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Investigation of Relations among Middle School (Junior High School) students' Gender, Learning Approaches, Perceptions of Learning Environment and Science Achievement

Ortaokul Öğrencilerinin Cinsiyeti, Öğrenme Yaklaşımı, Yapılandırmacı Öğrenme Ortamı Algıları ve Fen Bilgisi Başarıları Arasındaki İlişkilerin İncelenmesi

Yezdan Boz, *Orta Doğu Teknik Üniversitesi,* yezdan@metu.edu.tr
Sevda Yerdelen-Damar, *Boğaziçi Üniversitesi,* sevda.damar@boun.edu.tr
Hatice Belge-Can, *Mehmet Akif Ersoy Üniversitesi,* hbelgecan@mehmetakif.edu.tr

Abstract: The purpose of the present study is to explore the interrelationships among students' perceptions of constructivist learning environment, their learning approaches, gender and science achievement. Two hundred and forty-five 6th, 7th and 8th grade students were the participants. As research instruments, constructivist learning environment survey and learning approach questionnaire were used. Moreover, some demographic information about students were used in the collection of data. Structural equation modelling (SEM) was used to test the proposed model regarding the interrelationships among students' perceptions of constructivist learning, their learning approaches, gender and science achievement. The findings of the study showed that students' rote learning approaches, gender (through rote learning) and students' perceptions of constructivist learning environment (through meaningful learning approaches) were significantly related to their science achievement. The study has several educational implications.

Keywords: Gender differences, Learning approaches, Perceptions of learning environment, Science achievement, Structural equation modelling

Öz. Bu çalışmanın amacı; öğrencilerin yapılandırmacı öğrenme ortamına ilişkin algıları, öğrenme yaklaşımları, cinsiyetleri ve fen bilgisi dersi başarıları arasındaki ilişkileri tespit etmektir. Çalışmaya 245 6. 7. ve 8. sınıf öğrencileri katılmıştır. Araştırma araçları olarak, yapılandırmacı öğrenme ortamı ölçeği ve öğrenme yaklaşımı ölçeği kullanılmıştır. Ayrıca, öğrencilerin bazı demografik bilgileri hakkında da veri toplanmıştır. Öğrencilerin yapılandırmacı öğrenme ortamına ilişkin algıları, öğrenme yaklaşımları, cinsiyetleri ve fen bilgisi dersi başarıları arasındaki ilişkileri üzerine önerilen model, Yapısal Eşitlik Modellemesi (YEM) ile test edilmiştir. Çalışmanın sonuçları, öğrencilerin ezbere yönelik öğrenme yaklaşımları, cinsiyeti (ezbere yönelik öğrenme yaklaşımları üzerinden) ve yapılandırmacı öğrenme ortamı algıları (anlamlı öğrenme yaklaşımları üzerinden) ile öğrencilerin fen başarıları arasında anlamlı ilişkiler olduğunu göstermiştir. Bu çalışma, eğitsel önerilerde bulunmaktadır.

Anahtar Sözcükler: Cinsiyet farklılıkları, Öğrenme yaklaşımları, Öğrenme ortamı algıları, Fen başarısı, Yapısal eşitlik modellemesi

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UZUN ÖZET

Çalışmanın Amacı ve Önemi

Öğrenme yaklaşımları öğrencilerin başarısını etkileyen önemli bir faktördür. Öğrenmelerinde anlamlı öğrenme yaklaşımını benimseyen öğrencilerin akademik başarılarının arttığı görülmüştür (Cano, 2005; Cavallo, 1996). Öğrencilerin başarılarını etkileyen bir diğer önemli faktör de öğrencilerin öğrenme ortamı ile ilgili algılarıdır. Öğrenme ortamı ile ilgili algılar, öğrencilerin hem akademik başarısını hem de onların kullandığı öğrenme stratejilerini etkilemektedir. Bir diğer ifadeyle, öğrencilerin öğrenme ortamları ile ilgili algıları ortamın yapıcı ve destekleyici olduğu yönünde ise öğrencilerin daha anlamlı öğrenme stratejilerini kullandıkları (Dart vd, 2000; Eley, 1992; Entwistle ve Tait, 1990; Karagiannopoulou ve Christodoulides, 2005; Ozkal, Tekkaya, Cakiroglu ve Sungur, 2009; Yerdelen-Damar ve Aydın, 2015) ve başarılarının arttığı gözlenmiştir (Kingir, Tas, Gok ve Sungur Vural, 2013; Baek ve Choi, 2002). Öğrenme yaklaşımları ve öğrenme ortamı ile ilgili algılar dışında öğrencilerin başarılarını etkileyen bir diğer etken de cinsiyettir (Louis ve Mistele, 2012; Sun, Bradley ve Akers, 2012). Öğrencilerin başarısına etki eden bu faktörler arasındaki ilişkileri tespit etmek, dolaylı ve doğrudan etkileri anlamak oldukça önemlidir. Yapısal Eşitlik Modeli (YEM) kullanarak, bahsedilen faktörler arasındaki ilişkileri tespit etmek amacıyla yürütülen bu çalışma hem pratik hem de teorik açıdan önemlidir. Teorik açıdan önemlidir çünkü öğrencilerin başarısı, cinsiyeti, öğrenme yaklaşımları ve öğrenme ortamı algıları arasındaki ilişkileri tek bir çalışmada inceleyen çok çalışma bulunmamaktadır. Bu çalışma pratik açıdan da önemlidir, çünkü bu çalışmanın sonuçlarına göre eğitimciler öğrencilerin başarısını arttırmak için nelere dikkat edilmesi gerektiğini tespit edebilirler.

