SCIENTIFIC EPISTEMOLOGICAL BELIEFS, PERCEPTIONS OF CONSTRUCTIVIST LEARNING ENVIRONMENT AND ATTITUDE TOWARDS SCIENCE AS DETERMINANTS OF STUDENTS APPROACHES TO LEARNING

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ABSTRACT

SCIENTIFIC EPISTEMOLOGICAL BELIEFS, PERCEPTIONS OF CONSTRUCTIVIST LEARNING ENVIRONMENT AND ATTITUDE TOWARDS SCIENCE AS DETERMINANTS OF STUDENTS APPROACHES TO LEARNING

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The purpose of this study was to investigate scientific epistemological beliefs, perceptions of constructivist learning environment, attitude towards science, prior knowledge and gender as determinants of students' approaches to learning.

This study was carried out in 2005-2006 Spring Semester. One thousand, one hundred and fifty two eighth grade students from seven public schools in Çankaya, a district of Ankara participated in this study. Epistemological Beliefs Questionnaire, Constructivist Learning Environment Scale, Learning Approaches Questionnaire and Attitude towards Science Scale were administered to students in order to determine their scientific epistemological beliefs, their perceptions of constructivist learning environments, approaches to learning and attitudes towards science respectively.

Descriptive statistics were used in order to explore the general characteristics of the sample. Paired samples t-test was used in order to evaluate the mean difference between the scales of the actual and preferred learning environments. Pearson Correlation Analyses and Multiple Regression Analyses were conducted to see the relationships among the variables and the variables that contribute to students' meaningful and rote learning approaches.

Results of the paired samples t-test showed that the actual learning environments of the students did not adapt their preferences. In fact, students preferred more constructivist learning environments where they have more opportunity to relate science with the real world, communicate in the classroom, take role in the decision making process of what will go on in the lesson to be more beneficial for them, question what is going on in the lesson freely and experience the formulation of scientific knowledge. Pearson correlation analyses, however, showed that students who had meaningful learning orientations had tentative views of scientific epistemological beliefs, positive attitudes towards science, high prior knowledge and perceived their learning environments as constructivist. On the other hand, students who had rote learning approaches had fixed views of scientific epistemological beliefs, positive attitudes towards science and low prior knowledge. In addition, the rote learners perceived their environments as constructivist in all scales except shared control scale. Multiple Regression Analyses by using actual learning environment showed that attitude towards science is the best predictor of both meaningful and rote learning approaches.

Keywords: Attitudes toward Science, Constructivist Learning Environment, Gender, Learning Approaches, Prior Knowledge, Scientific Epistemological Beliefs.

ÖZ

BİLİMSEL EPİSTEMOLOJİK İNANÇLARIN, YAPILANDIRMACI ÖĞRENME ORTAMININ VE FENE YÖNELİK TUTUMUN ÖĞRENCİLERİN ÖĞRENME YAKLAŞIMLARINDAKİ ROLÜ

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Bu çalışma, bilimsel epistemolojik inançların, yapılandırmacı öğrenim ortamının, fene yönelik tutumun, ön bilginin ve cinsiyetin öğrencilerin öğrenme yaklaşımlarındaki rolünü araştırmak amacıyla yapılmıştır.

Çalışma 2005-2006 eğitim yılının ilkbahar döneminde yapılmıştır. Çalışmaya, Ankara ilinin Çankaya ilçesinden rastgele seçilen yedi devlet okullarında öğretim gören 1152 sekizinci sınıf öğrencisi katılmıştır. Öğrencilerinin bilimsel epistemolojik inançlarını, yapılandırmacı öğrenim ortamı hakkındaki düşüncelerini, öğrenim yaklaşımlarını ve fene yönelik tutumlarını saptamak amacı ile sırasıyla Bilimsel Epistemolojik İnançlar Anketi, Yapılandırıcı Öğrenim Ortamı Ölçeği, Öğrenim Yaklaşımları Anketi ve Fene Yönelik Tutum Anketi uygulanmıştır.

Katılımcıların genel karakterleri betimleyici istatistikler kullanılarak analiz edilmiştir. Mevcut olan ve tercih edilen öğrenim ortamları arasındaki fark t-test kullanılarak hesaplanmıştır. Değişkenler arasındaki ilişki Pearson korelasyon, bu değişkenlerin öğrencilerin anlamlı ve ezbere öğrenim yaklaşımlarına olan katkısı Çoklu regrasyon analizi kullanılarak hesaplanmıştır.

T-test sonuçları mevcut öğrenim ortamlarının öğrencilerin tercih ettikleri öğrenme ortamlarıyla örtüşmediğini göstermiştir. Öğrenciler bilimi gerçek hayatla ilişkilendirebilecekleri, sınıfta iletişim kurabilecekleri, derste onlara daha çok yararlı olabilecek nelerin yapılabileceğine karar verebilecekleri, derste ne olup bittiğini rahatça sorgulayabilecekleri ve bilimsel bilginin oluşumunu yaşayabilecekleri fırsatların daha çok olduğu yapılandırıcı öğrenim ortamlarını tercih etmektedir. Pearson korelasyon analizi anlamlı öğrenme yaklaşımını benimseyen öğrencilerin bilimsel bilginin değişebileceğine inandıkları, fene karşı pozitif tutum geliştirdiklerini, ön bilgilerinin yüksek olduğunu ve öğrenim ortamlarını yapılandırıcı bulduklarını göstermiştir. Diğer taraftan, ezbere öğrenim yaklaşımını benimseyen öğrencilerin bilimsel bilginin kesin olduğu ve değişmediğine inandıkları, fene karşı pozitif tutum geliştirdikleri ve ön bilgilerinin düşük olduğu bulunmuştur. Ezbere öğrenim yöntemini benimsemiş öğrenciler öğrenme ortamlarını kontrolü paylaşma bölümü dışında yapılandırıcı bulmuşlardır. Mevcut öğrenim ortamları esas alındığında çoklu regrasyon analizi fene karşı tutumun anlamlı ve ezbere öğrenim yaklaşımlarını en iyi tahmin ettiğini göstermiştir.

Anahtar Kelimeler: Fene Karşı Tutum, Yapılandırıcı Öğrenim Ortamı, Cinsiyet, Öğrenim Yaklaşımları, Ön Bilgi, Bilimsel Epistemolojik İnaçlar.

To my family

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TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

LIST OF ABREVATIONS

DV	: Dependent Variable
IV	: Independent Variable
LAQ	: Learning Approach Questionnaire
SEB	: Scientific Epistemological Beliefs
SEBFIX	: Fixed Views of Scientific Epistemological Beliefs
SEBTEN	: Tentative Views of Scientific Epistemological Beliefs
LAQ	: Learning Approach Questionnaire
LAQ-M	: Meaningful Learning Approach
LAQ-R	: Rote Learning Approach
ATS	: Attitude towards Science
LA	: Learning Approaches
CLES	: Constructivist Learning Environment Survey
PR	: Personal Relevance
SN	: Student Negotiation
SC	: Shared Control
CV	: Critical Voice
U	: Uncertainty
ACLES	: Actual form of CLES
PCLES	: Preferred form of CLES
MRC	: Multiple Regression Correlation
SPSS	: Statistical Package for Social Sciences
M	: Mean
SD	: Standard Deviation
r	: Pearson Product-Moment Correlation Coefficient

CHAPTER 1

INTRODUCTION

This study is conducted to investigate eighth grade students' scientific epistemological beliefs, perceptions of the constructivist learning environment, attitude towards science, prior knowledge and gender as determinants of students' approaches to learning.

Learning approach in science education has received attention by the researchers for many years. In the literature, learning approaches was studied in combination with aptitude and achievement motivation, meaningful understanding, prior knowledge, gender, reasoning ability, academic achievement, cognitive styles, and mode of instruction (Cavallo & Schafer, 1994; Cavallo, 1994, 1996; Cavallo, Potter & Rozman, 2004; Cano, 2005; Williams & Cavallo, 1995; Diseth & Martinsen, 2003; Chan, 2003).

According to the cognitivist perspective, meaningful learning occurs when an individual confronts a problem, existing information is reorganized and the new information is built on the existing ones or the existing information is changed. It is accepted that if the new knowledge does not associate with the prior knowledge, rote learning occurs. Ausubel (1961, 1963) states that if the learner does not build new information, he/she memorizes the information which leads rote learning to occur. The students with high reasoning abilities and more meaningful approach had more sound understandings while those with low reasoning abilities and rote learning approach had misconceptions (Williams & Cavallo, 1995).

Learning approaches was investigated by researchers in relation with scientific epistemological beliefs (Tsai, 1997; Saunders, 1998; Chan, 2003; Cavallo et al., 2003, 2004; Cano, 2005). Epistemological beliefs can be defined as the views that are hold about the nature of knowledge including the purpose of science, sources of scientific knowledge, role of evidence and experiments, changeability of knowledge in science and coherence of scientific knowledge (Elder, 1999; Hofer &

Pintrich, 1997). Epistemological beliefs were found to influence achievement indirectly by means of effecting learning approaches (Cano, 2005). Research has shown that scientific epistemological beliefs play a significant role on the students' learning approaches. For example, Tsai (1997) found that the students who think deeply applied what they learned in everyday life and ask questions if they have a problem in understanding since it is their responsibility to learn science. On the other hand, empiricist students tended to listen the teacher carefully did more problem-solving practices as their responsibilities. This result indicated that the constructivist students employed more meaningful learning strategies in science while empiricist students had rote learning strategies. Cavallo, Potter and Rozman (2004) found out that rote learning was negatively correlated with tentative science beliefs for both boys and girls.

Scientific epistemological beliefs have also been a concern for the researchers (Conley, Pintrich, Vekiri & Harrison, 2004; Donn, 1989; Schommer, 1998). Scientific epistemological beliefs are considered as the views students hold about the nature of knowledge. Elder (1999) investigated the relationship between epistemological beliefs and learning. Educators believe that people's beliefs about the nature of knowledge in science may affect the way in which the person approaches the task of learning in science. When a student memorizes the knowledge in order to learn, the student is said to be a rote learner. If the student tries to understand the knowledge by relating it to other knowledge then the student is said to be a meaningful learner. The relationship between the scientific epistemological beliefs and the learning approaches of the students has also been a concern for the researchers due to its effect on academic achievement (Cano, 2005; Saunders, 1998). Findings indicate that using meaningful or rote learning approaches may be influenced by the epistemological beliefs of the students which in fact are affected by the learning environment.

With the assumption that epistemological beliefs as an important factor influencing learning environment, relationship between learning environment and students' scientific epistemological beliefs has also been investigated (Tsai, 2000). For example, Tsai (2000) noted that the teachers' organization of the knowledge and the activities in the lesson represent a model for the students while determining the scientific epistemological beliefs. As a result, the teachers should design such kinds of learning experiences that students are encouraged to enhance meaningful science learning. Moreover, he found that students having scientific epistemological beliefs more oriented to constructivist views of science suffered from the inadequacy of the learning environment so that they can co-construct knowledge. In other words, constructivist oriented students preferred more constructivist learning environments than they actually had.

Students' learning approaches has also been investigated in relation with learning environment. Since the researchers are interested in the learning approaches of the students, learning environment becomes important factor influencing the learning approaches of the students. Previous research has indicated that learners have preferences for their learning environments (Aldridge, 2000; Johnson & McClure, 2003). These preferences represent how learning occurs and the determinants of the factors that affect learning in the classroom. In other words, if the students perceive their learning environments positively, they learn better. In the literature learning environment has been studied both as a dependent and an independent variable (Ferguson & Fraser, 1998; Johnson & McClure, 2004; Kim, Fisher & Fraser, 1999; Lorsbach & Jinks, 1999; Petegem, Donche & Vanhoof, 2005; Tolhurst, 2007; Tsai, 2000, 2003). According to the constructivist perspective the students are co-constructors of the knowledge. As a result, the extent to which the learning environment is constructivist becomes important. *Constructivist Learning Environment Survey* (CLES) that was developed by Taylor and Fraser (1991) is used in order to measure the extent to which a learning environment is constructivist. The CLES has actual and preferred forms in order to measure the present environment that the students have and to see their ideal learning environments.

Another important constructs determined for science lessons are attitude towards science and gender which may affect the students' learning science. The importance of developing positive attitudes towards science has received attention by researchers (Freedman, 1997; Gibson & Chase, 2002). Gibson and Chase (2002) stated that attitudes towards science are developed early in children's education and it is difficult to change once they reach middle school. Freedman (1997) found out a positive correlation between the students' attitudes towards science and their course achievements. Moreover, Uzuntiryaki and Geban (2005) found that use of conceptual change texts result in producing positive attitudes towards science. Osborne (2003) also emphasized the importance of gender as influencing attitudes towards science. Jones, Howe and Rua (1999) found out that boys had more positive attitudes towards physical sciences due to the experiences that they have and the girls had more positive attitudes towards biological sciences due to their out of school experiences. The science instruction should be prepared in such a way that it should encourage both the boys and girls to develop positive attitudes towards science.

In line with these findings, the current study investigates the scientific epistemological beliefs, learning environment, attitude towards science, prior knowledge and gender as determinants of learning approaches.

1.1. Significance of the Study

The literature examined the variables of this study and revealed interrelations between the variables and found that these variables affected learning approaches of the students. However, majority of research on learning approaches, constructivist learning environment and scientific epistemological beliefs was conducted with college and high school students. In addition, learning approaches was studied in relation with learning environment and scientific epistemological beliefs separately. In this study, however, all the variables were investigated in relation with each other by using elementary students. Specifically, this study explores the determinants of learning approaches of the students. By knowing the determinants the teachers can plan instructional activities in such a way that the students learn meaningfully. Moreover, this study provides the teachers to have an idea about the students' perceptions of the actual learning environments of the students and their preferences. By being aware of the students' perceptions the teachers can plan instructional activities in such a way that the students learn meaningfully by holding positive attitudes towards science and believing that scientific knowledge is changing and evolving. This study, therefore provides opportunity to understand Turkish 8th grade elementary students' learning approaches, constructivist learning environments, scientific epistemological beliefs and their attitudes towards science deeply.

CHAPTER II

REVIEW OF RELATED LITERATURE

2.1. Introduction

In this chapter of the study, the previous studies concerning scientific epistemological beliefs, learning approaches, attitudes towards science and constructivist learning environments are examined.

2.2. Learning Approach

If a student memorizes the knowledge in order to learn then she/he is said to have a "*rote learning approach"*. In the case of dealing with a learning task in order to understand the relationship between the new information and old information, the student is said to have a "*meaningful learning approach"*. Williams and Cavallo (1995) defines meaningful learning as "the formation of viable relationships among ideas, concepts and information" (p.312). If the new knowledge does not associate with the existing knowledge, then rote learning occurs.

Several studies investigated the students' learning approaches (Cavallo & Schafer, 1994; Cavallo, 1994, 1996; Cavallo et al., 2004; Cano, 2005; Williams & Cavallo, 1995; Diseth & Martinsen, 2003; Chan, 2003). For example, Cavallo and Schafer (1994) explored whether meaningful learning is a distinct variable, independent of aptitude and achievement motivation that is related to students' understanding of meiosis, genetics, and the relationships between these topics. In their study, the researchers investigated the relationships and the possible predictive influence of meaningful learning orientation, relevant prior knowledge, instructional treatment and all interactions of the variables on students' meaningful understanding of the biology topics. The sample consisted of 140 tenth grade students attending a public, suburban high school in central New York State. A 24-item *Learning*

Approach Questionnaire was used in order to categorize the students as "more meaningful learners", "less meaningful learners", "less rote learners" and "more rote learners". Teachers of the students also rated their students according to their perception of each students' general approach to learning after participating training sessions. When students' self-ratings and teachers' observation based ratings were analyzed for matches and mismatches, 94 matches were found. As a result, 94 students out of 140 students were analyzed during the study. *Differential Aptitude Test* scores were obtained from the school guidance counselor in order to have information about students' abilities in a variety of areas of mental activity. A 30-item subscale of Likert *Achievement Motivation* was used in order to measure the students' motivation towards performance goals such as high grades, praise and favorable judgments of their work. *Mental Model Assessment* was used in order to assess the students' understanding about the meiosis, the use of Punnett-square diagrams and the relationships between the biological topic of meiosis and the use of Punnett-square diagrams. Students' responses were categorized as conceptual knowledge, process knowledge and procedural knowledge. Pretest mental models were used in order to assess the students' prior knowledge of meiosis, then the students were given instruction on meiosis and later on two types of typewritten self-tutorial instructional packets were randomly assigned to the students. One of the packets consisted of highlighted questions and problems about the relationships between meiosis and the Punnett-square method with the answers to the questions and the other packet consisted of the same questions and problems, however, students were wanted to generate the answers to the questions themselves. About 53 students had the reception form of instruction and 41 students had generative form of instruction. After the administration of the instructional packets, the students were given mental model post-test on meiosis, the Punnett-square method and the relationship between them. Results indicated that meaningful learning orientation was a factor that contributed to students' meaningful understandings independent of aptitude and motivation. Meaningful learning orientation and prior knowledge of meiosis were found to be the significant predictors of students' meaningful understanding of meiosis, the Punnet-square method and the procedural and conceptual relationships between the topics. Moreover, students' meaningful understanding of relationship statements was predicted alone by students' meaningful learning orientation. Both meaningful learning orientation-prior knowledge interaction and the meaningful learning orientation-treatment interaction were found to be the significant predictors of post-test scores on the Punnett-square method. It was also found that as the students' prior knowledge of meiosis increased students' scores on the meiosis post-test increased. When students had higher levels of prior knowledge, their meaningful learning orientation made less difference in their meaningful understanding of meiosis. Prior knowledge of meiosis had less impact on meaningful explanations of the Punnett-square method for mid-range learners than it did for either rote or meaningful learners. Moreover, mid-range learners were found to develop more meaningful understanding than rote learners when they had little prior knowledge. When the students had high levels of prior knowledge the understandings attained were similar for mid-range learners and rote learners. Mid-range learners developed more meaningful understanding of the procedural relationships when they had high prior knowledge when compared with both the meaningful and rote learners with high prior knowledge. It was also found that with high prior knowledge of meiosis, meaningful, mid-range and rote learners all attained more meaningful understanding of the conceptual relationship. When the prior knowledge was low, meaningful learners attained more meaningful understandings in relationship statements than mid-range or rote learners. When the prior knowledge was high, mid-range learners attained more meaningful understandings of the terminology-based relationships compared with meaningful or rote learners. In addition, post-test scores of the Punnett-square method were not found to be increased with the reception treatment when compared with the generative treatment. For meaningful and rote treatments for mid-range learners post-test scores of the Punnett-square method increased when they had reception treatment as compared to when they had generative treatment.

