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THE RELATIONSHIP BETWEEN STUDENTS' PERCEPTIONS OF LEARNING ENVIRONMENT AND ACHIEVEMENT EMOTIONS: A MULTIVARIATE ANALYSIS[1]

Zeynep Avar
Ministry of National Education, Turkey

Özlem Sadi[2]
Karamanoglu Mehmetbey University, Turkey

Abstract

The purpose of this study is to determine the perceptions of the learning environment and achievement emotions of Turkish high school students in biology classes and to analyze the relationship among these variables. The sample consists of 2183 ninth, tenth, and eleventh graders from 12 high schools in Turkey. Both the Constructivist Learning Environment Scale and Biology Achievement Emotions Scale were used to identify the perceptions of the constructivist learning environment and biology achievement emotions of the participant students, respectively. The results of the canonical analysis showed that when the students perceive the learning environment to be comfortable, they express their opinions about the lesson, felt more joyful and proud and less anxious, angry, bored, or hopeless. Moreover, a negative relationship was found between shared control and anger, anxiety, and shame. The students who help their teachers to decide what activities or strategies to use while teaching, felt less anger, anxiety, or shyness.

Keywords: achievement emotions, biology education, canonical analyses, learning environment

Introduction

The constructivist approach is defined as the practice of associating newly-learned information with previously learned information to form unique new information (Hand & Treagust, 1991). Therefore, learners are expected to be individuals who understand and interpret science, generate ideas about scientific phenomena and solutions to scientific

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[2] *Correspondence*: ozlemsadi@kmu.edu.tr

problems, and contribute to the country's development. Biology is one of the scientific fields which conducts studies to achieve this goal.

The recent advances in the field of biology have influenced societies, both socially and economically. The studies conducted with the help of fast-growing and rapidly changing technology in many sub-disciplines such as biotechnology, genetics, and bioengineering have made it possible to create new and different products in such fields as agriculture, health, and industry. As a result, education in biology and other biology-related fields is highly important and necessary to raise biologically literate individuals who can follow the recent developments and analyze them from all aspects (Bal & Keskin, 2002). Within this framework, considering and researching different teaching methods and techniques alone would not be enough to raise the target individual. Besides, cognitive and affective factors that might directly or indirectly affect students' achievement have frequently been the focus of research studies. For example, it is seen in the related literature that along with students' demographic features, many different variables such as self-efficacy (Ashwin & Trigwell, 2012; Ekici, 2012), motivation (Tsai, 2004), learning strategies (Marton, Watkins & Tang, 1997; Lee et al., 2008), approaches to learning (Chiou & Liang, 2012), metacognition (Topçu & Yılmaz-Tüzün, 2009; Whitebread et al., 2009), epistemological beliefs (Liang & Tsai, 2010; Tümkaya, 2012; Sadi & Dağyar, 2015), perceptions of learning environment (Fraser & Fisher, 1982; Fraser & Butts, 1982; Ozkal, Tekkaya, Çakıroğlu & Sungur, 2009; Schreglman & Mengi, 2013), achievement emotions (Pekrun, Goetz, Frenzel, Barchfeld & Perry, 2011; Lichtenfeld, Pekrun, Stupnisky, Reissi & Murayama, 2012) have been analyzed.

However, the abovementioned variables were mainly considered in relation to achievement. Thus, it is less likely to come across the studies where the relationships among the variables were also analyzed within the scope of the same study. For example, most of the studies have clearly stated that the perceptions of learning environment are significantly related to student achievement (Fraser & Fisher, 1983; Talton & Simpson 1987; McRobbie & Fraser, 1993; Tosun, Şenocak & Taşkesenligil, 2009) as well as cognitive, motivational and emotional outcomes (Şahin & Özbay, 1999; Frenzel, Pekrun, & Goetz, 2007). However, what has been lacking is the research to understand how the perceptions of the learning environment are related to students' achievement emotions in high school education contexts. This also applies to the research in the domain of biology. The relational evidence concerning the students' emotions in connection with learning in the field of biology is considered as incomplete. Besides, little is known about the relationships between students' perceptions of their classroom environment and their emotional experiences in biology. Therefore, the present study surveys a large sample of Turkish High school students on their perceptions of the learning environment and achievement emotions in biology.

