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# Mathematics Pre-Service Teachers' Metaphorical Perceptions about Statistics in Turkey

Dilek Sezgin Memnun\*

*Assist.Prof.Dr. Uludag University, Bursa, Turkey*

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## Abstract

The research is aimed to reveal the thoughts the elementary mathematics pre-service teachers about “Statistics” concept through metaphors. A total of 62 mathematics pre-service teachers, taking statistics courses at a public university in Turkey in the spring semester of 2012-2013 academic year, participated in this qualitative research. The data of the research was obtained by having pre-service teachers answer the phrase of “Statistics is like.....because.....”. The data gathered from pre-service teachers have been analyzed using descriptive statistics and content analysis method. Research results revealed 32 metaphors and 3 categories about statistics.

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*Keywords:* Statistics, metaphor, content analysis, mathematics pre-service teachers.

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## 1. Introduction

Statistics is an important issue in all areas of daily life. It is concerned with the analysis of data and depends on mathematics and computing. It is essential for economic empowerment and decision-making about the issues such as economy, education, health that effect life (Utts, 2003). Statistical includes five basic knowledge; “knowing why data are needed and how data can be produced, familiarity with descriptive statistics, familiarity with graphical and tabular displays, understanding basic notions of probability, and knowing how statistical conclusions or inferences are reached” (Gal, 2004; Cited in Ozen, 2013: 9). It requires posing a research question, collecting data, analyzing data and interpreting. All of these encourage individuals into a variety of statistical thinking.

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\* Corresponding author. Tel.: +90-532-720-91-72 Tel. 2: +90-532-611-23-03

E-mail address: [dilekmemnun@gmail.com](mailto:dilekmemnun@gmail.com), [dsmemnun@uludag.edu.tr](mailto:dsmemnun@uludag.edu.tr)

The development of the statistical thinking begins in early grades. The necessity of the statistics knowledge in every grade is emphasized by National Council of Teachers of Mathematics (NCTM, 2000). In additionally, the importance of the statistical thinking and applications is increasing in these recent years in Turkey. The reforms in elementary school mathematics education programs have been carried out. Statistical thinking involves the understanding statistical concepts, analyzing the collected data and learning the ways to students by in-service teachers (Jacobs, 1999). Teachers play a crucial role in developing students' statistical thought processes (Pfannkuch, 2008). Teachers must be aware of and build on their students' thinking about statistical concepts. Because of that, teachers need to develop their knowledge and skills about statistics and foster their students' statistical abilities. On the other hand, students must construct their own individual meanings for mathematical concepts encountered within classrooms have an impact on the sort of meaning that are constructed (Presmeg, 1992). Students' thinking could be influenced by the metaphors implicit in teachers' presentations of subject matter else. Educators in the fields of mathematics and statistics education have recommended the use of metaphor and other teaching devices. Educators must assistance the construction of richer personal metaphors of students (Groth & Bergner, 2005). Because of that, it is very important that pre-service teachers could learn and teach statistics effectively. Nevertheless, our review of the literature display few different studies (Grant & Nathan, 2008; Groth & Bergner, 2005) have been carried out with pre-service teachers on metaphors about statistics. Grant and Nathan (2008) have been aimed to displays that graduate students use more than one metaphor for confidence limits which one of the implications for the statistical knowledge and applications. Groth and Bergner (2005) have been described personal metaphors of pre-service teachers' for the statistics concept by constructing metaphors for the sample concept and discussed its relationship to their knowledge of the concept. Therefore, it is aimed is to reveal the mathematics pre-service teachers' metaphorical perceptions about statistics in this research. Accordingly, the following research questions have been explored:

1. What are the elementary mathematics pre-service teachers' metaphors about statistics?
2. Under which conceptual categories could the elementary mathematics pre-service teachers' metaphors about statistics be classified when their common features are considered?

## **2. Methodology**

The conceptual categories related to metaphors about statistics have been exerted in this section.

### *2.1. Research Method*

The phenomenology design has been used in this qualitative research. Phenomenology design comprises a suitable context for conceptual research because it focuses on the phenomenon that we recognize but do not have detailed understanding (Yıldırım & Şimşek, 2006).

### *2.2. Participants*

The research has been carried out with total of 62 elementary mathematics pre-service teachers, who were studying as juniors at a public university in Turkey. These volunteered pre-service teachers participated in this research in the spring semester of 2012-2013 academic year.

### *2.3. Data Collection*

Mathematics pre-service teachers were asked to complete the phrases of "Statistics is like.....because....." to reveal pre-service metaphors about statistics. Pre-service teachers were asked to write their thoughts by focusing on just one metaphor for each concept. Mathematics pre-service teachers were asked not to write their names on their answer sheets to obtain their real feelings and thoughts. It took approximately 15 minutes to complete this phrase about statistics concept.

## 2.4. Data Analysis

The metaphors developed by the mathematics pre-service teachers were analyzed and interpreted in five steps as; determination of metaphors, classification of metaphors, development of the categories, providing the validity and reliability, transferring data to the computer.

