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THE INFLUENCE OF GENDER, TEOG EXAM SCORES AND SOCIOECONOMIC STATUS ON THE ACCOMPLISHMENT OF STUDENTS REGARDING READING AND INTERPRETATION OF THE FREQUENCY POLYGON AND HISTOGRAM

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ABSTRACT: The aim of this current study was to investigate the effects of variables, such as gender, TEOG exam scores and socio-economic status on the 8th grade students about the reading and interpretation of the Frequency Polygon and Histogram. The study included 388 eighth grade students who were from four different middle schools. The researchers used a multiple choice statistics test in the collection of the data. This test contained 22 questions about the reading and interpretation of graphs and finding of the measures of both central tendency and dispersion. This test was developed by the researchers who piloted it and found its reliability of *Cronbach's alpha* value as 0.80. In the analysis of the data, the researchers used the paired samples t-test, independent samples t-test and two- way ANOVA. The study pointed out that the participants of this study were more successful in reading and interpretation of Frequency Polygon than Histogram. There was no statistically significant difference found with regard to the value of mode in both types of graphs between the achievement levels of the students. However, the study also indicated that the participants were more successful on the items that required the interpretations of standard deviations than the items which required the computation of standard deviations. Moreover, although gender was not a great factor on the accomplishment levels of the participants on the test, both TEOG exam scores and socio-economic status played prominent roles on the students' achievements on the test. There was a positive relationship between the students' achievement levels and socio-economic status on the statistics test.

Key words: Gender, socioeconomic status, TEOG exam scores, graphs

INTRODUCTION

Research has documented that there have been many research studies done with students at different school levels on various issues, such as problem solving, performance, motivation, gender, effects of technology, parental support, peer-interactions and so on, in teaching and learning of different areas of mathematics, such as geometry, statistics, algebra, trigonometry and so forth for many years (e.g., Ethington, 1992; Middleton & Spanias, 1999; Thompson & Senk, 2001). Nowadays, in particular, many researchers and educators dealing with mathematics education have focused on the difficulties of students, spent more time, tried to find the possible solutions to these difficulties and helped the students overcome their learning difficulties in mathematics. For instance, curriculum change is one of the most important factors that influence the achievements and motivation of students from primary school level to undergraduate level in mathematics (i.e., Romberg & Shafer, 2003; Halat, Jakubowski & Aydın, 2008).

There can be seen many reform-based movements in curriculum change in many countries in the world and also in Turkey since 1980s (i.e., Billstein & Williamson, 2003; Chapell, 2003; Halat, 2007). Connected Mathematics Project (CMP), MATH Thematics, and Mathematics in Context were the middle school standard-based mathematics curricula funded by National Science Foundation (NSF) (e.g., Ridgway, Zawojewski, Hoover, & Lambdin, 2003; Chapell, 2003; Romberg & Shafer, 2003; Billstein & Williamson, 2003). These middle school mathematics curricula come up with different perspectives in teaching and learning of mathematics. The

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standard-based math curricula were shaped with several educational theories and strategies, such as van Hiele theory, multiple representations, and so on (c.f., Reys et al., 2003). They covered the similar mathematical strands. For instance, the mathematics in context (MiC) covered the following mathematical strands: "-number (whole numbers, common fractions, ratio, decimals fractions, percents, and integers), -algebra (creation of expressions, tables, graphs, and formulas from patterns and functions), -geometry (measurement, spatial visualization, synthetic geometry, coordinate and transformational geometry), and – statistics and probability (data visualization, chance, distribution and variability, and qualifications of expectations)" (p.225). These standard-based middle school mathematics curricula had positive effects on the students' performance and motivation in mathematics (Billstein & Williamson, 2003; Halat, 2006; Halat, Jakubowski & Aydın, 2008). Reform movements in the world and the great effects of the standard-based mathematics curricula on the students positively influenced and encouraged the Ministry of Education in Turkey to take action and renew the math curricula for primary, middle and high schools (Halat, 2007). The middle school math curriculum included the five strands; numbers and operations, algebra, geometry and measurement, data analysis, and probability. There have been many research studies done on the different part of this math curriculum since it was developed (e.g., Taşpınar & Halat, 2008; Kaynar & Halat, 2012; Selamet & Halat, 2014; Bunar, Halat & Bahar Erşen, 2014). In this study, the researchers focused on the data analysis part of the middle school mathematics curriculum.

