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Effects of Secondary School Students' Perceptions of Mathematics Education Quality on Mathematics Anxiety and Achievement

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Abstract

The two aims of this study are as follows: *(i)* to compare the differences in mathematics anxiety and achievement in secondary school students according to their perceptions of the quality of their mathematics education via a cluster analysis and *(ii)* to test the effects of the perception of mathematics education quality on anxiety and achievement via structural equation modeling. The research was designed using a causal design; the mathematics education quality comprised the independent variable, whereas mathematics anxiety and achievement comprised the dependent variables. This study was conducted with 638 secondary school students from schools located at the city center of Eskisehir, spread in the region [lower, middle and upper] according to the socio-economic classification of TUIK, which is referred to as layered sampling. Data were collected using the Mathematics Education Quality Scale and the Mathematics Anxiety Assessment Scale, whereas student achievement levels were obtained from the Placement Test [TEOG] score and the mathematics grade point average [GPA]. The data obtained in this study were analyzed using Ward's minimum variance hierarchical cluster, discriminant, ANOVA, MANOVA, paired-samples t-test and path analysis. The findings were grouped as *(i)* input, *(ii)* process and *(iii)* output clusters, which each presented different perceptions of secondary school students regarding the quality of mathematics education. In addition, these findings also indicated that mathematics education quality perception positively affects the TEOG and mathematics GPA, whereas it negatively affects mathematics anxiety.

Keywords: Mathematics education • Quality • Anxiety • Achievement • Cluster analysis • Structural equation modeling

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The current aim to create a competitive and knowledge-based economy has led countries to reconsider and structure their education systems. Initiatives in the education system are obliged to focus on and discuss concepts such as the quality of education, effectiveness, accountability and organizational learning (Agasisti, Catalano, & Sibiano, 2013; Carnoy & Loeb, 2002; Chen, Liu, & Lin, 2014; Grygoryev & Karapetrovic, 2005; Karip, 2005; Keeley, 2007; Okoro, 2011; Pashiardis, 2004). In parallel with these discussions, to improve its current international position, Turkey is working to achieve the universal dimensions in the education system and is engaged in various reform initiatives (Atar & Atar, 2012; Çorlu, Capraro, & Capraro, 2014; Çalışkan, Karabacak, & Meçik, 2013; Şengönül, 2013; Tutkun & Aksoyalp, 2010). Despite these efforts, it is clear that Turkey should take a significant distance to improve the quality of education in terms of international education quality indicators (Akyüz, 2014; Erberber, 2009; Sezer, Güner, & İspir, 2012; Mullis, Martin, Foy, & Arora, 2012; OECD, 2013).

Effective School and the Concept of Education Quality

The definition of quality in education is similar to the definition of quality in general. Quality is the sum of the characteristics that affect the product or service, which depend on the satisfaction degree of the identified needs (Cheng & Cheung, 2004). Therefore, first generation researchers who first used this concept have defined the concept of quality as excellence in education. Education quality is an appraisal regarding education and includes how learning is organized; how it is managed; what is taught; the level of learning; and the specific educational outcomes achieved (Akyüz, 2014; Erberber, 2009; Sezer, Güner, & İspir, 2012; Mullis, Martin, Foy & Arora, 2012; OECD, 2013). The concept of quality in education has triggered the emergence of effective schools and has opened the way to conduct numerous studies. Lezotte (1991) defined an effective school as a place in which there is a clear mission shared by everyone involved in the school community and there is a dedication to instructional objectives, priorities, assessment processes and accountability. According to Fisher and Cresswell (1988) and Townsend (1997), an effective school is formed by effective leadership, human resource management, a supportive environment, family and students who are motivated to learn. Gamage (2001) emphasized that high expectations exist in effective schools, and there are visible, accessible, and fair stakeholders.

When education quality is looked from a different perspective with efficient school movement, level of achieving the foundation of different dimensions of education draws attentions Education quality in terms of production function of education is the level reaching to desired aims and employment in accordance with the number of students who received diploma or in accordance with the type of received education (Ghabi, 2014; Kenny et al., 2014; Levine & Lezotte, 1990; McLeskey, Waldron, & Redd, 2014). Yet, approach of efficiency, unlike production function approach, focuses on the factors bearing results. Elements of input, process and environment are accepted as common responsibilities of educational outcomes (*see* Table 1, European Commission, 2000; UNESCO, 2004; Windham, 1988). According to the harmony perspective, the conditions that lead change in education are seen as a tool in improving the quality. Within this frame, educational aims are critically scrutinized. When education quality is looked from a perspective of equal opportunity, the fair distribution of input, process and outcome elements to the beneficiaries of education with different characteristics is taken into consideration. According to the efficiency perspective education quality is defined as obtaining the highest educational outcome with the minimum cost (Lockheed & Levin, 2012; Loeb, Kalogrides, & Béteille, 2012; Osher, Dwyer, Jimerson, & Brown, 2012).

