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Examining the Problem Solving Skills of the 4th Grade Primary School Students with Regards to Data Handling

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Abstract

The study aims to examine 4th grade primary school students' problem solving skills in data handling. The participants in the study consisted of 90 primary school students in total, 41 of whom were girls and 49 were males. The study group included students from selected 4th grades of three state elementary schools at middle socio-economic level which were located in Muş. A data handling problem that requires frequency, tally and column chart to be used as a data collection tool. In calculating students' scores, a rubric (Danielson & Hansen; 2016) was used. Problem solving approach, accuracy and precision, written communication are considered as variables with four levels in this rubric. When the scores of the students were examined, it was determined that the scores of the problem solving approach and accuracy scores were relatively higher than the written communication scores. The difference between the written communication scores of the girls and the communication scores of the boys was found to be significantly in favor of the girls. It was also determined that 91% of all students can draw a frequency chart, 83% can draw a tally chart, and only 63% can draw a column chart. The following recommendations can be made in line with the results obtained. Students should be given the chance in mathematics class and exams to explain, verbally and in writing, what they did and how they did. Furthermore, considering that the students had more difficulties in creating a column graph- ic than other types of graphics, more time could be allocated to activities related to drawing and read- ing column graphics.

Keywords: *Problem solving skills, Written communication, Data handling, Primary mathematics*

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İlköğretim 4. Sınıf Öğrencilerinin Veri İşleme Konusundaki Problem Çözme Becerilerinin İncelenmesi

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Öz

Bu çalışmanın amacı, ilköğretim 4. sınıf öğrencilerinin veri işleme konusundaki problem çözme becerilerini incelemektir. Katılımcılar 41'i kız, 49'u erkek olmak üzere toplam 90 ilkokul öğrencisinden oluşmaktadır. Veri toplama aracı olarak sıklık, çeteleme ve sütun grafiği gerektiren bir veri işleme sorusu kullanılmıştır. Öğrencilerin yanıtları bir değerlendirme rubriği (Danielson ve Hansen; 2016) kullanılarak hesaplanmıştır. Değerlendirme rubriğinde problem çözme yaklaşımı, doğruluk ve kesinlik, yazılı iletişim dört seviyeli değişkenler olarak kabul edilmektedir. Öğrencilerin puanları incelendiğinde, problem çözme yaklaşımı ve doğruluk puanlarının yazılı iletişim puanlarından daha yüksek olduğu belirlenmiştir. Kızların yazılı iletişim puanları ile erkeklerin yazılı iletişim puanları arasındaki fark, kızların lehine anlamlı bulunmuştur. Ayrıca tüm öğrencilerin %91'inin sıklık tablosunu ,% 83'ünün bir çeteleme tablosu ve sadece %63'ünün bir sütun grafiğini çizebildiği belirlenmiştir. Elde edilen sonuçlar doğrultusunda şu öneriler yapılabilir. Matematik derslerinde ve sınavlarında öğrencilere sözlü ve yazılı olarak ne yaptıklarını ve nasıl yaptıklarını açıklama şansı verilmelidir. Ayrıca, öğrencilerin sütun grafikleri oluşturmada diğer grafik türlerinden daha fazla zorluk yaşadıkları göz önüne alındığında, sütun grafikleri çizme ve okuma ile ilgili etkinliklere daha fazla zaman ayrılabilir.

Anahtar Kelimeler: *Problem çözme becerileri, Yazılı iletişim, Veri işleme, İlkokul matematiği*

Introduction

In the modern world, students are not only expected to have a grasp of a mathematics-related subject, but they are also expected to establish a relation between mathematics-related issues and other issues and subjects, to express mathematical concepts in a mathematical language, to make use of thinking skills between concepts and to develop problem solving skills. Gaining problem solving skills is particularly important for an individual in today's world (Tertemiz, 2017). Hence, it is safe to claim that problem solving would be among the most prominent skills in the future. An integral part of the education programs being used by Western countries since the early eighties is a problem solving-based learning approach (Baki, 2018; Schoenfeld, 1992). In recent years, international exams such as TIMSS, PISA, PIRSL tend to include more problem-solving related questions than before, which is a clear indication of the significance of this skill.

