3 \\ +2 \\ \hline 6 \end{array} \qquad 4 + 2 = 8 \qquad 5 + 1 = 5$$

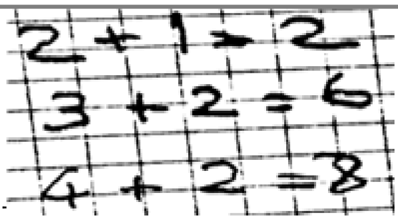

Figure 10. Error examples of students perceiving the plus (+) sign as a multiplication (x) sign

It was determined that the error type "perceiving the multiplication (x) sign as a division (÷) sign" in the category of symbol errors was made by 8 second grade students. Students who made errors in this code performed division in operations with the multiplication (x) sign representing the multiplication operation. Examples of errors made by students and visuals of student answers are given in Figure 11.

$$\begin{array}{r} 8 \\ x4 \\ \hline 2 \end{array} \qquad 6 \text{ x } 2 = 3$$

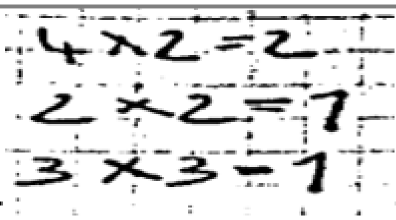

Figure 11. Error examples of students perceiving the multiplication (x) sign as a division (÷) sign

It is seen that the error type "perceiving the minus (–) sign as a division (÷) sign" in the category of symbol errors was made by 6 second grade students. Children perceive the (-) sign as (÷) in operations that represent the subtraction in which the minus (-) sign is used, and they perform division instead of subtraction. This type of error occurs mostly in horizontal transactions. Examples of errors made by students and visuals of student answers are given in Figure 12.

4 − 1 = 4 .... 6 − 3 = 2 ....

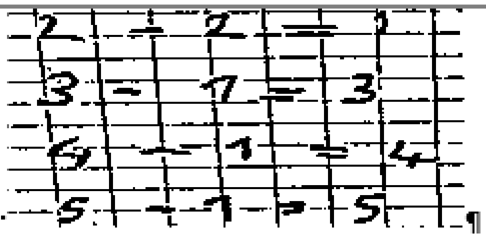

Figure 12. Error examples of students perceiving the minus (−) sign as a division (÷) sign

It was determined that the error code of "perceiving the division (÷) sign as a minus (−) sign", which is included in the category of symbol errors, was made by 13 second grade students. Especially in horizontal division operations, the student perceives the (÷) sign as minus (−) subtraction instead of division. Examples of errors made by students and visuals of student answers are given in Figure 13.

10 ÷ 2 = 8 **6 ÷ 3 = 3**

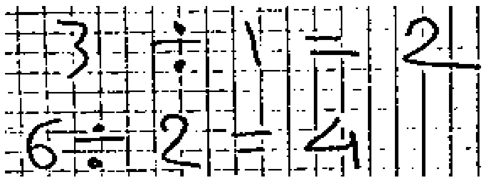

Figure 13. Error examples of students perceiving the division (÷) sign as a minus (−) sign

Discussion and Conclusion

Unaware of the complexities of early number understanding, it is easy to assume that children who can count are ready to add and subtract. Considered in this way, since mathematics teaching and learning is not built on solid foundations, children do not feel safe in their next education and may go backwards (Williams, 2008). Mathematical concepts are tightly bound to symbols that represent them. The use and interpretation of mathematical symbols begins very early in school life with mathematical symbols, which form the basis of mathematics teaching (Anghileri, 2005). Using the symbols and terms of mathematics effectively and correctly is indispensable for an effective mathematics teaching. Considering the research results it was determined that the error type "perceiving the minus (−) sign as a plus (+) sign" in the category of symbol errors was the type of error made with the highest rate by primary school 1st grade students. At the same time, it was determined that this type of error was also made at the 2nd grade level. It can be said that such a misunderstanding occurs because the first-grade children's teaching of four operations begins with the teaching of addition. This type of error is encountered in second-grade students as the addition operation in subtraction operations that require decimal decay. Cockburn (2005) stated that the child's addition rather than subtraction, as in the 6 – 4 = 10 operation, is the problem of not knowing the meaning of the sign. At the same time, we can say that students do not fully understand the concepts of addition and subtraction as the reason for this type of error.