When efficient school and education quality literature is looked into, it could be seen that aforementioned concepts are generally studied from education management. These properties play an important role in regulating these properties. Consistent with the effective school initiatives, questions, such as what is *good teaching* and *effective teaching*, are the questions that educational researchers have long sought to answer (Richardson & Thomas, 1989; Ubuz & Sarı, 2009). A review of the conducted studies indicates that there is not a unique definition for good teaching; it varies on the basis of the courses. For example, the features that a *qualified math teacher* should have, their order of priority and the importance of these features may vary according to the stakeholders. In a study of students that involved positioning the teacher to the basis of education quality, Buaraphan (2012) identified the most important features that a qualified teacher should have as follows: (*i*) content knowledge, (*ii*) honesty and (*iii*) general knowledge. According to teachers, the ordering of these features are content knowledge, pedagogical knowledge, and following actual issues in the field, whereas according to principals, they are content knowledge, following actual issues in the field and pedagogical knowledge.

Table 1
Education Quality Models

Model	Input Dimension	Process Dimension	Outcome dimension
Windham Model	Teacher properties Facilities and equipment Education materials managerial capacity	Managerial behavior Teacher's use of time Student's use of time	Academic achievement Results of learned knowledge Results of precautions maintaining equal opportunity and justice
European Commission Model	Schooling rate in early childhood education Number of student per computer Expenses per student Teacher education	Assessment and evaluation Participation of parents	Course achievement Learning how to learn Citizenship behaviors Technology skills Drop-out rates Graduate rates Higher education rates
UNICEF Model	Teaching materials Physical structure and facility Human Resources: teacher, manager, inspector and school management	Process of learning Teaching methods Assessment Feedback and promotion size of class	Verbal literacy Digital literacy Life skills Emotional skills Values and social skills

The scrutinizing of Turkish education system, according to the education quality models presented in Table 1 reveals that there are numerous shortcomings in all dimensions of these there models. In the literature, there are many discussions related to process and outcome dimensions; and the major problems of Turkish education system can be listed as managerial behavior problems, teachers' shortcoming in terms of class management, and discussions about the use of time, teaching management and the size of class (Demirel, 2011; Doğan, Uğurlu, & Demir, 2014; Gül, 2014; Selçuk, 2012; Yılmaz & Altınkurt, 2011). Besides the whole education system, these deficiencies can be encountered in curriculums and course levels as well. For instance, considering mathematic curriculum, the lack of educational materials and shortcomings of teacher education are the major discussion topics of the input dimension. Regarding process dimension, there is a consensus in the literature considering the discussions about mathematics course hours, teaching methods, size of class and assessment. For the outcome dimension, which is the final dimension of the models, the fact that mathematic is the discipline with lowest achievement, reveals the whole reality.

Education quality of Mathematics and Student Attainment

One of the indications of education quality is the student attainment. In Turkey, when student achievements were analyzed regarding courses, mathematics emerged as one of the most problematic areas (Haser, 2006; Memnun & Hart, 2012; Yetkiner, Özel, & Thompson 2013; Yetkiner, 2010). Mathematics, which was initiated in elementary school, became a nightmare for students at all educational levels. International educational assessment studies, such as the TIMSS and PISA, also provide evidence. Although there is an improvement in Turkey's TIMSS-2011 mathematics score, it remains below the scale averages determined for the 4^{th} and 8^{th} grade levels. As a general observation, Turkey's average score is lower than that of the European Union (Yücel, Karadağ, & Turan, 2013).

One of the most important aspects of academic, social and psychological development of students is to feel safe and happy in their schools and the positive perceptions regarding the education they receive. Within this context, schools, as the primary responsible institutions from multifaceted education, are closely related with many variables to meet this responsibility. For instance; all types of thoughts comprise student achievements, which can be read between the lines of studies, such as TIMSS and PISA, which constitute student perspectives towards this course; thus, their perceptions and anxiety toward these courses and this fact is reflected by their achievement levels. The expectation of today's students from school is not only academic achievement, but the qualities of school life and other services (e.g., social, cultural, sporting, transportation, and technical) also contribute to the development of a positive attitude towards school in students (Glasser, 1999). In particular, the central examination makes the performance of the students comparable to that of others. It simultaneously allows the monitoring of students, teachers and school performance in a simple way. It is not only on a student basis but also the achievement of a class or a school, which can be compared with the national average. Parents are asked to reflect on the reasons that lead to their children's success or failure; the spaces used on the request of the teachers are considered. School principals can assess teacher performance, whereas the government can assess school performance; thus, more effective use of resources is enhanced. A positive relationship is therefore established between central examinations and student performance in terms of the monitoring of the education system (Keeley, 2007; Wößmann, 2003).

Aim and Research Questions

There are a number of studies in the literature focusing on to what extent students' needs are met at schools and role of quality perceptions in achievement, including mathematics anxiety and the correlation of school with student achievement and mathematics anxiety. Dreger and Aiken (1957) defines mathematics anxiety as attitudinal difficulties in the field of mathematics and as emotional reactions syndrome in arithmetic and mathematics field. This shows that that mathematics anxiety is very much interrelated with concepts of fear and uneasiness (Baloğlu, 2001).