Yöntem

Araştırmaya altıncı, yedinci ve sekizinci sınıflarda öğrenim gören 245 öğrenci katılmıştır. "Yapılandırmacı Öğrenme Ortamı Anketi" ve "Öğrenme Yaklaşımları Anketi" kullanılarak çalışmanın verileri toplanmıştır. "Yapılandırmacı Öğrenme Ortamı Anketi", ilk olarak Taylor ve Fraser (1991) tarafından geliştirilmiş, Johnson ve McClure (2004) tarafından yeniden düzenlenmiş ve Yılmaz-Tüzün, Çakıroğlu ve Boone (2006) tarafından Türkçe 'ye uyarlanmış bir ankettir. "Öğrenme Yaklaşımları Anketi" ise Cavallo (1996) tarafından geliştirilmiş ve Özkan (2008) tarafından Türkçe 'ye uyarlanmıştır. Öğrencilerin cinsiyet ve son döneme ait Fen Bilgisi dersi başarı notlarını kapsayan demografik bilgileri de araştırmada toplanan veriler arasındadır.

Bulgular

Öğrencilerin fen bilgisi başarısı ile kullandıkları anlamlı öğrenme yaklaşımları arasında doğrudan bir ilişki bulunamamıştır. Fakat öğrencilerin fen bilgisi başarısı ile ezbere dayalı öğrenme yaklaşımları arasında anlamlı negatif bir ilişki bulunmuştur (β = -.12, p < .05). Öğrencilerin yapılandırmacı öğrenme ortamı algıları ile kullandıkları anlamlı öğrenme yaklaşımları arasında anlamlı pozitif bir ilişki bulunmuştur ve bu ilişki büyük etki değerine sahiptir (β = .88, p < .05). Başka bir deyişle, öğrencilerin öğrenme ortamını daha yapılandırmacı bulmaları durumunda, daha çok anlamlı öğrenme stratejilerini kullandıkları ortaya çıkmıştır. Öğrencilerin öğrenme ortamı algıları ile fen başarıları arasında doğrudan bir ilişki bulunamamıştır, fakat öğrencilerin öğrenme ortamı algıları ile anlamlı öğrenme stratejilerini kullanmaları arasındaki büyük etki değerine sahip ilişki toplam ilişkiyi anlamlı hale getirmiştir. Dolayısıyla öğrencilerin öğrenme ortamı algıları ile başarıları arasındaki ilişki anlamlı öğrenme yaklaşımları üzerinden anlamlıdır. Öğrencilerin cinsiyetleri ile öğrenme ortamı algıları arasındaki ilişki anlamlıdır (β = -.20, p < .05). Öğrencilerin cinsiyetleri ile anlamlı öğrenmeleri arasında doğrudan bir ilişki bulunmazken, ezbere yönelik öğrenmeleri arasında doğrudan anlamlı bir ilişki bulunmuştur. Erkek öğrencilerin daha çok ezbere dayalı öğrenme yaklaşımlarını tercih ettikleri gözlenmiştir. Cinsiyet ile anlamlı öğrenmeler arasında doğrudan bir ilişki bulunmazken, öğrencilerin öğrenme ortamı algıları üzerinden cinsiyetin anlamlı öğrenme yaklaşımlarına dolaylı

bir ilişkisi bulunmuştur. Cinsiyetin öğrencilerin fen başarısı üzerine doğrudan bir ilişkisi olmamakla birlikte, ezbere dayalı öğrenme yaklaşımı üzerinden dolaylı olarak anlamlı bir ilişkisi bulunmaktadır.

Tartışma ve Sonuç

Bu çalışma ile fen eğitimine yönelik birçok öneride bulunulabilir. Öncelikle, çalışmanın sonuçlarına göre ezbere dayalı öğrenme yaklaşımını kullanan öğrencilerin daha az başarılı oldukları belirlenmiştir. Dolayısıyla öğrencilerin anlamlı öğrenme yaklaşımlarını kullanmaları teşvik edilmelidir. Bunun için de anlamlı öğrenmeye dayalı ölçme ve değerlendirme tekniklerinin uygulanması önemlidir. Bu çalışmanın sonuçları ışığında çıkarılabilecek bir diğer öneri ise öğrencilerin öğrenme ortamlarını daha pozitif, yapılandırmacı olarak algılamaları sağlanmalıdır çünkü öğrenme ortamlarını daha yapılandırmacı algılayanların anlamlı öğrenme yaklaşımlarını kullandıkları tespit edilmiştir. Dikkate alınması gereken bir diğer öneri de sınıfta ya da bir ders materyali tasarlarken öğrencilerin cinsiyet farklılıklarının dikkate alınması gerekliliğidir. Erkek öğrenciler, anlamlı öğrenme yaklaşımlarını kullanmaları yönünde teşvik edilmelidir. Ayrıca, erkek öğrencilere, sınıfta daha çok fikir alışverişinde bulunma fırsatı tanıyarak daha aktif bir rol üstlenmeleri desteklenmelidir.