Problem solving

Problem is a case that stirs the feeling of solving in an individual and does not have a readily available solution procedure but it could be possible for the individual to overcome the situation by using his/her existing knowledge and experiences (Olkun and Toluk-Uçar, 2018). On the other hand, problem solving is to assume a task or which there is no previously known method of solution (National Council of Teachers of Mathematics [NCTM], 2000). During problem solving process, an individual is required to have a good grasp of available data, develop suitable plans and strategies for solution, implement the developed plans and strategies to obtain a result and to check the validity of the obtained result (Bayazit and Aksoy, 2012).

Problem solving is regarded as a tool to develop thinking capabilities (Schoenfeld, 1985). Problem solving opens a new path for children's mathematical thinking abilities (Charlesworth and Leali, 2012). Therefore, states nowadays seem to concentrate on teaching mathematics through problem solving oriented methods rather than shifting the whole attention towards trying to teach problem solving skills in mathematics (Liljedahl, Santos-Trigo, Malaspina and Bruder, 2016). For instance, National Council

of Teachers of Mathematics [NCTM] (2000) has placed problem solving at the Center of teaching mathematics in all levels of education including preschool era, in order to improve problem solving skills of students and to help them apply such skills into various conditions they may have during daily life. In Turkey, on the other hand, primary school mathematics teaching programs included problem solving-related purposes and descriptions from 1926 to 2015 (Artut and Dinç, 2015). Programs put into use after 2005 has taken problem solving as an important process skill rather than considering it as a mere tool to teach other mathematics subjects (Artut and Tarım, 2016).

From a development phase perspective, experiences and skills acquired during early ages are said to be highly important. In particular, acquiring problem solving skills at an early age provides a tool to develop mathematical understanding of young children. Because previously conducted studies have indicated that individuals who fail to acquire problem solving skills at earlier ages are less successful in problem solving in their older ages (Jordon et al., 2003, Anderson, 2010; Grimm 2008). Without any problem solving skills, the benefits and power of mathematical ideas are highly restricted (NCTM, 2000).

Assessment of problem solving process

Problem solving is a mental skill and it is difficult to observe it directly. To organize educational activities aiming to provide problem solving skills, the observable behaviours comprising this process need to be identified. Unless problem solving attitudes for different types of problem are identified, it is highly difficult to develop productive and effective education programs to develop problem solving skills (Erden, 1986). Therefore, student actions and written responses need to be monitored and they must allow the teacher to concentrate on students' cognitive and metacognitive skills and to establish an opinion related to their cognitive understanding levels (Ekici and Demir, 2018). There are different types of processes in literature with regards to assessing problem solving skills (Barmby, Bolden and Thompson, 2014; Danielson and Hansen, 2016). These are SOLO taxonomy, assessing creativity, assessing metacognition and problem solving processes (Barmby, Bolden and Thompson, 2014).

SOLO taxonomy has been developed by Biggs and Collis (1982) and it is assessing the thinking levels of children. Taxonomy consists of five levels. In the pre-structural level, the responses by children towards problems display indifference. In the non-structural level, there is only a single relevant direction taken into consideration during the problem solving process. In the multi-structural level, there are a number directions taken into consideration during problem solving process, even though the connections are not well associated. Relational level is to regard different aspects in problem solving process as a whole. Extended abstract level on the other hand, is where thought is taken into another abstraction or generalization level (Barmby, Bolden and Thompson, 2014).

Assessing metacognition, one of the problem-solving process assessment methods, is where students are examined under the criteria of metacognitive thinking processes, planning, monitoring, assessment and reflection (Barmby, Bolden and Thompson, 2014). With the purpose of self-proving the accuracy of procedure steps realized by the students during the problem solving process, students perform metacognitive questioning to assess as well as to monitor the process (Serin and Korkmaz, 2018).

In *problem solving processes,* processes that have the same basic content but are defined in different steps and different orders by the researchers are used to assess problem solving skills. For instance, Bourke and Stacey (1988) discuss a five-step process in assessing problem solving process. These are; inference (understanding a problem and distinguishing more important information), the method used in problem solving (the applicability of the method), accuracy in calculation, accuracy of result and the description quality of the solution (Barmby, Bolden and Thompson, 2014). Toh et al., (2009) on the other hand, report a four-step process which they have developed in consideration of Polya's problem solving stages. These are; understanding the problem (looking at the emotions related to problems, perceived difficulties and the approaches for understanding the problem), developing a plan (what are the key concepts and the resources required to tackle the problem, preparing a plan), implementation of the plan (decisions taken during any of the calculations, details of mathematical steps), controlling and generalization (taking control, expressing possible adaptations and generalization of the problem) (Barmby, Bolden and Thompson, 2014).

