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# Investigation Number Sense Test Achievements of Middle School Students According to Different Variables

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**Abstract** In this study, it was examined achievement in middle school students' number sense and its sub-dimensions according to various variables. Number sense means that people can make logical estimates about various uses area, be able to recognize arithmetic errors and number patterns, to choose the most effective way of calculation. Number Sense Scale consists of three dimensions: Flexibility in Calculation, Conceptual Thinking in Fractions, and Using Benchmark (reference points). Unrelated samples t-test, one-way Anova, two-way Anova, and Kruskal-Wallis analyzes were used to determine whether students' achievements in total and sub-dimensions of number sense scale differed significantly in terms of gender and grade levels. From findings obtained from the research, there was no meaningful difference in the students' achievement in numerical sense total and sub-dimensions in terms of gender and in using benchmark (reference points) in terms of grade level. However, there was a meaningful difference in the number sense total, flexibility in calculation and conceptual thinking in fractions scores. It has been determined that this is in favor of 8th grade students.

***Keywords:*** *number sense, dimensions of number sense, mathematics*

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## 1. Introduction

In our everyday life, we encounter many mathematical situations that require us to make calculations. We often need to use the number sense in order to make sense and interpret them reasonably. The number sense concerns the ability of dealing with situations which include numbers and operations. This skill is used to develop effective and flexible strategies on the numerical problems [1,2]. The person who has number sense can reasonably interpret the situations which involve numbers and operations and explain them. [3] also pointed out those individuals who have number sense can choose the most appropriate method realizing the relationship between numbers and operations without solving depending on a rule the problem and conclude the problem effectively and easily. Therefore, having the number sense eliminates the necessity of memorizing certain rules. Nowadays, it is possible to understand mathematics in a real sense grasping gist of operations. Therefore, it has become a necessity that mathematic is internalized and interpreted without memorization. Because of this, we needed to do studies about number sense. When the middle school education mathematics curriculum is examined, we didn't directly introduce the concept of the number sense, but it was addressed in mathematical process skills such as guessing, problem solving, reasoning, association and communication [4]. In fact, in the new mathematics curriculum, many strategies such as knowing the meaning of numbers and ranking them, creating equivalent expressions, forecasting strategies, operational forecasting strategies, rounding, transaction on the mind and estimating a size using measurement references seemed to be emphasized more than the old curriculum [5]. Number sense and understanding of numbers began to be learned in the first years of education and developed in the following years and number sense is within a strong relationship with other mathematical concepts. Because of this, teaching and learning the number sense is considered as an important subject in mathematics education [1,6]. When the literature is examined, it was seen that number sense was weak for middle school students [7,8,9] and prospective teacher [10,11]. [12] investigated students' achievement of number sense total according to various variables and relationship between dimensions. In this study, it was investigated that students' success in the sub-dimensions of number sense was examined according to various variables whether there were significant differences in the subscales of the scale depending on the variables. It is thought that the study will contribute to the literature. In this sense, the following problems have been sought in this research;

- Is there any significant difference on the middle school students' achievement of number sense total and its sub dimensions according to gender?
- Is there any significant difference on the middle school students' achievement of number sense total and its sub dimensions according to grade level?

- Is there any significant difference on the middle school students' achievement of number sense total and its sub dimensions according to gender and grade level?

### 1.1. Relative Research of Number Sense

When the related literature is examined, studies showed that students used rule-based strategies rather than number sense [5] and revealed that usage of number sense was very low level. It was investigated the relationship between number sense and grade level, gender and mathematics achievement in some studies [7,9,12,13,14]. [5] examined the strategies of the primary prospective teachers about number sense and detected that the prospective teachers use written methods instead of the number sense strategies. [7] investigated to use the number sense of primary school 4th graders and relationship between achievements of the number sense and mathematics lesson, and they determined that the students' number sense success was very low level and students used rule-operation-based strategies rather than number sense. It also found a positive relationship between the achievement of students' number sense and achievement of the mathematics. [8] has examined the number sense success of 8th graders students about exponential numbers. They detected that the students had insufficient understanding the increase of base on the effect of number size and students had difficulties on supposing sizes of minor and major exponential numbers. [9] examined what 8th grade students used the number sense strategies about subjects of natural number, decimal number, fractions and percent subjects. They found that students' number sense success was very low level and there was no significant difference about the students' performance of number sense in terms of gender.

## 2. Methodology

### 2.1. Research Model

It was used relational screening model because this study examined students' achievement of number according to some characteristics of students. Relational screening models are defined as models aiming to determine the presence and degree of exchange between two or more variables [15].