INTRODUCTION

Learning approach is one of the important constructs in education since it is related with course achievement of students. When students approach the tasks in a course by employing meaningful or deep learning strategies, their performance in the course increases (Cano, 2005; Cavallo, 1996; BouJaude, 1992; Cavallo, Rozman & Potter, 2004). Another important construct in education is the students' perceptions of learning environment. Students' perceptions of learning environment influence their achievement and use of learning strategies. When students perceive their learning environment supportive and constructive for their learning, they tend to use meaningful or deep learning strategies (Dart et al, 2000; Eley, 1992; Entwistle & Tait, 1990; Karagiannopoulou & Christodoulides, 2005; Ozkal, Tekkaya, Cakiroglu & Sungur, 2009; Yerdelen-Damar & Aydın, 2015) as well as their achievement increases (Kingir, Tas, Gok & Sungur Vural, 2013; Baek & Choi, 2002). Another construct related to the students' achievement is their gender (Louis & Mistele, 2012; Sun, Bradley & Akers, 2012). In the present study, we will examine the interrelationships among these constructs and determine the direct, indirect and mediating variables through structural equation modelling. This study has both theoretical and practical significance. Theoretically, it is significant because the interrelationships among students' achievement, gender, their learning approaches and their perceptions of learning environment have been rarely considered in the same study. Practically, it is important since the results of this study will be useful to help educators decide on what to consider in order to improve students' achievement.

Theoretical Framework

Biggs (1991) defined learning approach as students' strategies to solve the problems described by their motives. The study of Marton and Saljo (1976) was the first that mentioned two types of processing information, which are deep and surface approaches. In their study, students read an academic article and then some questions related to the text were asked to the students. Students with surface approaches tended to view the text as something including small pieces of information that needs to be memorized in order to answer the questions. Some students using deep approaches viewed the text as a whole having a meaning and they actively searched for the meaning. Though some studies (Marton & Saljo, 1976; Biggs, 1991) were conducted using the terminology of deep and surface learning approaches, some researchers (Ausubel, 1963) mentioned rote and meaningful to describe students' learning approaches. Despite different terminologies, students with rote or surface learning try to memorize the task without making any links with their prior knowledge and this usually results in little or no understanding while students having deep or meaningful learning try to understand the meaning of the task by relating the task with their previous experiences and making it meaningful. Biggs (1991) stated that students' motive is influential on selection of students' strategies. For example, extrinsically motivated students use surface approach while students who have interest in the task, in a way, having intrinsic motivation, use deep approach in dealing with the task.

Several studies (Cano, 2005; Cavallo, 1996; BouJaude, 1992; Cavallo, Rozman & Potter, 2004) showed that learning approach is one of the factors influencing students' achievement. Cano (2005) found a significant direct relationship between students' learning approach and their academic achievement. Students with deep learning approach are reported to be better academic achievers while students with surface learning approach have poor academic achievement. Similarly, Cavallo (1996) stated that students having meaningful learning approach tend to have better understanding regarding genetics. Similarly, Boujaude (1992) also found that students with meaningful learning approach had better scores with respect to the understanding of the chemistry while rote learners were found to have more misunderstanding. The negative relationship between rote learning and academic achievement was also reported by Cavallo, Rozman and Potter (2004).

With respect to the relationship between students' gender and their learning approaches, Cavallo, Rozman and Potter (2004) stated that male students used more meaningful approaches compared to the females while learning physics. Moreover, Cavallo (1994) also confirmed the

findings by indicating that females as more rote learners in learning biology. However, study of Boujaoude and Giuliano (1994) showed that female students preferred meaningful learning approaches in order to learn chemistry concepts.

Classroom learning environment is one of the constructs that need to be considered in education. Classroom learning environment, stated as "the educational environment or the classroom climate, is the social atmosphere in which learning takes place" (Johnson & McClure, 2004, p. 66-67). Some research studies revealed significant, positive direct relationship between these students' perceptions of classroom learning environment and their course achievement (Kingir, Tas, Gok & Sungur Vural, 2013; Baek & Choi, 2002). For example, Kingir, Tas, Gok and Sungur Vural (2013) found a positive and significant relationship between shared control, one of the variables of the constructivist learning environment, and science achievement. Similarly, Baek and Choi (2002) stated that students' perceptions of their constructivist learning environment was found to be a significant predictor of their course performance. On the contrary, some studies reported indirect relationships between students' perceptions of their learning environment and their course achievement through self-efficacy beliefs (Boz, Yerdelen-Damar, Aydemir & Aydemir, 2016; Fast et al, 2010) learning approaches (Uysal, 2010).