One of the tools that is contained in *using problem solving processes* as well as in this study is the problem solving skill assessment rubric developed Danielson and Hansen (2016). The assessment rubric is consisting of three variables. These are; problem solving approach; accuracy and precision and communication. "Problem solving approach" is expressing the ability of the students to understand a problem, organize the compounds, strategy selection and application skill or the method of solving an issue. "Accuracy and precision" is an expression that collectively refers to students' procedural fluency and whether a response is reasonable or not, and the ability to double check the reasonability by using another model or strategy. Finally the "communication" of the students is assessed. Most of the performance tasks in this collection require the students to describe their opinions verbally or in writing. When doing this, the students are asked to participate in the modelling of mathematics, and to use the structure and reasons just like a mathematician (Danielson and Hansen, 2016).

Beyond the skill and concept that can be assessed by a multiple-choice test, the tasks assigned to children must allow to assess competency through practices that prove implementation, strategic thinking and a deeper understanding (Danielson and Hansen, 2016). Because problem solving process should not be limited to taking responses from students. If problem solving is the focal point mathematics than the standard of reasoning and proof should emphasize logical thinking that helps us to decide and understand our responses. Students need to develop a skill of providing a logical reason as a supplemental part of each answer. Students need to learn the value of proving ideas through logical evidence (Van De Walle, Karp and Bay-Williams, 2012). Furthermore, one of the significant process with a key role in developing problem solving skills is the ability to provide valid and logical explanations of why the problem is right (Baki, 2018).

Data handling

Data handling plays an important role in mathematics education, because it covers real-life situations and helps students to develop their critical thinking skills (Reys, Lindquist, Lambdin and Smith, 2009). Data handling

is a mathematics compound that is using mathematical tools to collect, organize, represent and interpret mathematical data to solve real-life issues (Naidoo and Mkhabela, 2017; Julius, Mun, Abdullah, Mokhtar and Suhairom, 2018). Data handling, statistics and probability provide a meaningful context to encourage problem solving and critical thinking, develop communication and the sense of digits and help in calculation activities (Reys, Lindquist, Lambdin and Smith, 2009).

Data handling provides a connection between statistics, probability and other subjects of mathematics or different interdisciplinary subjects. Looking at primary school mathematics program, one can see that the expectation from students is to follow the steps of creating researchable questions, collect data, handle and analyse data and interpret results. In this process the target is to make the students create a problem, be able to use different indication styles to represent the data obtained from problem solutions, read the given figures, tables, graphics and to ensure transition between the different indication styles (MEB, 2017). Therefore, in primary school it includes data handling, data collection and recording and representing them afterward in a manner that is meaningful for others. Data handling constitutes an integral part of students' mathematical understanding. Students need to be introduced to the concept of data handling at an early age, because they will be using and developing this skill throughout their school life (Julius, Mun, Abdullah, Mokhtar and Suhairom, 2018).

In a global sense, international assessments reveal that students do not display a good performance with regards to data handling (Naidoo and Mkhabela, 2017). For instance, a study conducted in Turkey has revealed that students are having difficulties in creating research questions, collecting, organizing and representing data, analyzing and interpreting data, creating and interpreting tables, graphics and schemas from different representation types of data (Hacısalihoğlu-Karadeniz, 2016). Similarly, a study conducted by Rodrigues (1994) has also revealed that students are having difficulties in data handling.

Through data handling, students develop their data collection, organization, representing, interpreting, analyzing and reporting skills (Adu and Gosa, 2014). Furthermore, it is also deemed to be important in revealing the thinking processes of students when solving problems, as data

handling is related to the subjects of mathematics, subjects in other classes as well as daily life. In the current study, the problem solving skill assessment rubric developed by (Danielson and Hansen (2016) has been used with the purpose of revealing the thinking processes of students in terms of data handling. The reason for using problem solving skill assessment rubric as an assessment tool is the fact that it has been designed to provide a comprehensive picture of students' conceptual understanding and procedural knowledge through problem solving approach, accuracy and precision and communication (Danielson andHansen, 2016). In this sense, answers have been sought for the below research questions:

- What is the problem solving approach, accuracy and precision and written communication variable score distributions of primary school 4th grade students?
- Is there a significant difference between the average scores of primary school 4th grade students' problem solving approach, accuracy and precision and written communication variables in terms of gender?
- Is there a significant difference between the average scores of primary school 4th grade students' problem solving approach, accuracy and precision and written communication variables?
- What is the distribution of primary school 4th grade students in terms of being able to create column, tally and frequency graphics?