In Turkey, there are several studies looking to the relationship between mathematics achievement of secondary school students and mathematics anxiety. These studies have concluded that students were often experiencing mathematic anxiety. The research in this field (Baloğlu, 2004; Dursun & Bindak, 2011, Devine, Fawcett, Szucs, & Dowker, 2012; Hembree, 1990; Turanlı, 2013; Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013; Sonnert, Sadler, Sadler, & Bressoud, 2015) revealed that mathematic anxiety, together with the attitude, plays an important role in mathematic achievement. This creates a sense of stress and concern and causes students to lose their self-confidence while solving mathematical problems (Olatunde, 2009). Baloğlu (2001) stated that mathematic anxiety is not totally negative; in some cases (for example a small amount of anxiety) it may motivate students, however most of the time (especially in case of excessive anxiety) it affects students' achievement levels and their attitude towards mathematics negatively (in the long term).

In nearly all studies on mathematic success/ mathematic achievement is taken as student's grade point average. Research looking into mathematic score of TEOG is very rare. Moreover, there is no study exploring the relationship between the perception of mathematics education quality, students' mathematic achievement and mathematic anxiety. In this respect, the purposes of this study are as follows: (*i*) to compare the differences in mathematics anxiety and achievement in secondary school students according to their perception of their mathematics education quality via a cluster analysis and (*ii*) to test the effects of the perception of the mathematics education quality on anxiety and achievement via structural equation modeling. The research was designed using a *causal pattern*; the quality of the mathematics education comprised the independent variable, whereas mathematics anxiety and achievement comprised the dependent variables. This study aims to seek answers for the following questions:

- What are the secondary school students' perceptions of mathematics education clustering disposition and what are the features of this cluster?
- Do secondary school students' math anxiety, math grade average and TEOG scores differ according to the perception of math education quality clustering dispositions?
- Does the perception of secondary school students about mathematics teaching affect their mathematics achievement and mathematics anxiety?

Method

Research Design

The research has been designed using a causal pattern to examine the effect of secondary school student perceptions of mathematics education quality on their mathematics anxiety and achievement. A *causal design* is a research pattern that examines the cause-effect relationship that emerges or exists between variables (Neuman, 2005).

Participants

Participants of the study were selected using layered sampling. The study was conducted with 679 secondary school students in Eskisehir. Schools were diverse in terms of their socio-economic status [lower, middle and upper]. This classification was drawn from TUIK (Turkish Statistical Institute). For the sake of reliability, the data obtained from 41 students who provided the same score to all statements and who were considered insincere in their question answers were removed prior to the analysis. Eventually, the data obtained from 638 participants were used in the study. The demographic information of the participants is displayed in Table 2.

Table 2
The Demographic Characteristics of Participants

Characteristic		1	2	3	4	Total
Gender		Girl	Boy			-
	n	341	297			638
	%	53.4	46.6			100
Grade Level		6. Grade	7. Grade	8. Grade		-
	n	164	290	184		638
	%	25.7	45.5	28.8		100
Education Level of Mothers		Elementary	Middle	High	University	-
	n	450	100	63	18	631
	%	71.3	15.8	10.0	2.9	100
Education Level of Fathers		Elementary	Middle	High	University	-
	n	308	167	129	32	636
	%	48.4	26.3	20.3	5.0	100
Mathematics GPA	X	3.0				
	SS	1.3				
TEOG scores	*X*	345.1				
	SS	72.8				

Measurement Tools

The data were collected using the Mathematics Education Quality Scale and the Mathematics Anxiety Assessment Scale (Suinn & Edwards, 1988). Student achievement scores were calculated using (*i*) the mathematics GPA and (*ii*) the Placement Test [TEOG] scores.

The *Mathematics Education Quality Scale* was developed to determine the opinion of secondary school students regarding the nature of math education provided in their school (Çiftçi & Karadağ, 2015). The scale consists of 28 items, which are rated using a 7 point Likert scale from 1 (strongly disagree) to 7 (completely agree). The five factors that comprise the scale are: (*i*) quality of instruction (10 items α = .85), (*ii*) quality of school environment (7 items α = .82), (*iii*) quality of teacher (5 items α = .81), (*iv*) quality of family cooperation (4 items α = .75) and (*v*) quality of school guidance (2 items α=.73).

(i) Quality of instruction: Higher scores indicate that the quality of mathematics teaching activities is high

Examples of items:

(1) My math teacher makes learning interesting by offering a variety of activities and options.

(2) My math teacher provides examples of daily life in the course.

(ii) Quality of school environment: Higher scores indicate that the quality of the physical structure, equipment and environment of the school is high.

Examples of items:

(1) My school has modern equipment and technology.

(2) The physical conditions of my school are better than other schools.