Regarding the association between learning environment and learning approach, research studies indicated significant relationships (Dart et al, 2000; Eley, 1992; Entwistle & Tait, 1990; Karagiannopoulou & Christodoulides, 2005; Ozkal, Tekkaya, Cakiroglu & Sungur, 2009; Yerdelen-Damar & Aydın, 2015). To illustrate, Dart et al (2000) found that classroom environment that encourages the use of investigative skills such as the skills used for inquiry and problem solving promotes students' use of deep learning approaches. Moreover, Eley (1992) reported that students, who perceive their learning environment as promoting metacognition, independent learning, and support for higher education study, tend to use more deep learning approaches. On the contrary, there was a negative correlation between the students' perceptions of their learning environment that promotes the independent learning of students and students' surface learning approaches. Karagiannopoulou and Christodoulides (2005) also showed the relationship between students' perceptions of their learning environment and their learning approaches. Students' perceptions of learning environment that promotes good teaching, vocational relevance and friendly social climate are positively related to the students' deep learning approaches. Similarly, Yerdelen-Damar and Aydın (2015) stated that when students perceived their learning environment more constructivist, they tend to employ meaningful learning strategies. Ozkal, Tekkaya, Cakiroglu and Sungur (2009) found that students who can express their ideas about their learning freely and interact with other students in their classrooms and perceive their learning environment relevant to daily life tend to use more meaningful approaches.

Concerning the relationship between gender and classroom learning environment, research studies stated that female students had more positive perceptions of their classroom learning environment (Coll, Taylor & Fisher, 2002; Dart et al, 1999; Koul & Fisher, 2003; Rakıcı, 2004; Huang, 2003; Yılmaz-Tüzün, Çakıroğlu & Boone, 2006). For example, Koul and Fisher (2003) reported that female students perceived their classroom more positively in terms of cohesiveness, task orientation, cooperation and equity. To clarify, female students found their learning environment more supportive, cooperative, task oriented and providing students equal opportunity. In another study of Huang (2003), girls perceived their learning environment more positively; they had higher scores with respect to the seven scales; "student expectation, involvement, affiliation, investigation, teacher support, rule clarity and cooperation" (p. 128) of the 12-scale questionnaire.

With respect to the relationship between gender and science achievement, contradictory findings have been reported in the literature. Some studies stated that science achievement of male students is better than that of females (Louis & Mistele, 2012; Sun, Bradley & Akers, 2012) while some studies reported no significant differences between male and female students regarding their science achievement (Houtz, 1995; Greenfield, 1996). On the other hand, study of Acar, Türkmen and Bilgin (2015) found that 8th grade female students in Turkey had higher science achievement scores when compared to the male students. The superiority of females regarding science achievement were also reported by Bursal (2013).

Summary of the related literature

To sum up the relationships among learning approach, learning environment, gender and science achievement, it is found that students' learning approaches and their science achievement are significantly related. Students with deep or meaningful learning approaches have better course achievement while students with surface or rote learning approaches have poor academic achievement. Moreover, when students perceived their learning environment supportive for their learning, they tend to use deep or meaningful learning approaches, so there is a direct positive relationship between students' perceptions of learning environment and meaningful learning approaches. Similarly, students' perceptions of their learning environment are positively related to their course achievement. To clarify, they find their learning environment more positive for their learning, their course achievement increases. Gender is one of the variables that have relationships between students' perceptions of learning environment, their learning approach and science achievement. Based on the related literature, the model on Figure 1 was hypothesized. Research question of the present study is as the following:

What are the interrelationships among students' perceptions of their learning environment, learning approaches, gender, and science achievement?

METHOD

Sample

All sixth, seventh and eighth grade public school students in Turkey were the target population of this study. Since it is impossible to reach all these students, it is suitable to determine the accessible population. The accessible population in the present study was all the sixth, seventh and eighth grade students in public schools in Isparta. From the accessible population, we randomly selected a secondary public school. The participants of the present study were composed of 245 6th, 7th and 8th grade students attending at a secondary public school in Isparta, a city taking place in the south west/Mediterranean region of Turkey. Among these participants, 68 of them were 6th grade students while 88 and 89 of them were 7th and 8th grade students respectively. In terms of gender distribution, there were 124 female and 115 male students while six students did not report their gender.

Table 1. *Gender distribution of students across grade levels.*

Grade level	Female students	Male students
6th grade	33	35
7th grade	50	37
8th grade	41	43

Instruments

Two instruments were used in the present study namely, constructivist learning environment survey and learning approach questionnaire.

Constructivist learning environment survey

Taylor and Fraser (1991) originally developed the 28-item constructivist learning environment survey (CLES). This instrument, that included four dimensions, was used to assess to what extent students' learning environment is consistent with the constructivist approach.