### 2.2. Participants

The sample consisted of 138 students from the 6th, 7th and 8th grades who were studying in a middle school in Çorum province and selected by simple random sampling. The characteristics of the participants are presented in Table 1.

**Table 1. Characteristics of Middle School Students'**

| Participants' Characteristics | | Frequency (f) |
|---|---|---|
| Gender | Female | 79 |
| | Male | 59 |
| Grade levels | 6th grade | 38 |
| | 7th grade | 53 |
| | 8th grade | 47 |

### 2.3. Data Collection Tools

In this study, it was used "Number Sense Achievement Test" developed by [16] as data collection tool.

#### Number Sense Test

This test composed of the three components was improved by [16] to determine Number Sense Test success of 6th, 7th and 8th grade students. The ingredients of this scale are Flexibility in Calculation (FC), Conceptual Thinking in Fractions (CTF), and Using Benchmark (reference points) (UB). A total of 17 questions exist in the scale and each dimension respectively has 8, 4 and 5 questions. The first component, FC, includes flexible thinking in numerical calculation, the ability to choose the practical way in simple operations, practical thinking and the ability to choose the most effective and useful strategy. The second component, CTF, includes display of fractions on the number line and shape. The third component, UB, also indicates to decide comparison point and the implementation of this strategy [12].

Students who answered the questionnaire by using the number sense were given 1 point and calculated and solved correct or incorrect using standard routine were given 0 point. The highest score that can be taken from the scale is 17, the lowest score is 0. The reliability coefficient of the scale was calculated as 0.86 [16].

### 2.4. Data Collection

The data of the study were collected from 138 middle school students who were studying in a public school in Çorum. The instrument used to collect the data was adminestered to the students by the mathematics teacher of the classes, one of the study's authors. Students answered the questions in one lesson hour at the silent environment.

Styles for table title, table head, and table text are provided. Tables should be set in one column wherever possible and be placed near their first mention in the body. Tables and figures do not need to be placed on separate pages at the back of the manuscript.

### 2.5. Data Analysis

The data obtained from the achievement test were analyzed using SPSS 20 packet program. Independent samples t-test was used to determine whether varied significantly in terms of gender and One way variance analysis (ANOVA) and Kruskal Wallis was utilized to detect whether succes of the of the middle school students in number sence total and subdimensions varied significantly in terms of class level. However, two-way variance analysis (ANOVA) was used to determine achievement of number sense in terms of gender and grade level.

## 3. Findings

Participant numbers (N), mean and standard deviation values related to achievement scores of the students' NST, FC, CTF and UB were given in Table 2.

**Table 2. Descriptive Statistics Results of Success in Number Sense Total and Its Sub-Dimensions**

| Variables | N | $\overline{X}$ | S |
|---|---|---|---|
| NST | 138 | 2.2464 | 2.03190 |
| FC | 138 | 1.0360 | 1.31000 |
| CTF | 138 | .5612 | .76248 |
| UB | 138 | .5899 | .75000 |

Table 2 explained the achievements in students' NST and its subdemisions. The fact that the overall average of 17 problems is a value of 2.24 shows that students were very weak in number. When we looked at the dimensions, it was determined that the students showed the highest average in FC with 1.03 and the lowest average in UB with 0.5899.

### An Analysis of Middle School Students' Number Sense Achievement in Terms of Gender Variable

Achievement of NST and its subdimension in terms of gender was assessed using independent samples t-test. The findings of this analysis were given in Table 3.

**Table 3. Results of the T-test of Middle School Students' Number Sense Achievement in Terms of Gender**

| Scale and its sub-dimensions | Gender | N | $\overline{X}$ | S | df | t | Sig. |
|---|---|---|---|---|---|---|---|
| NST | Female | 79 | 2.4810 | 2.17126 | 136 | 1.578 | .058 |
| | Male | 59 | 1.9322 | 1.79908 | | | |
| FC | Female | 79 | .9873 | 1.35395 | 136 | -.580 | .844 |
| | Male | 59 | 1.1186 | 1.26061 | | | |
| CTF | Female | 79 | .4937 | .71385 | 136 | -1.276 | .080 |
| | Male | 59 | .6610 | .82232 | | | |
| UB | Female | 79 | .6076 | .72355 | 136 | .372 | .618 |
| | Male | 59 | .5593 | .79375 | | | |

p>.05.

Table 3 showed that mean score (X = 2.4810) of the the females' on NST was higher than males' mean score (X= 1.9322). But, this difference between means was not significant t (136) = 1.578, p> .05. The results indicated that NST achievement didn't alter in terms of sex.