(*iii*) Quality of teacher: Higher scores indicate that mathematics teachers have desired and positive teaching behavior.

Examples of items:

(1) My math teacher trusts us.

(*iv*) Quality of family cooperation: Higher scores indicate that the students' parents are involved, enthusiastic and supportive in the learning process of the children.

Examples of items:

(1) While doing my homework, my parents help me when I need it.

(2) My parents want to have information regarding the school.

(*v*) Quality of school guidance: Higher scores indicate that there is a guidance system in the school that guides and directs students during and outside lessons.

Examples of items:

(1) I can always find someone who listens/care about me in school.

(2) I get help from a counselor when I need it.

The *Mathematics Anxiety Assessment Scale*, which was developed by Suinn and Edwards (1988) to determine the anxiety of secondary school students towards mathematics, is often used in studies that assess mathematics anxiety. The scale consists of 8 items, which are rated using a 5 point Likert scale from 1 (I never worry) to 5 (I worry very much). Turkish linguistic adaptation of the scale was performed within the study. The adaptation study was conducted in five stages. These are (*i*) English-Turkish translation validity, (*ii*) language and meaning validity of Turkish form, (*iii*) language equivalence between English-Turkish forms, (*iv*) construct validity (confirmatory factor analysis) and (*v*) reliability. The findings of translation validity, which were obtained via re-translation of the translated form to English, were in line with the original English version. The degree of language and meaning compliance was high for each statement of the scale. In order to determine the language equivalence of the scale's items, an application has been conducted on 30 participants; as a result of paired t-test, no significant differences has been observed between the averages of the answers given to English-Turkish versions of the scale. Within the scope of the study, the scale was adapted to Turkish, and its structural validity was tested using a confirmatory factor analysis with a maximum likelihood technique. The Chi-square ($\chi2$) value and statistical significance levels were calculated [$\chi2$ = 78.01, df = 20]. Depending on the degrees of freedom, a low Chi-square value [$\chi2/df$ = 3.9] indicated that the proposed structure is suitable for the collected data. In addition, other goodness of fit indices for the models [RMSEA = .06, CFI = .97, NFI = .95, and AGFI = .92] also indicated that the structure proposed for the scale is suitable. According to this result, the modeled factor structure has been validated within the scope of the standard fit index. In addition, the correlation coefficients between the scale's factors, which were obtained via the confirmatory factor analysis, were determined to be between .58 and .69, whereas the Cronbach's Alpha internal consistency coefficient of the scale was .89.

Procedure: Data Collection and Analysis

The data were collected by administration of the scale to the students. The participants first completed the part that comprised demographic information questions; they subsequently completed the assessment questions according to their agreement level with the scale items. The completion of the scale was optional, and the permission of school principals was granted prior to the application of the scale. Students' Mathematics GPA and TEOG scores were obtained using e-school system. During the study, the following analyses were used: (*i*) *correlation analysis* to determine the relationships among mathematics education quality, mathematics anxiety and achievement; (*ii*) *Ward's minimum variance hierarchical cluster analysis* to demonstrate how students configured their perceptions of mathematics education quality; (*iii*) *discriminant function analysis* to assure the validity of the cluster solution; (*iv*) *ANOVA and MANOVA analysis* for comparisons between the clusters; (*v*) *paired-samples t-test* for comparisons between the clusters; and (*vi*) *path analysis* to demonstrate the impact of the mathematics education quality perceptions on mathematics anxiety and achievement.

Findings

The main purposes of this study are as follows: (*i*) to compare the differences in mathematics anxiety and achievement of secondary school students according to their mathematics education quality perceptions via a cluster analysis and (*ii*) to test the effects of the mathematics education quality perceptions on anxiety and achievement via structural equation modeling.

In the first aim of the study, the nature of the relation between secondary school student perceptions of the mathematics education quality and their mathematics anxiety and achievement was investigated. In this study, the correlations between the factors of the Mathematics Education Quality Scale and mathematics anxiety and achievement (TEOG score and mathematics GPA) were analyzed (Table 3); it was unlikely that student perceptions of the mathematics education quality exist differently from each other. Rather, student perceptions of the quality of education were located and operated as part of a large and complex perception system. Therefore, it is important to identify what type of perceptions of individuals is in relation to each other (Fives & Buehl, 2008; Matthews, Jagger, Miller, & Brayne, 2009; Schady, 2011). In this study, it has been particularly underlined that the configurations of the mathematics education quality perceptions of the students and the mathematics anxiety and achievement of the student clusters have a similar quality perception pattern. In this respect, the hypothesis "students who have different views regarding the quality of mathematics education will have different mathematics anxiety and achievement levels" has been supported. To address this hypothesis, the focus was moved to a person-centered approach rather than a variable-centered

Table 3
Correlation Matrix among the Mathematics Education Quality Perceptions, Anxiety and Achievement