Later, Johnson and McClure (2004) revised the instrument and that instrument included 20 items with five dimensions. Yılmaz-Tüzün, Çakıroğlu and Boone (2006) translated and adapted the Johnson and McClure's survey into Turkish. For the reliability analysis, Cronbach alpha values for each sub-scale were found. They ranged from .72 to .86. In the present study, we used the survey of Yılmaz-Tüzün, Çakıroğlu and Boone (2006). The instrument has five dimensions that were *personal relevance, uncertainty, shared control, critical voice* and *student negotiation.* Personal relevance dimension assesses to what extent science is linked to students' daily life in the classroom. Uncertainty is related to the tentativeness of the scientific knowledge. Shared control is about whether students share the control of their learning with the teacher in that classroom. Student negotiation is about whether students discuss and defend their own ideas by negotiating with each other while critical voice dimension assesses to what extent students in the classroom can critically comment on their teachers' instructional decisions. In the present study, Cronbach alpha values were 0.70, 0.50, 0.79, 0.66 and 0.66 for personal relevance, uncertainty, shared control, critical voice and student negotiation dimensions respectively.

Learning approach questionnaire

Originally, Cavallo (1996) developed the learning approach questionnaire (LAQ) in order to reveal the approaches students use in order to learn. The questionnaire contained two sub-scales as *meaningful learning* and *rote learning*. Meaningful learning dimension measures to what extent students learn meaningfully by linking the new knowledge with their prior knowledge and having the intention to learn the meaning of the content while rote learning dimension assesses to what extent students learn rote by having the intention to memorize the facts in the content without making any link between what is learnt and students' prior knowledge. Özkan (2008) translated and adapted the LAQ into Turkish. She reported that Cronbach alpha values were 0.79 and 0.62 for meaningful and rote learning respectively. In the present study, Özkan's (2008) instrument was used in order to understand students' learning approaches. In the present study, for the reliability analysis, Cronbach alpha values were found as .86 and .80 for meaningful learning and rote learning dimensions respectively.

In addition to these instruments, some demographic information such as gender was collected from the participants. Their previous semester science grades were used to determine their science achievement scores.

Ethical precautions

After taking necessary permissions, we distributed the related questionnaires to the students. Participation to the study was based on voluntariness. Students were not asked to write their names while filling in the questionnaires. We ensured that students will not be held responsible in any way due to their responses in the questionnaire.

Data Analysis

The proposed model was tested applying structural equation modeling (SEM). Figure 1 illustrates this model. The latent variable (CLE) was represented in a circle and the measured variables are given in rectangles. In the present study, LISREL 8.8 program (Jöroskog & Sörbom, 2006) was employed for data analysis. The model was tested by means of maximum likelihood estimation method and the covariance matrix. In order to assess whether the model fit the data, multiple fit indexes—Chi-square/degrees of freedom (χ^2/df), Normed Fit Index (NFI), Comparative Fit Index (CFI), root mean square error of approximation (RMSEA), and standard root mean square residual (SRMR) were used. The cutoff values for an acceptable fit— $\chi^2/df \leq 3$, $NFI \geq .95$ $CFI \geq .95$ RMSEA < .06 to .08, with confidence interval SRMR $\leq .08$—suggested by Schreiber, Nora, Stage, Barlow, and King (2006) was employed in the current study.

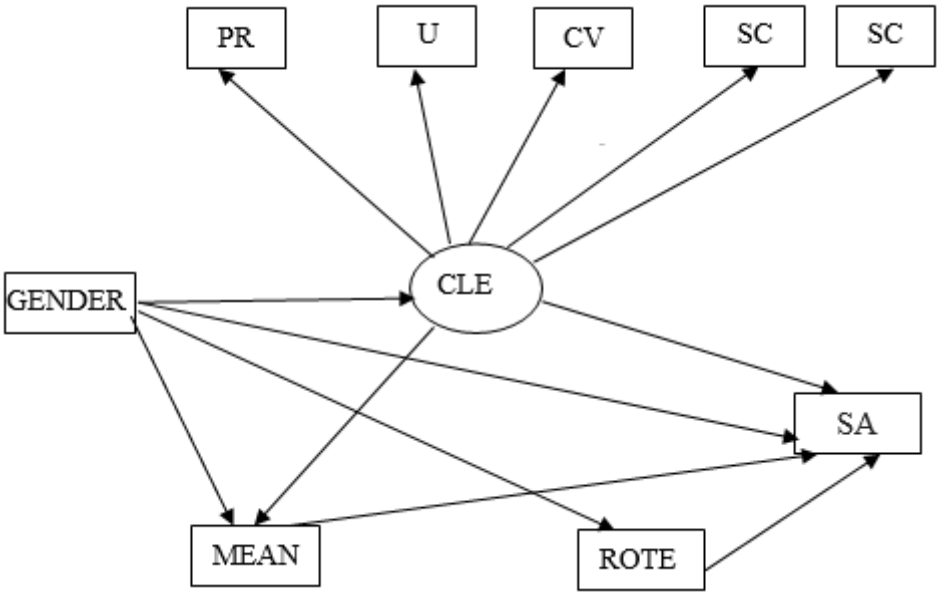

Figure 1. *The proposed model*

Abbreviations: PR: Personal Relevance; U: Uncertainty; CV: Critical Voice; SC: Shared Control; SN: Student Negotiation; MEAN: Meaningful Learning Approach; ROTE: Rote Learning Approach, SA: Science achievement