As a result of the research, it was determined that the error type of perceiving the plus (+) sign as a minus (−) sign was made by 19 first-grade students and 7 second-grade students. According to Roberts (1968), the student should first recognize the relevant numbers. Then it must distinguish the trading symbol (+) from other symbols (-), (x) or (÷). After making this distinction, he should reach the result by choosing the appropriate steps 8 + 3 =? (11). When it is determined that students have answered 5 to this question, the ability to distinguish between appropriate and inappropriate answers should be determined. Some of these errors may be due to the over-generalization process from previous learning. Here the child may have produced an automatic reaction to the stimulus strong enough to affect his attention on the whole picture (the stimulus picture) rather than focusing on the action cue. To overcome the difficulties shown in this subject, more importance should be given to training on differentiation of answers in distinguishing stimuli and teaching arithmetic operations (8 – 3 = 5, 8 + 3 = 11). Another recommendation is to avoid questions based on incomplete and superficial stimuli in problem solving sets (8 3 =?). According to Bamberger, Oberdorf and Schultz Ferrell (2010), students answering 14 = ▯ +7 as 21 is due to students' misinterpretation of the two numbers in the process and the plus sign in between. It is a common problem for students who have not seen such a structured statement. Students have overgeneralized their limited understanding of addition and subtraction.

According to another result of the research, 13,33% of the second-grade students of the error type "perceiving the multiplication (x) sign as a plus (+) sign", and the error type of "perceiving the division (÷) sign as a minus (–) sign" error type was the second-grade students. It was concluded that it was done by 10.3% of the students. Hansen (2014) stated that in (5x4= 9, 6÷3= 3), children confuse the x symbol with the + symbol, and the ÷ symbol with the – symbol. Addition and multiplication symbols; likewise, the subtraction and division symbols are visually similar to each other. It can be difficult for children to distinguish each pair of symbols, moreover, if the child has a poor conceptual understanding of multiplication and division, he will turn to the concepts of addition and subtraction that he encounters more. Kubanç (2012) concluded that the students generalized the rules of addition to subtraction, multiplication and division, the rules of subtraction to addition, multiplication and division, the rules of multiplication to addition, subtraction and division, and the rules of division to addition, subtraction and multiplication. reached. According to Devlin (2000), when children are seven years old, they start making careless errors when multiplication tables are introduced. Children who confidently say 2 + 3 = 5 can answer 2 + 3 = 6, rarely 2 + 3 = 7. The operations of addition and multiplication are confused with each other. It was determined that at the second-grade level, students also made the type of error "perceiving the multiplication (x) sign as a division (÷) sign". According to Hansen (2014), there may be several reasons why children make these errors in operations 3x8 = 24, 8x3 = 24, 3 ÷ 8 = 24, 8 ÷ 3 = 24. It can be said that they are trying to create a pattern that they see to create a pattern, and they are trying to do the operations without considering whether what they wrote is logical or not. They may also not know what the division sign means, or they may not understand the difference between multiplication and division.