Variables	1	2	3	4	5	6	7	8
Mathematics Education Quality Scale								
1–Quality of instruction	1	.37**	.48**	.41**	.41**	-12**.	.09*	.17**
2–Quality of school environment		1	.22*	.28**	.27*	-.01	-.04	.03
3–Quality of teacher			1	.37**	.28**	-.17**	.14**	.10*
4–Quality of family cooperation				1	.29**	-.11**	.21**	.25**
5–Quality of school guidance					1	-.14**	.12**	.16**
6– Mathematics Anxiety						1	-.33**	-.32**
7– Mathematics GPA							1	.61**
8–TEOG score								1

$n = 626$, $^*p < .05$, $^{**}p < .01$.

approach; student clusters were formed via a *cluster analysis* in terms of mathematics education quality perceptions. The differences in mathematics anxiety and achievements were subsequently examined according to the cluster that they belong.

Determination of Clusters

A cluster analysis was conducted to determine how mathematics education quality perception was configured by the students. The factors of mathematics education quality perception were considered cluster variables. This approach indicates that mathematics education quality perception clusters may act as a filter for mathematics anxiety and achievement. To decrease the differences among the clusters, primary clusters were formed using *Ward's minimum variance hierarchical cluster technique* (Ward, 1963). This technique is often considered useful to improve the underlying data structure (Atlas & Overall, 1994; Blashfield, 1976).

Several steps were used to determine the appropriate number of clusters. To ensure the consistency/reliability of a cluster, Everitt (1993) recommended dividing the sample into two samples. Therefore, cluster analyses were independently applied to two randomly selected groups ($n = 313$ & $n = 312$), and the obtained results were compared to test the consistency of the sub-samples. In addition, the data were analyzed in the form of a graphical representation, i.e., a *dendrogram*; a suitable number for the cluster was obtained via observation of large gaps between the cluster sets (Olson & Biolsi, 1991). Further examination of the dendrogram identified three, four or five cluster solutions. To theoretically identify the most significant cluster solution, the clusters regarding these potential solutions were independently formed. Finally, the triple cluster solution was chosen.

To ensure the subsequent validity of the cluster solution, a *discriminant function analysis* was performed on the whole sample (Romensburg, 1984). The triple cluster solution predicted cluster membership by 93%, whereas the four-cluster solution predicted 87% of the membership and the five-cluster solution predicted 84%. Regarding the purposes of this study, the triple cluster solution offered the best representation among the profiles. Compared with the other solutions, the triple cluster solution covered the differences among the student groups without differentiating to a small extent; thus, the triple cluster solution was preferred for the study (Table 4).

Table 4
Results of the Hierarchical Cluster Distribution

Clusters	*n*	%
Cluster 1	182	29.1
Cluster 2	369	58.9
Cluster 3	75	12.0
Total	626	100

Cluster Comparison

Following the determination of the clusters, inter- and intra-cluster comparisons were performed for student answers regarding the mathematics education quality perceptions and mathematics anxiety and achievement.

Inter-cluster Comparisons: The comparison of the three clusters, which were determined based on the cluster variables (i.e., the perception of mathematics education quality) using ANOVA, indicated that the assumption regarding the homogeneity of variance was not met (Levene test, $p = .000\text{-}.021$). When groups have approximately equal sample sizes, ANOVA is quite resistant to the conditions in which these assumptions are not met (Stevens, 2012). However, in our study, the sample sizes were not equal (Cluster 1 = 182, Cluster 2 = 369, and Cluster 3 = 75). As a result, 75 data points from each of the first, second and third sets were selected randomly, and all analyses were conducted on a total of 225 individuals in three sets.

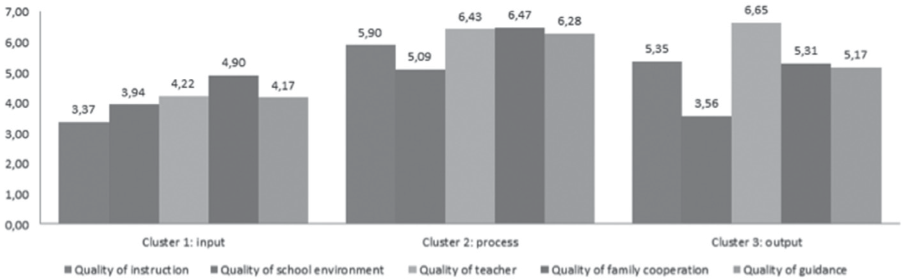

Figure 1: Average values of the Mathematics Education Quality Scale in the clusters.

When clusters with equal sample sizes were used, significant differences were identified in the clusters regarding the factors of mathematics education quality [Teaching quality: F = 145.06; $p < .001$, η2 = .56; school environment quality: F = 44.80; $p < .001$, η2=.28; teacher quality: F = 156.01; $p < .001$, η2 = .58; family cooperation quality: F = 47.03; $p < .001$, η2 = .29; and counseling quality: F = 37.67; $p < .001$, η2 = .25]. Figure 1 displays the features of each cluster. The indices next to the statistical means indicate the differentiations of the clusters according to the factors of mathematics education quality.

