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Geometry anxiety scale for secondary school students

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Abstract

Geometry is taught as a subject-matter in mathematics courses at elementary school level, and as an independent course at secondary school level in Turkish education system. When the success levels of students regarding these two subjects are examined, it can be seen that there are differences. Anxiety is an important variant on success in mathematics. But whereas geometry is considered as a different field from mathematics by the students, mathematics anxiety cannot cover geometry anxiety completely and that geometry anxiety can be observed separately from mathematics anxiety. Thus the aim of this study is to develop a scale for secondary school level students in order to determine their anxiety towards geometry.

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Keywords: Mathematics anxiety, geometry anxiety, secondary school level;

1. Introduction

In the Turkish education system, geometry, an important field within mathematics, is taught as a topic within mathematics in primary school, and in secondary school as a subject independent from it. Encountering mathematics and geometry as two different subjects in the rest of their learning process leads said subjects to be regarded as separate entities by students. When students' success levels concerning these two subjects are examined, the results encountered are dissimilar; it can be observed that in mathematics, success levels are higher compared to geometry.

Students' success levels in mathematics have been the subject of various studies and have been examined considering different variables (Fenemma & Sherman, 1977; Singh, Granville, & Dika, 2002 et al). Taking into consideration that there are more than a handful of variables affecting success levels, the idea that mathematics anxiety concept, which affects students' mathematics success levels considerably cannot completely cover the subject of geometry anxiety and that geometry anxiety can be observed separately from mathematics anxiety, has emerged.

1.1. Anxiety and Mathematics Anxiety

There is no consensus on the nature of anxiety; nonetheless it is considered to be composed of two distinct components and is classified accordingly: Trait anxiety and state anxiety (Baloğlu, 1999). While trait anxiety refers

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to ‘relatively stable individual differences in anxiety proneness’, state anxiety consists of a ‘transitory emotional condition’.

On the other hand, mathematics anxiety refers to combination of concepts such as test stress, low self-confidence, anxiety of failure and negative attitude towards learning (Bessant, 1995). Furthermore, certain pedagogic practices, negative behavior on the teacher's part and difficulties students have with mathematics at an early age (Cornell, 1999; Jackson & Leffingwell, 1999 as cited in Brady & Bowd, 2005) contribute to the emergence of mathematics anxiety. As a matter of fact, mathematics anxiety is not a concept created solely by the school and school environment. The development of concepts such as "not being good at maths" and the transfer of such concepts from parents to the children, contribute to the creation of an anxiety of this kind (Haylock, 2003; Furner & Duffy, 2002 as cited in Jackson, 2008). Moreover, the almost direct association of success or intellect levels with mathematics; mathematics taught after primary school taking on abstract quality that is detached from everyday life; curriculums that are intensive and severely consecutive, are amongst the causes of the emergence of mathematics anxiety. Such factors also lead to the development of fear, anxiety and negative attitude, which contribute hugely to students' failure (Uğurel & Morali, 2006). Mathematics anxiety is also an important phenomenon in the development of educated individuals (Yenilmez & Özabacı, 2003). This brand of fear is a significant factor that hinders the discovery and development of people's mathematics skills (Civelek, Meder, Tüzen, & Aycan, 2000). The relation between mathematics success and mathematics anxiety was demonstrated in various studies (Ma & Xu, 2003). This anxiety has an adverse affect on students' success levels and obstructs their attendance to courses on mathematics (Hembree, 1990).

The aim of this study is to develop a geometry anxiety scale concerned with determining students' anxiety with regard to geometry.

2. Methodology

The scale developed during this study, has been devised by the reevaluation for secondary school students, of a geometry anxiety scale previously evolved by researchers for elementary school students.

2.1. Sampling

The samples of this study consist of 250 high school students from the city of Ankara attending various grades (9th, 10th, 11th, 12th grades) in different types of secondary schools (high schools, Anatolian high schools, private high schools, and vocational high schools). The distribution of said students according to gender and the type of schools they attend were presented in Table 1.

Table 1. The distribution of students according to gender and type of school

Gender	High School	Vocational School	Private School	Anatolian High School
Female	82	14	6	51
Male	43	8	6	40
Total	125	22	12	91

2.2. The Adaptation Process of the Elementary School Anxiety Scale

In the beginning of the adaptation process, the items on the geometry anxiety scale developed for elementary school students were reexamined by the researchers. Seeing as geometry is a part of mathematics on elementary school level, items describing geometry as a topic within mathematics were rearranged for secondary school level, in which it is an independent subject. An expert was consulted for the new items on the geometry anxiety scale, prepared in the five-point likert-type with an item pool of 25 items and the grammatical structure of the items were checked by a linguist. The study was carried with 250 students.