According to the results of the research, it was concluded that the "mistaking the equal (=) sign" error type, which is in the category of symbol errors, was made by 9.26% of primary school first grade students and 4.24% of second grade students. It was concluded that the students focused on the interpretational symbol instead of the equality symbol. Yaman, Toluk and Olkun (2003) in their research examining how primary school 2nd, 3rd, 4th, 5th and 6th grade students perceive the concept of equality and the equal sign. They concluded that students perceive the equal sign not as a "relational symbol" but rather as an "operation sign". This result is like the research. Carpenter and Levi (2000), Falkener, Levi and Carpenter (1999) concluded that students have misconceptions about calculating the equal sign, the numbers to be processed on the left side of the equal sign and finding the result of the operation on the right side. According to Van de Walle, Karp and Bay-Williams (2014), the equal sign should be given special attention. The equal sign means "same as ...". When most students see this symbol, they think of the message "the answer will come out". This symbol is treated in the same sense as the = key in the calculator. It is a key that must be pressed to get the answer. The equation 4+8 = 3+9 has no answer; but it represents the same multiplicity on both sides. The construct "same as ..." can be used in place of "equals" when dealing with equations with students. According to Ryan and Williams (2007), children's first understanding of the equal sign is often in the context of instruction to perform an arithmetic operation. For example, 3 + 5 =? for the most part, how much does this 'operation' view of the sign make if we add 5 to 3, or how many more to 3, 5? displayed as read. When this process is then understood as a number clause, the equality sign acquires an additional meaning, such as 'is the same' or 'equals'. Total 3 + 5 = 8 would be a sentence that could be read equally as "3 and 5" 8' or "8" 3 and 5'. This is an important conceptual change. According to Olkun and Toluk Uçar (2012), if the meaning of the "=" sign is not emphasized at the conceptual level, students develop ideas based on their own experiences. It should not be attempted to give operational information devoid of conceptual knowledge.

According to the results of the research, it was determined that students at both grade levels made errors such as "using the operation line in the wrong place", "not using the operation line", "confusing the places of the operation symbols", "not using the operation symbols". According to Engelhardt (1977), several procedures can be applied to assist children who show mechanical errors. One of them is lined notebooks, which can be turned sideways and used. Vertical lines and columns can be provided to help align the number columns. Special applications can be made for separating and formatting symbols. Pre-made calculations can be given. After the child has calculated on his own understanding, he can be allowed to use a calculator. Physical examination may be ordered for vision and neuro-motor function. According to Harris (2000), after the child learns a rule, model or method, he applies it to inappropriate situations. Therefore, it is important not only to learn the mechanics of a procedure, but also to make sense of it.

Recommedations

It is necessary to be aware that children need to have a solid understanding of the meanings as well as recognizing symbols. Teachers need to teach their students accurate definitions of symbols and provide opportunities for them to practice understanding of symbols in a variety of contexts. Teachers can explain and model symbols using concrete examples; they can then ask students to give and explain their own examples. Students can create their own mathematical dictionaries to represent symbols. Teachers need to know that some children will inevitably make some of these errors.

When teachers detect errors in their students, they should intervene immediately. Otherwise, errors made by students negatively affect their further learning in mathematics teaching, where teaching one subject is a prerequisite for teaching another subject. Appropriate teaching methods should be applied to correct the detected errors. Class discussions can be used to identify potential errors.

In addition, one-on-one interviews with a certain number of students can be made to further elaborate the study and help determine the causes of these errors. An extra worksheet can be prepared to measure the knowledge of students about symbols and thus enrich the data.

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İlkokul Öğrencilerinin Dört İşlem Sembol Hatalarının Belirlenmesi ve Çözüm Önerileri

Giriş

İlkokul yılları birçok matematiksel kavramın temelinin atıldığı yıllardır. Matematiksel kavramlar, sembolik ilişkisel yapılar olarak inşa edilir ve matematiksel işlemlerde mantıksal olarak birleştirilebilen işaretler ve semboller aracılığıyla kodlanır (Steinbring, 2006). Semboller matematikte önemli yer tutmakta ve genellikle düzen ve yönetim sağlamaktadır (NCTM, 2000; Adams, 2003; Esty, 2011; Bardini & Pierce, 2015). Semboller matematikte hesaplama ve problem çözmede niceliklerle meşgul olmak açısından son derece kolay bir yöntem sunmakta, matematiksel işlemler üzerinde düşünme fırsatı vermektedir (Tall ve diğerleri, 2001). Matematiksel kavramlar kendilerinin gösterimi olan sembollere sıkıca bağlıdır. Matematiksel semboller (1,2,3, +, −, x, ÷, <, >, %, vb.) matematiksel bilginin iletilmesinde kullanılan önemli araçlardır (Olkun ve Toluk Uçar, 2012, s.9). Bir sembol birçok bağlantıdan oluşan komplike (karmaşık) bir ağı temsil edebilir. Sayılar için kullanılan semboller, toplama için kullanılan sembol ve eşittir sembolü kullanıldıkları durum ve şekle bağlı olarak farklı anlamlara sahiptir (Haylock ve Cockburn, 2014, s.14-15).