Perceptions of the learning environment

Learning environment is one of the essential factors which may influence students' cognitive and affective learning and learning objectives (Urdan, 2004; Koul, Roy & Lerdpornkulrat, 2012). With the conducted studies, especially in the 1960s and the early 1970s, Rudolf Moos and Halbert Walberg formed a foundation for further studies on the learning environment. In many later studies, the classroom environment was taken into consideration as an essential variable, and its effect on students' attitudes and achievement was analyzed (Fraser & Fisher, 1983; Talton & Simpson 1987; Tosun, Şenocak & Taskesenligil, 2009). Uslu (2002) stated that a classroom environment where students feel comfortable with the cooperation between themselves and the teacher, and their social and scientific needs are fulfilled, which is essential to achieve target learning. Likewise, Ülgen (1995) emphasized that the preparation of convenient learning environments by

considering the individual characteristics of students is crucial for learning to take place.

It is also known that a convenient learning environment or classroom atmosphere is useful in helping students to feel secure. Nevertheless, it was also stated in the studies that negative features in the learning environment are one of the problems that might affect student achievement. It is highly relevant to establish a learning environment where students are more active and can improve their cognitive and motivational skills by constructing the information they have acquired. Therefore, while creating convenient learning environments on an individual basis, it is necessary to consider the issue from many angles and pay attention to physical limitations. While enabling students to benefit from educational technologies, it is also necessary to ensure student-student and student-teacher interaction. During this interaction, such values as respect, patience, tolerance, and empathy, which might positively affect the learning environment should be promoted (Şahin & Özbay, 1999).

There are several research studies in the literature which have emphasized the importance of learning environment and examined students' opinions about learning environments (Walberg, Singh & Rasher, 1977; Fraser & Fisher, 1983; Cheong, 1994; Chionh & Fraser, 1998; Waldrip & Fisher, 1998; Okurut, 2010). In these studies, the similarity between the learning environment which the student has envisioned and the one he/she is actually in is a positive indicator in terms of academic achievement or that there is a consistent relationship between the learning environment and notably cognitive variables that was highlighted. In brief, there might be several factors influencing or influenced by the learning environment. Researching these factors and examining not only the link between the learning environment and academic achievement but also the link between the learning environment and some other student characteristics are essential.

Achievement Emotions

Achievement emotions were defined as emotions that are directly tied to achievement activities and their achievement results (Pekrun, 2006). Thus, achievement-related situations are accepted as achievement emotion. Learning-oriented emotions such as enjoyment, pride, anger, shame, hopelessness, and boredom, which may be felt depending on the activities, are some examples of achievement emotions. Achievement-oriented emotions such as pleasure linked to learning, boredom felt during the lesson, or anxiety raised when faced with a difficult task can also be considered as achievement emotions. According to researchers, there are two types of achievement emotions that can be felt either during the task or afterward, depending on the outcome of the task (Pekrun, Elliot, & Maier, 2006). The outcome of the task or hope for achievement/anxiety of failure can evoke prospective, anticipatory emotions. In contrast, feedback after achievement can result in retrospective emotions such as pride or shame (Pekrun, Elliot, & Maier, 2006). It may also be the emotions that an individual feel for a certain period, depending on the given or experienced situation (before, during, or after an exam or lesson) (Pekrun, 2006). Besides, there might be emotions that recur in a familiar situation, such as exam anxiety.

However, different from habitualized emotions, situational achievement emotions can also arise. For instance, some achievement emotions can be experienced only when the topic is mathematics (Pekrun, 2006). Lichtenfeld et al. (2012) stated that a student feels proud of himself/herself when he/she gets a high grade in math, feels anxious when he/she does not understand concepts regarding the lesson, and feels bored when the topic does not interest him/her. Stipek and Gralinski (1991) studied the third graders' level of pride and shame concerning math course and found that female students did not feel much pride when they became successful. Also, they indicated that female students were more worried about feeling degraded in front of others when compared with male students. In another study, Putwain and Best (2011) studied with forty primary school students and

tried to find out whether fear affected exam anxiety and test results. The findings of their study pointed out that students' anxiety increased depending on the level of fear, but the decrease in their test scores was not related to exam anxiety. Similarly, Peker and Sentürk (2012) analyzed fifth graders' anxiety levels in math in terms of some variables. The findings of their study revealed that together with campus variables, sex, and achievement, students' interest in math course and the role of the teacher influenced the anxiety level of the students.