Purpose of the Study

The aim of this current study was to investigate the effects of variables, gender, TEOG exam scores and socio-economic status (SES), on the achievements of 8th grade students about the reading and interpretation of the Frequency Polygon and Histogram.

METHOD

Participants

There were a total of 388 eighth grade students involved in this current study. The participants were from four different middle schools located in the city center of Aydın. The researchers used the convenience sampling procedure in the selection of the participants. This sampling procedure was the most commonly used one in todays' educational research studies (McMillan, 2000; Wiersma, 2000). The participants were classified into three groups, low SES, middle SES and high SES, based on their schools.

Data Collection & Analysis Procedures

The researchers used a multiple choice statistics test that included 22 questions, 9 questions about Frequency Polygon that was drawn based on the test scores of students taken from a math test, 9 questions about the Histogram that was drawn based on the time spent on the social media, and 4 questions about the standard deviation. These questions were about the reading and interpretation of graphs and finding of the measures of both central tendency and dispersion. Both Frequency Polygon and Histogram had similar questions. For instance, "How many students got 50 points on the Math test?," "How many students got 60 or below 60 points on the Math test?," and so on.

This statistics test was developed by researchers who piloted it and found its reliability of *Cronbach's alpha* value as 0.80. After the collection of the quantitative data, the researchers used the paired samples t-test, independent samples t-test and two- way ANOVA in the analysis of the data.

RESULTS AND FINDINGS

Graph Reading and Interpretations

Table 1 below showed that the mean score of the eighth grade students was numerically higher on the Frequency Polygon than Histogram. This numerical difference was statistically significant [$t_{(387)}=3.475$ and $p=0.001 < \alpha=0.05$]. That is, the participants of this study were more successful in reading and interpretation of the questions on the Frequency Polygon than the Histogram. This result supports the findings of several research findings (e.g., Kaynar & Halat, 2012; Selamet & Halat, 2014) who found similar results for the middle school students about the reading and interpretation of graphs. Furthermore, there can be seen numerical differences in terms of students' mean scores of median and range between the Frequency Polygon and Histogram. These numerical differences were statistically significant [$t_{(387)}=3.327$ and $p=0.001 < \alpha=0.05$; $t_{(387)}=15.618$ and $p=0.000 < \alpha=0.05$] favoring the graph, Frequency Polygon. On the other hand, although there were mean score differences of the participants about the value of mode between the Frequency Polygon and Histogram, this difference was not statistical significant [$t_{(387)}$=1.399 and p=0.163> α=0.05].

Likewise, paired samples t-test results for the standard deviation (SD) indicated that the participants performed better on the questions about the interpretation than the questions regarding computation (see Table 2).

Table 1. Paired Samples T-Test Results For The Graph Reading And Interpretation

Achievement levels	N	$\bar{X}$	SD	df	t	p
Frequency Polygon (line graph)- Reading & Interpretation	388	4,14	0,71	387	3,475	0,001
Histogram- Reading & Interpretation	388	3,95	0,95			
Frequency Polygon-Mode	388	2,70	2,23	387	1,399	0,163
Histogram -Mode	388	2,49	2,26			
Frequency Polygon -Median	388	2,31	2,27	387	3,327	0,001
Histogram -Median	388	1,86	2,23			
Frequency Polygon -Range	388	3,47	1,92	387	15,618	0,000
Histogram -Range	388	1,73	1,21			