Öğrenci hataları "bireysel zorlukları" gösterir. Hatalar; öğrencinin belli kavramları, teknikleri, problemleri anlamadığını, "bilimsel" veya "yetişkin" olarak kavramamış olduğunu gösterir. Hatalı kavramları ve süreçleri öğrenciler benzer şekilde öğrenirler. Öğrenciler, bir kavram veya işlemle ilgili ilk temasları arasında ortak noktalar ararlar. Bunlarla belirli ortak özelliklere sahip bir soyutlama oluştururlar. Kavramları ve algoritmalarını şekillendirirler (Aschlock, 2002, s.9). Öğrencilerin yaptıkları hatalar, temel gerçekler ve dikkatsizlik sonucu kaynaklanan hatalar hariç olmak üzere rastgele değildir. Yapılan hatalar son derece tutarlıdır. Öğretmenler yıllarca aynı hataları tekrar tekrar görürler. Çoğu durumda, çocukların hataları kurallara bağlı, doğru bir algoritma yerine yanlış bir işlemin uygulanmasının sonucudur. Ancak bu yanlış işlemler de mantık yanlış olsa dahi, çocuğa mantıklı gelebilir (Burns, 2007, s.10). Matematikte, dört işlemi (toplama, çıkarma, çarpma, eşittir) ifade eden anahtar kelimelerin ve bu kelimelerin gösterimi olan (+, −, x, ÷, =) matematiksel sembollerin yoğun kullanımı vardır. Bu yoğun kullanım sonucu, sembollerin aralarında ayırt edilememesi öğrenmeyi engelleyebilir (Baroody ve Standifer, 1993; Patkın, 2011; Hansen, 2014). Öğrenciler genellikle matematik sembollerine anlam yüklemede zorluk yaşarlar (Adams, 2003; Anghileri, 2005; Powell, 2015; Powell & Driver, 2015). Bunun sonucunda ise hatalar oluşabilir. Hatalar öğrencilerin bir sonraki öğrenmeleri de olumsuz etkiler (Engelhardt, 1977; Ashlock, 2002; Spooner, 2002; Hansen, 2014; Ojose, 2015).

Öğrenci hatası söz konusu olduğunda o hatayı ortaya çıkaran ve üreten durumların bilinmesi yapılan hatanın anlamlandırılması açısından oldukça önemlidir. Matematiksel işlem yapan çocukların hatalarını incelemek; onların düşüncelerini anlama, öğretmenlerden kaynaklı öğretim problemlerine katkılar sağlayabilir. Çocuklar sayılar arasında var olan ilişkileri ve sayılar üzerinde kullandığımız işlemleri anlayacaklarsa, öğretmenin ne dediğini ve bunun bir sayfada gördükleri ve hesaplamalar için kullandıkları sembollerle nasıl ilişkili olduğunu anlayabilmeleri çok önemlidir. Bu tür zorlukların üstesinden gelebilmek ve çocuklara sunulacak yardımın uygun olabilmesi için çocuklar tarafından yapılan hataların belirlemesi önemlidir. Öğrenci hatalarını analiz etmek hatalı problem çözme süreci, matematiksel anlayış ve tutumlar hakkında bilgi verir. Hatalar belirlenerek öğrencilere gerekli dönütler verilmezse, öğrencilerin hatalarını anlamaları, sistem içerisinde ortaya çıkamayabilir ve öğrenciler de yanlışlarını düzeltme fırsatı bulamayabilir. Bu nedenlerden dolayı özellikle dört işlemin temelinin atıldığı ilkokullarda öğrenciler tarafından yapılan sembol hatalarını belirlemenin önemli olduğu düşünülmektedir. Bu araştırmanın amacı ilkokul 1. ve 2. sınıf öğrencilerinin dört işlemde yaptıkları sembol hatalarını belirlemeye yöneliktir.