In another study focusing on anxiety, Alkan (2011) emphasized that fourth-grade primary school students with a high level of anxiety in math and low self-confidence avoided asking questions. As seen in the studies mentioned above, the level of students' achievement emotions has usually been studied in relation to testing anxiety. However, Lichtenfeld et al. (2012) examined achievement emotion as well as anxiety within the scope of enjoyment and boredom and developed "Achievement Emotions Scale-Primary School" by adapting the Achievement Emotions Scale developed by Pekrun and Best (2011) in order to investigate primary school students' level of achievement emotions in math. While developing this scale, Pekrun's control-value theory of achievement emotions (Pekrun, 2000; Pekrun, 2006; Pekrun, Frenzel, Goetz and Perry, 2007) was used as the theoretical framework.

This scale focuses on three achievement emotions of students which are enjoyment, anxiety, and boredom. It was emphasized that these three emotions were chosen because they were linked to achievement environments (Csikszentmihalyi & Larson, 1987; Pekrun et al., 2002; Pekrun, Goetz, Frenzel & Perry, 2011). From the same theoretical framework, achievement emotion was considered together with anxiety and other sub-dimensions as enjoyment, pride, anger, shame, hopelessness, and boredom in this study, too. Nevertheless, it is essential to mention that these seven sub-dimensions have been identified in the literature, especially for math courses, and not many studies have been conducted regarding science and specifically biology. In the school context, students' achievement emotions in different domains can vary greatly, t, and it can be challenging to predict the achievement emotions in other disciplines based on the students' achievement emotions in a discipline (Goetz, Pekrun, Hall & Haag, 2006). In this context, it is essential to identify Turkish students' achievement emotions in biology in this research study.

The Link Between Perceptions of Learning Environment and Achievement Emotions

The present study examined the relationship between students' perceptions of the learning environment and achievement emotions in biology. The empirical studies in the literature provide consistent support of a relation between perceived learning environments and achievement emotions (Helmke 1983; Pekrun, 1992; Jacob, 1996; Goetz et al., 2006; Pekrun, 2006; Kohoulat et al., 2017; Ayiro, 2014). However, the existing studies addressing emotions in relation to perceived classroom environments mostly concentrate on anxiety and other emotions in mathematics. Helmke (1983) reported the positive relationship between the students' emotions of anxiety and the perceived punitive teachers' behavior.

Concerning studies that address other achievement emotions combined with anxiety, Franzel, Pekrun, and Goetz (2007) investigated relationships between perceived classroom environments and students' emotions, including enjoyment, anxiety, anger, and boredom in mathematics. They analyzed these relationships using a multilevel approach and found that perceived quality of instruction and perceived peer esteem proved to be positively related to enjoyment and negatively related to anxiety, anger, and boredom. Moreover, they stated that perceived peer esteem also proved to be relatively strongly negatively related to anxiety and anger. Another important finding from this study was

that environmental variables were closely linked to the emotional experiences by functioned predominantly at the individual level. Similarly, Jacop (1996) summarized that while individual student perceptions of the teacher as enthusiasm and supportive achievement-contingent feedback were positively correlated to enjoyment. Jacop, also, reported positive correlations between student perceptions of the teacher (e.g., outcome-related teacher punishment) and anger, hopelessness, shame, and anxiety.

Finally, perceived competition among classmates positively correlated with anxiety and enjoyment. Correspondingly, Goetz, Pekrun, Hall, and Haag (2006) investigated relationships between academic emotions, students' cognitions, and aspects of the social environment across grade levels 7 to 10. Students' academic emotions were tested in the context of Latin language instruction. They reported positive correlations between teacher enthusiasm, elaborative instruction in Latin, and students' emotional experiences (e.g., enjoyment and pride). In addition, elaborative instruction also showed negative relationships with anxiety, anger, and boredom in Latin (instructional variable). Furthermore, in cross-sectional and longitudinal analyses, Pekrun (1992) found positive correlations between individually perceived achievement-related pressure and punishment from teachers and perceptions of competition among classmates. In summary, the above findings provide a strong relationship between the achievement emotions and learning environment. Perceived learning environments (e.g., personal relevance, peer engagement, support after failure) would appear to be positive correlates of enjoyment and pride, and negative correlates of shame and anxiety.