Studying with the same students, Cavallo (1994) examined 140 high school biology students' learning approaches with respect to gender in a suburban high school in New York State. During the study, the teachers rated their students as meaningful and rote learners based on the training sessions they participated. Results showed that the teachers viewed females as more rote learners and males as more meaningful learners when learning biology topics. The students were also given a 24-item *Learning Approach Questionnaire* to determine their own perceptions of how they learn. Results of the questionnaire indicated no significant difference between males' and females' learning orientations. Since the views of teachers and the students were different, the researcher used open-ended tests to investigate students' performance and multiple-choice tests to test the students' knowledge about various topics covered during the course. The results of the open-ended essays indicated that there is no difference in meaningful understanding based on gender. However, multiple choice tests indicated that males performed significantly better than the females.

In another study, Cavallo (1996) explored the relationships among students' meaningful learning orientation, reasoning ability and their meaningful understanding of genetics topics and ability to solve problems using Punnett-square diagrams. The subjects of the study were 189 tenth grade students enrolled in a college-entrance biology course at a Midwestern suburban school. The students were in one of the two biology teachers' classes; one of which were male and the other was female. Laboratory based, learning-cycle teaching procedure was used with the same instructional activities in both of the classrooms by the teachers. A 20-item Likert *Learning Approach Questionnaire* was used in order to assess the students' approach to learning ranging from meaningful to rote. In order to decide students' general level of cognitive operation ranging from concrete to formal, a 12-item multiple-choice, *Classroom Test of Scientific Reasoning* was used. Students' genetics knowledge was assessed by means of three tests; *Test of Genetics Meaning, Test of Genetics Problems* and *Mental Model Test.* One group pretest-posttest design was used during the study. In order to learn about the prior knowledge *Test of Genetics Meaning, Test of Genetics Problems* and *Mental Model Tests* were administered to the students before genetics instruction. Results of the pretest indicated that students had no prior knowledge about the topics. The students were given the same test as posttest after the instruction. Correlation analyses showed that students' meaningful learning orientation and reasoning ability was not correlated. It was found that both meaningful learning orientation and reasoning ability were positively correlated with the students' performance on *Test of Genetics Meaning* and *Test of Genetics*

Problems. Moreover, students' performance on *Test of Genetics Meaning* was found to be positively correlated with the performance on *Test of Genetics Problems*. Meaningful learning orientation was found to be positively correlated with all mental model test scores except for Punnett-square diagrams. Reasoning ability was not correlated with any of the mental model tests. Positive correlations were found between *Test of Genetics Meaning* and all mental model tests. There were also positive correlations between *Test of Genetics Problems* scores and all mental model scores except for the procedural relationship between meiosis and the Punnett-square diagrams. Stepwise multiple regression analyses showed that students' meaningful learning orientation and reasoning ability both predicted scores on the test of genetics meaning with meaningful learning explaining 13 % of the variance. Moreover, both reasoning ability and meaningful learning orientation predicted scores on the *Test of Genetics Problems* with reasoning ability explaining 9 % of the variance and meaningful learning orientation explaining 5 % of the variance.

In a similar study, BouJaoude and Giuliano (1994) investigated the relationships between students' approaches to studying, prior knowledge, logical thinking ability, and gender and their performance in a nonmajors' chemistry course. The sample of the study consisted of 220 students that enrolled in the second semester of a chemistry course. *Demographic Questionnaire* was used in order to collect information like gender, age, racial background, etc., *The Approaches to Studying Inventory* was used in order to measure the students' approaches to studying and *Test of Logical Thinking (TOLT)* was used to measure formal thought. The results of the study indicated that female students had higher meaningful orientation score than male students. Moreover, meaning orientation was found to be correlated with final exam for males but not for females. Multiple regression analyses showed that meaningful orientation, TOLT and prior knowledge were the predictors of the final exam scores by explaining the 32% of the variance in the final exam scores.

Williams and Cavallo (1995) explored the possible relationships between students' reasoning ability, meaningful learning approach and their understanding of physics concepts. The sample of the study was 41 students who enrolled in the fall semester of a first-level and a second-level physics course at a small Midwestern university. *Test of Logical Thinking* (TOLT) was used in order to determine the students' reasoning ability, *Learning Approach Questionnaire* (LAQ) was used in order to measure the students' approaches to learning, *Force Concept Inventory* (FCI) was used in order to determine the misconceptions that the students have about the Newtonian physics concepts. Researchers found out that TOLT and LAQ were positively correlated to physics understanding. In other words, the students that had higher reasoning abilities had greater understanding of physics concept so that they had fewer misconceptions and the students that have greater meaningful understanding had greater physics understanding. Moreover, the students with high reasoning ability and a more meaningful learning approach had more sound understandings, while those with low reasoning ability and a more rote learning approach had more misconceptions. When regression analyses were performed it was found that TOLT was the significant predictor of the misconceptions by explaining 37.3 %. On the other hand, LAQ was not the significant predictor of students' misconceptions.

Studying with 192 undergraduate psychology students Diseth and Martinsen (2003) analyzed the relationship between approaches to learning, cognitive style, motives and academic achievement. *Approaches and Study Skills Inventory for Students* was used in order to measure the learning approaches, *Need for Cognition* was used in order to determine the cognitive styles, *Assimilator-explorer styles* was used to characterize the students with assimilator style and explorer style and *Achievement Motivation Scales* were used to determine the *Academic Achievements* of the students. Significant positive relationships were found between the deep approach and assimilator-explorer styles, motive for success and need for cognition. On the other hand, negative correlations were found between the surface approach and assimilator-explorer styles, motive to avoid failure and need for cognition. Moreover, surface and strategic approaches to learning were found to be the best predictors of academic performance while deep approach did not predict achievement. Furthermore, styles and motives were found to have indirect effects on achievement through approaches to learning.

In a recent study, Yenilmez (2006) investigated the relative predictive influences of prior knowledge, meaningful learning orientation, formal reasoning ability and mode of instruction on understanding in photosynthesis and respiration in plants concepts. Photosynthesis and Respiration in Plants Concept Test, Test of Logical Thinking and Learning Approach Questionnaire was applied to 233 eighth grade students. The results of the study showed that students hold several misconceptions about photosynthesis and respiration in plants concepts and have a low level of conceptual understanding. The achievements of the students in the experimental group were found to be higher than the ones in the control group. Prior knowledge was the most important determinant of the students' ability to learn photosynthesis and respiration in plants than is formal reasoning ability in conceptual change classroom. Moreover, meaningful learning orientation accounted for a small amount of variance in conceptual change classrooms. In traditional classrooms, reasoning ability was the main predictor of achievement. Meaningful learning orientation was not found to contribute to achievement scores of the students in the traditional classrooms.

More recently, Başer (2007) investigated the contributions of learning motivation, reasoning ability, learning orientation and gender to International Baccalaureate and National Program students' mitosis and meiosis achievement. A total of 472 ninth grade students in Ankara participated the study. Data were collected by using *Students' Motivation toward Biology Learning Questionnaire*, *Test of Logical Thinking Ability*, *Learning Approach Questionnaire* and *Mitosis and Meiosis Achievement Test*. Multiple regression analyses showed that achievement was explained in positive direction by formal reasoning ability and in negative direction by active learning strategies and rote learning lerning in National Program classes. Self-efficacy and formal reasoning ability had significant contributions to achievement for International Baccalaureate students. The main predictor of achievement was formal reasoning ability for both International Baccalaureate and National Program students, explaining 4.7% and 10.9% variance respectively. All the students were found to use active strategies like finding relevant sources, discussing with other students and trying to form connections between new and previous knowledge. Moreover, the students also thought that the materials learned in biology lessons were relevant to their daily lives and beneficial for developing problem solving and inquiry skills while satisfying their curiosity. Furthermore, in National

Program classes rote learning was found to be negatively correlated with achievement.

To sum up, available studies generally revealed that meaningful learning orientations of the students predicted the students' meaningful understandings of the topics and their science achievements. Educators believe that people's beliefs about the nature of knowledge in science may affect the way in which the person approaches the task of learning in science.

2.3. Scientific Epistemological Beliefs (SEB)

Epistemological beliefs are the views that are hold about the nature of knowledge including the purpose of science, sources of scientific knowledge, role of evidence and experiments, changeability of knowledge in science and coherence of scientific knowledge (Elder, 1999; Hofer & Pintrich, 1997). Students may believe that the purpose of the science is to explain phenomena or to discover things. Sources of scientific knowledge can be aroused from thinking and reasoning or coming from an authority (e.g. teachers, books) (Elder, 1999; Schommer, 1989). Role of evidence and experiments depends on the students' understanding of the relationship between theory and evidence. About the changeability of science the students may think that scientific knowledge is tentative and can change by time or they can think that it is certain. Students' beliefs about the coherence of scientific knowledge may be understanding science as body of knowledge of interrelated concepts or separate pieces of knowledge.

Study on epistemological beliefs in learning began with Perry (1968) whose research was based on interviews with undergraduate college students for four years. Perry found out that many first year students believe in the simple, unchangeable facts that are handed by authority. Moreover, as the students reach the senior year they believed in the complex, tentative knowledge that derived from reasoning and inquiry. Perry hypothesized developmental positions that served as the path from being a dualistic thinker in early college years to being a committed relativistic thinker at the end of the four-year college experience. Thinking that Perry's theory has only one restrictive dimension while defining epistemological beliefs, Schommer

(1989, p.13) decomposed Perry's theory into three more-or-less independent beliefs about knowledge as; "a) knowledge is simple, b) knowledge is certain and c) knowledge is handed down by authority". She also emphasized the acquisition of knowledge to be considered. Based on the literature Schommer (1989), developed a test for five hypothesized epistemological dimensions of simple knowledge, certain knowledge, omniscient authority, quick learning and innate ability. In her study, the relationship between scores from the questionnaire and students' written conclusions for a passage and cued-recall for elements of the passage was examined. Sixty eight college freshmen and sophomores from an educational psychology class in a large Midwestern university enrolled the study. Half of the students were given a passage about aggression and the remaining half was given a passage about school achievement to read. It was found that the students who believed that knowledge is certain interpreted tentative information as absolute and the students who believed that learning is quick or not at all failed to integrate complex information. In the second part of the study, students' epistemological beliefs were assessed and related to students' characteristics after revising the epistemological beliefs questionnaire. Two hundred and sixty six students from a junior college and a large university in a Midwestern city participated the second part of the study. Moreover, a vocabulary test, survey of student characteristics and filler task was used with revised epistemological beliefs questionnaire (innate ability, simple knowledge, quick learning, certain knowledge). In the third part of the study, the sample was the ones that participated the first study. The purpose was to explore the relationship between students' epistemological beliefs and their comprehension. Aggression passage and another passage about vitamin B-6 were used. Findings indicated that the more students believed in certain knowledge, the more they wrote certain conclusions. Moreover, the more students believe in quick, all-or-none learning, the more likely they performed poorly on comprehension tests of passages. It was also suggested that beliefs in the nature of learning (Innate ability and quick learning), rather than beliefs in the nature of knowledge influenced students' self-assessment of their comprehension. Effect of prior knowledge on interpretation of information was found to be mediated by the epistemological belief of certain knowledge. The influence of prior knowledge on certain conclusions was mediated by the beliefs in certainty of knowledge. Belief in gradual learning lead to greater effort by the students, which in turn resulted in the students writing conclusions that elaborate on the complexity of passage information. Later Schommer (1990, p.498) defined epistemology as "A system of more-or-less independent beliefs." due to the fact that individuals might be sophisticated in some beliefs whereas not sophisticated in other beliefs. In 1990, Schommer proposed that personal epistemology should be considered as a set of different beliefs and she developed a questionnaire that assesses four beliefs of stability of knowledge, structure of knowledge, speed of learning and ability to learn. Again Schommer (1994) stated that researchers of personal epistemology are interested in what individuals believe about the source, certainty, organization of knowledge, control and the speed of learning. She concludes that epistemological beliefs are related to students' persistence, active inquiry, integration of information, and coping with complex and ill-structured domains. Moreover, she emphasizes the subtle, yet critical role of epistemological beliefs in learning. Later Schommer with Dunnell and Patricia (1994) compared the epistemological beliefs of gifted and non-gifted 1165 high school students. Epistemological beliefs questionnaire that was developed by Schommer (1989, 1990) was used in the study. One sample of gifted students and three samples of non-gifted students were randomly selected from the whole participants of the study. Results showed that there were no differences at the beginning of high school in students' epistemological beliefs. However by the end of high school gifted students were found to be less likely to believe in simple knowledge and quick learning while non-gifted students beliefs remained stable. Moreover, boys were more likely to believe in fixed ability and quick learning

Schommer and Walker (1995) investigated the domain generality of epistemological beliefs across two academic domains of social sciences and mathematics. The students were asked to complete the *Epistemological Beliefs Questionnaire* twice, once with the social sciences in mind and once with mathematics in mind. Moreover, the students were given two passages about social sciences and mathematics, on one of which the students were tested. Epistemological beliefs in both domains were found to predict passage comprehension. Schommer and Walker (1997) investigated the relationship between high students' epistemological beliefs and their attitudes towards education. One hundred and fifty-eight students from high school were assessed by *Epistemological Questionnaire* and open-ended questions that determined the students' valuing of school. Results showed that the students who believed in the fixed ability to learn thought that more hours of study needed to go to college. Moreover, the more the students believed in certain knowledge the more likely they reported that they were average students and believed the need to go to college arises from financial aid or work.

Schommer-Aikins and Hutter (2002) investigated the relationship between individuals' beliefs about the nature of knowledge and the nature of learning and their thinking about everyday controversial issues with a sample of one hundred and seventy four adults from Wichita, Kansas. Schommer's (1990) *Epistemological Beliefs Questionnaire* and two surveys assessing the thinking dispositions were used in the study. It was found that the more individuals believed in the complexity of knowledge, the more likely they were to acknowledge complexity of knowledge, to take on multiple perspectives, to be more flexible in their thinking, and to think in a time-consuming reflective manner. Moreover, the more individuals believed in the evolving nature of knowledge, the more likely they were to acknowledge multifaceted aspects of an issue and to recognize that today's answers may not be appropriate in the future. In short, these results suggest that there is a relationship between individuals' beliefs about the nature of knowledge and learning, a set of beliefs that is heavily influenced by education and higher order thinking in day-to-day life. None of the epistemological beliefs predicted thinking about omniscient authority. Furthermore, no relationship was found between a belief in quick learning and time-consuming reflective thinking. Although belief in complexity of knowledge predicted reflective thinking, belief in gradual learning did not. Women were more likely to display higher order thinking by having a stronger propensity to embrace the complexity of issues and to consider multiple perspectives.

Neber and Schommer-Aikins (2002) investigated the isue of self-regulated learning among highly gifted ninety three elementary and forty hgh school students in science. *Motivated Learning Strategies Questionnaire, Personal Goals Scale, Epistemological Beliefs Questionnaire* and *Classroom Environment Scale* was used in the study. High school students were found to aim at acquiring more applicable knowledge than the elementary students. Moreover, high school students were not more advanced than the elementary level. In addition, high school students' learning environment was found to offer less opportunity for their own investigations than did science classrooms at elementary levels. Furthermore, gender-related differences in epistemological beliefs were restricted to the beief in quick learning which was stronger for boys than for girls. Generally boys were found to hold naive beliefs in quick learning, whereas epistemological beliefs were weaker with high school girls compared to elementary school girls.

Schommer-Aikins, Duel and Barker (2003) examined the students' epistemological beliefs across domains that varied according to Biglan's classification of academic disciplines. One hundred and fifty fifty-two university students completed three domain specific epistemological beliefs questionnaires for mathematics, social sciences and business. Results indicated that both social science epistemological beliefs and business epistemological beliefs predicted mathematical epistemological beliefs. When the amount of academic experience was taken into account it was found that students with low academic experience the students generalize the epistemological beliefs they had developed across all the domains. On the other hand, as the students gained more academic experience in domains of interest, they began to develop differences between their emerging epistemological beliefs in their domain of interest and their general epistemological beliefs developed from childhood.

More recently, Schommer-Aikins (2008) investigated university students' beliefs about the nature of mathematical knowledge and learning. Twenty undergraduate students from an introductory psychology class and four mathematicians were interviewed. Five epistemological dimensions were examined based on the Schommer's (1994) study. Students' epistemological beliefs were found to develop in synchrony. In other words students were found similar to mathematicians in their beliefs about learning. In contrast, students were not sophisticated compared to mathematicians in their beliefs about the structure and stability of knowledge.

Many studies investigated students' epistemological beliefs (Tsai, 1997; Elder, 1999; Conley et al., 2004; Cano, 2005; Cavallo et al., 2003, 2004; Chan, 2003;

Pomeroy 1993). For example, Elder (1999) focused on the fifth grade students' epistemological beliefs. Epistemological beliefs were investigated in five dimensions including the purpose of science, changeability of science, role of experiments in developing scientific theories, coherence of science and source of science knowledge and the relationships between the constructs. About 211 fifth grade students (57% male, 43% female) in Southern California participated in the study. Science instruction was based on inquiry model of learning. The questionnaire used to measure the epistemological beliefs of the students contained two parts. In part I, the students were expected to express their understandings about the purpose of science by means of three open-ended items. Part II contained 25 Likert-scaled items that explored specific epistemological beliefs of the students. The questionnaire was administered during the third week of a nine week hands on science unit. When the students were asked about their thoughts of what science is, 4.3% of the students explained the purpose of science as explaining phenomena or figuring out how things work and these responses were assumed as good definitions that showed that the students had sophisticated understanding of science. About 33 % of the students mentioned the purpose as promoting a process of learning in which new knowledge is acquired or discoveries are made and these responses were also assumed to be the good definitions showing the sophisticated understanding of the students. Forty five percent of the students explained purpose as performing activities and these responses were assumed as fair definitions with unclear understanding of science. Only 16.6% of the students mentioned the purpose as completing a task and 1.9% gave vague responses to the question, all of which were assumed as poor definitions with unrelated ideas of giving value for science. Opposite to the expectations of the researcher, most of the students were not found to be holding sophisticated beliefs about the purpose of science, 75% of the students were found to be holding fair or poor understanding of the purpose of the science. Students were also asked about the sources of their ideas and scientists' ideas for doing science. The responses of the students were grouped based on whether their sources stemmed from an active or passive agent and whether their sources stemmed from independent or dependent endeavors. Results showed that 66% of students generated passive types of source such as books, teachers, family members or their mind or brain. About the scientists' ideas largest proportion of the students named active endeavors. About 10% of the students named both active and passive sources for their own and scientists' ideas. Passive sources for scientists' ideas were named by 42% of the students. "Brain" was the largest passive source followed by books and other people. Students were also found to hold more sophisticated responses when they are asked about the scientists' ideas than when asked about their own due to the fact that they consider the experts not their works in the school. Students who gave independent sources for their own ideas also gave independent sources for scientists' ideas and the ones that gave dependent sources for their own ideas gave dependent sources for the scientists' ideas. The researcher also found out that students showed similar responses to the open-ended items with except that greater percentage of girls than boys supplied dependent endeavors or both dependent and independent endeavors as sources for science and the percentage of the students reporting active sources for their own ideas in science varied by the ethnic group. When the 25 Likert-scaled items were analyzed three scales (change, authority, reason) were emerged from the data. Students agreed that knowledge arises from testing and thinking, scientific knowledge develops over time and disagreed that scientific knowledge comes from authority. It was also found that students hold similar epistemological beliefs regardless of their gender or ethnicity regarding authority, changeability and reasoned efforts in science. To conclude, the students' individual epistemological beliefs were found to be a mixture of naïve and sophisticated understanding. The students having more sophisticated views about the purpose of science view scientists as active agents in recreation of scientific ideas. They also viewed scientific knowledge as changing over time and arising from reasoning and testing. Students who believed that they were active seekers of science hold similar beliefs about the nature of scientists' sources. The students who believed in the changeability of science knowledge also believed that knowledge derived from thinking and testing and they believed that knowledge does not come from teachers and experts. The researcher also broadened the study by investigating the relationship between epistemological beliefs of the students and science learning. Elementary students who hold more sophisticated epistemological beliefs were found to perform better on assessment of circuits and electricity than did students who held less sophisticated beliefs.