Yöntem

İlkokul 1. ve 2 sınıf öğrencilerinin dört işlemde yaptıkları sembol hatalarının belirlenmesinin amaçlandığı, araştırmanın modelini, nitel araştırma yaklaşımlarından durum çalışması oluşturmaktadır. Araştırmada veri toplama yöntemi olarak doküman analizi kullanılmıştır. Bu araştırmanın çalışma grubunu amaçlı örnekleme yöntemlerinden ölçüt örnekleme yoluyla seçilen 2015-2016 eğitim-öğretim yılında İstanbul ilindeki ilkokul birinci sınıf düzeyinde öğrenim gören 83 kız ve 79 erkek toplam 162 öğrenci, ikinci sınıf düzeyinde öğrenim gören 84 kız ve 81 erkek toplam 165 öğrenci oluşturmaktadır. Bu araştırmada veri toplama aracı olarak ilkokul 1. sınıf ve 2. sınıf öğrencilerinin matematik ders defterleri kullanılmış doküman analizi yapılmıştır. Araştırmacı tarafından uygulama yapılacak okullarda görevli okul yöneticileri ve öğretmenler çalışma ve süreç hakkına bilgilendirilmiştir. Öğrencilerin matematik dersinde kullandıkları defterler matematik ders saati dışındaki derslerde araştırmacı tarafından sınıflardan toplanarak fotokopileri ve fotoğrafları çekilerek tekrar sınıflardaki öğrencilere dağıtılmıştır. Ayrıca ikinci defteri kullanmaya başlayan öğrencilerin önceki defterleri sınıf öğretmenleri tarafından istenerek verilerin toplanması sağlanmıştır.

Araştırmada öğrenci defterinden toplanan veriler içerik analizi tekniği ile analiz edilmiştir. Analiz edilen veriler frekans ve yüzde değerleri verilerek gösterilmiş ve yorumlanmıştır. Kategori ve kodlar oluşturulurken ulusal ve uluslararası literatür, matematik eğitimi alanında uzman kişiler ve ilkokul birinci ve ikinci sınıf öğretmenlerinin görüşlerinden yararlanılmıştır. Hata yapan öğrenci sayısı ile hatanın kaç kez yapıldığı hesaplanmış ve yüzde değerleri bulunmuştur. Güvenirliği sağlamak için, öğrenci defterlerinden rastgele seçilen örnekler farklı zamanlarda analiz edilerek aynı sonuçlar elde edilmiştir.