MANOVA was also conducted by considering the cluster membership as the independent variable and the mathematics anxiety and achievement (TEOG score and mathematics GPA), which are interrelated, as the dependent variables. As a result of the analysis, significant multiple effects were detected [F = 14.206; $p = < .01$, $\eta^2 = .18$]. The univariate tests indicated that there were significant differences among the groups in terms of mathematics anxiety [F = 15.55; $p = < .01$; $\eta^2 = .14$], TEOG score [F = 31.84; $p = < .01$; $\eta^2 = .25$] and mathematics GPA [F = 6.77; $p = < .01$; $\eta^2 = .06$]. The significant differences among the students' mathematics anxiety, TEOG score and mathematics GPA from different clusters, which were formed according to the mathematics education quality perceptions, validate the hypothesis that "students who have different views regarding the mathematics education quality will have different mathematics anxiety and achievement levels" (Table 5).

Intra-clusters Comparisons: Intra-clusters comparisons were used to describe the clusters. A *dependent sample t-test* was used to compare the particular perception factors (mathematics education quality, mathematics anxiety and mathematics achievement) in each cluster. Considering five factors of mathematics education quality perception, five paired-samples t-tests were used for each cluster. Regarding mathematics anxiety and achievement, six paired-samples t-tests were used for each cluster. To prevent Type 1 error, a Bonferroni adaptation and more rigid p-values (MEQS: $p < .05/5 = .001$; mathematics anxiety and achievement: $p < .05/6 = .008$) were used. The explication of each cluster, which was based on inter- and intra-cluster differences in mathematics education quality, mathematics anxiety and mathematics achievement, are subsequently provided. Based on the differences in mathematics education quality perceptions, the clusters were referred to as *Input* (Cluster 1), *Process* (Cluster 2) and *Output* (Cluster 3).

Description of Clusters

The three created clusters were compared within and between clusters, according to the mathematics education quality; the mathematics anxiety and mathematics achievement, as well as the results are subsequently summarized.

Cluster 1 – Input: This cluster is formed by the students who predominately expressed mathematics education quality perception in terms of family cooperation. This cluster has the lowest average in terms of education quality. Therefore, because the number of individuals who believe that the base of mathematics education quality is family cooperation accompanied by the teacher and the counseling

Table 5
Average Values of Mathematics Anxiety, Mathematics GPA and TEOG Scores in the Clusters

	Mathematic Anxiety		Mathematics GPA		TEOG Score	
	X	SD	X	SD	X	SD
Cluster 1: *input*	2.42	0.87	3.51	1.27	371.84	50.17
Cluster 2: *process*	1.76	0.47	4.19	1.06	415.29	30.54
Cluster 3: *output*	2.20	0.76	3.06	1.51	348.66	61.08

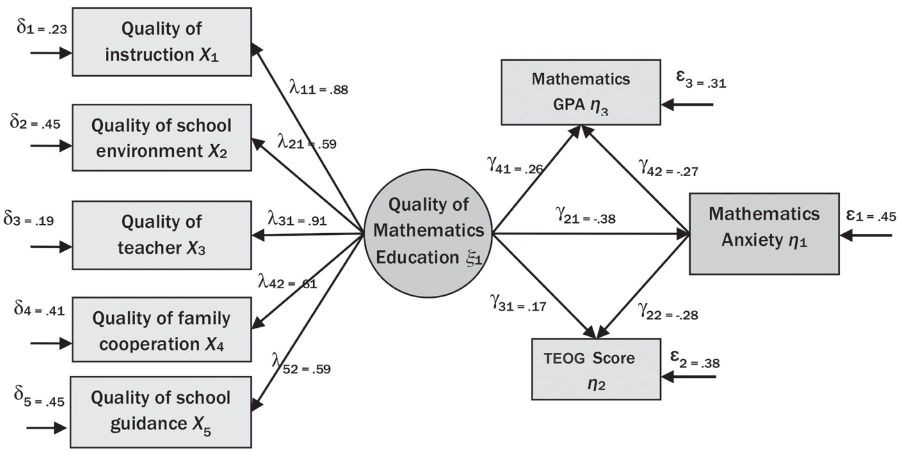

Figure 2: Structural equality diagram model of the mathematics education quality on mathematics anxiety and achievement.

quality is more that the individuals who advocate teaching and school environment quality, it can be said that the mathematics education quality perception of the students who belong to this cluster is the *input*. When students in the Input cluster were compared in themselves, their *mathematics anxiety level was higher, whereas their TEOG scores and mathematics GPA were at the average level.*

Cluster 2 – Process: This cluster is referred to as the process because the students who formed this cluster have similar averages for all factors that formed mathematics education quality. In addition, compared with the other clusters, the students of this cluster have higher averages than the other clusters in terms of all five mathematics education quality factors. This fact supports the hypothesis that this cluster adapted the process idea. When the Process cluster students were compared in themselves, their *mathematics anxiety level was lower, whereas their TEOG scores and mathematics GPA* were higher than the other clusters.