As stated in the abovementioned studies, the perceptions of the learning environment and students' achievement emotions at different grade levels were investigated by the researchers, and generally, these studies were conducted over the mathematics domain. Therefore, the present study might be considered as an attempt to determine the relationship between perceptions of the learning environment and achievement emotions among young Turkish students studying in different learning contexts.

Research Questions

In the literature, the researchers who have conducted studies on perceptions of constructivist learning and achievement emotions mainly analyzed each variable together with different variables (sex, grade level, academic achievement, etc.) independently and adopted single-variable analysis methods (i.e., one dependent variable) such as especially Pearson correlation and t-test. However, when more than one Pearson correlation or single-variable analysis is conducted to identify the relationships between the variables, the probability of making Type I error is high (Yerdelen, Sungur & Klassen, 2016; Sherry & Henson, 2005). Therefore, the dataset obtained from the current study was tested through a stronger multivariate analysis method called canonical correlation analysis, which reduces the probability of making Type I mistakes (Thompson, 1991).

Canonical correlation analysis not only maximizes the relationship between the dependent and independent variable sets but also identifies the variables in both sets, which contribute the most to the interset correlation (Sherry & Henson, 2005; Tabachnick & Fidell, 2007). For this reason, different from the studies which separately analyzed the relationships between the various groups, which consist of perceptions of learning environment factors as well as achievement emotion factors, canonical correlation analysis was preferred for this study.

Moreover, it is emphasized in the related literature that variables such as perceptions of the learning environment and achievement emotions may vary depending on the social and cultural characteristics. Therefore, these variables should be analyzed in different cultures (Aldridge, Fraser & Huang, 1999; Aldridge, Fraser & Taylor, 2000; Rubenstein, 2006) and different domains (Goetz et al., 2006). Testing the data gathered

from sample groups from different grade levels, cultures, domains, and environments through stronger statistical methods is vital in terms of the generalizability of the studies (Yerdelen, Sungur & Klassen, 2016). Therefore, this study, which is conducted in the learning environments where young Turkish students are educated, will make a significant contribution to the relevant literature. Furthermore, some studies emphasize that achievement emotions should be considered as domain-specific.

Thus, this study is thought to be necessary because of the lack of empirical studies on academic emotions that are specific to the area (i.e., biology) other than mathematics. In this regard, it is believed that determining Turkish high school students' perceptions of the learning environment, biology achievement emotions, and identifying the relationship between those through a multivariate analysis approach will contribute to the literature. For this reason, in the light of the related literature, the purpose of this study is to determine perceptions of learning environment and achievement emotions of the high school students in Turkey and below are the research questions that the researcher sought answers for:

1) What are the profiles of high school students in Turkey in terms of their perceptions of the learning environment and achievement emotions in biology?

2) What is the relationship between Turkish high school students' perceptions of learning environment for biology variables (personal relevance, uncertainty, critical voice, shared control, and student negotiation) and their biology achievement emotions (enjoyment, pride, anger, anxiety, shame, hopelessness, and boredom)?

Method

This is a quantitative study, which was conducted using a survey model. With the help of this relational survey model, it aimed to identify students' perceptions of the learning environment and biology achievement emotions and factors without forming cause-effect relationships (Karasar, 2016).

Sample

In the Turkish education system, high school education lasts four years, and it takes place in different types of high schools including Science High Schools, Anatolian High Schools, Religious Vocational High Schools, and Vocational High Schools. The sample group of the current study consisted of 2,183 high school students who live in an Anatolian city in the Central Anatolia Region in Turkey and attend Anatolian High Schools from the ninth, tenth, and eleventh-grade levels.

Among the participant students (with an average age of 15.87), 911 students (41.7%) attend ninth grade, 875 students (40.1%) attend tenth grade, and 397 students (18.2%) attend eleventh grade. As for the sex distribution, 1,151 (52.7%) of the students are female, and 1,032 (47.3%) of them are male.

Instrument

In line with the purpose of the study, to determine Turkish high school students' perceptions of the constructivist learning environment and biology achievement emotions, the 'Constructivist Learning Environment Scale (CLES)' and 'Biology Achievement Emotions Scale (BAES)' were implemented, respectively.