2.3. The Analysis of Data

The analysis utilized in this study was carried out using SPSS 15.0 program with meaningfulness level set at .05. While the positive items included in the scale have been coded as 5 (I absolutely agree), 4 (I agree), 3 (neutral), 2 (I do not agree), 1 (I absolutely do not agree), the negative ones have been coded as 1, 2, 3, 4, 5.

The item analysis of the Geometry Anxiety Scale developed for secondary school students has been examined by using item-total correlation. Principal Component Analysis was employed in order to examine the structural validity of this scale. Factor analysis is one of the widely used multivariate statistics methods that turn multiple interrelated variants into a limited number of meaningful independent factors (Kleinbaum, Kupper, & Miller, 1998 as cited in Kalaycı, 2006).

Before commencing with factor analysis, Kaiser Meyer Olkin (KMO) scale of sampling adequacy and the Bartlett test were employed for their appropriateness for the factor analysis of the data set. In these tests the KMO result is supposed to be higher than .60 and the Bartlett test result, significant (Büyüköztürk, 2007). In this study, the KMO sampling suitability coefficient was found to be .93 and the Bartlett Sphericity test χ^2 value, found to be 2404.666 ($p < .001$). After the data set was found suitable for factor analysis, principal components analysis with a varimax rotation, a factorization method was used. In the aftermath of the rotation process, three factors with an eigenvalue higher than 1.00 emerged. Then, items in which the difference of loading in more than one factor is less than 0.20 were removed from the scale and thus the scale was finalized with two factors.

3. Features of Geometry Anxiety Scale

The scale developed during this study, has been devised by the re-evaluation for secondary school students, of a geometry anxiety scale previously evolved by researchers for elementary school students. After the analysis of re-examined data it can be said that a valid and reliable scale that determines the level of anxiety concerning geometry in secondary school students was brought into literature. The final form of the scale was presented in Appendix-1.

3.1. Reliability and Validity of the Scale

According to Nunally (1967), if the reliability of a scale in relation to the alpha (α) coefficient is higher than .80, the scale is reliable. The reliability of the Geometry Anxiety scale developed for secondary school students was found to be 0.939. According to this result, this scale devised for secondary school students is reliable. During the preparations of items, expert views and total point correlation coefficients of items which are higher than .40 regarded as the validity dimension of the scale.

3.2. The Structure of the Scale

It was observed that 15 of the analyzed items were gathered under two factors with eigenvalues higher than 1 (Table 2). The first factor was named as the “Anxiety according to geometry perception” and the second factor “Geometry anxiety related to social environment”. The variance accounted by these two factors regarding the scale is 63%. The communalities concerning the common variance of the two factors defined in connection with the items were detected to range between 0.405 and 0.753. Accordingly, it was discovered that together, the two factors appearing to be important factors represent the total variance of the items and the generality of the variance concerning the scale. According to the final scale, the distribution of items into factors and factor loadings are as follows.

Table 2. Factor Loading of the Geometry Anxiety Scale

Item	Factor 1	Factor 2
12.	,798	
5.	,777	
1.	,772	
4.	,764	

10.	,756	
14.	,720	
16.	,720	
2.	,701	
9.	,697	
3.	,688	
17.	,634	
7.		,854
8.		,759
6		,690

While the first factor, consisting of 11 items, explains 42% of the total variance related to the scale, the second factor, consisting of 4 items, explains 21% of them.

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Appendix-1**Geometry Anxiety Scale for Secondary School Students**

		Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Kesinlikle Katılmıyorum
1.	Geometri dersleri beni tedirgin eder.					
2.	Geometri konuları derste anlatılırken anlamama rağmen tek başıma kaldığım zaman yapamıyorum.					
3.	Geometri derslerine nasıl çalışacağımı bir türlü bilemiyorum.					
4.	Geometri en çok korktuğum derstir.					
5.	Geometride bir konuyu anlasam bile sonraki konularda yine zorluk yaşayacağımı düşünürüm.					
6.	Geometri derslerinin işleneceği günlerde okula gelmek istemem.					
7.	Geometri derslerinde, sınıfta göz önünde bir yere oturmak istemem.					
8.	Geometri derslerinde herkesin içinde soru sormaktan çekinirim.					
9.	Geometri ile ilgili soruların daha çok olduğu sınavlardan yüksek not alamayacağıma inanıyorum.					
10.	Matematik dersinde başarılı olsam bile geometride başarılı olamam.					
11.	Testlerde geometri ile ilgili bölüme geldiğimde tedirgin olurum.					
12.	Geometri derslerinde tahtaya kalkmaktan hoşlanmam.					
13.	Geometri en sevdiğim dersler arasındadır.					
14.	Geometri sorularımı çözmek zorunda olmak beni kaygılandırır.					
15.	Geometri çalışırken kendimi rahat hissedirim.					