However, it could be interpreted whether the dimensions of number sense varied according to gender or not. Students' achievement on all subdimensions of the number sense-FC, CTF, UB- didn't show a significant Difference, t (136) = - .580, t (136) = - -1.276, t (136) = 372, p> .05 .

### An Analysis of Middle School Students' Number Sense Achievement in Terms of Grade Level Variable

A one-way ANOVA was conducted to determine whether the middle school students' number sense success differed in terms of grade level. Participant numbers (N), mean and standard deviation values related to achievement scores of the students' NST, FC, CTF and UB were given in Table 4 and results of this analysis were presented in Table 5. According to one way ANOVA, the Levene test results of NST and UB demonstrated that there were no significant differences in the homogeneity of the variances. It was respectively obtained F (2, 135) = 3.018, F (2, 135) = 0.120, p> .05 for these dimensions. One way ANOVA was continued for these dimensions. But, It was detected that the Levene test results of FC and CTF demonstrated that their variances were not equal. It was respectively obtained F(2, 135)= 8.410, F(2, 135)=6.927, p<.05 for these dimensions. Since this situation contradicted with the assumption of ANOVA, the non-parametric Kruskal-Wallis test was performed. The test results were presented in Table 6.

**Table 4. Results of Descriptive Statistic of Middle School Students' Number Sense Achievement in Terms of Grade Level**

| Scale and its sub-dimensions | Grade Level | N | $\overline{X}$ | S |
|---|---|---|---|---|
| NST | 6th grade | 38 | 1.8421 | 1.58585 |
| | 7th grade | 53 | 1.7736 | 1.79359 |
| | 8th grade | 47 | 3.1064 | 2.34274 |
| | Total | 138 | 2.2464 | 2.03190 |
| FC | 6th grade | 38 | 1.0789 | 1.28150 |
| | 7th grade | 53 | .60350 | .76811 |
| | 8th grade | 47 | 1.5106 | 1.64010 |
| | Total | 138 | 1.0435 | 1.31176 |
| CTF | 6th grade | 38 | .7105 | .80229 |
| | 7th grade | 53 | .3208 | .54679 |
| | 8th grade | 47 | .7234 | .87730 |
| | Total | 138 | .5652 | .76375 |
| UB | 6th grade | 38 | .5000 | .76229 |
| | 7th grade | 53 | .5472 | .69520 |
| | 8th grade | 47 | .7021 | .80528 |
| | Total | 138 | .5870 | .75191 |

Table 4 explained the achievements of students' NST and its sub-dimensions in terms of grade level. It was determined that the achievement averages of scale and its dimension were higher for the 8th grade students. Lowest average happened in 7th grade students for the NST, FC and CTF and in 6th grade for UB.

**Table 5. Results of the One-Way ANOVA of Middle School Students' Number Sense Achievement in Terms of Grade Level**

| Dimensions | Source | SS | df | MS | F | Sig. |
|---|---|---|---|---|---|---|
| NST | Between | 52.819 | 2 | 26.410 | 6.953 | .001* |
| | Within | 512.804 | 135 | 3.799 | | |
| | Total | 565.623 | 137 | | | |
| UB | Between | .995 | 2 | .497 | .878 | .418 |
| | Within | 76.462 | 135 | .566 | | |
| | Total | 77.457 | 137 | | | |

*p<.05, p>.05.

As Table 5 was examined, it was detected that there was a significant difference between the NST scores of participants (F (2,135) = 6.953, p <.05). The Scheffe test was conducted to determine between which groups there were significant differences. According to the results of the Scheffe test, it was found that achievement of the 8th grade students about number sense was higher than 6th and 7th grades and this difference was significant, p <.05. There was no significant difference between the achievements of 6th and 7th grade students, p>.05. Moreover, it was determined that there was no a significant difference on the achievement of students' UB dimension of number sense in terms of grade level.

The results of Kruskal-Wallis test detected students' achievement on FC and CTF test were shown in Table 6.

**Table 6. Results of the Kruskal-Wallis Test of Middle School Students' Achievement Related to FC and CTF Dimensions in Terms of Grade Level**

| Variable | Grade Level | N | Mean Rank | Kruskal-Wallis Chi-square | Sig. |
|---|---|---|---|---|---|
| FC | 6th grade | 38 | 71.29 | 9.086 | .011* |
| | 7th grade | 53 | 58.22 | | |
| | 8th grade | 47 | 80.78 | | |
| | Total | 138 | | | |
| CTF | 6th grade | 38 | 76.91 | 8.154 | .017* |
| | 7th grade | 53 | 58.66 | | |
| | 8th grade | 47 | 75.73 | | |
| | Total | 138 | | | |

*p<.05, p>.05.