Bulgular

İlkokul birinci ve ikinci sınıf öğrencilerinin dört işlemde yaptıkları sembol hatalarına ilişkin olarak; "eksi (−) işaretini artı (+) işareti olarak algılama" hata türünün 26 birinci sınıf öğrencisi, 9 ikinci sınıf öğrencisi toplamda ise 35 öğrenci tarafından en yüksek oranda yapılan hata türü olduğu belirlenmştir. Aynı zamanda "eksi (−) işaretini artı (+) işareti olarak algılama" hata türünün birinci sınıflar içerisinde yapılan en yüksek yük değerine sahip hata türü olduğu tespit edilmiştir. Bu hata türünü sırasıyla 19 öğrenci tarafından yapılan "artı (+) işaretini eksi (−) işareti olarak algılama", 15 öğrenci tarafından yapılan "eşit (=) işaretini yanlış algılama", 14 öğrenci tarafından yapılan "sayı sembollerini yanlış yazma", 13 öğrenci tarafından yapılan "işlem çizgisini yanlış yerde kullanma", 12 öğrenci tarafından yapılan "işlem çizgisini kullanmama", 11 öğrenci tarafından yapılan "işlem sembolü kullanmama" hatalarının izlediği görülmüştür. "Çarpma (x) işaretini artı (+) işareti olarak algılama", "bölme (÷) işaretini eksi (−) işareti olarak algılama", "artı (+) işaretini çarpma (x) işareti olarak algılama", "çarpma (x) işaretini bölme (÷) işareti olarak algılama", "eksi (−) işaretini bölme (÷) işareti olarak algılama" hata türlerinin ise hiçbir birinci sınıf öğrencisi tarafından yapılmadığı belirlenmiştir. İkinci sınıf öğrencileri tarafından yapılan hata frekanslarına bakıldığında ise; "çarpma (x) işaretini artı (+) işareti olarak algılama" hata türünün 22 ikinci sınıf öğrencisi tarafından yapılan en yüksek yük değerine sahip hata olduğu tespit edilmiştir. Bu hata türünü sırasıyla; 17 öğrenci tarafından yapılan "bölme (÷) işaretini eksi (−) işareti olarak algılama", 9 öğrenci tarafından yapılan "eksi (−) işaretini artı (+) işareti olarak algılama" 8 öğrenci tarafından yapılan "çarpma (x) işaretini bölme (÷) işareti olarak algılama", 7'şer öğrenci tarafından yapılan; "artı (+) işaretini eksi (−) işareti olarak algılama" ve "eşit (=) işaretini yanlış algılama", 6'şar öğrenci tarafından yapılan; "sayı sembollerini yanlış yazma" ve "eksi (−) işaretini bölme (÷) işareti olarak algılama", 5'er öğrenci tarafından yapılan; "işlem çizgisini yanlış yerde kullanma", "işlem çizgisini kullanmama" ve "artı (+) işaretini çarpma (x) işareti olarak algılama", 3 öğrenci tarafından yapılan ve ikinci sınıf öğrencileri içerisinde en düşük yük değerine sahip "işlem sembollerinin yerlerini karıştırma" hata türlerinin izlediği belirlenmiştir.

Tartışma ve Sonuç

Araştırma sonuçlarına bakıldığında, sembol hataları kategorisinde yer alan "eksi (−) işaretini artı (+) işareti olarak algılama" hata türünün ilkokul 1. sınıf öğrencileri tarafından en yüksek oranda yapılan hata türü olduğu belirlenmiştir. Aynı zamanda bu hata türünün 2. sınıf seviyesinde de yapıldığı tespit edilmiştir. Birinci sınıf seviyesinde çocukların dört işlem öğretimine ilk olarak toplama işleminin öğretilmesinden başlanmasından dolayı böyle bir yanlış anlamanın oluşması söylenebilir. Bu hata türü ikinci sınıf öğrencilerinde ise daha çok onluk bozma gerektiren çıkarma işlemlerinde toplama işleminin yapılması olarak karşımıza çıkmaktadır. Cockburn (2005), 6 – 4 = 10 işleminde olduğu gibi çocuğun çıkarma yerine toplama işlemi yapmasını işaretin anlamını bilememe sorunu olarak belirtmiştir. Aynı zamanda bu tür hata nedeni olarak, öğrencilerin toplama ve çıkarma kavramlarını tam olarak anlayamadıklarını söyleyebiliriz. Araştırmanın bir diğer sonucunda artı (+) işaretini eksi (−) işareti olarak algılama hata türünün ise 19 birinci sınıf öğrencisi, 7 ikinci sınıf öğrencisi tarafından yapıldığı tespit edilmiştir.