Table 2. Paired Samples T-Test Results For The Standard Deviation

	N	$\bar{X}$	SD	df	t	p
Standard Deviation – Computation	388	2,36	1,52	387	-2,649	0,008
Standard Deviation - Interpretation	388	2,62	1,68			

Findings about the Gender

Table 3 indicated that although there was numerical difference found with reference to the total test score between the mean scores of boys and girls, this numerical difference was not statistically significant [$t_{(387)}$= -1.462 and p=0.145>α=0.05]. Similarly, although there were numerical differences detected in regard to students' mean scores for both graphs between boys and girls, these numerical differences were not statistically significant [$t_{(387)}$= -1.176 and p=0.145>α=0.05 ; $t_{(387)}$=0.357 and p=0.240> α=0.05]. In other words, both 8th grade boys and girls performed equally on the Frequency Polygon and Histogram about the items that required reading and interpretation on the graphs. Gender was not a great factor on the students' accomplishments in graph reading and interpretations.

Table 3. Independent Samples T-Test Results About The Gender For The Variables

Variables	Gender	N	$\bar{X}$	SD	df	t	p
Frequency Polygon - reading and	Boys	155	4,08	0,74	386	-1,176	0,145
	Girls	233	4,17	0,68			
Histogram – reading and	Boys	155	3,98	0,95	386	0,357	0,240
	Girls	233	3,94	0,95			
Total Test Score	Boys	155	67,06	16,16	386	-1,462	0,145
	Girls	233	69,27	13,39			

The Effects Of Variables, Socioeconomic Status (SES) And TEOG Exam Scores

Table 4 about the descriptive statistics demonstrated that there can be seen mean scores differences based on the TEOG exam scores and socioeconomic status (SES). For instance, when we looked at the total test scores of the students labeled as high SES, their test scores increased as their TEOG Exam scores also increased.

Table 4. Descriptive Statistics About The Reading And Interpretation Of Graphs For SES & Teog Exam Score

		Test Scores about the Socioeconomic Levels											
		High SES			Middle SES			Low SES			Total		
		N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
TEOG Exam Scores	0-45	55	65,78	15,57	58	66,55	12,75	84	60,82	11,90	197	63,01	13,36
	46-55	13	68,18	11,58	12	66,66	15,17	12	63,25	9,58	37	66,09	12,14
	56-70	21	69,91	12,81	11	72,72	11,31	5	70,90	14,58	37	70,88	12,33

71-85	30	72,42	14,81	8	74,43	7,65	7	70,77	13,34	45	72,52	13,39
86-100	57	80,38	13,14	10	80,00	11,37	5	81,81	11,13	72	80,42	12,64
Total	176	72,31	15,19	99	67,49	13,48	113	63,07	12,71	388	68,39	14,58

According to the ANOVA results shown on Table 5, while there were no statistically significant differences found about the socioeconomic status (SES) and interaction of both SES and TEOG exam scores between the groups, there was a statistically significant difference detected for TEOG exam scores. Regardless of socio-economic status of students, post Hoc Scheffe test results indicated that there were statistically significant differences found regarding the total test scores between the students who had TEOG exam scores, 86-100, and the students who had other levels of TEOG exam scores. Similarly, there were statistically significant differences detected about the total test scores between the students who had lowest TEOG exam scores (0-45) and the students who had the TEOG exam scores above 45 (see Table 6).