In another study, Conley et al. (2004) examined the changes in epistemological beliefs of 187 fifth grade elementary students in relation to gender, ethnicity, socioeconomic status (SES) and achievement in nine week hand-on science unit. Conley and her colleagues used Elder's instrument that measured the epistemological beliefs of the students with four dimensions of (1) Source (beliefs about knowledge residing in external authorities); (2) Certainty (belief in a right answer); (3) Development (beliefs about science as evolving and changing subject); (4) Justification (role of experiments and how individuals justify knowledge). Information about gender, ethnicity, SES and achievement was collected from school results. Achievement scores were obtained by combining math and reading achievement test scores from the Stanford Achievement Test. Epistemological beliefs of the students were measured first at the beginning of the unit and second after completing the unit in order to see the changes. The researchers found out that students who had higher levels of achievement also had more sophisticated epistemological beliefs. Moreover, it was seen that students' epistemological beliefs changed during the instruction in such a way that the students had more sophisticated beliefs at the end of the unit. Gender, ethnicity and SES were no found to moderate the change in the epistemological beliefs of the students during the course of the study. The researchers suggested that students in constructivist learning environments developed more sophisticated epistemological beliefs compared with the ones in traditional classrooms. Although the students scored significantly higher on certainty and source scales, changes over time for development and justification were no longer significant when group differences and achievement were accounted for. Boys and girls were not different in terms of their thinking about the source of knowledge, the certainty of knowledge or development and justification of knowledge. However, the results also showed strong SES differences in students' beliefs. Lower SES students had less sophisticated beliefs. However, there were no differences in change over time by SES so SES did not moderate the general change in epistemological beliefs. Moreover, higher achieving students had more sophisticated beliefs.

In another study, Schommer-Aikins and Easter (2006) investigated 107 college students' ways of knowing and epistemological beliefs in order to obtain a more complete understanding of personal epistemology. *Attitude Toward Thinking and Learning* instrument was used in order to measure the ways of knowing and *Kardash Epistemological Belief* scale was used in order to measure the epistemological beliefs. A reading comprehension test and final grades were used in order to measure academic performance. Both men and women were found to have significantly higher "connected knowing" scores than "separate knowing" scores. In addition men were found to have significantly higher score in "separate knowing" than female. Both "connected knowing" and "separate knowing" were found to be significantly correlated with speed, construction and the final course grade. Among the epistemological beliefs, only speed was correlated with reading comprehension and the final course grade so speed was used to represent epistemological beliefs in the pathway analyses. Two hypothetical paths were tested. Direct paths between ways of knowing and academic performance were not significant. On the other hand, paths from ways of knowing to speed learning and from speed of learning to academic performance were significant. These results suggested that ways of knowing may have an effect on academic performance due to speed of learning.

For his study of beliefs of scientists, secondary and elementary science teachers about the nature of science, Pomeroy (1993) used a survey in which there were three clusters namely traditional views of science, traditional views of science education and nontraditional views of science. The participants were a group of Alaskan research scientists and secondary science and elementary teachers in Alaskan cities who responded to the survey by mailing. Results indicated that scientists had more traditional views of science than all teachers combined. Moreover, all men, participated in the study, had more traditional views of science than all women. The combined group of teachers had more traditional views of science education than did the scientists. Men also had more traditional views of science education than women and secondary teachers had more traditional views of science education than elementary teachers. Women had higher non-traditional views of science than men and elementary teachers scored higher than secondary teachers.

Moreover, a weak but significant negative correlation was found between the traditional science and nontraditional science clusters (r = -0.25, p = 0.0008).

Chai, Khine and Teo (2006) investigated epistemological beliefs of 537 pre-service teachers in Singapore. Epistemological Beliefs Questionnaire that was adapted from Schommer's Questionnaire was used in order to gather data. Results showed that pre-service teachers in Singapore hold the strong belief that effort is required to acquire knowledge. Besides, they were found to believe in the experts' assessment as being correct although they did not believe that knowledge is stable and unchanging. Pre-service teachers in the "hard" subjects such as mathematics or sciences treated the contents as more certain than the ones in "soft" subjects like humanities and languages. It was also found that females were less likely than males to have naïve beliefs in fixed ability or quick learning, while females were more likely than males to have naïve beliefs in simple knowledge. In other words, female pre-service teachers were epistemologically less sophisticated than their male counterparts. Moreover, no significant differences were found for epistemological beliefs and teaching experience.

In Turkey, there are also numbers of studies conducted about the epistemological beliefs (Kızılgüneş, 2007; Kaynar, 2007). For example, Kızılgüneş (2007) investigated the predictive influences of epistemological beliefs, achievement motivation and learning approaches on sixth grade students' achievement in classification concepts. The sample of the study included 1041 six grade students. Turkish versions of Learning Approach Questionnaire, Epistemological Beliefs Questionnaire, Achievement Motivation Questionnaire and Classification Concept test were used during the study. Results showed that students mostly believed in the tentative nature of science. In other words, they thought that science is an evolving process that is constructed. Moreover, it was also found that students mostly used meaningful learning approaches when studying science. The students also had the desire to learn something new. A positive correlation was found between students' learning approaches, epistemological beliefs and learning goal orientations. Students' achievement scores were found to be correlated with their goal orientations, epistemological beliefs and learning approaches. About 12% of the variance in students' achievement in the classification concepts was best explained by learning approaches of the students and 2% of the variance was explained by the epistemological beliefs of the students.

To sum up, these studies show that purpose of science is not fully understood by the students. Students' epistemological beliefs have been found as a mixture of naïve and sophisticated understanding. Although the students agreed that knowledge arises from testing and thinking, scientific knowledge develops over time and disagreed that knowledge comes from authority they considered sources of knowledge mostly as books, teachers or family members (passive types of sources). In addition, investigations showed that students that had higher levels of achievement had more sophisticated epistemological beliefs. Type of instruction used in the lessons can also change the epistemological beliefs of the students. Students that are in constructivist learning environments have greater chance to develop more sophisticated epistemological beliefs compared with the ones in traditional learning environments. In the literature not only the students' epistemological beliefs were investigated but also the college students', pre-service teachers', teachers' and scientists' epistemological views were investigated. When gender effect was examined, it was seen that in some cases epistemological views changed based on gender, however in some cases it did not have any significant effect.

With the assumption that learning approaches as an important factor influencing learning environment, relationship between learning environment and students' learning approaches has also been investigated by the researchers.

2.4. Learning Environment

In the literature, educators mainly talk about the students, the teachers and the learning environment. Since the students are wanted to learn science meaningfully in the school, the environment that the students learn plays an important role. Learning environment, in fact, involves the students, the teachers, the content that the students need to explore and the teaching methods that are used in order to make the students discover the knowledge by means of learning activities. The learning environment determines the students' cognitive and affective outcomes directly so that it becomes the most important determinant in education.

First studies related with the learning environment were conducted by Hartshorne and May (1928) and Newcomb (1929). Their common idea was that student behavior could be changed by the environment. Lewin (1936) stated that both the environment and its interaction with personal characteristics of the individual are the determinants of human behavior. Lewin defined human behavior (B) as a function of two interdependent influences, the person (P) and the environment (E) in Lewinian formula as B = f (P, E). Later, Moos (1976, p.29) stated five conceptions of how the environment worked as follows:

> … 1. from the perspective of evolution and human ecology, that environments can be limiting on the actions of people;
> 2. from the perspective of social Darwinism, the environments choose, or favor people by those with stronger characteristics;
> 3. that environments motivate and challenge individuals, facilitating individual and social growth in terms of the development of civilizations;
> 4. from a social ecological approach, that individuals seek information about environments in order to select those with the greatest probability of success; and
> 5. that individuals seek increase their control over environments in order to increase individual freedom.

Several years later, Moos (2002) defined organizational environment system domains in social ecology in terms of three dimensions as *the Relationship Dimension*, *the Personal Growth Dimension* and *the System Maintenance and Change Dimension*. Personal Relationship Dimension was related with the extent to which people worked with and assisted one another. Personal Development Dimension was characterized by personal growth and self-enhancement opportunities offered by the environment. System Maintenance and Change Dimension was defined by the degree of control of the environment, the orderliness, clarity in expectations and responsiveness to change.

Fraser (1994) emphasizes that the educators conducted lots of studies concerning conceptualizing and assessing the learning environment and researching its effects. Later, Fraser (1998) emphasized the remarkable improvements in the studies concerning the learning environment. There are three common approaches to studying learning environment including systematic observations, case study, and assessing student and teacher perceptions. Student and teacher perceptions are mostly measured by paper-and-pencil perceptual measures since they are more economical than classroom observation techniques and they are based on students' experiences over many lessons while the observational data are restricted to the number of lessons observed. In order to evaluate the learning environment qualitative research methods, quantitative research methods and the combinations of quantitative and qualitative methods have been used together (Aldridge et al., 2000). As Fraser (1998) emphasized the instruments used to assess the learning environment in the history are available, economical, valid and widely-applicable. Table 2.1. gives information about the nine major instruments. The studies were performed to find out the learning environment in which the students can have higher performance. Literature reviews also showed that learning environment was used as dependent and independent variables in lots of research (Ferguson & Fraser, 1998; Fraser, 2002; Karagiannopoulou & Christodoulides, 2005).

Early questionnaires include the *Learning Environment Inventory* (LEI), and the *My Class Inventory* (MCI). MCI is the simplified version of the LEI which assumes that the students are the determinants of learning environment as well as the teacher (Anderson & Walberg, 1974). *College and University Classroom Environment Inventory* (CUCEI) focused on the perspectives at post-secondary school levels and *Individualised Classroom Environment Questionnaire* (ICEQ) used in order to distinguish individualized classrooms from conventional ones.

A distinctive feature of mode of the learning environment instruments is that they do not have a form that measures the actual learning environments; they also have forms that measure the preferred learning environments. For example, *Constructivist Learning Environment Survey* (CLES) has two forms of actual and preferred. Actual form of CLES measures the extent that a classroom is constructivist and the preferred form measures the extent of the constructivist learning environment that students prefer. Since the wordings of the actual and preferred forms are similar although the instructions for answering them are different. The studies in the literature showed that students preferred more constructivist learning environments than they actually had (Kim & Fisher, 1999; Tsai, 2000).

Table 2.1. Overview of scales contained in nine classroom environment instruments (LEI, CES, ICEQ, MCI, CUCEI, QTI, SLEI, CLES and WIHIC)

Instrument	Level	Items per scale	Scales classified according to Moos's scheme		
			Relationship dimensions	Personal development dimensions	System maintenance and change dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material environment Goal direction Disorganisation Democracy
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher support	Task orientation Competition	Order and organisation Rule clarity Teacher control Innovation
Individualised Classrom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Elementary	6 – 9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalisation Involvement Student cohesiveness Satisfaction	Task orientation	Innovation Individualisation
Questionnaire on Teacher Interaction (QTI)	Secondary/ Primary	8 – 10	Helpful/friendly Understanding Dissatisfied Admonishing		Leadership Student responsibility and freedom Uncertain Strict
Science Laboratory Environment Inventory (SLEI)	Upper Secondary/ Higher Education	7	Student cohesiveness	Open-Endedness Integration	Rule clarity Material environment
Constructivist Learning Environment Survey (CLES)	Secondary	7	Personal relevance Uncertainty	Critical voice Shared control	Student negotiation
What is Happening in this Classroom (WIHIC)	Secondary	8	Student cohesiveness Teacher support Involvement	Investigation Task orientation Cooperation	Equity

Source: Fraser (1998, p.10)

Although limited, there are some studies conducted in Turkey about the learning environment. For example, Rakıcı (2004) investigated eighth grade students' perceptions of the science learning environment and teachers' interpersonal behavior, and the relationships of these with students' cognitive and affective outcomes. *Questionnaire on Teacher Interaction*, *What is Happening in This Class?* Questionnaire and *Science Attitude Scale* were used during the study in order to gather data about the teacher communication style, classroom learning environment and attitudes of the students towards science, respectively. The sample consisted of 722 students in Yenimahalle, Ankara. Results indicated that students generally perceived a positive science classroom learning environment. Moreover, students perceived their teachers as displaying cooperative behaviors in terms of the interaction between the students and the teachers. In addition, positive correlations were found between students' attitudes towards science and students' perceptions of the learning environment; students' science achievement and students' perceptions of their learning environment; science achievement and their science teachers' interpersonal behavior. Furthermore, girls had more positive perceptions about their learning environment and teachers' interpersonal behavior compared to the boys. Besides, the students viewed science learning environment of their male teachers' classes more cooperative than female teachers' classes. Students also perceived their teachers as displaying cooperative behaviors rather than opposition behaviors.

A similar study was performed by Telli (2006). The researcher investigated Turkish secondary school students' perceptions of their science teachers' interpersonal behavior; teacher profiles and variables affecting Turkish students' perceptions of their science teachers' interpersonal behaviors. Differences in perceptions between Turkish students and their Dutch counterparts were also examined. The participants of the study were 7484 secondary school science students (grades 9-11) in thirteen cities of Turkey. QTI and *Test of Science Related Attitudes* (TOSRA) were used in order to gather data. Students' had positive perceptions of teacher interpersonal behavior. Students generally perceived more dominance than submissiveness and more cooperation than opposition in their classes. Teachers' self and ideal perceptions were higher on both dimensions than students' as other studies investigating difference between student and teacher perceptions. Significant differences were found between countries in terms of students' perceptions of their teachers' interpersonal behaviors as well as different distribution of teacher profiles. When the profile of the Turkish teacher with Dutch and US/Dutch sample were compared more Directive, Authoritative and Tolerant/Authoritative teachers were found in Turkish sample. The large Dutch sample contains more Authorities classes and US/Dutch sample contains more Tolerate. Turkish teachers were perceived higher on Influence and Proximity than Dutch colleagues. In both countries students had positive perceptions towards their science teachers. It was also found that students' perceptions of their teachers' interpersonal behavior were related to their effective learning outcomes, to several student, class and teacher background characteristics and to the subject taught.

To sum up, students' perceptions and preferences about their learning environment has been a lot interest for the researchers. The effect of gender to the perception has also been a lot concern (Fraser & Tobin, 1989; Chang & Tsai, 2005; Johnson, 2006; Chang & Barufaldi 2006). Different learning environments like technology based or problem-based, inquiry-based learning environments were created to see the effect of the environment on the students' achievements (Wang & Thomas, 2007; Benson & Mekolichick, 2007).

2.4.1. Constructivist Learning Environments

As the constructivists see the students as the co-constructors of knowledge, they give importance to the perceptions of the students about the learning environment to see the extent to which the constructivist approaches are met in the learning environment. According to constructivist view, meaningful learning is a cognitive process in which individuals make sense of the world in relation to the knowledge which they already have constructed by active negotiation and consensus building.

In order to measure the extent that a classroom learning environment is constructivist, the Constructivist Learning Environment Scale (CLES) was used. The CLES assessed the personal relevance (extent to which teachers relate science to students' out of school experiences), student negotiation (extent to which opportunities exist for students to explain and justify to other students their newly developing ideas and listen and reflect on the viability of other students' ideas), shared control (extent to which students are invited to share with the teacher control of the learning environment, including the articulation of their own learning goals, design and management of their learning activities and determining and applying assessment criteria), critical voice (extent to which a social climate has been established in which students feel that it is legitimate and beneficial to question the teacher's pedagogical plans and methods and to express concerns about any impediments to their learning), and uncertainty (the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory dependent inquiry, involving human experience and values, evolving and non-foundational, and culturally and socially determined).

The original version of CLES (Taylor & Fraser, 1991) was developed to assist researchers and teachers to assess the degree to which a particular classroom's environment is consistent with a constructivist epistemology. It also aims to assist teachers to reflect on their epistemological assumptions and reshape their teaching practice. It has 36 items with five response alternatives ranging from "Almost Never" to "Almost Always". The CLES had two forms; one the actual form that represents the students' perceptions about their learning environments and the other preferred form that represents the students' preferences about their ideal learning environments.

There have been many studies in the literature concerning the validation of the CLES so that it can be used in order to see the extent that a classroom learning environment is constructivist in different countries (Kim, Fisher & Fraser, 1999; Nix, Fraser & Ledbetter 2003; Johnson & McClure, 2004). For example, Kim et al. (1999) investigated the validity of the Korean version of the CLES, the learning environment in the science classes and the students' attitudes towards science. The CLES was administered to 1083 students in 12 different schools. One 10^{th} grade class and one 11^{th} grade class were sampled. Actual and Preferred forms of the CLES that has five scales with 30 items and seven-item "Attitude to this class" based on the *Test of Science Related Attitudes* were used during the study. Korean version of the CLES was found to be valid and reliable to be used. Tenth grade students were found to perceive their learning environment as more constructivist than the 11th grade students that studied academic-centered science curriculum showing that the reform in the curriculum produced positive effects. In addition, 10th and 11th grade students were found to prefer more constructivist learning environments than they actually had. Moreover, a statistically significant relationship was found between classroom environment and student attitudes.

In another study, Nix et al. (2003) reported on the validity and use of a new form of the existing Constructivist Learning Environment Survey, comparative student version (CLES-CS). It was developed to evaluate the impact of an innovative teacher development program in public/private school classrooms. CLES-CS had five point responses. It was administered to 1079 students in 59 classes in North Texas to assess the degree to which the principles of constructivism were implemented in the class taught by their current teacher relative to classes taught by other teachers in their school. The data obtained supported the factorial validity of the five-scale comparative student version of the CLES-CS. The results suggested that each scale assess a unique dimension and, nearly all scales of CLES-CS are able to differentiate between the perceptions of students in different classes. Results indicated small differences between scores for THIS and OTHER on Critical Voice, Shared Control and Student Negotiation scales suggested consistent perceptions about administrative policy and classroom management policy. Moreover, students perceived the ISLE (Integrated Science Learning Environment) science classrooms as more relevant and uncertain in terms of content. In addition, students of the science teachers who attended other field trip programs (non-ISLE) perceived their science classrooms as slightly more constructivist than did students of the ISLE science teachers for two scales (Critical Voice and Student Negotiation). Moreover, students perceive the science classrooms of ISLE teachers as more relevant and the topic more uncertain than do students in classrooms of teachers who attended other field trip programs. In summary, the ISLE program was effective in terms of the degree of implementation of constructivist teaching approaches in teachers' public/private school classrooms for the ISLE science teachers, as perceived by their respective students. To sum up, factor structure, internal consistency reliability, discriminant validity and ability to distinguish between different classes were supported for the CLES-CS (THIS and OTHER) with the sample of 1079 students. The overall results validate use of the CLES-CS with students in public/private schools in Texas. ISLE program provided an opportunity for teachers to gain organized knowledge to make practical changes in their school classrooms. CLES-CS also provides complementary means of evaluating the degree to which students feel that the principles of constructivism have been implemented in the class taught by their current teacher relative to classes taught by other teachers in their school.