Araştırmanın bir diğer sonucuna göre "çarpma (x) işaretini artı (+) işareti olarak algılama" hata türünün ikinci sınıf öğrencilerinin % 13,33'ü, "bölme (÷) işaretini eksi (−) işareti olarak algılama" hata türünün ise ikinci sınıf öğrencilerinin % 10,3'ü tarafından yapıldığı sonucuna ulaşılmıştır. Hansen (2014) (7x3= 10, 8÷4= 4) işlemlerinde çocukların x sembolünü + sembolüyle, ÷ sembolünü – sembolüyle karıştırdıklarını belirtmiştir. Toplama ve çarpma sembolleri; aynı şekilde çıkarma ve bölme sembolleri görsel olarak birbirlerine benzemektedir. Çocuklar için her sembol çiftini ayırt etmek zor olabilir, ayrıca çocuk çarpma ve bölme konusunda zayıf bir kavramsal anlayışa sahipse, daha fazla karşılaştığı toplama ve çıkarma kavramlarına yönelir. Araştırma sonucuna göre sembol hataları kategorisinde yer alan "eşit (=) işaretini yanlış kullanma" hata türünün ilkokul birinci sınıf öğrencilerinin % 9,26'sı, ikinci sınıf öğrencilerinin ise % 4,24'ü tarafından yapıldığı sonucuna ulaşılmıştır. Öğrencilerin eşitlik sembolü yerine işlemler arası sembole odaklandıkları sonucuna ulaşılmıştır. Carpenter ve Levi (2000), Falkener, Levi ve Carpenter (1999) öğrencilerin eşit işaretini işlem yapma, eşit işaretinin sol tarafında işlem yapılacak sayıların olması, sağ tarafında ise işlem sonucunun bulunmasına yönelik yanlış anlamalara sahip oldukları sonucuna ulaşmışlardır.

Araştırma sonuçlarına göre her iki sınıf seviyesinde de öğrencilerin "işlem çizgisini yanlış yerde kullanma", "işlem çizgisini kullanmama", "işlem sembollerinin yerlerini karıştırma", "işlem sembolü kullanmama" hata türlerini yaptıkları belirlenmiştir. Engelhardt'a (1977) göre, mekanik hatalar gösteren çocuklara yardımcı olmak için birkaç prosedür uygulanabilir. Bunlardan biri çizgili defterler yan çevrilip kullanılabilir. Rakam sütunlarının hizalanmasına yardımcı olacak dikey çizgiler ve sütunlar sağlanabilir. Sembolleri ayırma ve biçimlenmesine ilişkin özel uygulamalar yapılabilir. Önceden yapılmış hesaplamalar verilebilir. Çocuk kendi anlayışıyla hesaplama yaptıktan sonra, hesap makinesi kullanmasına izin verilebilir. Görme ve nöro-motor işlev için fizik muayene istenebilir. Harris'e (2000) göre, çocuk bir kural, model ya da yöntem öğrendikten sonra onu uygun olmayan durumlara uygulamaktadır. Dolayısıyla bir prosedürün mekanik öğrenimi değil, aynı zamanda anlamlandırılması da önemlidir.

Öneriler

Çocukların, sembolleri tanımalarının yanı sıra anlamları konusunda da sağlam bir anlayışa sahip olmaları gerektiğinin farkında olmak gerekmektedir. Öğretmenlerin öğrencilerine sembollerin doğru tanımlarını öğretmeleri ve çeşitli bağlamlarda sembol anlayışını uygulamaları için fırsatlar sağlaması gerekir. Öğretmenler, somut örnekler kullanarak sembolleri açıklayabilirler ve modelleyebilirler; daha sonra öğrencilerden kendi örneklerini vermelerini ve açıklamalarını isteyebilirler. Öğrenciler sembolleri göstermek için kendi matematiksel sözlüklerini oluşturabilirler. Öğretmenler, öğrencilerinde var olan hataları tespit ettiğinde anında müdahale etmelidir. Aksi takdirde, öğrencilerin yaptığı hatalar, bir konunun öğretiminin diğer konunun öğretimi için ön şart niteliği taşıdığı matematik öğretimde sonraki öğrenmelerini olumsuz etkiler. Tespit edilen hataların düzeltilmesi için uygun öğretim yöntemleri uygulanmalıdır. Sınıf tartışmaları olası hataları belirlemek için kullanılabilir.