Constructivist Learning Environment Scale (CLES): Yılmaz-Tüzün, Çakıroğlu, and Boone (2006) adapted the 'Constructivist Learning Environment Scale (CLES)' to Turkish, which had been developed by Taylor and Fraser (1991) and revised by Johnson

and McClure (2004). In the current study, this scale was used to determine the high school students' perceptions of particularly biology learning environments. The scale consists of 20 items and five sub-dimensions, which are personal relevance, uncertainty, critical voice, shared control and student negotiation, and it has been used by several researchers to determine students' perceptions of learning environment in science lessons (Ozkal, Tekkaya, Çakıroğlu & Sungur, 2009; Yerdelen-Damar & Aydın, 2015).

According to the findings of the exploratory factor analysis to test the validity of the data gathered through the implementation of CLES and to determine the relationships between the scale items and sub-dimensions, the 18th item was omitted from the scale (Tabachnick, & Fidell, 2001). Because its factor load was below 0.40; therefore, other analyses were conducted on the remaining 19 items. It was observed that the items in the scale were distributed over five factors. Cronbach's alpha was calculated for the reliability analysis of the data gathered through CLES in the study. The reliability coefficient was found to be 0.91 for the whole scale. As for the sub-dimensions, this value was 0.76 for personal relevance, 0.65 for uncertainty, 0.67 for critical voice, 0.77 for shared control, and 0.69 for student negotiation.

Biology Achievement Emotions Scale (BAES): The main scale which formed the basis of the current study to identify Turkish high school students' biology achievement emotions was 'Achievement Emotions Questionnaire- Mathematics (AEQ-M)' which was developed by Pekrun, Goetz and Frenzel (2005). Since it was aimed in this study to identify students' achievement emotions, particularly for biology, by referring to the application guide, the scale was adapted to biology after the authors gave the necessary permissions. The scale was first translated from English to Turkish, and then, from Turkish to English by academicians with high proficiency in English who are experts in their fields and work in education departments, and these translations were then compared. Similarly, an expert who works in the field of Turkish Language Education examined it in terms of Turkish grammar and made the necessary changes. After this procedure, by making comparisons, it was decided that the consistency in meaning between the original scale and the Turkish version was maintained. The scale is a five-point Likert type scale and consists of 60 items and three main sections in total, which are emotions about the lesson, learning, and exams. The whole scale is made up of seven sub-dimensions, which are enjoyment (10 items), pride (6 items), anger (9 items), anxiety (15 items), shame (8 items), hopelessness (6 items) and boredom (6 items).

Validity and reliability analyses were conducted on the revised version of 'Achievement Emotions Scale-Mathematics' for biology (BAES). Firstly, SPSS missing value analysis was conducted for the items that were left blank by the participant high school students. The unanswered items made up a far smaller proportion than 10% of the test, and the missing values were replaced through mean substitution-MS. For the structural validity of the scale, exploratory factor analysis was used. Although the original scale is comprised of seven sub-dimensions; enjoyment, pride, anger, anxiety, shame, hopelessness, and boredom, the items in our scale were distributed over six sub-dimensions. Because enjoyment and pride sub-dimensions were gathered under the same sub-dimension, depending on Turkish context participants and cultural differences, such a result may be obtained (Tüzün & Topçu, 2008). Besides, such a result may have been obtained because it is performed in a different discipline than the original scale. Of course, more work can be done with more studies and different disciplines. Moreover, the scale items loading on more than one factor or the ones with a factor load below 0.40 were omitted from the scale (6th, 7th, 27th, 33rd, 52nd, and 53rd items). For the reliability analysis of the scale, Cronbach's Alpha coefficient was calculated. Cronbach's Alpha reliability coefficient was found to be 0.88 for the whole scale. For each sub-dimension reliability coefficients were examined separately, and for enjoyment-pride sub-dimension,

it was found to be 0.90, for anger 0.82, for anxiety 0.85, for shame 0.72, for hopelessness 0.78 and for boredom 0.78.