Table 5. Two-Way ANOVA About Reading And Interpretation Of Graphs For Socio -Economic Level & Teog Exam Score

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
TEOG Exam Score	9234,269	4	2308,567	13,47	0,00
Socio -economic Level	113,608	2	56,804	0,33	0,71
TEOG Exa.S.* Socioeco. L.	403,070	8	50,384	0,29	0,96
Error	63892,744	373	171,294		
Total	1897231,405	388			

Table 6. Post Hoc Scheffe Results Based On Teog Exam Scores

TEOG Exam Scores	**TEOG Exam Scores**	**Mean Differences**	**SE**	**p**
0-45	46-55	-3,0800	2,345	0,786
	56-70	-7,8711*	2,345	0,025
	71-85	-9,5119*	2,162	0,001
	86-100	-17,4159*	1,802	0,000
86-100	0-45	17,4159*	1,802	0,000
	46-55	14,3359*	2,647	0,000
	56-70	9,5448*	2,647	0,012
	71-85	7,9040*	2,487	0,041

*: $p < \alpha = 0.05$

Table 7. Post Hoc Scheffe Test Results Based On The Socioeconomic Status Levels (SES)

SES	**SES**	**Mean Differences**	**SE**	**p**
High SES	Middle	4,8209*	1,64	0,014
	Low	9,2408*	1,57	0,000
Middle SES	High	-4,8209*	1,64	0,014
	Low	4,4199	1,80	0,051
Low SES	High	-9,2408*	1,57	0,000
	Middle	-4,4199	1,80	0,051

Moreover, although there was no statistically significant difference found for the variable, socioeconomic status (SES), the Scheffe test results indicated that there were statistically significant differences detected about the test scores between the students who had high SES and the students who had both middle and low SES. In other words, the socioeconomic status (SES) had positive effects on students' achievements levels in both graphs.

CONCLUSION

The current study documented that the participants of this study were more successful in reading and interpretation of the questions on the Frequency Polygon than the Histogram. This result supports the findings of several research studies (i.e., Kaynar & Halat, 2012; Selamet & Halat, 2014). For instance, Kaynar & Halat (2012) stated that the eighth grade students involved in their study were successful in the following order, firstly in the frequency polygon, secondly in the histogram, and thirdly in the pie graph. Although their study was done with fifth grade students, the findings of Selamet & Halat (2014) showed that regardless of graph types, frequency polygon and bar graph, there was no statistically significant difference found with regard to students 'graph reading and interpreting.

Furthermore, the current study pointed out that the 8th grade students showed greater performance on the frequency polygon about the items, median and range, than the Histogram. The study also indicated that the participants were more successful on the items that required the interpretations of standard deviations than the items which required the computation of standard deviations.

There were many factors that affected students' success in mathematics. Forgasız (2005) highlighted the importance of searching the effects of gender on students' achievements in mathematics. Therefore, this current study examined the influence of gender on students' graph reading and interpretation. Moreover, although gender was not a great factor on the accomplishment levels of the participants on the test, both TEOG exam scores and socio-economic status (SES) played prominent roles on the students' achievements on the test. There was a positive relationship between the students' Teog Exam Scores and socio-economic status on the statistics test. This result was not in contradiction with the findings of several research studies (e.g., Friedman, 1994; Fennema & Hart, 1994; Selamet & Halat, 2014). For example, Selamet & Halat (2014) claimed that although 5th grade boys performed better on the frequency polygon than girls, there was no statistically significant difference found in reference to the students' graph reading and interpreting on the bar graph between boys and girls. Likewise, the current finding about the gender was lined up with the claim of Kaynar & Halat (2012) who found that in reading and interpretations of the graphs there was no statistically significant difference detected between boys and girls. They also stated that while the math interest as a variable played important role on the students' success in reading and interpretation of the graphs, family- support as a variable was not an influential factor on the students' success.

The findings of the current study imply that the eighth grade students were more successful on the Frequency Polygon than Histogram. In other words, the eighth grade students had difficulties in solving the questions on the Histogram. Therefore, the in-service mathematics teachers should spend more time on the Histogram and solve more questions on the Histogram.

As a conclusion, the participants of this study indicated that 8th grade students showed greater performance on the questions that required reading and interpretations on the Frequency Polygon than the questions which required reading and interpretations on the Histogram. Moreover, even though gender was not an influential factor on the students' achievements on the graphs, both TEOG exam scores and socioeconomic status (SES) played important roles on the students' achievements on the test.

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