RESULTS

Descriptive Statistics

Table 1 indicates descriptive statistics of observed variables and reliability coefficients. According to skewness and kurtosis values, the scores of the measured variables were normally distributed since all values between -2 and 2, threshold values for normality assumption (George & Mallery, 2003). There were no influential outliers considering 5% trimmed mean values (Pallant, 2001). The Cronbach's alphas of personal relevance, shared control, rote and meaningful approach were greater than .70 while those of uncertainty, critical voice and student negotiation variables were less than .70. Briggs and Cheeks (1986) claimed that the magnitude of Cronbach's alpha rely on number of items in a scale and for short scales including less than 10 item, the alpha might be small. Therefore, they recommend using mean inter-item correlation (MIIC), which is independent of number of items for short scales. The threshold value of MIIC for a reliable scale is suggested as .20 (Briggs & Cheeks, 1986). Since all MIIC values were greater than this threshold, it can be said that all variables were reliably measured.

Table 2. D*escriptive statistics of observed variables*

Observed variable	N	Mean	5% Trimmed Mean	SD	Min	Max	Skew.	Kurt.	α	MIIC
Personal relevance	245	17.43	17.64	2.52	9	20	-1.01	.48	.70	.36
Uncertainty	245	15.58	15.65	2.74	8	20	-.28	-.45	.50	.21
Critical voice	245	16.71	16.89	2.69	6	20	-.89	-.80	.66	.33
Shared control	245	13.24	13.37	4.05	4	20	-.38	-.68	.79	.48
Student negotiation	245	15.27	15.36	2.81	6	20	-.43	-.05	.66	.33
Science achievement	245	4.47	4.53	.67	2	5	-1.19	1.24	-	-
Meaningful Approach	245	51.64	52.02	8.56	25	65	-.57	-.03	.86	.51
Rote Approach	245	10.16	9.97	4.68	4	20	.51	-.80	.80	.33

Abbreviations: Skew.: Skewness, Kurt.: Kurtosis, α : Cronbach's alpha, and MIIC : Mean Inter-Item Correlations.

The correlation among observed variables ranged from .02 to .71. (see Table 2). Meaningful approach was highly correlated to student negotiation while the least related variables were rote approach and uncertainty.

Table 3. *Correlations for Observed Variables*

Observed variables	PR	U	CR	SC	SN	MEAN	ROTE	SA
Personal relevance	1.00							
Uncertainty	.47	1.00						
Critical voice	.64	.42	1.00					
Shared control	.31	.42	.43	1.00				
Student negotiation	.50	.52	.44	.45	1.00			
Meaningful Approach	.60	.52	.63	.49	.71	1.00		
Rote Approach	-.14	.02	-.18	.08	.07	-.07	1.00	
Science Achievement	.35	.18	.34	.05	.18	.30	-.15	1.00

Abbreviations: PR: Personal relevance, U: Uncertainty, CR: Critical voice, SC: Shared control, SN: Student negotiation, MEAN: Meaningful Approach, ROTE: Rote Approach, SA: Science Achievement.

Measurement Model of the CLE

The confirmatory factor analysis was employed to test a five-factor structure of the CLE. The results of the analysis revealed that the model did not match the data ($\chi^2(5, N = 245) = 38.14$, χ^2/df = 7,69, *NFI* = .93, *CFI* = .93, *RMSEA* = .16 (90% *CI* = .12, .22), *SRMR* = .06). Based on modification indices, the errors of personal relevance and critical voice, the errors of shared control and critical voice were left to be correlated. After those modification, the good fit of the model was observed ($\chi^2(3, N = 245) = 3.18$, $p > .05$, *NFI* = .99, *CFI* = .99, *RMSEA* = .02 (90% *CI* = .00, .10), *SRMR* = .02). Unstandardized coefficients, standard errors, t-values, and explained variances of each indicator are given in Table 3. All estimated parameters were significant. The five-factor structure of the CLE was confirmed relied on these results.

Table 4*. Unstandardized coefficients, standard errors, t-values, and explained variances for the measurement model*

Observed Variable	Unstandardized Coefficient (B)	Standard Error	t-value	R^2
Personal relevance	1.60	.17	9.69	.40
Uncertainty	1.94	.18	10.98	.50
Critical voice	1.54	.18	8.32	.32
Shared control	2.31	.27	8.53	.33
Student negotiation	2.13	.18	11.79	.57

Testing Proposed Model

After confirming the measurement model of the CLE, the other hypothesized paths presented in Figure 1 were included to the model. According to the second part of the analysis, the model had a good fit to the data ($\chi^2(21, N = 245) = 55.51$, χ^2/df = 2,54, *NFI* = .95, *CFI* = .97, *RMSEA* = .08 (90% *CI* = .06, .11), *SRMR* = .02). Figure 2 displays the resulting model with the explained variance (R^2), standardized path coefficients and insignificant paths with dashed lines. The explained variances of dependent variables ranged from .04 to .77. Effect sizes for R^2 changed between small and large based on cut off values suggested by Cohen and Cohen (1983).