Procedure

For the current study, students attending high school in a city in Central Anatolia Region in Turkey were identified, and the sample group was determined accordingly. The aim was to reach as many high school students as possible, and 2183 students were chosen to participate in the study through a convenience sampling method. The researcher visited each school to explain the purpose of the study and to give information about the quality of the scales to be implemented. These scales were distributed to the students who volunteered for the research study. The scales were implemented in a class by the researcher together with the course teacher, who was on duty at that specific time and the school counselors. Each student who participated in the study answered the items in the 'Constructivist Learning Environment Scale (CLES)' and 'Biology Achievement Emotions Scale (BAES)' one by one and at the same time. The statistical analyses of the data gathered first on the classroom level, and then the school level was conducted.

Data Analysis

The relationship between Turkish high school students' perceptions of the constructivist learning environment and biology achievement emotions were tested through canonical correlation analysis. Canonical correlation is one of the multivariate statistical analysis techniques which reveals the level of the relationship between more than one dependent variable set and one or more independent variable set (Tabachnick & Fidell, 2007). Within the scope of this study, in the light of the studies carried out in the related literature, achievement emotion sub-dimensions were considered as dependent variables, and perceptions of learning environment sub-dimensions were considered as independent variables in the analysis.

Results

In this study, all descriptive and canonical analyses were obtained using the Statistical Package for Social Sciences (SPSS) software.

Table 1. Descriptive statistics with respect to Constructivist Learning Environment Scale and Biology Achievement Emotions.

Variables	M	SD	Skewness	Kurtosis
CLES				
Personal relevance	12.30	3.48	.023	.12
Uncertainty	11.95	3.06	.11	.58
Shared control	10.62	3.61	.09	.08
Critical voice	9.07	2.62	.04	.15
Student negotiation	11.12	3.31	.08	.21
BAES				
Enjoyment-pride	48.19	12.03	.09	
Anger	19.72	6.46	.37	.02
Anxiety	36.65	10.04	.26	.36
Shame	14.61	4.64	.28	.02
Hopelessness	14.39	4.59	.15	-.23
Boredom	13.34	4.67	.27	-.30

Results for the First Research Question: "What are the profiles of high school students in Turkey in terms of their perceptions of the constructivist learning

environment and achievement emotions?" Descriptive statistics were used to investigate Turkish high school students' profiles about their perceptions of a constructivist learning environment and achievement emotions in biology classes (Table 1). On a five-point scale, although the average of personal relevance was partially higher than the averages of the other sub-dimensions, the average of each sub-dimension was still almost at a moderate level.

As it is shown in Table 1, students had an average, which could be considered as high in the enjoyment-pride sub-dimension. In other words, they enjoyed attending biology classes or felt pride due to their success in biology. Although these students did not have a very high average in anger, anxiety, shame, hopelessness, and boredom, they sometimes felt relatively negative emotions towards biology.

Results for the Second Research Question: "What is the relationship between Turkish high school students' perceptions of learning environment for biology variables (personal relevance, uncertainty, critical voice, shared control, and student negotiation) and their biology achievement emotions (enjoyment, pride, anger, anxiety, shame, hopelessness and boredom)?" Canonical correlation analysis was made to conduct a relational analysis between the variables dealt with within the scope of the study and to determine at what level another set of variables could explain one set of variables. Nonetheless, it is necessary to confirm some assumptions. For example, variables should display a multivariate normal distribution before the analysis, there should be no multiple relationships between the variables, and for the reliability of the results obtained, the sample size should be 20 times bigger than the number of variables (Nakip, 2003). As for the premises, it is thought that the data gathered from the high school students were appropriate. Moreover, especially when the fact that there were ten sub-dimensions in the dependent variable set and five in the independent one was considered, it could be concluded that 2183 samples were enough for the canonical analysis and met the related premise.

According to the findings of the canonical correlation between perceptions of learning environment variable set and biology achievement emotion variable set, the first canonical correlation was found to be .59 (53% overlapping variance, $p<.05$), the second was .19 (4% overlapping variance), and the third one was .11 (1.2% overlapping variance). While the first three canonical variate sets showed statistically meaningful relationships, the fourth and the fifth canonical variate sets were not found to be statistically meaningful. Therefore, while interpreting the findings, the first three canonical variate sets were taken into consideration (Table 2).

In the first significant canonical variate sets, perceptions of learning environment variables accounted for 63.2% of the variance in their own set, and biology achievement emotion variables accounted for 26.2% of the variance in their own set. In the second significant canonical variate sets, perceptions of learning environment variables accounted for 15.4% of the variance in their own set, and biology achievement emotion variables accounted for 15.9% of the variance in their own set. Finally, in the third significant canonical variate sets, perceptions of learning environment variables accounted for 8.3% of the variance in their own set, and biology achievement emotion variables accounted for 34.7% of the variance in their own set.