Johnson and McClure (2004) investigated the use of an existing instrument, the CLES for providing insights into the classroom learning environments of beginning science teachers by computer-scorable answer sheets. Participants were also asked to record, directly on the survey, comments about items that they felt were difficult to understand. Results showed that CLES provided valuable information but that, for use with teachers, it needed to be revised to reduce redundancy and eliminate confusing items. A decision was made to keep the five scales but to reduce the number of items in each to four. Some items were also rewritten to ensure that different aspects of each scale's construct were addressed. Revised form of the CLES contained 20 items. Revised CLES was used in subsequent years of the Teacher Research Network (TRN) study which aims to build pictures of the classrooms of the beginning teachers. Results were for a student sample rather than for the teacher form of the CLES. Results indicated that good internal consistency for the student form, with the same item and scale structure as is found in the teacher form.

Cross national studies have also been performed in the literature about the constructivist learning environments (Aldridge et al. 2000; Dorman et al., 2001). For example, Aldridge et al. (2000) studied on the validation and use of English and Chinese versions of the Constructivist Learning Environment Survey (CLES) in a cross-national study of high school science classrooms in Australia and Taiwan. The CLES was administered to 1081 students from 50 classes in Australia and 1879 students from 50 classes in Taiwan. Thirty item CLES with five scales (Personal Relevance, Student Negotiation, Shared Control, Critical Voice and Uncertainty) with a five point response ranging from "Almost Always" to "Almost Never" was used in the study. Moreover, in order to measure the satisfaction of the students about the science classes, an eight-item scale, *Test of Science Related Attitudes*

(TOSRA) was used. Away from the quantitative methods used in the study, qualitative methods were also used. The researchers observed the classrooms and interviewed with the students and the teachers in both of the countries. By this way the quantitative data gained more meaning. Quantitative data analysis showed that science classrooms in both of the countries have given similar emphasis to constructivist learning environment where students from Taiwan perceived the scales of Personal Relevance, Uncertainty and Shared Control as occurring more frequently in their science class and students in Australia perceived the scales of Critical Voice and Student Negotiation as occurring more frequently. Moreover, each of the constructivist dimensions measured by the CLES occurs "Sometimes" in each country. T-tests for independent samples indicated that there was a statistically significant difference between countries for all five scales of the CLES. Moreover, students in Taiwan had a more positive attitude towards their science class than did students in Australia. Furthermore, simple correlation analyses for Taiwan and Australia indicated that all five of CLES scales were statistically significantly associated with student attitudes towards their science class at both the individual and class mean levels of analyses. In addition, the quantitative data supported the cross-cultural validity of the CLES. When the qualitative data were used in order to interpret the quantitative data more meaningfully, it was seen that in some cases the qualitative data supported the quantitative data and in some it did nor due to the cultural differences. As a result, the researchers advised to take into account the cultural differences while interpreting the data gathered by CLES.

In another study, Dorman et al. (2001) conducted a study in order to validate scales from the *What is Happening in this Class (WIHIC)* and *Constructivist Learning Environment Survey* questionnaires in mathematics classes in Australia, Canada, and the United Kingdom and to examine differences in students' perceptions of mathematics classroom environment according to country, grade level and gender. The sample was 3602 students from 9 Australian, 4 Canadian, and 16 British high schools with grades of 8, 10 and 12. Since the WIHIC was not designed to assess constructivist classroom environments, 7 scales from the WIHIC (42 items) and 3 scales from the CLES (18 items) were combined in the study; with each item having 5-point response from "*Almost Never*" to "*Almost Always*". All scales were found to have good internal consistency for both the individual and school grade mean as units of analyses ranging from .76 to. 93 for both the individual and school grade mean as units of analysis. Results showed that the environment in mathematics classes in these three countries differed significantly on 5 scales; Teacher Support, Investigation, Task orientation, Equity and Personal relevance. Canadian students perceived higher levels of Investigation and Personal Relevance than Australian and British students. Equity was higher in the British schools than in Australian schools. In terms of Investigation, Task Orientation Personal Relevance, and Shared Control scales, 8th grade students held more positive perceptions than did the 10th and 12th grade students. It showed that as grade increased the perceptions of Investigation, Task Orientation, Personal Relevance, and Shared Control decreased. It was also found that, in general, female students perceived their mathematics classrooms more positively than did male students.

In a study, Chang and Tsai (2005) investigated the effects of a teacher-centered versus student-centered computer-assisted instruction on 10th grade earth science students' learning outcomes. Moreover, researchers explored whether the effects of different forms of computer-assisted instruction on student learning outcomes were influenced by the students' preferences of the learning environment. The participants were 347 tenth grade students and two earth science teachers. In order to measure the learning outcomes *Earth Science Achievement Test* and the *Attitude Toward Earth Science Inventory* were developed. Achievement test and Attitude inventory were both administered to the students at the beginning and end of the study. Chinese version of the *Constructivist Learning Environment Survey* was used in order to determine the students' preferences abut the learning environments. Teacher centered computer-assisted instruction emphasized direct guidance and presentation, occasional demonstrations and clear explanations of important concepts to the students given by teachers in earth science classes. A software was used by using a high speed computer and a high-resolution projector. In contrast, the student-centered computer assisted instruction was based on the students' self learning by using the software on their individual computers. Two hundred sixteen students were assigned to the traditional group and 131 students were assigned to the experimental group. Pretest data showed that all groups had approximately the same achievement and attitude. Results indicated that the treatment did not play a role in students' achievement. Moreover, it was also found that students in the traditional group attained better attitude than the student centered computer assisted group after the instructional treatment. The regression analyses revealed that achievement pretest scores was the only significant predictor in explaining students learning outcomes in achievement and attitude pretest scores was the significant predictor of the students' attitudes. Moreover, less constructivist-oriented students receiving the teacher-centered strategies appeared to increase more positive attitudes compared to students taught by the student-centered instruction; while the more constructivist-oriented students seemed to benefit more from the teacher-centered condition.

Later Arısoy (2007) conducted a study that examined the relationship between the elementary students' perceptions of the science classroom environment, their adaptive motivational beliefs and their attitudes towards science. The sample consisted of 956 eighth grade students in Çankaya, Ankara. *Constructivist Learning Environment Survey* (CLES), *Test of Science Related Attitude* (TOSRA), and M*otivated Strategies for Learning Questionnaire* (MSLQ) were administrated to the sample. All constructivist learning environment variables and all the motivational beliefs variables were found to be positively correlated with each other. Besides, all constructivist learning environment variables was positively related with each other. Results also showed that girls had more personal relevance and critical voice than boys. Girls were also found to have higher levels of intrinsic goal orientation, control of learning belief and task value than boys. In addition, girls were found to have higher science attitudes, enjoyment of science lesson, leisure interest in science and career interest in science than the boys.

To sum up, studies on constructivist learning environment showed that there is a positive relationship between constructivist learning environment and attitudes towards science.

2.5. Attitude towards Science and Gender

Based on the need to meet the economic, environmental and technological improvements, the governments aimed to increase the people's interest in science so that they can have a place among the developed countries. This aim leads education researchers to investigate attitudes towards science. The first thing to be investigated was the definition of the term “attitude”. Fishbein and Ajzen (1995) pointed out that *“Attitude can be described as a learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object”* (p. 6). According to the researchers attitude was an important factor while determining the behaviors. Kind et al. (2007) defined attitude as “*the feelings that a person has about an object, based on their beliefs about that object.”*(p.873). Furthermore, he defined attitude towards science as “*cognitive and emotional opinions about various aspects of science*” (p.873). Osborne (2003) defined “attitude towards science” as the “feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves” (p.1053).

The measurement of “attitude” has also been the concern for the researchers. Mostly, attitudes have been measured by means of questionnaires consisting of Likert-scale items. The statements reflected either favorable or unfavorable attitude to the objects being studied. Osborne (2003, pp.1055-1059), reviewed types of measurements of attitudes in the literature as;

1. Subject preference studies: Ask students to rank their liking of school subjects
2. Attitude scales: Consist of Likert-scale items with a five point response
3. Interest Inventories: Students are asked to select the items, from a given list, which they are interested in.
4. Subject Enrolment: Gathering data on enrolment in various subjects.
5. Qualitative methodologies: Explore students’ attitudes through interviews.

There have been lots of studies concerning the factors that are influencing the students’ attitudes towards science. Osborne (2003) identified the general factors influencing attitudes towards science as gender, personality, structural variables and curriculum variables. Due to the fact that curriculum developers pay attention to the students’ positive attitudes towards science while preparing the educational aims, the relationship between the positive attitude towards science and high achievement has been a lot concern. For example, Freedman (1997) examined the relationship among laboratory instruction, attitude toward science, and achievement in science knowledge of the students that enrolled in a ninth grade physical science course in a large urban high school. Students' achievement in science knowledge was measured by using the scores on midterm examination, final examinations and final report card grade for the course. Students' attitudes towards science were measured by Humphrey's adaptation of the questionnaire that was suitable for use in classroom. A significant difference was found in achievement between the students who received the treatment and the students in the control group in favor of treatment group. A positive relationship was also found between the students' attitude towards science and their performance on the final examination.

In another study Choi and Cho (2002) investigated if teaching ethical issues related to science affected 8th grade students' achievement and their attitudes towards science in a Korean middle school. There were four classes that participated in the study. Two of the classes were assigned as the experimental group and the other two were assigned as the control group. Teaching-learning materials were prepared for the experimental groups about the ethical issues that were chosen. Traditional textbooks were used for the control groups. The students' science achievements were evaluated by using the final exam. *Attitude Assessment in Science Questionnaire* was used in order to explore the students' attitudes towards science. The control and the experimental groups were both pre-tested and post-tested on the science achievement ability. No difference was found between the groups for the pre-test. Post-test was given after the intervention and although no significant differences were found between the groups, the mean of the experimental group was higher than the control group. Both pre-test and post-test were also used for the students' attitudes towards science. Post-test results indicated that the students that were in the experimental group interested more in the science classes. Post-test also revealed that the students in the experimental groups significantly differed from the control group that they perceived more relevance and practicality of science knowledge and content to everyday life. No significant differences were found between the experimental and the control group about the definition of science and the body of scientific knowledge. However, the experimental group emphasized science as a tool to improve the standard of living. The experimental group also recognized a higher level of social responsibility for the scientists than the control group. The experimental group also identified the need to explore and solve the ethical issues along with the development of science. No significant differences were found between the groups related with the value of science. To conclude, the results showed that teaching science ethics reinforced students' interest level in science.

Frederick, Edward and Shaw (1999) investigated the elementary science students' achievement and attitudes and journal writing in conjunction with an Alabama Hand-on Activity Science Program. The sample consisted of 20 fourth grade students. A Full Option Science System unit on electricity and circuits was presented to the students by the same teacher. The students were pre and post tested with 15 items test that had application and knowledge level questions about the topic. Moreover, a 12 item attitude pre and post tests were also given to the students before and after the instruction. In addition the students were also requested to reflect upon their participation by writing in journals. The post test scores of the students were significantly differed from their pre test scores which may depend on the science instruction. Students were found to believe that their science grades were good, enjoyed learning science by themselves, would like a science career, learned safety rules for using electricity, and enjoyed studying about electricity.

Jones, Howe and Rua (1999)'s research has attempted to explore the influence of gender on students' experiences, interests and attitudes toward science and scientists. Jones et al. (1999) found out that boys tended to have more experiences in the physical sciences and girls in the biological sciences in their out of school lives. Moreover, boys were found to be more interested in the physical science areas and girls in the biological science areas. Researchers also concluded middle school years as the time when gender differences in achievement and attitudes widen due to the difference in their science experience.

Studies have also shown that students who use inquiry approach while learning improved positive attitudes towards science. For example, Gibson and Chase (2002) explored the impact of a two-week inquiry-based science camp on middle school students' attitudes towards science. Both qualitative and quantitative methods were used in order to gather data. A total of 22 participants were selected by stratified random sampling for the interviews. Science Opinion Survey and the

Career Decision-Making Revised Surveys were administered to 79 students that enrolled the camp and 35 students who applied but not accepted to the camp. Qualitative results showed that students who enrolled the camp in which inquiry based approach was used remained interested and became motivated through their studies. Since the study was a longitudinal one, it also showed that high school students had lower interest in science than the middle school students. It was known that high school teachers used traditional teaching methods while middle school teachers used inquiry based teaching methods in their lessons. The students who attended the camp had more positive attitudes towards science and higher interests in science careers than the students who applied but not accepted to the camp. This study also showed that attitudes towards science are developed early in children's education and it is difficult to change once they reach middle school.

Attitudes towards science were also studied in Turkey in relation with other concepts. For example Uzuntiryaki and Geban (2005) examined the effect of conceptual change texts on eighth grade students' understanding of solution concepts with the attitudes towards science. Results showed that use of conceptual change texts resulted in better understanding of the solutions concept and produced significantly higher attitudes towards science. Another study was performed by Sungur and Tekkaya (2003) in which the effect of gender and reasoning ability on the human circulatory system concepts achievement and attitude toward biology was investigated. No significant difference was found between boys and girls with respect to achievement and attitude toward biology.

Balcı (2005) invetigated the effects of 5E learning cycle, conceptual change texts and traditional instruction on 8^{th} grade students' understanding of photosynthesis and respiration in plants and their attitudes towards science were investigated. The sample of the study consisted of 101 eighth grade students in Ankara. First experimental group consisted of 33 students and received 5E learning cycle based instruction, the second experimental group consisted of 34 students and received conceptual change text based instruction. There were 34 students in the control group who received traditional instruction. Results showed no significant effect of instruction on the students' attitudes towards science. In addition, no significant effect of gender difference was found on students' attitudes towards science.

Recently, Atay (2006) investigated the relationships among elementary school students' gender, relevant prior knowledge, meaningful learning orientation, reasoning ability, self-efficacy, locus of control, attitudes towards science and achievement in genetics in learning cycle and traditional classrooms. The sample was 213 eighth graders. One hundred and four students that were in the experimental group received learning cycle instruction while the remaining 109 students in the control group received traditional instruction. *Genetics Knowledge Inventory*, *Genetics Achievement Test*, *Learning Approach Questionnaire*, *Test of Logical Thinking*, *Self-Efficacy Scale*, *Locus of Control Scale*, *Attitude towards Science Scale*, were used during the study. Results showed that learning cycle instruction improved students' achievement in genetics compared to traditional instruction. Moreover, in learning cycle classrooms the main predictors of achievement in genetics were students' meaningful learning orientation (49.6%) and their attitudes towards science (11.8%). In traditonal classrooms, students' attitudes towards science (44%) and reasoning ability (9.8%) were the main predictors of achievement while remaining 5.7% of the variance explained by relevant prior knowledge, locus of control and meaningful learning orientation.

One of the recent study, Soylu (2006) investigated the effect of gender and reasoning ability on 8th grade students' understanding of ecological concepts and attitude toward science. The sample contained 600 students from Tosya, a district of Kastamonu. *Test of Ecology Concepts*, *Attitude Scale towards Science*, *Test of Logical Thinking* (TOLT) were used in the study. Moreover, interviews were also conducted during the study in order to reveal the reasons behind the misconceptions that they have. The results of the study showed that the students have many misconceptions about basic ecological terms, food chain, food web, energy flow and source of energy. Female students were found to have higher understanding of ecological concepts and more positive attitudes towards science than male students. Moreover, mean of attitude scores of girls was found higher than boys at low and medium level reasoning ability; thus, girls at low and medium level reasoning ability had more positive attitude towards science than boys at low and medium level reasoning ability but boys at high level reasoning ability had more positive attitude than girls at high level reasoning ability. Furthermore, mean of attitude scores of girls was lower than boys at higher level reasoning ability. No significant main effect of gender was found on the population means of understanding of ecological concepts and attitude towards science when the effect of TOLT scores was controlled.

More recently, Kaynar (2007) investigated the effectiveness of 5E learning cycle on sixth grade students' understanding of cell concepts, their attitude toward science and their scientific epistemological beliefs. Turkish version of Epistemological Beliefs Questionnaire, Cell Concept test and Science Attitude Scale was administered to 160 sixth grade students. No effect of the method was found on the students' attitude towards science. However, the method had a significant effect on the students' scientific epistemological beliefs.

To conclude, the literature shows that the attitude towards science affects the achievements of the students. The students' gender and interest also play an important role in the students' attitude towards science and by the way in the success of the students. This makes the attitude concept so important that the teachers should create learning environments in which the students can develop positive attitudes towards science.

2.6. Relationship between Learning Approaches, Scientific Epistemological Beliefs, Learning Environment and Attitudes towards Science

Learning Approaches, Scientific Epistemological Beliefs, Learning Environment and Attitudes towards science have been a great concern for the science education researchers. Some of these studies have focused on the relationship between scientific epistemological beliefs and learning approaches (Tsai, 1997; Saunders, 1998; Chan, 2003; Cavallo, 2003, 2004, Cano, 2005). For example, Tsai (1997) conducted a study in order to explore the interplay between 8th grade students' SEB and their learning orientations. The participants were 202 eighth graders in a large urban junior high school near Taipei City, Taiwan. The researcher selected 20 information rich students so that they were above average achievers and expressed a strong *Certainty* and clear *Tendency* regarding their SEB based on their responses on Chinese version of Pomeroy's (1993) questionnaire that is composed of 5-point Likert scale ranging from empiricist to constructivist views about science. A knowledge constructivist group that was composed of 3 male and 3 female students was selected from the students, who scored in the top 15% of Pomeroy's questionnaire. A mixed group that composed of 4 male and 2 female students was randomly selected from the bottom 15 % and a knowledge empiricist group that composed of 5 male and 3 female students was selected from the average group. In other words, knowledge constructivist group had high scores in the questionnaire and knowledge empiricist group had low scores while the mixed group had average scores on the questionnaire. According to the results of interview constructivist students believed that science was closely related to everyday lives and they believed in the tentative and dynamic nature of scientific knowledge. According to them scientists' ideas come from their intuitions or flashes of insight, the theories proposed by earlier scientists and even ancient folklore, but none of them mentioned anything about observations. Moreover, they believed that scientists did not have certain method or a series of procedures in doing science, the existence of different theories came from the variety of theories taken by scientists, power or acceptance of a new theory caused theory changes in science. On the other hand empiricist students were found to believe that science was a collection of correct facts so that scientific knowledge is valid and accurate. Moreover, empiricist students gave importance to experimental evidence in science. Although three of the 6 empiricist students believed that scientists' intuitions play a role in their ideas, many of them viewed careful observations as the main sources of scientists' ideas. In addition, empiricist students gave value to the validity of codified procedures of the "scientific method". Empiricist students believed that the existence of different theories came from the limitations of technology or inadequate observations and asserted that the evidence and the correctness engendered changes of scientific theories. Results of the study also revealed that constructivist students think deeply, apply what they learned in everyday life and ask questions immediately if they could not understand since these are their responsibilities of learning science. On the other hand, empiricist students were found to tend to listen carefully in classes, do more problem-solving practices as their responsibilities. This showed that constructivist students tended to employ more meaningful learning strategies in learning science, while empiricist aligned students had rote learning orientations. Moreover, constructivist students emphasized the importance of true conceptual understanding whereas empiricist students emphasized to do more problem solving practices and to listen the teacher carefully in the class for the success of learning science. The empiricist students' goals of learning was more oriented to course grades than real understanding, on the other hand, constructivist students were mainly motivated by their interest and desire to understand more. The results also suggested that students' SEB play a significant role in students' learning orientations and how they organize scientific information.