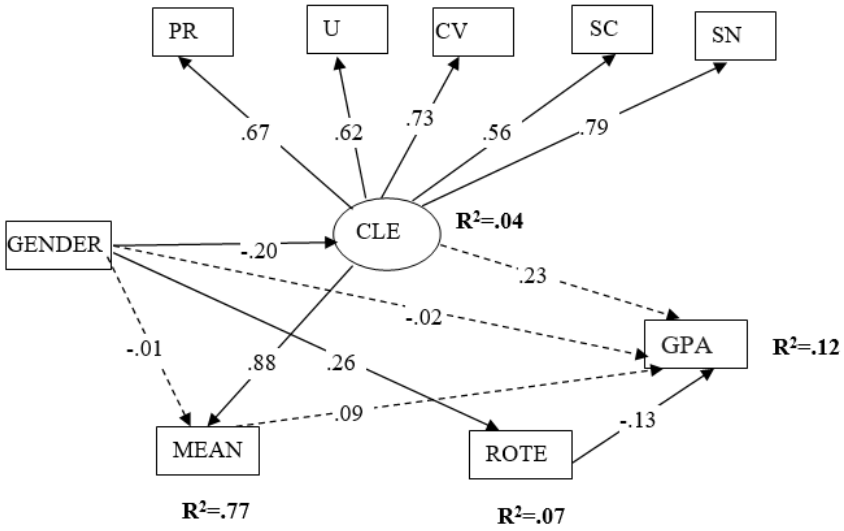

Figure 2. *The resulting model in this study.*

Abbreviations: PR: Personal Relevance; U: Uncertainty; CV: Critical Voice; SC: Shared Control; SN: Student Negotiation; MEAN: Meaningful Approach; ROTE: Rote Approach, SA: Science achievement

Inter-Relations among the Variables

The direct, indirect, and total relations (βs) with standard errors and t-values are given in Table 4. Considering the relations of gender to other variables, it should be clarified that male students were coded as the value of "1" whereas female students were coded as the value of "0" in the data of the current study. Thus, the associations of gender with other variables should be interpreted with respect to being male. For female students, the magnitudes of associations are the same but the directions of relations would be opposite.

Table 5. *Direct, Indirect, and Total Relations in Model*

		CLE			Mean			Rote			SA		
Variables		**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
Gender	**β**	-.20	-	-.20	-.01	-.18	-.19	.26		.26	-.02	-.09	-.11
	SE	.14	-	.14	.69	1.04	1.08	.58		.58	.08	.04	.08
	t	-2.90	-	-2.90	-.24	-2.92	-2.99	4.13		4.13	-.24	-3.15	-1.76
CLE	**β**				.88		.88				.23	.08	.31
	SE				.68		.68				.12	.10	.05
	t				11.12		11.12				1.31	.53	4.26
Mean	**β**										.09		.09
	SE										.01		.01
	t										.53		.53
Rote	**β**										-.13		-.13
	SE										.01		.01
	t										-2.01		-2.01

The relations of gender to science achievement, the CLE and learning approaches.

The direct relation of gender to the CLE was significant (β = -.20, p < .05). The effect size of this relation was small to medium in terms of the cut off values suggested by Kline (1998). Based on those values, for standardized coefficients less than .10, around .30, and larger than .50, effect

size was considered as small, medium and large, respectively. Male students perceived classroom learning environment more negatively than female students.

The direct effect of gender on meaningful approaches was not statistically significant (β = -.01, p > .05, small effect size). Male students were less likely to use meaningful approaches than female students. On the other hand, the indirect effect of gender through the CLE (β = -.18, p < .05, small to medium effect size) and the total effect on meaningful approaches (β = -.19, p < .05, small to medium effect size) were significant. That is, the CLE mediated the relation of gender to meaningful approaches.

Gender was directly associated with rote approaches (β = .26, p < .05, medium effect size). Male students were more likely to endorse rote approaches than female students.

Finally, the direct relation of gender to achievement was insignificant (β = -.02, p > .05, small effect size) while indirect relation via the CLE, meaningful and rote approaches was significant (β = -.09, p < .05, small effect size). The sign of the relation was negative; that is, the achievement scores of male students were smaller than those of female students. Total relation of gender to achievement did not reach to statistically significant, either (β = -.11, p > .05, small effect size).

The relation of the CLE to achievement and meaningful approaches.

The most related variables in this study were the CLE and meaningful approaches (β = .88, p < .05, large effect size). The students having positive classroom learning perceptions were most likely to adopt meaningful learning approaches.

The direct effect of the CLE (β =.23, p > .05, small to medium effect size) and indirect effect through meaningful approach (β =.08, p > .05, small size) on achievement were insignificant. On the other hand, the small indirect effect led to the total effect to be statistically significant (β = .31, p < .05, medium effect size). That is meaningful approaches mediated the relation of the CLE to achievement.

The relations of learning approaches to science achievement.

The direct effect of meaningful approach on achievement was insignificant (β =.09, p > .05, small effect size) while that of rote approach on achievement was significant but had negative sign (β = -.12, p < .05, small to medium effect size).