As it is shown in Table 2, when a cut-off value of 0.30 was applied (Tabachnick & Fidell, 2007), the first canonical variate sets showed a meaningful relationship between each variable of perceptions of the learning environment and biology achievement emotions (enjoyment-pride, anger, anxiety, hopelessness, boredom). In other words, it can be said that students who had constructivist learning environment perceptions such as acquiring information about the world in and outside the school in biology courses and associating these pieces of information with the experiences outside the school, understanding that science is part of this world, believing that scientific solutions can

change, thinking of offering help to the biology teacher during activities or assessment of the acquired information, and expressing opinions comfortably in classroom environment might feel positive achievement emotions such as enjoyment-pride.

Table 2. Canonical Correlation Analysis' Results for First, Second and Third Canonical Variates

	First Canonical Variate		**Second Canonical Variate**		**Third Canonical Variate**	
	Corr	**Coeff**	**Corr**	**Coeff**	**Corr**	**Coeff**
SET 1						
Personal relevance	-.87	.42	-.29	.42	-.02	.41
Uncertainty	-.75	.06	-.20	.27	-.60	.63
Shared control	-.68	.17	-.67	.87	-.03	.09
Critical voice	-.89	.37	-.15	.40	-.17	.86
Student negotiation	-.78	.20	-.41	.43	-.13	.20
Percent of Variance	.63		-.15		.08	
SET 2						
Enjoyment-pride	-.99	1.03	-.04	.01	.07	.42
Anger	.39	.05	.65	1.24	.51	.08
Anxiety	.30	.15	.39	.20	.70	.04
Shame	.03	.02	.58	.44	.50	.02
Hopelessness	.35	.03	.04	.74	.93	1.08
Boredom	.47	.29	.18	.64	.48	.18
Percent of Variance	.26		.16		.35	
Canonical Correlation	.59		.19		.11	

In addition, it was found that such a classroom environment perception was negatively associated with emotions such as anger, anxiety, hopelessness, and boredom. When the second canonical variate sets were examined, it was seen that shared control and student negotiation were negatively associated with anger, anxiety, and shame. This finding showed that students did not experience such negative emotions as anxiety, anger, and shame when they managed the learning environment with their teachers and comfortably asked their classmates for their opinions. Lastly, when the third canonical variate sets were examined, it was observed that there was a negative relationship between uncertainty and such achievement emotions as anger, anxiety, shame, hopelessness, and boredom. In other words, in a learning environment where opportunities to question the changing nature of science and the link between theoretical knowledge and daily life were offered, students felt emotions such as anger, anxiety, shame, hopelessness and boredom less.

Discussions and Recommendations

The purpose of this study was to determine Turkish high school students' perceptions of the constructivist learning environment and biology achievement emotions and to analyze the relationships between the variable sets taken into consideration at sub-dimensional levels. Firstly, the average values obtained for the biology achievement emotion showed that Turkish high school students experienced an average level of enjoyment-pride, but they also experienced negative emotions such as anger, anxiety, shame, hopelessness, and boredom, although not at very high levels. This finding is parallel to the findings of other studies which revealed that the students in Turkey did not have very high or entirely positive attitudes towards biology and that their average attitude scores were moderate (Atik, Kayabaşı, Yağcı & Erkoç, 2015). Although this result cannot be considered a very negative situation for biology education, it pointed out the need to reveal the necessary and essential factors in order to increase students' positive achievement emotions (enjoyment-pride) and decrease their negative emotions (anger, anxiety, shame, hopelessness, boredom) as much as possible. Secondly, when the students' perceptions of the constructivist learning environment for biology were examined, it was seen that they had moderate levels of personal relevance, uncertainty, critical voice, shared control, and student negotiation. From an overall perspective, this finding is parallel to the findings of some other studies conducted with Turkish students in the related literature (Ozkal, Tekkaya, Çakıroğlu & Sungur, 2009). Although the effectiveness of students in planning of their own learning and their ability to express their opinions and comments in a comfortable manner in biology classes were at moderate levels, it is still important to investigate the factors that might cause an increase in students' perceptions of the constructivist learning environment. In this context, the research problem of this study is highly significant in that manner.