Another related research was conducted by Saunders (1998) by using 232 college students that enrolled in an introductory chemistry laboratory course at a large Midwestern university. The researcher found out that students' scores on the Learning Approach Questionnaire represented a wide range of approaches to learning. In other words, some of the students used meaningful approaches, some used rote approaches and some used both of them. Students' scores on Science Knowledge Questionnaire ranged from received to moderate. There were no students who believed strongly in reasoned knowledge meaning that they do not have tentative views of science. He also found out that there were no correlation between students' meaningful approaches and their rote learning approaches as a result they are unrelated approaches. Meaningful learning approach was not related to students' scientific epistemological beliefs. Moreover, a negative but small relation was found between students rote learning approaches and their scientific epistemological beliefs (r = -.143, p<.05). In addition, more inquiry and less inquiry lessons that the students experienced in their lessons did not relate to their epistemological beliefs, meaningful learning approaches and rote learning approaches. In other words, type of instruction had nothing to do with the epistemological beliefs and learning approaches of the students. None of the variables were significant predictors of meaningful learning approach. However, scientific epistemological beliefs of the students were found to be the only significant predictor of rote learning approach. The students who believed that knowledge comes from an external authority were more likely to attempt to memorize the information than to try to make sense of the information themselves.

Chan's (2003) study investigated the relations between scientific epistemological beliefs and conceptions about teaching and learning of 292 teacher education students of the Hong Kong Institute of Education. Epistemological beliefs of the students were investigated based on Schommer's *Epistemological Beliefs Questionnaire*. The 30-item instrument had Innate/Fixed Ability, Learning Effort/Process, Authority/Expert Knowledge and Certainty Knowledge dimensions with a 5-point Likert scale. Except the Learning Effect dimension, other dimensions had mean sub-scale scores below 3. This showed that students did not believe that ability is fixed and innate, knowledge is handed down by authority or experts and knowledge is certain and permanent. Instead the students were found to believe that learning requires effort and process of learning including understanding. Moreover, when the dimensions were regressed across age, no significant effect was found except Authority/Expert Knowledge. The older the students, the less they believed in Authority/Expert Knowledge. No significant differences were found in the epistemological beliefs of the students across gender. *Teaching/Learning Conceptions Questionnaire* was used in order to assess the beliefs and conceptions of the pre-service teachers. No significant differences were found in the conceptions of the pre-service teachers with respect to age and gender. Moreover, students who had traditional conceptions of teaching and learning hold beliefs that knowledge is certain, knowledge is derived from experts and one's learning ability is innate. On the other hand, students who had constructivist conceptions of teaching and learning believed that knowledge is constructed from one's experiences and judgment, knowledge is tentative and changing and that one's ability is not inborn, in fact it can be changed.

Cavallo, Rozman, Blickenstaff and Walker (2003) investigated learning, reasoning, motivation and epistemological beliefs of the college biology, physics majors and physics nonmajors students. The sample consisted of 291 sophomore and junior science majors, that enrolled either in a biology course, the students of which were majors in life sciences, or one of two different physics courses, the students included nonphysics majors and physics and engineering majors, at a large university in the western United States. Results indicated that means in reasoning ability and rote learning were significantly different among students in the three courses.

Moreover, students holding tentative views of scientific epistemological beliefs were the high achievers in biology courses. Furthermore, the predictive influences of these variables on achievement in three different courses were examined. For biology students it was found that reasoning ability, learning goals and science beliefs were positively correlated with course grade. Moreover, meaningful learning was significantly correlated with learning goals; rote learning was positively correlated with performance goals and negatively correlated with learning goals. No correlation was found between meaningful learning and rote learning. Learning goals was negatively correlated with performance goals; positively correlated with epistemological beliefs and was not correlated with reasoning ability. In addition, performance goals were negatively correlated with epistemological beliefs. For physics non-majors results indicated that reasoning ability was not correlated with the other variables; meaningful learning was positively correlated with learning goals; rote learning was negatively correlated with course achievement; course and physics concept understanding scores were positively correlated. For physics majors, reasoning ability was negatively correlated with meaningful learning, rote learning and learning goals. Reasoning ability was positively correlated with performance goals and concept understanding. Meaningful learning was positively correlated with learning goals. For the biology students, learning goals and reasoning ability predicted course achievement. For physics non-majors, rote learning best predicted course achievement in a negative direction and for the physics majors none of the variables predicted course achievement. Reasoning ability predicted concept understanding of physics majors and none of the variables predicted physics non-majors understanding of the subject.

In another study, Cavallo, Potter and Rozman (2004) investigated possible shifts in students' epistemological beliefs from beginning to the end of the course based on gender. The sample was composed of 290 college students who are enrolled in a full academic year structured inquiry physics course at a large university in the western United States 28-item Likert *Science Knowledge Questionnaire* was used in order to measure the students' epistemological beliefs about the nature of science. The results indicated nonsignificant shift in both male and female students' science beliefs toward a more tentative view of the nature of science. The researcher also investigated the differences in students' learning approaches. The 24-item Likert *Learning Approach Questionnaire* was used in order to identify the learning approaches of the students as "meaningful learning" and "rote leaning". The results indicated that rote learning is significantly different among students in three courses and meaningful learning did not differ among the courses. It was also found that biology students used the most rote learning approaches among physics majors and nonmajors and these students could not get high grades from the course. The high grades were determined by the motivation to learn for the sake of learning. For the physics nonmajors, rote learners achieved lower in the course. Moreover, none of the learning variables in the study contributed to the students understanding of physics concept, only course achievement was found to be positively correlated to concept understanding. For the physics majors, reasoning ability determined the understanding of the physics concept. In other words, students using formal reasoning abilities had more complete understanding of the concept. Reasoning ability was either not related or was negatively related to meaningful or rote learning. Moreover, physics nonmajors had significantly lower reasoning abilities than the physics majors. Results also showed that female students used less meaningful learning strategies at the end of the inquiry physics course compared to the beginning. On the other hand, males were found to use more meaningful learning strategies at the end of the course compared to the beginning. In addition, no significant differences were found in students' use of rote learning strategies throughout the course. The shifts in male and female students' motivational goals, self-efficacy, reasoning ability and concept understanding throughout the structured inquiry physics course was also investigated, in addition to learning approaches and the epistemological beliefs. The study also investigated the possible differences between males' and females' achievement in the course and the relationships between the variables. A 12-item Likert *Achievement Motivation Questionnaire* consisting of three scales (learning-goal orientation, performance goal orientation, students' self efficacy) was used in order to measure the motivation to learn in the physics course. A two-item Reasoning Ability Test and a 30-item, multiple choice, *Force Concept Inventory* were also used. Moreover, course grades from students that are obtained at the end of each 10-week academic quarter were averaged to obtain a score that represented the overall physics achievement. A significant shift was found toward a more learning goal orientation among the students for both boys and the girls throughout the structured inquiry physics course. When compared with the beginning of the course, both male and female students had more learning goal orientation at the end of the course. In addition, the students were found to have higher performance goals at the end of the course with males having higher performance goals compared with females. Students' self efficacy was not found to change throughout the course. However, male students had higher physics self-efficacy throughout the course compared with the females. A nonsignificant positive shift was found in students' reasoning ability throughout the course. Moreover, students' concept understanding was found to increase considerably throughout the course, with the males performing higher than the female students on both pretest and posttest. When the physics achievements of the male and female students were compared, males were found to outperform the females. Correlation results showed that meaningful learning and learning goals; rote learning and performance goals were positively correlated for both males and females. Meaningful learning was found to be negatively correlated with rote learning and performance goals for females but not for males. Learning goals were found to be negatively correlated with performance goals for females but not for males. Self-efficacy was positively correlated with meaningful learning and learning goals for both males and females and negatively correlated with rote learning among females only. Moreover, performance goals and rote learning were found to be negatively correlated with tentative science beliefs for both male and female students. Reasoning ability was found to be correlated with concept understanding and course achievement only among females. Students' concept understanding was correlated with course achievement for both male and female students. Regression analyses indicated that female students' physics concept understanding was best predicted by higher self-efficacy and reasoning ability. In addition, male students' concept understanding was positively predicted by self-efficacy and negatively predicted by learning goals and rote learning. The variables that best predicted students' physics understanding also predicted males' and females' course achievement.

Cano (2005) investigated the relationship among 1600 Spanish secondary school students' epistemological beliefs, learning approaches and academic performance by a cross-age study. Boys' and girls' epistemological beliefs became less naïve and more realistic as they advanced through high school. However, girls' epistemological beliefs, at all school levels, were found to be more realistic than boys'. Results also indicated that learning approaches in boys and girls were similar at the beginning of the secondary education and became differentiated at the end. Boys had higher surface approach scores in junior high and senior high. In senior high level girls had higher deep approach scores than boys. Moreover, it was found that epistemological beliefs and learning approaches influenced achievement directly. Moreover, epistemological beliefs were found to influence achievement indirectly by means of effecting learning approaches. This mean that if a student had naïve epistemological beliefs, he/she had poor academic performance and the students who believed that learning occurred rapidly and without effort adopted surface approach. In addition a student having surface approach had low performance and the one having deep approach had high performance.

Beside the studies that investigated the relationship between learning approaches and epistemological beliefs, some other studies were concentrated on the possible link between students' learning approaches and the learning environment (Dart et al., 1999; Dart et al., 2000; Petegem et al., 2005). For example, Dart et al. (1999) investigated the relationship between 484 secondary school students' (from 8th graders through 12th graders) perceptions of their classroom environment and their approaches to learning in Australia. Learning Process Questionnaire (LPQ), actual and the preferred forms of the Individualized Classroom Environment scale (ICEQ) and the Learner Self Concept scale (LSC) were used in the study. LPQ measures the students' motives for studying and the learning strategies adopted by students as "Surface, Deep and Achieving". ICEQ measures the actual and preferred learning environment with the dimensions of "Personalization, Participation, Independence, Investigation and Differentiation. LSC measures relationship between learner self concept and learning strategies. Simple correlations between LSC, LPQ and ICEQ actual variables indicated that high learner self concept scores were associated with high Deep Approach, high Personalization, high Participation and high Investigation scores but low Surface Approach scores. Moreover, high Surface Approach scores were associated with lower levels of Personalisation and Participation. Furthermore, students' adoption of Deep Approaches to learning is facilitated by a classroom in which the teacher provides opportunities for the students to interact with, encourages the students to be the active participants of the lesson and uses inquiry in the lessons. Moreover, Junior High students (8^{th}, 9^{th} and 10^{th} graders) perceived their classrooms as encouraging the use of inquiry skills more than the senior high students (11^{th} and 12^{th} graders). On the other hand, senior high students perceived their classrooms offering them more opportunities to be the active learners compared with the junior high students. All the students' scores on the preferred form of the ICEQ were higher than the students' scores on the actual form of the ICEQ. To conclude, the students having deep approaches to learning perceived their classrooms as more personal, encouraging more active involvement and greater use of inquiry skills. Moreover, males were found to use more Surface Approach than the females.

Another study of Dart et al. (2000) investigated 457 Australian students' conceptions of learning, the classroom learning environment and students' approaches to learning in grades 8 through 12. Instruments used in the study were the Conceptions of Learning Inventory (COLI), Individualized Classroom Environment Questionnaire (ICEQ) and the learning Process Questionnaire (LPQ). Students responded to the questions within the context of subjects typically offered in secondary schools-mathematics, science, English, German, Japanese, history, art and accounting. COLI is a 45-item measuring secondary students' conceptions of learning. Items representing qualitative, quantitative and experiential perspectives on learning were selected for the study. Quantitative perspective suggests learning as acquisition and accumulation of content. Qualitative perspective suggests learning as understanding by connecting new material with prior knowledge. Experiential perspective suggests learning as the product of daily experiences. COLI had 6-point Likert type scale. Short form of the ICEQ consisted of 25 items, 5 on each dimension- personalization, participation, independence, investigation and differentiation- to gather students' perceptions of their learning environments. It has a 5-point Likert type scale. Factor analyses resulted in the retaining of 5 items for personalization, and 4 items for investigation. Personalization was selected as the best measure of climate of the learning environment since it contained opportunities for individual students to interact with the teacher as well as to show concern for their personal welfare and social growth. Investigation was used as the most appropriate measure of the cognitive dimension of the learning environment because it emphasized skills and processes inquiry and their use in problem solving and research. LPQ contains 6 scales with 6 items; 3 of them measure students' motives for studying (Surface, Deep, Achieving) and the other three measure corresponding learning strategies adopted by students (Surface, Deep, Achieving). It had a five-point Likert type scale. Results of the study indicated that students who reported qualitative conceptions used deep approaches to learning. On the other hand, students who have quantitative conceptions of learning used surface approaches. However, a positive relationship was found between quantitative conceptions and deep approaches to learning. In addition, students who reported qualitative conceptions perceived the classroom learning environment as high in personalization, and to a lesser extent, investigation. The classrooms in which investigative skills and strategies were used had been perceived as high in personalization by giving way to the use of deep approaches. As a consequence the relationship between personalization and investigation in classroom environments mediates the relationship between qualitative conceptions of learning and deep approaches to learning. Researchers concluded that, if teachers require their students to develop meaning and understanding of their subjects through deep approaches to learning, then students must hold qualitative or experiential conceptions of learning. That is, the classroom environment, the teaching strategies and the assessment procedures must reflect the qualitative view. Result also indicated that providing a learning environment in which students' feelings are considered, individual interactions with students occur, and students are helped when needed, by itself has no direct influence with the adoption of deep approaches to learning.

In another study, Petegem et al. (2005) investigated the relationship between the 1618 student teachers' learning approaches and their preferences for learning environments. Vermunt's Inventory of Learning Styles (ILS) (1996, 1998) was used in order to measure the learning approaches of the pre-service teachers. Two scales from Roelofs and Visser's (2000) instrument was used in order to explore the learning environment. The items in the questionnaire were related with the preferences for meaningful and strategic learning environment (MSLE) and preferences for discovery-oriented learning environment (DOLE). Results showed pre-service teachers prefer to construct and use knowledge in occupation-oriented context and perceive learning as knowledge centered. When the learning styles of the sample was clustered as "Meaning Oriented", "Reproduction Oriented", "Ad hoc" and "Unregulated" the largest group of the sample was found to be meaning-oriented. It was also found that the sample agreed most with the statements related with MSLE and less with DOLE. Females were also found to have higher preference for MSLE than males. The researchers suggested influencing the students to conceptualize learning as construction and use of knowledge. Moreover, if the students were more personally oriented in their learning and found it interesting to construct knowledge then the students' preference for DOLE increased. Researchers also concluded that pre-service teachers' preferences for MSLE and DOLE are positively related to their learning conceptions.

In the literature there have been some studies concerning the relationship between the learning environment and the scientific epistemological beliefs (Tsai, 2000; Tolhurst, 2007; Tsai, 2003). Tsai (2000), for example, summarizes the relationship between the philosophy of science and students' learning psychology in science as seen in Table 2.2.

TABLE 2.2 The constructivist epistemology: the interplay between the philosophy of science and students' learning psychology in science

	Constructivist philosophy of science	*Students' learning psychology in science*
1	Observations are theory-laden	Students' existing conceptions play an important role for new knowledge acquisition
2	Theories will be retained even when encountering apparent anomalies	Students' alternative conceptions are resistant to change by conventional teaching strategies

Table 2.2. continued

3	Science grows through a series of revolutions	Students should experience a series of conceptual changes when learning science
4	The scientific theories between two (or more) paradigms are incommensurable	Students' ideas and those of teachers may be incommensurable; teachers should understand students' learning/thinking from their perspectives
5	Science does not represent the reality while scientists are producers of the reality, not the reproducers of the reality; scientific knowledge comes from human imagination	Students are knowledge producers, not knowledge reproducers; learning is an active process of knowledge construction, not a passive process of knowledge reproduction; learning science requires students' creativity
6	Scientific knowledge comes from a series of criticism, validation, consensus and social negotiation in the scientific community	Students learn effectively and meaningfully in a favorable environment where their ideas are explored, compared, criticized and reinforced through talking and listening to others
7	There is no certain 'scientific method' and there is not only one way to interpret the same natural phenomena	Students learn by various methods; teachers should encourage students' multiple ways of researching, questioning and problem solving
8	Scientific knowledge is the product of a complex social, historical, cultural and psychological activity	Students' knowledge acquisition occurs in a complex social, historical, cultural and psychological context

Source: Tsai (2000, p.196)

Interplay between students' perceptions of constructivist learning environments and their scientific epistemological beliefs was investigated by Tsai (2000), with a sample of 1283 Taiwanese tenth graders in Northern, Central and Southern Taiwan. Six high schools from Northern Taiwan, 4 schools from Central Taiwan, and 4 schools from Southern Taiwan were selected. For each selected school, 2 classes were chosen. After excluding missing data from the study final sample was 1176 students and 47% was females. Chinese version of Pomeroy's questionnaire was used to assess students' scientific epistemological beliefs. Questionnaire consists of bipolar agree/disagree statements on a 5-1 Likert Scale with a continuum from empiricist to constructivist perspectives. To assess students' perceptions of constructivist learning environments, a Chinese version of the Constructivist Learning Environment Survey (CLES) originally developed by Taylor and Fraser (1991) was administered to the sample with the actual and the preferred forms. The CLES contained 4 scales of Negotiation scale, Prior Knowledge scale, Autonomy scale and Student-Centeredness scale each with 7 items. Each CLES item had a five-point response ranging from 'very often' to 'never'. Preferred form of the CLES was administered to the sample one to two weeks after the actual form of the CLES was administered. Findings of the CLES indicated that students favored learning environments that takes their prior knowledge and everyday experiences into account. On the other hand, students believed in the teacher's authority in facilitating their learning. The analysis showed that the students think that their learning environments did not adapt their preferences so that they can have more opportunities to interact with others, integrate their prior knowledge, think independently and to resolve personally problematic experiences. Students' responses on the SEB instrument were found to be significantly correlated with their scores on two of the four scales of the CLES actual form (negotiation, prior knowledge) and on three of the four scales of the CLES preferred form (negotiation, prior knowledge, autonomy). Students having SEB more oriented to constructivist views of science tended to perceive that their actual learning environments did not offer adequate opportunities for them to negotiate their ideas nor integrate the new information they face with their prior knowledge. Moreover, they preferred to learn in the constructivist environments where they could interact with others, integrate their prior knowledge and experiences with the new constructed knowledge and control their learning activities. To conclude, there were negative relationships between student SEB orientations and perceptions of actual learning environments, but positive relationships between student SEB and preferences for constructivist learning environments.