Methodology

The current study has been conducted with instrumental case study pattern, one of the case study types. A case study is defined a detailed and systematic description of a sample case with defined limits (Stake, 1995, Merriam, 2013). Stake (2005) divides case studies into three groups, which are intrinsic, instrumental and collective. In instrumental case studies, phenomena that are existing but are not easily spotted at first glance are examined and revealed. As such, the problem-solving skills of primary school 4th grade students are examined over four levels within the context of three variables.

Participants

The participants in the study consisted of 90 fourth grade primary school students in total, 41 of which whom girls and 49 were boys. The study group included 4th grade students from three state elementary schools with middle socio-economic levels located in Muş. The schools were chosen from the middle socio-economic level because of a reluctance to include in the study extreme examples which might bring in very positive or negative factors (at least with regard to resource factors). Also, the aim was to examine and interpret data from ordinary/mainstream schools.

Data collecting tool and process

A data handling problem that requires frequency, tally, and column chart to be used as a data collection tool. The following problem was created considering the data handling outcomes of the fourth grade mathematics course. To help the students to demonstrate their written communication skills, the problem had to be as simple and understandable as possible.

"A teacher researched to determine the favourite season of the students. The teacher reached the conclusion that there are nine students who love spring, five who love summer, four who love autumn, and six who love winter. In line with this information, create frequency, tally, and column charts." The problem statement was created with the help of the 4th grade mathematics textbook of the Ministry of Education in Turkey. In order to check whether the questions had content validity, they were sent to be reviewed by class teachers who have taught or are teaching fourth grade (3 teachers), mathematics educators (1 professor, 1 assistant professor and 1 research assistant), a program development expert (1 associate professor) and a measurement and evaluation expert (1 assistant professor).

Also, the students were asked to write how they solved the problem. However, no time limitation was made for the problem solving of the students. The students completed the problem solving in approximately 8-12 minutes.

Analyzing data

The rubric shown in Figure 1 (Danielson and Hansen; 2016) was used in determining students' scores by using three variables. Rubric allows each variable to be evaluated at four levels. The criteria and explanations given for each level in the rubric allow for more reliable scoring. After calculating the scores some analysis were performed. Firstly, frequencies and percentages of student responses were determined through the levels of each variable. Then an independent sample t test was made to determine whether there were differences between male and female students in terms of problem solving approach, accuracy and certainty and communication skills. Also, paired sample t-tests were conducted to determine whether there were significant differences between the students' scores. Along with these, the average score of students' problem solving approach, accuracy and precision, written communication were determined. Finally, the percentages of students' tally charts, frequency charts and column charts were calculated.

	Level One	Level Two	Level Three	Level Four
Problem Solving Approach	The chart is unorganized; incomplete.	The chart is mostly organized; not in the format suggested and information is incomplete.	The chart is organized and include numbered rows; observation statements and equeations.	The chart is well organized and complete.
Accuracy and Precision	The chart and statements have major computation errors.	The chart and statements have mostly accurate computation.	The chart, equations and statements reflect accurate computations.	The chart, equations and statements reflect anvanced computation strategies and operations.
Written Communication	The explanation is unclear.	The explanation shows an incomplete understanding of data handling and drawing charts.	The explanation include the visual model, equations and mathematical language.	The explanation is clear with new generalizations about data handling and drawing charts.

Figure 1. Adapted from Danielson and Hansen (2016).

Findings

In this section, data obtained with the rubric variations and graphic types have been shared after being analysed based on gender and total number of students. Table 1 provides the distribution of student responses per

level, on the basis of problem solving, accuracy and precision and written communication variables.

Table 1. Distribution of students responses based on variables

Variables	Level	Girls	Boys	Total	Percentage
Problem solving approach	1	3	6	9	10,0
	2	1	9	10	11,1
	3	16	18	34	37,8
	4	21	16	37	41,1
Accuracy and precision	1	3	5	8	8,9
	2	3	10	13	14,4
	3	12	12	24	26,7
	4	23	22	45	50,0
Written communication	1	14	28	42	46,7
	2	14	13	27	30,0
	3	4	7	11	12,2
	4	9	1	10	11,1

Table 1 indicates that 41% of the students are at the fourth level of problem solving approach, in other words they can well organize and complete graphics, but at the same time, 10% of the students are incompetent in terms of this problem solving approach. If Levels 3 and 4 are deemed to be successful levels, then around 80% of the students can be deemed to have succeeded terms of problem solving approach.