Metaphors developed by mathematics pre-service teachers were listed and coded according to alphabetical order in determination of metaphors step. Metaphors were analyzed to find similarities and common features with other metaphors in classification of metaphors step. Target metaphors were determined by analyzing the connection between the metaphors. In this step, a total of 32 available mental symbols were obtained. Metaphors were analyzed in terms of common characteristics that they had relations with the statistics concept in development of the categories step. In this step, 3 different conceptual categories were created in relation with a particular theme according to any metaphors produced by pre-service teachers' perspectives. Two different researchers opinions have been applied to confirm whether metaphors under 3 conceptual categories represent in question to any conceptual category or not. These researchers were given metaphors and conceptual category list and matched these metaphors and categories. After that, the matched lists compared with each other revealed by both of the researchers. It has understood that almost all of the metaphors in category lists of these researchers were the same.

## 3. Findings

The content analysis results that were performed to reveal the mathematics pre-service teachers' metaphorical perceptions about statistics have been reported in this section.

### 3.1. Metaphors about Statistics

The elementary mathematics pre-service teachers, who were studying as juniors at a public university in the spring semester of 2012-2013, developed 32 valid metaphors related to statistics as indicated in Table 1.

Table 1. Elementary mathematics pre-service teachers' metaphors about statistics

	Metaphor	f	%		Metaphor	f	%
1	General view	5	8.93	17	Real life	1	1.79
2	Real	5	8.93	18	Gulf	1	1.79
3	Sorting data	5	8.93	19	Sky	1	1.79
4	Puzzle	3	5.36	20	Construction	1	1.79
5	Future	3	5.36	21	Complex skein	1	1.79
6	Maze	3	5.36	22	Classical music	1	1.79
7	Ocean	3	5.36	23	Ships in ocean	1	1.79
8	Analyze	2	3.57	24	Braid	1	1.79
9	Soup	2	3.57	25	Scrip	1	1.79
10	Philosophy	2	3.57	26	Watch	1	1.79
11	Graphic	2	3.57	27	Chess	1	1.79
12	Computer	1	1.79	28	Exam	1	1.79
13	Mountain	1	1.79	29	Question mark	1	1.79
14	Grain of sand	1	1.79	30	Chance game	1	1.79
15	Universe	1	1.79	31	Train	1	1.79
16	Awareness	1	1.79	32	Time	1	1.79

The most repeated metaphors developed by elementary mathematics pre-service teachers are; general view, real, sorting data, puzzle, future, maze and ocean.

### 3.2. Conceptual Categories related to Metaphors about Statistics

Elementary mathematics pre-service teachers' metaphors about statistics are classified into 3 categories; structure of statistics, solving process and difficulty and complexity of statistics. Structure of statistics category consists of 13 (40.6%) metaphors and 23 pre-service teachers. The most repeated metaphors are; general view, real, analyze and graphic for this first category when considering the frequency distribution of metaphors. Solving process category consists of 6 (18.8%) metaphors and 14 mathematics pre-service teachers. The most repeated metaphors are sorting of statistics, puzzle and future for the solving process category. Similarly, difficulty and complexity of statistics category consists of 13 (40.6%) metaphors and 19 pre-service teachers and the most repeated metaphors are; maze, ocean, soup and philosophy for the difficulty / complexity of statistics category (Table 2).

Table 2. Mathematics pre-service teachers' metaphors about statistics according to categories

Structure of Statistics			Solving Process			Difficulty / Complexity		
Metaphor	F	%	Metaphor	f	%	Metaphor	f	%
General view	5	21.77	Sorting data	5	35.72	Maze	3	15.80
Real	5	21.77	Puzzle	3	21.43	Ocean	3	15.80
Analyze	2	8.70	Future	3	21.43	Soup	2	10.53
Graphic	2	8.70	Computer	1	7.14	Philosophy	2	10.53
Grain of sand	1	4.34	Complex skein	1	7.14	Mountain	1	5.26
Universe	1	4.34	Chess	1	7.14	Gulf	1	5.26
Construction	1	4.34				Sky	1	5.26
Awareness	1	4.34				Classical music	1	5.26
Real life	1	4.34				Braid	1	5.26
Ships in ocean	1	4.34				Watch	1	5.26
Scrip	1	4.34				Question mark	1	5.26
Exam	1	4.34				Chance game	1	5.26
Train	1	4.34				Time	1	5.26

It was understood that a large part (33.9%) of the metaphors were about the difficulty and complexity of statistics category while many of the metaphors (41.1%) were about the structure of statistics category as indicated in Table 2.

## CONCLUSION

This research has examined to reveal the metaphors of elementary mathematics pre-service teachers about statistics. Results have shown that a total of 32 metaphors and 3 categories are determined in order to explain statistics concept. The mathematics pre-service teachers used metaphors related to structure of statistics (40.6%), solving process (18.8%) and difficulty and complexity of statistics (40.6%). In other words, statements emphasized the structure and complexity of statistics in general. Statistics stated as general view, real, analysis, graphic, sorting, puzzle, future, maze, ocean, soup and philosophy in this research. This situation indicates that

the statistics concept could not be expressed in a single mental image. Different factors such as instruction of teacher, social environment or individuals' interest could be effective on these individual metaphors of mathematics pre-service teachers. Because of that, teacher educators must be conscious of designing instruction to expand and revise the personal metaphors of pre-service teachers. Teacher educators might encourage pre-service teachers to share their individual metaphors about statistics with one another to motivate them on considering in great detail (Groth & Bergner, 2005). Educators may use more effective activities teaching statistics to their students using metaphors in their courses and encourage them to learn about everyday statistics through performance tasks.

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