This study is designed to find an answer to the research question structured to determine the factors that contributed to Turkish high school students' moderate level perceptions of the constructivist learning environment through the canonical correlation analysis between perceptions of the learning environment and achievement emotion in biology class. First of all, based on the result of the canonical analysis between perceptions of learning environment variable set and biology achievement emotion variable set, it can be said that the first significant canonical variate sets showed that critical voice had the highest load in the related set. In other words, when the students comfortably expressed their opinions about what they have learned in biology lessons and how they learned it, they felt more joyful and proud and less anxious, angry, bored, or hopeless. This might be an expected finding because students feel more relaxed and independent in an environment where they freely comment on the topics they have learned or comfortably ask for elaboration during a complicated activity.

This situation might result in the arousal of more positive emotions towards biology lessons. Similarly, Goetz et al. (2006) examined students' perceptions of learning environment and their emotions in Latin lessons and emphasized that in learning environments where the achievement of the individuals was positively reinforced, and the teachers focused on student development and felt more enthusiastic, students' emotions such as enjoyment and pride were positively affected, and emotions of boredom and anger decreased. Thus, it is especially crucial to create environments where students express their opinions in a comfortable manner. On the other hand, the second significant canonical variate sets showed that shared control had the highest load in the related set, and it was negatively connected to anger, anxiety, and shame. In other words, students expressed that they felt less angry, anxious, or shy when they acted in cooperation with their teachers when, for example, deciding on what would be taught in biology lessons, which activities would be done, or how the assessment would be made. Moreover, in the third canonical variate sets, uncertainty was negatively connected to such negative

emotions as anger, anxiety, shame, hopelessness, and boredom. That is, students felt more relaxed and independent when they had perceptions regarding the fact that scientific explanations in biology might change in time, science might not always be able to offer solutions to problems or science might be influenced by cultural values or opinions of people, and this might result in the development of the idea that students could be productive in the field of biology by studying by themselves.

In brief, the findings obtained from all three significant canonical variate sets exhibited parallelism to the explanations in the related literature. It was observed that the behavior and attitude of the teacher and the feedback, which is not considered useful, are significant and in a learning environment where the link between the topics in the lesson and daily life is not established, and the students are not able to express their emotions and opinions about the lesson or their problems and solutions in a comfortable manner, positive achievement emotions cannot be created (Frenzel et al., 2007). In the Turkish education system, promoting environments where students are offered with the opportunity to express their emotions and opinions in class freely, discuss the topics they have learned and know-how assessment and evaluation are conducted might be useful in helping them feel more joyful and proud in biology lessons and preventing negative emotions such as anger, anxiety, shame, hopelessness, and boredom.

When the findings were taken as a whole, it is thought that students' perceptions of learning environment might have an influence on their achievement emotions in biology. Notably, it is necessary to obtain more precise and more generalizable findings of the reason-result relationship that is predicted through experimental studies. Similar studies should be conducted mainly in the other science fields (e.g., physics, chemistry) as well as biology in different cities and with different grade levels, and the differences and similarities between students' preferences for these variables should be determined. Some solutions should be offered based on the factors determined in research studies. For example, as it was revealed in the current study, if students are motivated to learn and encouraged to express themselves, and if learning environments where teachers have the chance to plan the activities to be conducted in class with their students are promoted, students will probably feel enjoyment and pride during the lesson and spend an effort to learn in-depth. To create such an environment, teachers, school administrators, and every educator who has a role in the education system should be informed about these variables.

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About the Authors

Zeynep Avar is a high school teacher in Turkey. She also taught science-technology at the secondary school level. She successfully completed a master's degree. She has worked on students' achievement emotions, approaches to learning, and perceptions of the learning environment in high school. She has published various papers in her field of study in national and international congresses.

Özlem Sadi is an associate professor in the program of primary education at Karamanoglu Mehmetbey University, where she teaches undergraduate and graduate courses in science education and classroom teaching. She earned her PhD in science (biology) education from Middle East Technical University (METU). She studies the role of cognitive and motivational variables and conceptions of learning in science education. Currently, she is investigating the relationships between perceptions of learning, conceptions of learning science/biology, and academic achievement.