When problem solving process is assessed in terms of accuracy and precision variable, around 9% of the students made great mistakes when drawing graphics while 50% were able to wholly complete frequency, tally and column graphics.

Under the written communication variable, around 11% of the students were able to express in a clear and comprehensible manner how they had solved the problem while around 47% failed to provide a clear explanation on how the problem was solved.

Table 2. Comparison of problem solving approach, accuracy and precision and communication variables

	M	**Sd**	***t***	***p***
Problem solving approach	3,10	0,96	-1,35	1,79
Accuracy and precision	3,17	0,98		
Problem solving approach	3,10	0,96	-11,19	.00
Written communication	1,87	1,01		
Accuracy and precision	3,17	0,98	11,36	.00
Written communication	1,87	1,01		

Table 2 provides the dependent groups t test analysis outcomes, which have been conducted to determine whether there are any significant differences between problem solving approach, accuracy and precision and written communication averages. Table 2 indicates that there is no significant difference between the problem solving approach and accuracy and precision variable averages [$t(90)$= -1,35, p< .05], the difference between problem solving approach and written communication skill average scores is significant [$t(90)$= -1119, p< .05], and the difference between accuracy and precision and written communication skill average scores is also significant [$t(90)$= 11,36, p< .05].

Table 3. Comparison of problem solving approach, accuracy and precision and communication according to gender.

	Groups	**N**	**M**	**Sd**	***t***	***p***
Problem solving approach	Girls	41	3,34	0,85	2,23	.028
	Boys	49	2,89	1,00		
Accuracy and precision	Girls	41	3,34	0,91	1,44	.152
	Boys	49	3,04	1,04		
Written communication	Girls	41	2.20	1.14	2.81	.006
	Boys	49	1.61	0.81		

Looking at Table 3, addressing the variables from a gender perspective, the average scores of girls were higher from the boys in all three variables (problem solving approach 3,34 -2,89, accuracy and precision 3,34-3,04, written communication 2.20-1.61). In terms of written communication, the score difference between girls and boys has increased. An independent

groups t test analysis has been performed to determine whether the difference between average scores of girls and boys is significant. In terms of problem solving approach, the difference between groups has been observed to be significant in favour of the girls [$t(90)= 2,23$, $p< .05$]. There was no significant difference [$t(90)= 1,44$, $p< .05$] between accuracy and precision variable averages, but a significant difference in favour of girls has been observed between the written communication average scores of the groups [$t(90)= 2.81$, $p< .05$].

Table 4. Distribution of student responses based on charts

Chart	Girls	Boys	Total	Percentage
Frequency	38	44	82	91,1
Tally	35	40	75	83,3
Column	31	32	63	70,0

Looking at Table 4, it can be seen that during the problem solving stage around 90% of the students were able to draw the frequency graphic, around 83% of the students were able to draw the tally graphic, while 70% of the students were able to draw column graphic. When these values are compared, it is possible to claim that students had more difficulties in drawing column graphic than other types of graphics.

Conclusion and Discussion

Problem solving is the building stone of mathematics program. Problem solving opens-up a window for children's mathematical thinking and it is an important tool for assessing students' mathematic-related ideas (Charlesworth and Leali, 2012). During the problem-solving process, control and assessment skill (Serin and Korkmaz, 2018; Van De Walle, Karp and Bay-Williams, 2012), presenting an environment where the students can read and express what they have read in their own words (Ekici and Demir, 2018) are issues that should not be ignored. The purpose of this study was to assess the problem-solving skills of primary school 4th grade students based on data handling. The results obtained in line with this purpose are as follows:

Majority of the participating students were able to well organize and complete the graphics in terms of data handling. When problem solving process is assessed from the perspective of accuracy and precision variable; students were able to fully complete frequency, tally and column graphics. Students being able to well-organize the graphics, as well as being successful in fully completing frequency, tally and column graphics during the problem solving process are in parallel with literature findings. For instance, a study conducted by Kaytancı (1999) has concluded that students failed to display the attitudes to draw figures or sketches and to confirm the correctness of the problem during the problem solving skill process. In a similar way, a study conducted by Gökkurt and Soylu (2013) has revealed that students were unable to effectively use the sense of meaning during the problem solving process, failed to correctly describe the contents of the problem and correctly explain the meaning of the values they have obtained and were also unable to transform the relational expressions of the problems into the right equations. The probable reason for the differences between the findings could be associated with the fact that data as a subject is in the curriculums of primary school and secondary school mathematics program as one of the basic learning areas such as geometry and measurement. Because in the 2005 program, data target and acquirements have been addressed within a holistic process and harmonized with current tendencies in the field of statistics when compared to previously published programs (1983, 1990 etc.). This approach has become particularly more obvious in the renewal of primary school mathematics program in 2015. Until the year 2005, mathematics programs expected data and graphics to be formed with the help of teachers, but along with the 2015 program the expectation shifted towards the students from 1st grade onwards to form graphics related to acquirements from data and graphics (Ader, 2015). Therefore, it can be said that students were not granted sufficient amount of practice in learning-teaching process in the past, as previous programs expected the graphics to be formed by the teachers first and then by the students.

Another finding acquired from the study is related to the written communication skills of the students. With regards to the written communication dimension of the problem solving process, students had difficulties in providing a comprehensible description of how they have solved the

problem. A study conducted by Yüzerler and Doğan (2012) reported that the majority of students failed, either completely or partially, to use an appropriate mathematical language when expressing their mathematical thoughts. Written communication provides the students with the chance to convey ideas, feelings and experiences that can develop their critical thinking, sound reasoning and problem solving skills. Furthermore, writing to describe their thinking processes is a way for students to bind their ideas into solutions (Fuehrer, 2009). It is among the goals of mathematics class to have correct use of mathematical terminology and language for a logical description and sharing of mathematical ideas (Ministry of National Education, 2018). In this context, one can claim that the unsatisfactory performance of students in written communication is a significant deficiency in terms of mathematical competency. The explanations of students with regards to problem solving strategies and reasoning and developing their skills such as note taking and writing to explain the response to a question are deemed to be important for the problem solving process.

With regards to the finding related to whether data handling related problem solving skill process had any significant difference between genders, gender variable did not yield any significant difference in terms of precision and accuracy variable, but there was a significant difference in favour of girls in terms of problem solving approach and written communication. Girls were more successful than boys during the problem solving process in terms of understanding a problem, organizing its components, selecting and implementing a strategy and on finding ways to solve a problem. Similarly, girls were again more successful than boys when it came to expressing their thoughts in writing under the scope of written communication dimension. This finding of our study is parallel to the study conducted by Selamet (2014). Another conclusion of this study is that girls were more successful than boys in terms of solving problems related to graphics. Kaynar (2012), however, reported that gender variable is not an effective factor on problem solving skills related to frequency table reading, interpreting, calculation and graphic drawing. In another study by Kaynar and Halat (2012), no significant difference has been observed between the success levels of boys and girls in terms of reading and

interpreting run charts and histogram graphics but boys were more successful in reading and interpreting pie charts.

The primary school 4th grade students participating in the study problem have been more successful in drawing frequency and tally graphics when compared to drawing column graphic. They had more difficulties in drawing the column graphic than in other types of graphics. A study conducted by Selamet (2014) revealed that students were most successful in the run chart when compared to column and frequency graphics. Another study by Kaynar (2012) has revealed that students had great difficulties in conveying data from frequency chart into graphics in Kaynar and Halat's (2012) study, students were most successful in drawing run chart, followed by histogram and then pie chart.

In summary, the findings of the study were as follows; during the problem solving process, students were generally successful in problem solving approach and solution but majority of the students were unable to clearly express themselves when asked to explain in writing their method of solving the problem, and they had the most difficulty in creating a column chart when compared to other types of graphics. In this context, students should be given the chance in mathematics class and exams to explain, verbally and in writing, what they did and how they did. This would help to enhance their communication skills. Furthermore, considering that the students had more difficulties in creating a column graphic than other types of graphics, more time could be allocated to activities related to drawing and reading column graphics.

The current study is limited to data handling learning and a problem defined within this field of learning. Furthermore, the participants of the study are limited to primary school fourth grade students. Studies to be conducted in the future could increase the amount of fields of learning and the variety of problem situations and participants could be selected from different levels and classes.

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