Tolhurst (2007) investigated the influence of learning environments on students' epistemological beliefs. The sample consisted of 418 first-year undergraduate students in Information systems. Schommer's (1998) General Epistemological Beliefs Questionnaire with five dimensions (quick learning, certain knowledge, innate ability, omniscient authority, simple knowledge) and Hofer's (2000) Domain Specific Epistemological Beliefs Questionnaire with for dimensions (certainty and simplicity of knowledge, Justification of knowing: personal, Source of knowledge: authority, Perceived attainability of truth) were used in order the measure the epistemological beliefs of the students. Epistemological beliefs of the students was measured at the beginning of the study and then at the end of the study again 12 weeks later. The students were expected to attend the lessons since the lesson would be structured based on the preparation of the students before coming to the class. The course was based on the web – supported independent activities and regular small – group workshops. Schommer's questionnaire indicated that the students reduced to seek single answers after the instruction. Students increased their beliefs that it is possible for them to learn how to learn. After the instruction the students also increased their belief that learning occurs in the first instance. The students' belief on the omniscient authority was also found to increase. The results of the Hofer's questionnaire indicated that the students beliefs about the source of the authority was increased so that they accept expert knowledge, texts and other external authority as the source of knowledge. Moreover, students viewed knowledge as less certain and simple after the instruction. When the students' final course grades were correlated with Schommer's and Hofer's questionnaire it was found that students who had complex epistemological beliefs had higher grades and the ones that do not have complex epistemological beliefs had lower grades in the course.

To conclude, learning approaches, scientific epistemological beliefs, constructivist learning environments and attitudes towards science has been studied by the researcher in relation with each other. These studies generally showed that the students that have meaningful learning orientations have tentative views of scientific epistemological beliefs. Moreover, the students that have tentative views of scientific epistemological views perceived their learning environment as moderately constructivist. The students who have constructivist learning environments learned meaningfully with having positive attitudes towards science.

2.7. Summary

The studies in literature showed the importance of the learning approaches on science learning. In addition, the importance of the students' scientific epistemological beliefs, learning environment and attitude towards science are also described. Many of research has been done in the past that explored the relationships between students' learning approaches and scientific epistemological beliefs; learning approaches and learning environments and scientific epistemological beliefs and learning environment. None, however, described the relationship among learning approaches, learning environment and scientific epistemological beliefs.

CHAPTER III

PROBLEMS AND HYPOTHESES

This chapter includes main problems, sub-problems, and the hypotheses of the study.

3.1. Main problems

1. What is the possible relationship among 8th grade students' scientific epistemological beliefs, actual learning environments, learning approaches, attitudes towards science, prior knowledge and gender?
2. What are the contributions of attitude, actual learning environment, scientific epistemological beliefs, prior knowledge and gender on 8th grade students' meaningful learning orientations?
3. What are the contributions of attitude, actual learning environment, scientific epistemological beliefs, prior knowledge and gender on 8th grade students' rote learning orientations?

3.2. Sub-problems

1. What are 8th grade students' learning orientations?

2. What are 8th grade students' scientific epistemological beliefs?

3. What are the attitudes of the 8th grade students towards science?

4. How do 8th grade students perceive their actual learning environments and prefer their learning environments to be?

3.3. Hypothesis

1. There will be no significant relationship among 8th grade students' scientific epistemological beliefs, actual learning environments, learning approaches, attitudes towards science prior knowledge and gender.

2. There will be no significant contribution of attitude, actual learning environment, scientific epistemological beliefs, prior knowledge and gender on 8th grade students' meaningful learning orientations.

3. There will be no significant contribution of attitude, actual learning environment, scientific epistemological beliefs, prior knowledge and gender on 8th grade students' rote learning orientations.

CHAPTER IV

METHOD

4.1. Introduction

This chapter includes the information about the design of the study, sample, variables, instruments, data collection and analysis, and the assumptions and limitations of the study.

4.2. Design of the study

The design of the study is correlational survey, due to the fact that information is collected from a group of people in order to describe the characteristics, beliefs, perceptions and attitudes of the population from a randomly selected sample, and then relationships are determined based on the correlation coefficients. Information is collected through taking the responses of the students to given items. By means of the survey it was easy to take the responses of the students to different areas in a short time.

4.3. Sample

The target population was all eighth-grade students in Ankara. The accessible population of the study was all the eighth graders in Çankaya district. There were 10260 eighth graders in Çankaya, according to the data gathered from Çankaya Directorate of National Education. The desired sample size was determined as 1026 students that are 10% of the whole population. The number of students reached during the study is 1152. About 46 % of the sample was composed of girls and the rest 53.9 % were composed of boys. The mean age of the students is about 14 while the range lies between the ages of 13 and 16. As indicated in the table 4.1., the students have a mean score of 3.03 as their report card grades at the end of the 2005 fall semester which indicated their prior knowledge. These scores are used as an indication of their previous learning in science.

The more detailed characteristics of the sample are presented in Table 4.1.

Table 4.1. Characteristics of the sample

	Frequency (%)
GENDER	
Female	46.1
Male	53.9
AGE	
16	0.7
15	11.4
14	86.8
13	1.1
FINAL REPORT CARD GRADE FOR SCIENCE	
1	18.4
2	18.9
3	23.4
4	20.1
5	19.3

Information regarding the students' fathers' educational level (FEL), mothers' educational level (MEL), fathers' work status (FWS), mothers' work status (MWS), amount of reading material at home, presence of private study room, and frequency of buying newspapers as indicators of socio-economic status are presented in Table 4.2. Table revealed that the majority of fathers graduated from high school and lower. A similar situation is found with the mothers. Although 39 % of the fathers have university degree, that is 29% for the mothers. Moreover, about 7% of the fathers and 4 % of the mothers had MS or PhD degree.

Table 4.2. Socio-economic Status of the sample (SES)

%

EMPLOYMENT	FWS	MWS
Employed	87.9	36.1
Unemployed	2.0	53.6
Offensively employed	2.3	1.5
Retired	7.7	8.8
EDUCATIONAL LEVEL OF PARENT	FEL	MEL
Illiterate	0.2	2.4
Primary School	12.2	20.8
Secondary school	14.6	13.7
High School	26.9	29.7
University	39.4	29.3
MS & PhD	6.8	4.1
Amount of reading material in the home		
0-10 books	4.3	
11-25 books	14.0	
26-100 books	34.5	
101-200 books	22.5	
More than 200 books	24.7	
Study room		
Have a room	90.3	
No room	9.7	
Newspaper		
Never	2.7	
Sometimes	41.8	
Always	55.5	
SIBLING		
0	12.5	
1	53.5	
2	22.2	
3	8.6	
4-9	3.2	

Parents' employment status data revealed that while mothers are mostly unemployed, majority of fathers are employed. As far as the number of the reading materials at home is considered, it can be said that many students had books at their home. It was also found that while majority of the students have their own study room at home, only 10 % do not have. More than half of the students indicated that they are always able to find daily newspaper at their home.

4.4. Variables

There are two types of variables in this study; the dependent variable and the independent variable (Table 4.3).

Table 4.3 Variables of the study

	Dependent Variable	Independent Variables
Variables	Learning Approaches	Gender
	MLO	Prior Knowledge
	RLO	Scientific Epistemological Beliefs
		Constructivist Learning Environments
		Attitudes towards Science

4.4.1. Dependent Variables

The dependent variables of the study are students' learning approaches that are meaningful learning approach and the rote learning approach scores that are measured by the instrument "Learning Approaches Questionnaire (LAQ)".

4.4.2. Independent Variables

The independent variables of the study are, gender, students' prior knowledge, students' scores on scientific epistemological beliefs instrument, actual learning environments and attitudes towards science. Gender is considered as discrete variable and measured on nominal scale. The rest of the variables are considered as continuous variables and measured on interval scale.

4.5. Instruments

The questionnaire consisted of 5 parts. First part investigated the demographic characteristics of the sample. In the following parts, the instrument investigating students' scientific epistemological beliefs, perceptions of the students' about their learning environments as actual and preferred, learning orientations and the attitudes of the students towards science are presented.

4.5.1. Demographic Characteristics

There were 13 items investigating the characteristics of sample, namely, gender, sibling, age, report card grades belonging to the fall semester of 2005, parents' education level and occupation, number of the books found at their home, presence of separate study room and the frequency of buying daily newspapers (Table 3.1-3.2). While students' grade in a science course in the previous semester was used as an indication of their previous learning in science, information regarding the students' fathers' educational level (FEL), mothers' educational level (MEL), fathers' work status (FWS), mothers' work status (MWS), amount of reading material in the home, study room, and frequency of buying newspapers were used as indicators of socio-economic status.

4.5.2. Learning Approach Questionnaire (LAQ)

The instrument, developed by Cavallo (1996), was used to assess the perceptions of the students about how they learn. It is a 22 item, 4-point scale (Strongly Disagree, Disagree, Agree, Strongly Agree) questionnaire. Eleven of the items are used to assess the tendency toward rote learning (LAQ-R) and the remaining 11 items are used to assess the tendency toward meaningful learning (LAQ-M). A high score on the meaningful scale indicates students have a high meaningful learning approach; a high score on the rote scale indicates students have a high rote learning approach.

The instrument was translated into Turkish by Yenilmez (2006). For this study, the Cronbach alpha internal consistency coefficient was calculated as .88 for the LAQ-M and .71 for the LAQ-R.

4.5.3. Scientific Epistemological Beliefs (SEB)

The instrument, developed by Saunders (1998), was used to assess the epistemological beliefs of the students with two dimensions as fixed and tentative views. It consists of bipolar agree/disagree statements on a 4-1 Likert Scale. The scores of the questionnaire viewed as representing a one-dimensional assessment of

SEB indicating a continuum from fixed to tentative views. Fixed views (8 items) are related with traditional views and describe scientific knowledge as unchanging truth beyond doubt that is discovered by a few experts by using valid scientific method objectively. On the other had, tentative views (8 items) are related with constructivist views and describes the tentativeness of scientific laws, theories and concepts in the face of new evidence and scientific knowledge as subject to review and change in the light of solid new observations by means of the creativity of scientists and accepts the fact that historical, cultural, and social settings can lead to variations in scientific questions, methods and results and the subjectivity of the scientists.

In this study, for the tentative items, a "strongly agree" response was assigned a score of 4, whereas "strongly disagree" response was assigned a score of 1. Items representing the fixed views were scored in a reverse manner and added to the scores of tentative scores to obtain total scientific epistemological beliefs scores. Students having higher scores on the SEB are the ones having strong beliefs regarding the tentative views and the ones having lower scores are the ones having fixed views. Saunders reported the reliability for the instrument as .78.

SEB was translated into Turkish by Çalışkan (2004). Before using this instrument some words of the items were changed slightly so that the 8^{th}-grade students could understand the items more clearly. For this study, Cronbach alpha reliability was calculated as .80 after pilot study.

4.5.4. Constructivist Learning Environment Survey (CLES)

It was developed to assess the students' perceptions of the extent that the learning environment in a classroom is constructivist oriented based on the one revised by Johnson and McClure (2003) which was originally developed from Taylor and Fraser's (1991). Revised form contained 20 items, with 5 scales (4 items in each scale). The scales are Personal Relevance, Student Negotiation, Shared Control, Critical Voice and Uncertainty.

It is a five point response scale of "Almost Always, Often, Sometimes, Seldom, Almost Never". Moreover, the survey consists of two forms that are "Actual" and

"Preferred" Forms. Actual form assesses the present learning environment of the classroom and the preferred form assesses the students' preferences about the learning environment.

CLES was translated into Turkish by Yılmaz, Çakıroğlu and Boone (2006). Before conducting this study some of the words are rewritten so that the students can understand the items more clearly and pilot tested. The results of the pilot study showed that the internal consistency reliability results for the scales of the actual form of the CLES were .72 for personal relevance scale, .57 for uncertainty scale, .69 for critical voice scale, .74 for shared control scale and .69 for student negotiation scale. For the preferred form of the CLES, the internal consistency reliabilities were .78 for personal relevance scale, .69 for uncertainty scale, .76 for critical voice scale, .77 for shared control scale and .74 for student negotiation scale. Internal consistency reliability results outlined by Johnson and McClure (2003) for the actual form of *Constructivist Learning Environment* was .90 for the personal relevance scale, .81 for the uncertainty scale, .88 for critical voice scale, .76 for shared control scale and .81 for student negotiation scale. The results of the pilot study yielded that the reliability of the scales for both of the actual and preferred forms of the CLES are moderate to high reliable.

Turkish versions of all instruments were pilot tested by 270 elementary students during the middle of 2004-2005 fall semester. The researcher revised the Turkish versions of the instruments so that the students understand the items easily and clearly before used in this study.

4.5.5. Science Attitude Scale

It is a 15-item, 5 point Likert type scale (Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree) developed by Geban, Ertepınar, Yılmaz, Altın and Şahbaz (1994) to determine students' attitudes toward science as a school subject. The reliability coefficient computed by Cronbach alpha estimates of internal consistency of this scale was found to be 0.91.

4.6. Data Collection Procedure

The participant schools were selected from Çankaya district randomly and the permission was granted from the Ministry of Education (see Appendix G).

When it came to administering the instruments, the researcher collected the data from 1152 eighth grade students by visiting 7 schools in two weeks in spring semester of 2005-2006. It took about 40-minutes for the students to complete the survey. All the necessary explanations were done and the directions were made clear by the researcher before the students completed the survey. Participants were also warned not to miss any of the items since it is important due to the importance of the study. Participants were assured that any data collected from them would be held in confidence. The researcher was in the classes during the administration of the survey and no specific problems were encountered.

4.7. Data Analysis

SPSS (Statistical Package for Social Sciences) were used in order to analyze the data. Data obtained by the study were analyzed by using both the descriptive statistics and the inferential statistics.

4.7.1. Descriptive Statistics

The mean, standard deviations, range, minimum and maximum of the variables and histograms that represent the general characteristics of the sample are used.

4.7.2. Inferential Statistics

Pearson Correlation Analysis, Paired Samples t-tests, Multiple Regression Analysis and Part and Partial Correlation Analyses were conducted that are presented under the research questions. The level of significance for all measures was defined as α=0.05.

4.8. Assumptions and Limitations of Research

The assumptions and limitations encountered during this study are given as below:

4.8.1. Assumptions

1. The researcher who administered the survey did not influence the students' responses while they were completing the survey.

2. All the participants of the study responded to the items in the survey sincerely.

4.8.2. Limitations

1. Although the instruments are shortened, the survey totally had too many items so that it might be too long for the students.

2. The participants of the study belonged to public schools located in Çankaya.

3. The subjects of this study were limited to 8th grade students.

4. This study was limited by its relevance on self-reported data.

5. SEB has fixed and tentative dimensions however in this present study one dimension that is determined by looking at the total score of the SEB scores is investigated. In other words, the students that had high scores from SEB was considered as the ones that had tentative beliefs and the ones that had low scores were considered as the ones that had fixed beliefs of scientific epistemological beliefs.

CHAPTER V

RESULTS

5.1. Introduction

This chapter contains the results of the statistical analyses that were conducted in order to answer the research questions. The chapter includes 2 sections. The first section presents the general characteristics of the sample (5.2) and the second section (5.3) presents the relationships among the variables by individual mean analysis. Before conducting the statistical analyses assumptions were checked first. Since the assumptions were met, the analyses were carried on.

5.2. Descriptive Statistics

In this section, general characteristics of the sample with respect to variables of the study are explored by means of descriptive statistics. The descriptive statistics of the sample are seen on Table 5.1.

Table 5.1. Descriptive Statistics for the variables of the study

	Boys (*N*=621)		Girls (*N*=531)		Total (*N*=1152)		Possible Range	Actual Range
	Mean	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*		
LAQ	58.37	6.86	60.93	7.47	59.55	7.26	22-88	39-82
LAQ-M	31.72	5.94	32.95	5.70	32.29	5.86	11-44	11-44
LAQ-R	28.35	5.26	27.02	5.03	27.74	5.20	11-44	11-44
SEB	41.79	4.53	42.69	4.39	42.21	4.48	16-64	26-57
SEBFIX	21.30	3.57	21.19	3.43	21.25	3.50	8-32	8-32
SEBTEN	23.09	3.81	23.88	3.37	23.46	3.63	8-32	8-32
ATS	47.40	8.94	46.63	7.49	47.05	8.31	15-75	15-75
PRIOR KNOWLEDGE	2.84	1.39	3.25	1.32	3.03	1.38	1-5	1-5

This part of the study will answer the sub-problems that are related with the general characteristics of the sample. The results will be explained under the headings of the sub-problems.

5.2.1. Sub-Problem 1:

"What are 8th grade students' learning orientations?"

In order to investigate the participants' learning approaches Learning Approach Questionnaire (LAQ) was used, that classifies the students as meaningful learners and rote learners. While students' LAQ-M scores offer low to high meaningful approaches to learning, LAQ-R scores offer low to moderate rote approaches to learning (Table 5.1.). The mean of meaningful learning scores (M= 32.29) is higher than rote learning (M= 27.74) which means that students use meaningful learning approaches more than rote learning approaches. A clear picture can be seen in Figure 5.1.