Cluster 3 – Output: This cluster is formed by the students who predominately expressed mathematics education quality perception in terms of teacher quality. This cluster has the lowest average in terms of school environment quality. Therefore, the students identified the quality of mathematics education with the quality of the teachers. When the Output cluster students were compared in themselves, their *mathematics anxiety level was medium, whereas their TEOG scores and mathematics GPA were at low levels.*

The second aim of the study is to test the effects of the mathematics education quality perception on anxiety and achievement via structural equation modeling. In this context, a theoretical model, which was based on structural equation modeling, was formed to determine the relationships among mathematics education quality perception, mathematics anxiety and achievement: (*i*) mathematics education quality perception has an impact on mathematics anxiety and achievement. The goodness of fit indices of the theoretical models were subsequently calculated, and the consistency of the models and the variable effects were determined.

Parameter Estimates and Goodness of Fit Indices

After the formation of the theoretical model in the study, an acceptable, independent structural equation model, which reflects the relationship among mathematics education quality perception, mathematics anxiety and achievement, was developed and is displayed in Figure 2. Figure 2 also includes the parameter estimates of the resulted model.

Table 6 shows the goodness of fit indices of the simultaneous contribution of all observed and latent variables to the whole model for the theoretical models developed to explain the causal relationships among mathematics education quality perception, mathematics anxiety and achievement. The goodness of fit of the developed theoretical model was determined as follows: RMSEA, χ^2 and χ^2/df, GFI, AGFI, CFI, and NFI. In this study, the RMSEA value was .07, the χ^2/df ratio was 1.2, the GFI value was .95, the AGFI value was .94, the CFI value was .92 and the NFI value was .90. These goodness of fit indices are an indication that the theoretical model is in accordance with the collected data.

Table 6
Goodness of Fit Index Parameters of the Structural Equality Model

Goodness Parameters	Value
GFI	.95
AGFI	.94
CFI	.92
NFI	.90
RMSEA	.07
sd	8
χ^2	9.65
χ^2/sd	1.2

Table 7 and Figure 2 display the standardized regression matrix among mathematics education quality perception, mathematics anxiety and achievement. The mathematics education quality perception positively affects the TEOG score (.17) and mathematics GPA (.26) and negatively affects the mathematics anxiety (-.38); the mathematics anxiety negatively affects both the TEOG score (-.28) and the mathematics GPA (-.27).

Table 7
Standardized Regression matrix of the Mathematics Education Quality on Mathematics Anxiety and Achievement

Variable	TEOG Score	Mathematics GPA	Mathematics Anxiety
Mathematics Anxiety	-.28*	-.27*	-
Quality of Mathematics Education	.17*	.26*	-.38*

*$p < .01$.

Discussion

As a result of analysis in this study, the data allowed the students to be grouped into clusters, which each promoted different perceptions of mathematics education quality. These clusters are as follows: (*i*) Input, (*ii*) Process and (*iii*) Output. To cluster students according to their mathematics education quality perceptions and to determine the cluster to which student opinions are closer will help to plan student education-training processes and activities and provide more accurate decisions in student counseling.

Regarding the clusters obtained via the cluster analysis, the *Process* cluster (n = 369) has the largest number of participants, whereas the *Output* cluster (n = 75) has the smallest number. A review of the literature indicated that in some studies, the education quality was considered the input, process and output (Levacic & Vignolles, 2002; Matthews, Jagger, Miller, & Brayne, 2009; Schady, 2011). The input includes the familial perspectives of the students, pre-school orientation, family environment, and student characteristics; the process primarily includes the teaching-learning process, feedback and incentives, whereas the output includes what has been achieved more than what has been done (Schady, 2011; Scheerens, 1992). The Process cluster students have higher averages that the other clusters in terms of all five mathematics education quality factors. In education quality, the input, process and output are different quality dimensions that are intertwined with each other (Scheerens, 1992). Although the process quality significantly affects the output quality, because of difficulties in control and measurement, it is predominately expressed with the output quality. Because educational results are defined as value-added inputs through the process, output measurements are needed to interpret the measures regarding the process. In light of this knowledge, it was expected that the mathematics education quality perception of the students from the process cluster had higher scores than the other clusters in all factors, including the input, process and output.

The *Output* cluster students predominately expressed mathematics education quality perception in terms of teacher quality. Furthermore, this cluster has the lowest average in terms of school environment quality. Therefore, the students identified the mathematics education quality with the quality of the teachers. The students included in this cluster who viewed the mathematics education quality as the *input* (n = 182) are the students who expressed mathematics education quality perception in terms of familial features. This cluster also has the lowest average in terms of education quality.