DISCUSSION and CONCLUSION

In the present study, the interrelationships among students' perceptions of constructivist learning environment, their learning approaches, gender and science achievement were investigated. It was found that students' rote learning approaches, gender (through learning environment perceptions and learning approaches) and students' perceptions of constructivist learning environment (through meaningful learning) were significantly related to their science achievement. While no significant direct relationship was found between students' meaningful learning approaches and their science achievement, students' rote learning approaches were significantly related to their science achievement and this relationship was negative. This means that students with rote learning approaches tend to be less successful. This is actually an expected result and was confirmed by different research findings (BouJaude, 1992; Cavallo, Rozman & Potter, 2004).

While there was no direct significant relationship between students' perceptions of the constructivist learning environment and their science achievement, students' meaningful learning approaches mediated the relationship between students' perceptions of their learning environment and science achievement. This means that when students perceive their learning environment more constructivist, they tend to employ meaningful learning strategies more and this increased their science academic achievement. The significant relationship between learning environment and use of learning strategies has also been reported by several researchers (Dart et al, 2000; Eley, 1992; Entwistle & Tait, 1990; Karagiannopoulou & Christodoulides, 2005; Ozkal, Tekkaya, Cakiroglu & Sungur, 2009; Yerdelen-Damar & Aydın, 2015). When students perceived their learning environment more constructivist, they tend to employ more meaningful learning

strategies. In the present study, the strong relationship between students' perceptions of constructivist learning environment and their meaningful learning approaches caused the total relationship between learning environment and science achievement to be significant. Meaningful learning approaches being a mediator between students' perceptions of constructivist learning environment and their science achievement was also supported by Uysal (2010).

Another finding of the present study was that students' gender and their science achievement were not found as directly related with each other. However, rote learning mediated the relationship between students' gender and academic achievement. In a way, students' gender was indirectly related to their science achievement. Male students tend to apply rote learning strategies and students with rote learning strategies tend to be less successful. Science achievement of male students were found to be less. There were inconsistent claims regarding this relationship in the literature. Male students being less successful with respect to science achievement was also confirmed by studies of Acar, Türkmen and Bilgin (2015) and Bursal (2013).

In terms of the relationship between students' learning approaches and their gender, there was not a direct significant relationship between students' meaningful learning approaches and gender, however, constructivist learning environment mediated that relationship. To clarify, male students tend to view their learning environment less constructivist and thereby use less meaningful learning approaches. In other words, they prefer surface approaches to learning., These results were also supported by a significant direct relationship between gender and rote learning approaches. Male students tend to use rote learning approaches more. This result is supported by the study of Boujaoude and Giuliano (1994) stating that female students preferred more meaningful learning approaches compared to the males in order to learn chemistry concepts.

Another important finding of the present study was the negative and significant relationship between students' gender and their perceptions of constructivist learning environment. To clarify, boys tend to view their learning environment more negatively compared to the females. This finding is supported by the related literature (Coll, Taylor & Fisher, 2002; Dart et al, 1999; Koul & Fisher, 2003; Rakıcı, 2004; Huang, 2003; Yılmaz-Tüzün, Çakıroğlu & Boone, 2006).

The present study has some implications for science education research. First of all, students with rote learning approaches tend to be less successful; therefore, students should be encouraged to use meaningful learning approaches while dealing with the task. Moreover, as Uysal (2010) stated, the use of meaningful assessment techniques is a necessity to promote students' meaningful learning approaches. When the teacher relies on the tasks that are based on memorization of facts, students will not adopt meaningful learning approaches instead they will tend to memorize. Another implication of the present study is that when students perceive of their learning environment more constructivist, their adoption of meaningful learning strategies increase. Therefore, students should be instructed in a constructivist environment; that is, science should be more relevant to daily life, students should be encouraged to express their ideas in the classroom, take part in their learning process.

As another implication of the present study, gender differences should be considered in the design of the instruction. In the present study, male students were found to apply rote learning strategies and they perceived their learning environment less constructivist, and they were less successful compared to the female students. As an implication, male students should be encouraged to apply meaningful learning strategies, and this could be possible when they perceived their learning environment more constructivist due to the strong positive relationship between students' perceptions of constructivist learning environment and their use of meaningful learning approaches. Therefore, male students should be made more active in the classroom, they should be given more chance to express their ideas and question the teacher's instructional decisions in the classroom so that this would help them perceive their learning environment more constructivist.

In conclusion, the present study contributes to the related literature by showing the interrelations, both direct, indirect relations, and mediator variables among students' perceptions of learning environment, their learning approach, gender and science achievement. These

interrelationships would help science teachers and educators make some decisions on their instruction. Future studies can design experimental studies to test causal relations among the variables suggested by the current study. For example, researchers can investigate the effect of an intervention training students to use meaningful approaches in terms of closing gender gaps in students' science achievement and perceptions of classroom learning environment or directly on science achievement. The model tested in this study can be extended by adding related variables such as students' epistemic cognitions, goal orientations and metacognitions.

Limitations of the Study

The present study has some limitations. First of all, the study was conducted in a school in a city of Turkey. More schools in other cities of Turkey can also be involved in order to increase the generalizability of the study. Another limitation was that students' science achievement was measured by their previous science grades instead of a science achievement test. For further study, a science achievement test may be developed to assess students' science achievement.

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