As Table 6 was examined, it was determined that there was a significant difference at the FC and CTF scores of participants in terms of grade level, $\chi^2$ = 9.086, p<.05 for FC and $\chi^2$ = 8.154, p<.05 for CTF. According to the results of the test, it was found that achievement of the 8th grade students about FC and CTF dimensions was higher than 6th and 7th grades. It was concluded that 8th grade students were more successful than the other students in FC and CTF dimensions.

### An Analysis of Middle School Students' Number Sense Achievement in Terms of Gender and Grade Level Variables

Two-way ANOVA was conducted to determine whether NST score of middle school students differed by gender and grade levels. As a result of this analysis, the N numbers, mean and standard deviations related to scale were presented in Table 7 and the results of the two-way ANOVA were presented in Table 8. According to two-way ANOVA analysis, the results of Levene test demonstrated that there were no significant differences in the homogeneity of the variances, F (5, 132) = 1.626, p> 0.05. Because of this, this the analysis was continued and the results were interpreted according to this analysis. But, it was detected that there was no equality in the homogeneity of the variances of number sense scale's sub dimensions. This test could not be performed for the subscales.

**Table 7. Results of Descriptive Statistic of Middle School Students' NST and Its Subdimension Achievement in Terms of Gender*Grade Level**

| Gender | Grade Level | $\overline{X}$ | S |
|---|---|---|---|
| Female | 6th grade | 2.400 | 1.68184 |
| | 7th grade | 1.882 | 1.99643 |
| | 8th grade | 3.200 | 2.41261 |
| | Total | 2.481 | 2.17126 |
| Male | 6th grade | 1.478 | 1.44189 |
| | 7th grade | 1.578 | 1.38707 |
| | 8th grade | 2.941 | 2.27680 |
| | Total | 1.9322 | 1.79908 |
| Total | 6th grade | 1.8421 | 1.58585 |
| | 7th grade | 1.7736 | 1.79359 |
| | 8th grade | 3.1064 | 2.34274 |
| | Total | 2.2464 | 2.03190 |

From Table 7, it was found that the number sense total mean score of the 8th grade students was higher than 6th and 7th grade students and achievement of female students from the 6th, was higher than male students of 6th, 7th and 8th grades respectively. Table 8 was examined in order to determine whether these differences were significant.

**Table 8. Results of the two-way ANOVA Test of Middle School Students' Achievement Related to FC and CTF Dimensions in Terms of Gender*Grade Level**

| Scale and its sub-dimensions | Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| NST | Gender | 7.745 | 1 | 7.745 | 2.031 | .156 |
| | Grade level | 45.879 | 2 | 22.940 | 6.017 | .003* |
| | Gender* Grade level | 2.673 | 2 | 1.337 | .351 | .705 |
| | Error | 503.241 | 132 | 3.812 | | |
| | Total | 1262.00 | 138 | | | |

As Table 8 was evaluated, it was found that there was no significant difference between students' total score averages according to their gender and grade levels, F (2, 132) = .351, p> .05. This result showed that achievement of NST dimension did not change according to gender and grade level.

## 4. Results

In this study, it was aimed to determine the number sense achievements of the middle school students. For this purpose, the Number Sense Scale developed by [16] was used. This scale consists of three dimensions as FC, CTF and UB. It was determined whether achievement on NST and scale's sub dimensions of the students according to gender and grade level has a significant difference or not. Independent samples t-test, one way ANOVA, Kruskal-Wallis test and two way ANOVA were utilized to analyze data.

From the findings of the study, it was seen that the achievements of the students on the sense of the numbers were generally very low. It was determined that the average of 17 items for students was 2.25 and average of its sub dimensions was one or below one. This finding supported the findings of the literature [4,12,18].

In the study, it was determined that there was no significant difference in the success of NST and its sub dimensions in terms of gender. These results assisted findings of [12]) and [19].

Whilst evaluated in terms of grade levels, it is seen that the averages in NST and its sub dimensions for 8th grade students were generally higher than other grades. Lowest average happened in 7th grade students for the NST, FC and CTF and in 6th grade for UB. It was detected that there is a significant difference on the achievement of NST, CTF and UB dimensions and no significant difference on the achievement of FC dimension. In terms of NST, this finding was parallel to result of [20] and contradicted result of [12]. Because, [12] stated that the success of the number sense decreased when class level increased.

Another finding of study was that gender and grade level didn't create a significant difference on the total sense of number sense.

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