Inter-clusters comparisons indicated that the *Input* cluster students' mathematics anxiety level is higher than the other clusters, whereas their *TEOG scores and mathematics GPA* are at the average level. The *Process* cluster students' mathematics anxiety level is lower than the other clusters, whereas their *TEOG scores and mathematics GPA* are higher than the other clusters. Finally, the *Output* cluster students' mathematics anxiety level is medium, whereas their *TEOG scores and mathematics GPA* are at lower levels. When these findings are interpreted as a whole, the students who view mathematics education as a process exhibit low-anxiety and high achievement. In contrast, students who view mathematics education as a result exhibit low achievement.

The second aim of the study is to investigate the impact of mathematics education quality perception on anxiety and achievement and to test an independent model. For this purpose, a theoretical model, which was based on structural equation modeling, was formed. In the model, the mathematics education quality comprised the independent variable, whereas mathematics anxiety and achievement comprised the dependent variables. Structural equation modeling analyses indicated that the goodness of fit indices of the model were sufficient (Anderson & Gerbing, 1988; Cole, 1987; Kline, 2005; Joreskog & Sörbom, 2001; Schumacker & Lomax, 1996; Marsh, Balla, & McDonald, 1988). This result demonstrated that a model of mathematics education quality perception, anxiety and achievement can be created. The finding of the studies, which indicate the relationships between quality perception and anxiety (Dubayova et al., 2013; Mark Hyman, Clary, Fayyad, & Endicott, 2005; Yen et al., 2011) and anxiety and achievement (Ahmad, 2012; Ntoumanis & Biddle, 1998; Zakaria, Zain, Ahmad, & Erlina, 2012), demonstrate that mathematics education quality perception is one of the significant determinants of mathematics anxiety and achievement and supports the generation of the resulting model.

Mathematics education quality, which is the external variable of the study, is formed by five observed variables (the teaching process, school environment, teacher, family cooperation and counseling quality). The measurement model of this study has provided tips regarding the quality of mathematics education: the teacher quality factor is the most significant and reliable variable in the determination of the mathematics education quality.

The structural equation components of the study are as follows: (*i*) a direct impact of the mathematics education quality on math anxiety, TEOG score and mathematics GPA and (*ii*) a direct impact of mathematics anxiety on the TEOG score and mathematics GPA. The findings regarding the structural equation components can be summarized as follows:

- Mathematics education quality perception positively affects the TEOG score (.17) and mathematics GPA (.26) and negatively affects mathematics anxiety (-.38)
- Mathematics anxiety negatively affects both the TEOG score (-.28) and mathematics GPA (-.27).

The findings of this study overlap with the previous results (Ahmad, 2012; Dubayova et al., 2013; Mark Hyman, Clary, Fayyad, & Endicott, 2005; Ntoumanis & Biddle, 1998; Yen et al., 2011; Zakaria, Zain, Ahmad, & Erlina, 2012). However, the structural equation model created in this study should be enriched by the addition of different variables. Structurally, the created model is not complex, and more models, especially models related to teacher classroom outcomes, should be consulted for the parameter estimates regarding the relations among the variables defined in the model (mathematics education quality, mathematics anxiety and achievement). Causal or structural modeling techniques do not allow the researcher to decide the direction of the cause-effect relation between latent variables or conclude the existence of the causal relationship. Therefore, in the model, the quality of mathematics education (causes) and mathematics anxiety and achievement (results) are assumed to be linked. The data analysis has been designed to enlighten the consistency of the model with the data. Model compliance with the data still does not create an absolute sense evidence of causality; however, it does provide some support. Because the compliance of the studied model with the data is reasonable, the proposed model can be supported (Karadağ, 2009).

Directions for Future Research and Limitations

Following suggestions for future research about mathematics education quality, anxiety and achievement can be proposed:

- Since the perception of mathematics education quality significantly affect students' TEOG scores and mathematics grade point average [GPA], as well as their mathematics anxiety, educational institutions should focus on perception studies on the students.
- Since mathematics anxiety has a negative effect on mathematics achievement, school guidance units should concentrate on students' struggle with mathematics anxiety.
- In this study, we attempted to apply the modeling of mathematics education quality on public secondary schools; its validity can be tested for different school types and levels.

Consequently it can be argued that the findings obtained from the experimentally tested model shows that students' perception of mathematics education quality affects their mathematics achievement and anxiety. Therefore, some initiatives aiming to enhance students' perceptions should be taken. Since the data of the research were collected from one city center of Turkey, the generalizability of the findings is limited. In addition the collection of the data via self-reporting might have caused subjectivity and therefore the relationships between variables might fail to reflect the reality. The most important limitation of this research is the common method bias. The main reason of this limitation is the collection of the data from a single source (students). This fact might have caused an artificial increase on the observed correlations. Even though the mentioned limitation cannot be completely removed, the error can be minimized (Karadağ et al., 2015). For this reason, some precautions were taken during data collection stage as mentioned in the paper. First of all, the validity and reliability of the scales used on the data collection stage of the research have been tested. Second, respondents were clearly informed before the interviews that their answers are confidential and would not be disclosed.

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