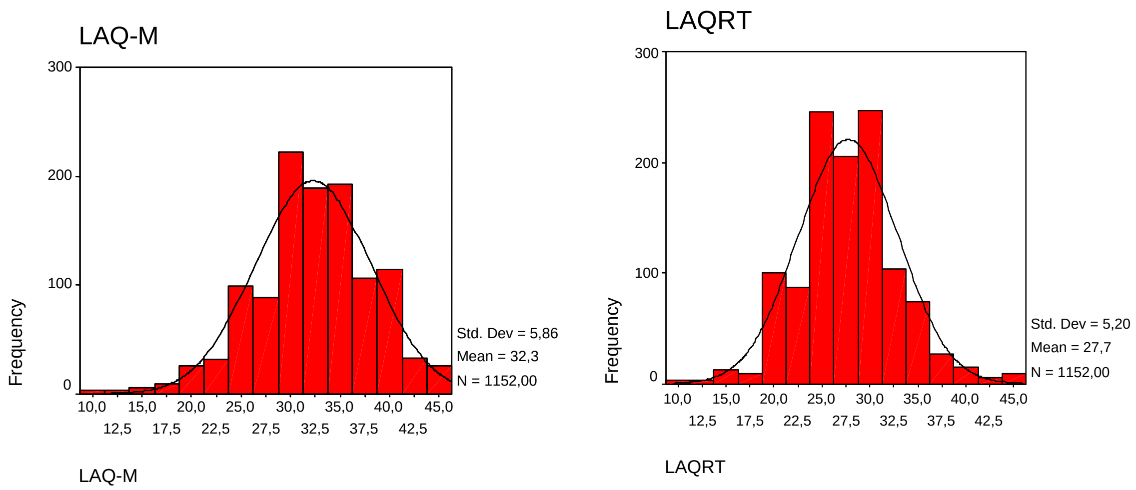

Figure 5.1. Range on LAQ-M and LAQ-R

Regarding gender difference, data suggest that female students (M= 60.93) have more meaningful learning approaches compared to male students (*M*= 58.37).

5.2.2. Sub-problem 2:

"What are 8th grade students' scientific epistemological beliefs?"

In order to determine the scientific epistemological beliefs of the students, SEB instrument were used. From the 16 items, 8 items were related with the fixed views of SEB (SEBFIX) and the rest 8 views were related with the tentative views of the SEB (SEBTEN). The responses of the students for the fixed views were reversed during the analysis (i.e. strongly agree response given for a fixed view item were transformed as strongly disagree) in order to evaluate the total SEB scores. Then the total of the scores were taken in order to see whether the student has fixed views or tentative views.

As seen in Table 5.1, the scores of the students for SEBTEN and SEBFIX could range between 8-32. The mean of SEBTEN scores (*M*=23.46) is higher than SEBFIX scores (*M*=21.25) indicating that the students have slightly more tentative views of scientific epistemological beliefs. This means that students are aware of the fact that scientific knowledge can change by time and it is not certain. The data from SEB showed a normal distribution as shown in Figure 5.2.

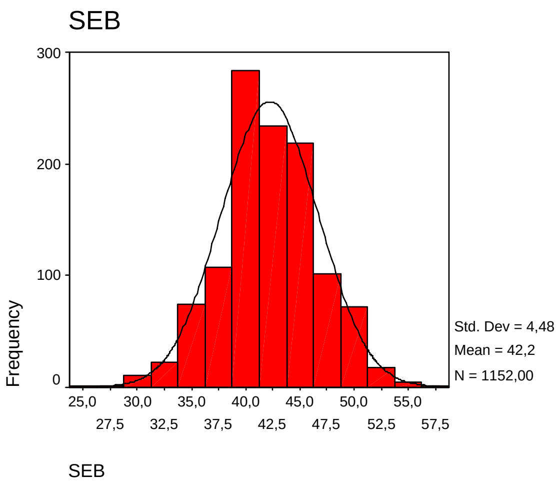

Figure 5.2. Range on SEB

When the SEB mean sores were considered according to gender it was found that female students (*M*= 42.69) had slightly more tentative views compared with the male students (*M*= 41.79).

5.2.3. Sub-problem 3:

"What are the attitudes of the 8th grade students towards science?"

In order to investigate the students' attitudes towards science, Attitude scale (ATS) was used. The students having high scores on the ATS means that the students have a positive attitude towards science and the students having low scores have negative attitudes towards science. The mean of attitude scores is 47.05 out of 75 as seen on Table 5.1. and as Figure 5.3. implies that attitude scores are normally distributed. This means that the students have positive attitudes towards science. The mean for boys (*M*= 47.40) is slightly higher than the mean for the girls (*M*= 46.63) which means that boys have slightly more positive attitudes towards science.

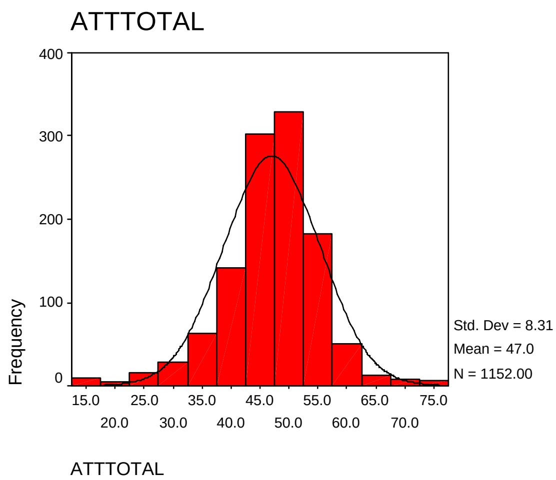

Figure 5.3. Range on ATS

5.2.4. Sub-problem 4:

"How do 8th grade students perceive their actual learning environments and prefer their learning environments to be?"

This research question will be answered by means of individual unit analysis and class mean unit of analysis. Individual means are used in order to explore the students' views. On the other hand, class means are used in order to understand the class's views about their actual and preferred learning environments.

Firstly, actual form of the Constructivist Learning Environment Survey was used in order to see how the students perceived their actual learning environments and preferred their learning environments to be by using individual unit analysis.

As the individual unit of analysis, Figure 5.4 shows that the scores on the actual form of the CLES are normally distributed (*M*=60.4) where the students could have scores ranged between 20-100. Moreover, while students perceive their actual learning environments as moderately constructivist, they prefer more constructivist learning environments where they have more opportunities to relate science with the real world, communicate in the classroom, take role in the decision making process of what will go on in the lesson to be more beneficial for them, question what is going on in the lesson freely and experience the formulation of scientific knowledge.

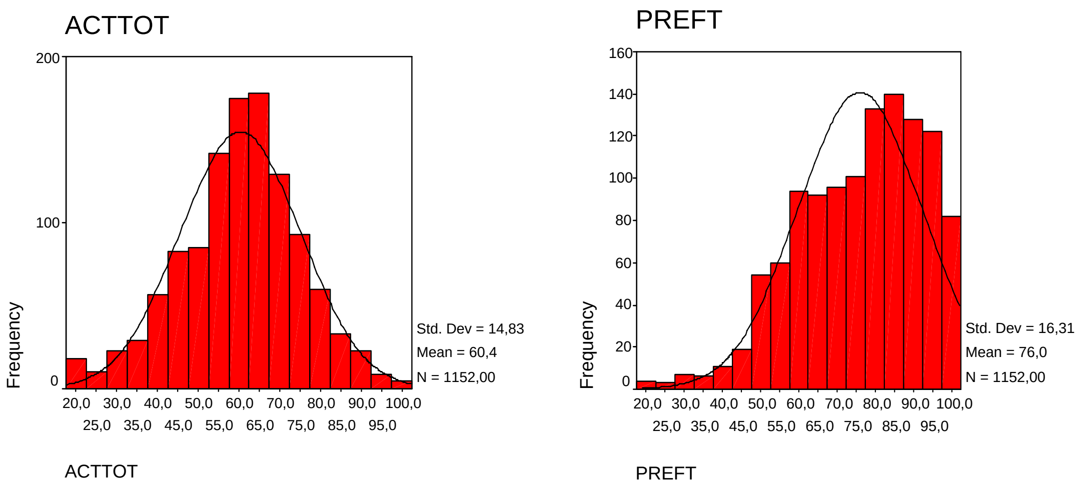

Figure 5.4. Range on ACTOTAL and PREFTOTOTAL

Descriptive statistics for each of the scales of the actual and preferred forms of CLES are given on Table 5.2. According to this table students perceive their actual learning environments moderately offering adequate opportunities for them to relate science to real world (*M*= 3.35), question what is going on in the lesson freely (*M*=3.25), experience the formulation of scientific knowledge (*M*=3.01) and communicate in the classroom (*M*=3.01). However, students seldom find adequate opportunities to take role in the decision making process of what will go on in the lesson to be more beneficial for them (*M*=2.48).

Students prefer learning environments, however, that often offer them chance to question what is going on in the lesson freely (*M*=3.60). The students also prefer to have learning environments that often offer them to relate science with real world (*M*=4.00), often communicate in the classroom (*M*=3.73), often have chance to experience the formulation of scientific knowledge (*M*=3.66) and often take role in the decision making process of what will go on in the lesson to be more beneficial for them (*M*=4.02).

To investigate the differences between students' perception of the actual and preferred learning environment, paired t-tests was carried out. Results showed that students' scores on the preferred form were significantly higher than those of the actual form on each scale, as shown in Table 5.2 and Figure 5.5. This means that the actual learning environment did not adapt their preferences. In other words, the students prefer more constructivist learning environments where they have more opportunity to relate science with the real world, communicate in the classroom, take role in the decision making process of what will go on in the lesson to be more beneficial for them, question what is going on in the lesson freely and experience the formulation of scientific knowledge.

TABLE 5.2. Perceptions of constructivist learning environments as assessed by CLES Actual and Preferred forms by individual and class mean unit of analysis (*N* = 1152 for the individual analysis and *N* =40 for the class mean analysis)

CLES Scales	Unit of Analysis	Actual *M*	Actual *SD*	Preferred *M*	Preferred *SD*	Possible Range	Actual Range	t-test scores	p values
Student Negotiation	**Individual**	3.01	.92	3.73	.98	1-5	1-5	-24.63*	.000
	Class Mean	3.04	.30	3.73	.31	1-5	1-5	-14.622**	.000
Shared Control	**Individual**	2.48	1.00	3.60	1.05	1-5	1-5	-31.64*	.000
	Class Mean	2.51	.33	3.63	.28	1-5	1-5	-20.817**	.000
Uncertainty	**Individual**	3.01	.85	3.66	.94	1-5	1-5	-20.58*	.000
	Class Mean	3.03	.31	3.66	.27	1-5	1-5	-10.760**	.000
Personal Relevance	**Individual**	3.35	.97	4.00	.95	1-5	1-5	-20.78*	.000
	Class Mean	3.38	.43	4.01	.35	1-5	1-5	-10.218**	.000
Critical Voice	**Individual**	3.25	.96	4.02	.92	1-5	1-5	-24.25*	.000
	Class Mean	3.28	.36	4.02	.28	1-5	1-5	-12.893**	.000

As far as class means are concerned, it is seen that, classes had significantly higher scores on the CLES preferred from than those on the actual form. When using paired t-tests to examine the difference between classes' perceptions of the actual learning environments and the preferred learning environments, it was found that classes' scores on the preferred form were significantly higher than those of the actual form on each scale. This means that the actual learning environment did not adapt their preferences, in other words the classes prefer more constructivist learning environments where they have more opportunity to relate science with the real world, communicate in the classroom, take role in the decision making process of what will go on in the lesson to be more beneficial for them, question what is going on in the lesson freely and experience the formulation of scientific knowledge. This can also clearly be seen on Figure 5.6.

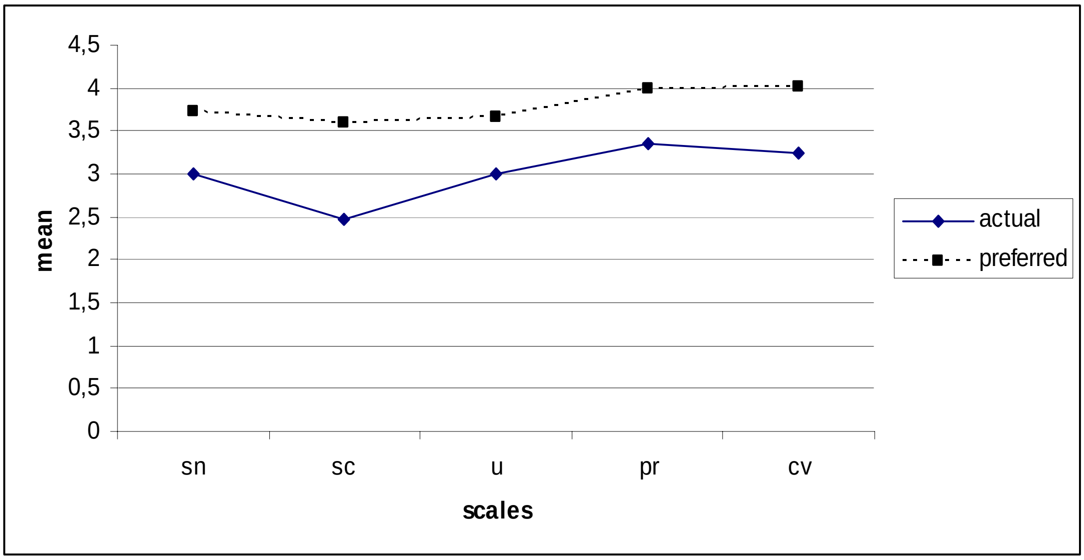

Figure 5.5. Individual mean scores of the students' actual and preferred CLES scores

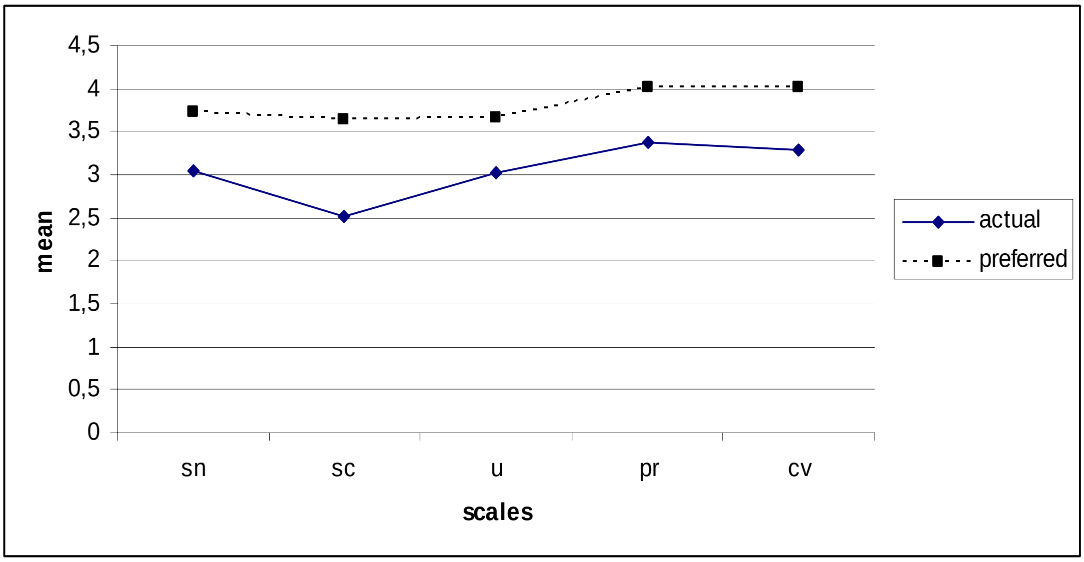

Figure 5.6. Class mean scores of the students' actual and preferred CLES scores

5.3. The Relationships among Variables of the Study

This section presents the relationships among the variables and explores the 5th research question.

5.3.1. Main Problem 1:

"What is the possible relationship among 8th grade students' scientific epistemological beliefs, actual learning environments, learning approaches, attitudes towards science, prior knowledge and gender?"

In order to see the relationships that might exist between the variables, firstly Pearson Correlation Analyses were conducted. Second, Multiple Regression Analyses were conducted in order to see whether the variables contribute to the meaningful and rote learning orientations of the students. This research question will be handled under two sub-research questions; in the first one, analyses will be conducted by using the actual form of the CLES.

Table 5.3. Pearson product-moment correlation coefficients (*r*)
*Correlation is significant at the 0.05 level
**Correlation is significant at the 0.01 level

	SEB	PR	U	CV	SC	SN	LAQ-R	LAQ-M	ATS	PRIOR KNOWLEDGE
SEB	-	-	-	-	-	-	-	-	-	-
PR	.106**	-	-	-	-	-	-	-	-	-
U	.111**	.557**	-	-	-	-	-	-	-	-
CV	.117**	.654**	.528**	-	-	-	-	-	-	-
SC	-.013	.385**	.477**	.517**	-	-	-	-	-	-
SN	.120**	.536**	.488**	.621**	.544**	-	-	-	-	-
LAQ-R	-.094**	.074*	.182**	.069*	.158**	.049	-	-	-	-
LAQ-M	.140**	.457**	.317**	.458**	.283**	.435**	.142**	-	-	-
ATS	.065*	.308**	.225**	.301**	.258**	.298**	.196**	.486**	-	-
PRIOR KNOWLEDGE	.163**	.164**	.035	.220**	.051	.246**	-.237**	.227**	.176**	-
GENDER	-.100**	-.059*	.004	.006	.089**	-.037	.128**	-.104**	.047	-.150**

In order to see the relationships that might exist between the variables Pearson product-moment correlation coefficients (*r*) were calculated. The results are presented on Table 5.3.

Results indicated that students' meaningful learning orientations were significantly correlated with all of the scales of the actual form of CLES instrument. Students having meaningful learning approaches tended to perceive their actual learning environments as offering adequate opportunities for them to relate science with the real world (r = .457, p<.01), experience the formulation of scientific knowledge (r = .317, p<.01), question what is going on in the lesson freely (r = .458, p<.01), take role in the decision making process of what will go on in the lesson to be more beneficial for them (r = .283, p<.01) and communicate in the classroom (r = .435, p<.01).

Besides, LAQ-M scores were significantly correlated with students' SEB scores (r = .140, p<.01), attitudes scores (r = .486, p<.01) and their prior knowledge (r = .227, p<.01). Moreover, a significant correlation between LAQ-M and LAQ-R (r = .142, p<.01) was found. These mean that the students having meaningful learning orientations tended to have tentative views of epistemological beliefs and higher attitude towards science. Data also suggest that students having meaningful learning orientations can also be learned by rote. But it is necessary to note that although the correlation is significant, it is very low.

These results led to the conclusion that students having meaningful learning orientations also have tentative views of SEB, positive attitudes towards science, high prior knowledge and perceive their learning environments as constructivist.

Students' responses on the LAQ-R, however, were significantly correlated with four of the five scales of the CLES (PR, U, CV, SC). The students having rote learning orientations perceived their learning environments as offering them adequate opportunities to relate science with the real world (r = .074, p<.05), experience the formulation of scientific knowledge (r = .182, p<.01), question what is going on in the lesson freely (r = .069, p<.05) and take role in the decision making process of what will go on in the lesson to be more beneficial for them (r = .158, p<.01).

Significant correlations were also found between LAQ-R and ATS scores (r

= .196, *p*<.01) indicating that the students having rote learning approaches had positive attitudes towards science. Moreover, significant but negative correlations between LAQ-R and SEB (*r* = -.094, *p*<.01) and prior knowledge (*r* = -.237, *p*<.01) were found. These results indicate that the students learning by rote have fixed views of SEB and had low prior knowledge.

Nevertheless, no significant correlations were found between students' responses on LAQ-R and Negotiation scale of CLES, which means the communication in the classroom, does not have an effect on the rote learning orientations of the students.

To conclude, students having rote learning orientations had fixed views of SEB, positive attitudes towards science and low prior knowledge in science. Furthermore, these rote learners perceived their learning environments as offering them adequate opportunities to relate science with the real world, take role in the decision making process of what will go on in the lesson to be more beneficial for them, question what is going on in the lesson freely and experience the formulation of scientific knowledge. However, the extent to which students can communicate does not have a significant effect on the rote learning orientations of the students.

5.3.2. Main Problem 2

"What are the contributions of attitude, actual learning environment, scientific epistemological beliefs, prior knowledge and gender on 8th grade students' meaningful learning orientations?"

Multiple Regression Analysis is used to evaluate the contributions of each variable to meaningful learning orientations of the students. LAQ-M scores are used as the dependent variable and attitude actual learning environment, scientific epistemological beliefs, prior knowledge and gender are used as independent variables.

Multiple regressions have a number of assumptions which are sample size, multicollinearity and singularity, normality, homoscedasticity, independence of residuals and outliers. Before conducting the analyses assumptions of Multiple Regression are checked.

According to Tabachnick and Fidell (1996) the sample size can be calculated by N>50+8m where m is the number of independent variables. In this case there are 10 independent variables, then if the formula is calculated N>130. In this case this assumption is satisfied since the sample size is 1152 as a result; this sample size assumption is met.

Multicollinearity exists when the independent variables are highly correlated (r=0.9 and above). Singularity occurs when one independent variable is actually a combination of other independent variables. However, multiple regression does not like multicollinearity or singularity. In this case correlations between independent variables should not be too high. As seen in table 4.3, none of the correlations exceeded r=0.9. Collinearity diagnostics resulted in Tolerance values that were all large enough (minimum 0.421). Since the multiple correlations with other variables are not high, the multicollinearity and singularity assumption is not violated.

Multiple regression is very sensitive to outliers. For this case when the Normal Probability Plot is observed (Figure 5.7, 5.8), it is easily seen that the points lie in a reasonably straight diagonal line from bottom left to top right. This suggests no major deviations from the normality. Since there is a straight line it also shows the linearity.

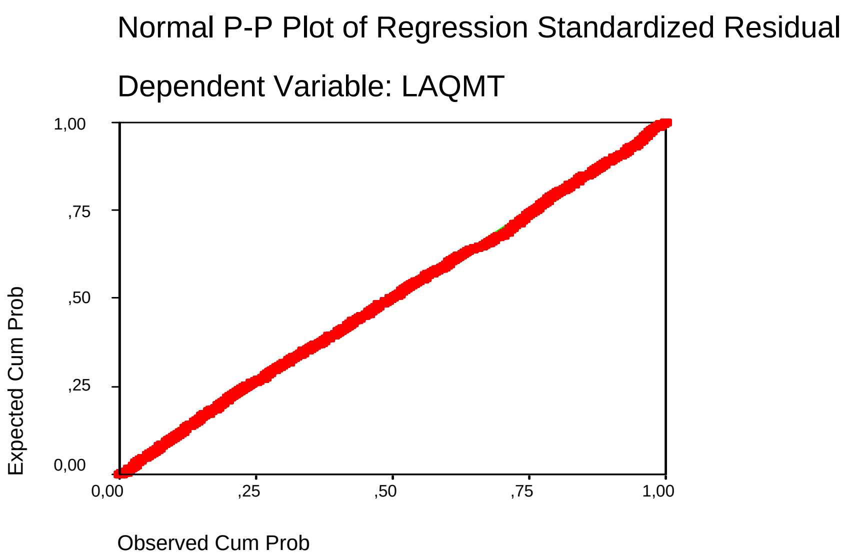

Figure 5.7. Normal probability plots for LAQ-M

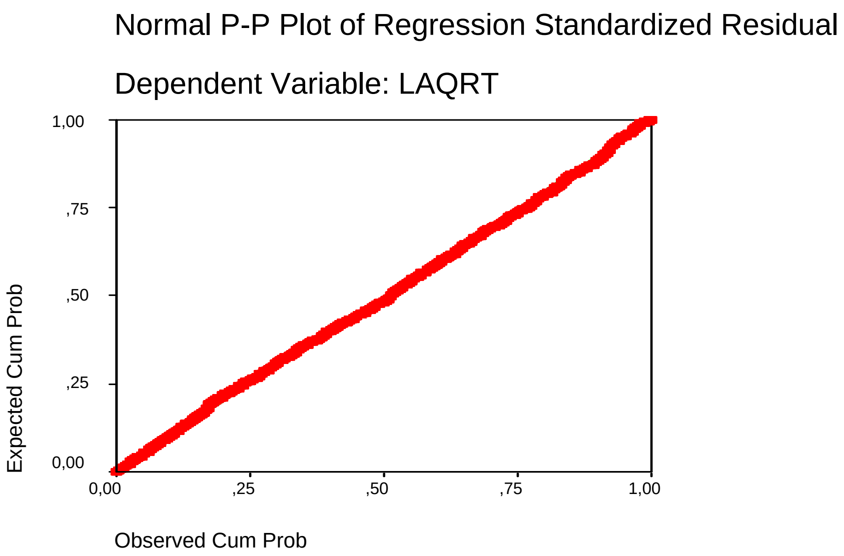

Figure 5.8. Normal probability scores for LAQ-R

When the scatterplot of the standard residuals are (Figure 5.9., 5.10.) investigated, it is seen that the residuals are roughly rectangularly distributed, with most of the scores concentrated in the centre, along the 0 point as below:

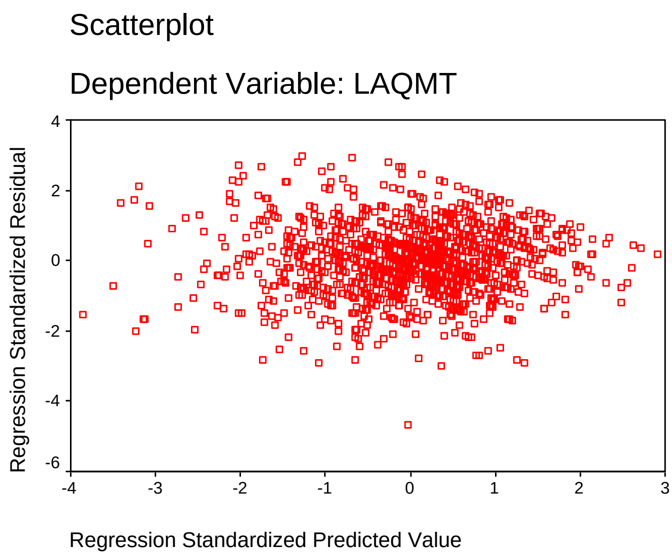

Figure 5.9. Scatterplot of the residual for LAQ-M

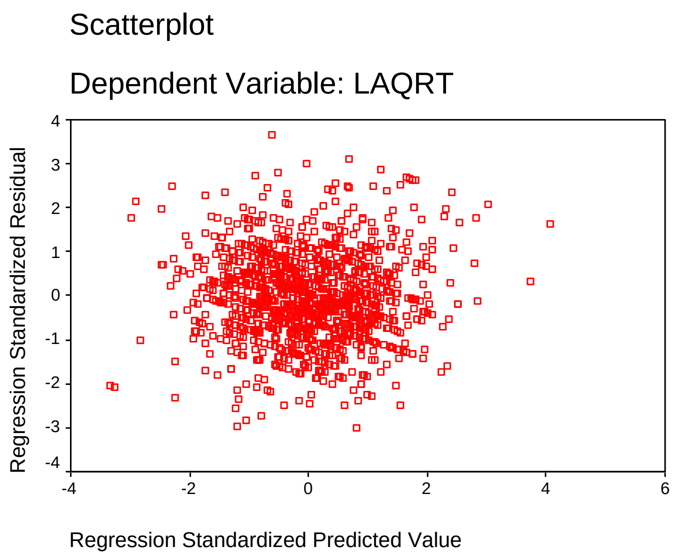

Figure 5.10. Scatterplot of the residual for LAQ-R

When the scatterplot is observed again, it is seen that the shape likes a cigar shape along its length. Moreover, when the Residuals Statistics table is observed, it is seen that the means for residuals, std. residual and stud. residuals are equal. As a result it can be said that the homogeneity of variances it met.

In order to check for the outliers the Mahalanobis distances are investigated. In the data file there is a variable called Mah_1. to identify which cases are outliers, the critical square value is needed to be determined. According to Tabachnick and Fidell's guidelines (1996), since there are ten independent variables in this case, the critical value is 29.59. There were 5 values that exceeded the critical value. Since the size of the data is large (1152), it is not unusual for a few outliers (5) to appear so they will be ignored.

In the previous research question, significant correlations were found between LAQ-M and attitude, actual learning environment, scientific epistemological beliefs, prior knowledge and gender were found. A multiple linear regression analysis was conducted to evaluate how well the variables predicted meaningful learning approach. Meaningful learning approach was assigned as the dependent variable and the other variables were assigned as predictors.

Results showed that students' attitude towards science, three scales of the actual learning environment (Personal Relevance, Critical Voice, Student

Negotiation), scientific epistemological beliefs and prior knowledge significantly contributed to their meaningful learning approaches. The sample multiple correlation coefficient (R) was .63, R^2 was 39.1% indicating that 39 % of the variance of the meaningful learning approach in the sample can be accounted for by the linear combination of the students' attitude towards science, learning environment that offers adequate opportunities for them to relate science with real world (PR), question what is going on in the lesson freely (CV), communicate in the classroom (SN), scientific epistemological beliefs, prior knowledge and gender ($F (9, 1142) = 83.14$, $p = .000$) (See Table 5.4).

When the partial correlations were examined, it was found that attitude towards science was the best predictor of meaningful learning approach followed by critical voice, personal relevance, student negotiation, prior knowledge, scientific epistemological beliefs and gender. Briefly, this result suggested that attitude towards science was the main predictor of meaningful learning approach.

TABLE 5.4. Independent contributions of ATS, actual CLES scales, SEB, PRIOR and GENDER to LAQ-M

Variables	*β*	*t*	*Correlations* Part	*Correlations* Partial	*p*
Constant		6.725			.000
ATS	.345	13.869	.319	.380	.000
PR	.162	4.909	.113	.144	.000
U	.003	.098	.002	.003	.922
CV	.156	4.433	.102	.130	.000
SC	-.017	-.556	-.013	-.016	.579
SN	.134	4.089	.094	.120	.000
SEB	.048	2.027	.047	.060	.043
PRIOR KNOWLEDGE	.052	2.089	.048	.062	.037
GENDER	-.093	-3.928	-.090	-.115	.000

5.3.3. Main Problem 3

"What are the contributions of attitude, actual learning environments, scientific epistemological beliefs and prior knowledge and gender on 8th grade students' rote learning orientations?"

In the 6th research question, significant correlations were found between LAQ-R and attitude, four scales of the actual learning environment (PR, U, CV, SC), scientific epistemological beliefs, prior knowledge and gender.

In order to evaluate how well attitude, scales of the actual form of the CLES, SEB, prior knowledge and gender predicted rote learning approach, a separate multiple regression analyses were conducted. Rote learning approach was assigned as the dependent variable and the other variables were assigned as independent variables.

Results showed that students' attitude towards science, only one scale of the learning environment (U), scientific epistemological beliefs, prior knowledge and gender significantly contributed to their rote learning approaches. The sample multiple correlation coefficient (R) was .385, R^2 indicating that 14.3 % of the variance of the rote learning approach in the sample can be accounted for by the linear combination of the variables (ATS, actual U, SEB, PRIOR, gender) (F (8, 1143) = 24.928, p = .000.). (See Table 5.5.).

TABLE 5.5. Independent Contributions of ATS, actual CLES, SEB, PRIOR and Gender to LAQ-R.

			Correlations		
Variables	*β*	*t*	*Part*	*Partial*	*p*
Constant		14.846			.000
ATS	.210	7.091	.194	.205	.000
PR	-.027	-.701	-.019	-.021	.484
U	.154	4.297	.117	.126	.000
CV	-.011	-.252	-.007	-.007	.801
SC	.070	1.988	.054	.059	.047
SEB	-.069	-2.451	-.067	-.072	.014
PRIOR KNOWLEDGE	-.247	-8.405	-.229	-.241	.000
GENDER	.065	2.303	.063	.068	.021

When the partial correlations were examined, it was found that prior knowledge was the best predictor of rote learning approach, followed by attitude towards science, uncertainty and shared control. Briefly, this result suggested that attitude towards science was the main predictor of meaningful learning approach.

5.4. Summary

The students used more meaningful learning approaches than rote learning approaches. Moreover, girls had more meaningful learning approaches compared with boys.

The students' scores on the Scientific Epistemological Beliefs Questionnaire showed that the subjects of the study have slightly more tentative views indicating that they are aware of the fact that scientific knowledge can change by time and it is not certain. Girls were also found to have slightly more tentative views compared with the boys.

The students generally had positive attitudes towards science. Boys have more positive attitudes towards science than girls.

Students perceived their learning environment as offering them adequate opportunities to relate science to real world, question what is going on in the lesson freely, experience the formulation of the scientific knowledge and communicate in the classroom. However, the students mentioned that they did not have adequate opportunities to take role in the decision making process of what will go on in the lesson to be more beneficial for them.

Students prefer learning environments in which they have the chance to question what is going on in the lesson freely, relate science with the real world, communicate in the classroom, experience the formulation of scientific knowledge and take role in the decision making process of what will go on in the lesson to be more beneficial for them.

Based on the individual and class mean scores of the students on the CLES paired samples t-test was used in order to see if the students' present learning environments matched their preferences about the learning environment. Results showed that sample preferred more constructivist learning environments in which there is more chance to relate science with the real world, communicate in the classroom, take role in the decision making process of what will go on in the lesson to be more beneficial for them, question what is going on in the lesson freely and experience the formulation of scientific knowledge.

Meaningful learning approaches scores were significantly correlated with all the scales of the actual CLES, scientific epistemological beliefs, attitudes towards science and prior knowledge.

A significant, positive but small correlation was found between meaningful learning approach and rote learning approach.

Rote learning approach scores were significantly and positively correlated with Personal Relevance, Uncertainty, Critical Voice, Shared Control subscale of Constructivist Learning Environment Survey and attitudes towards science.

Significant but negative relationship was found between LAQ-R and SEB and prior knowledge.

There were no significant correlations between rote learning approaches and Negotiation scale.

MRC results showed that 39% of the variance of the meaningful learning approach can be accounted for by the linear combination of the students' attitude towards science, learning environment that offers adequate opportunities for them to relate science with real world (PR), question what is going on in the lesson freely (CV), communicate in the classroom (SN), scientific epistemological beliefs, prior knowledge and gender. Part and partial correlations showed that meaningful learning is best predicted by the students' attitudes towards science.

MRC results also showed that 14.3% of the variance of the rote learning approach can be accounted for by the linear combination of attitude towards science, uncertainty scale of actual form of the CLES, scientific epistemological beliefs, prior knowledge and gender. Part and partial correlations indicated that rote learning approach is best predicted by students' prior knowledge.

CHAPTER VI

DISCUSSION

6.1. Discussion

The purpose of this study was to investigate scientific epistemological beliefs, perceptions of constructivist learning environment, attitude towards science, prior knowledge and gender as determinants of students' approaches to learning.

Learning approaches of the students have taken a great interest by the researchers. The research conducted by Diseth and Martinsen (2003) revealed approaches to learning as the best predictors of academic performance. Other researches indicated that meaningful learning contributed to the students' meaningful understandings (Cavallo & Schafer, 1994; Williams & Cavallo, 1995).

Findings of this study indicate that the students used meaningful learning approaches (*M*=32.29) more than rote learning approaches (*M*=27.74). The students that use meaningful learning approaches build new information on the existing ones or change the existing information while the rote learners do not associate new knowledge with the existing knowledge (Ausubel, 1968, Williams et al., 1995). As Williams and Cavallo (1995) stated the students with meaningful learning approaches have more sound understandings while the students with rote learning approaches have misconceptions. Moreover, data suggest that girls (*M*= 60.93) have more meaningful learning approaches compared to boys (*M*= 58.37). BouJaoude et al. (1994) also indicated that female students had higher meaningful orientation score than male students.

The present study also indicated that students have slightly more tentative views of scientific epistemological beliefs than fixed views of scientific epistemological beliefs meaning that the students are aware of the nature of knowledge including the purpose of science, sources of scientific knowledge, role of evidence and experiments, changeability of knowledge in science and coherence of scientific knowledge. In other words, the students think that the purpose of science is to discover things instead of explaining phenomena, sources of scientific knowledge arise from thinking and reasoning instead of coming from an authority, role of evidence and experiments depends on the students' understanding of the relationship between theory and evidence, scientific knowledge can change by time and understand science as a body of knowledge of interrelated concepts. Moreover, girls (*M*= 42.69) were found to have slightly more tentative views of science compared with the boys (*M*= 41.79).

Another finding of the study is that the students have positive attitudes towards science (*M*=47.05) with the boys (*M*=47.40) having slightly more positive attitudes towards science than girls (*M*=46.63). This showed that boys were interested more in the science topics ending with more favorable attitudes towards science than the girls.

Individual unit analysis showed that the students perceive their actual learning environments as moderately constructivist and prefer more constructivist learning environments. In other words, the students perceived their learning environments as moderately offering them adequate chance to relate science to real world, question what is going on in the lesson freely, experience the formulation of scientific knowledge and communicate in the classroom. However, they stated that they seldom take role in the decision making process of what will go on in the lesson to be more beneficial for them. Moreover, the students preferred learning environments in which they can often relate science with the real world, question what is going on in the lesson freely, communicate in the classroom, experience the formulation of scientific knowledge and take role in the decision making process of what will go on in the lesson to be more beneficial for them. Regarding the students' responses to actual form of the *Constructivist Learning Environment Survey* the highest mean score was obtained for the *Personal Relevance* scale which is not surprising since the science curriculum in Turkey is based on relating the science content to everyday experiences. The lowest mean score for the actual form was for the *Shared Control* scale indicating that the students do not have a role in planning the learning activities. This shows that the teachers plan the learning activities. When the mean score for the same scale in the preferred form was observed it was seen that the students preferred to take role in this decision making process. When the preferred form of the *Constructivist Learning Environment Survey* is considered the highest mean score was gathered for the *Critical Voice* scale indicating that the students prefer to criticize the learning environment so that their learning can be improved. Similarly, class mean analyses with the *Constructivist Learning Environment Survey* show that the students also prefer learning environments in which they can often relate science with the real world, question what is going on in the lesson freely, communicate in the classroom, experience the formulation of scientific knowledge and take role in the decision making process of what will go on in the lesson to be more beneficial for them. This showed that the learning environment that the students have are based on constructivism however, this is not enough for the students. The findings of this study were similar to some studies in the literature (e.g. Kim, Fisher & Fraser, 1999; Tsai, 2000). For example, Tsai (2000) found that the students' learning environments did not adapt their preferences. Similarly, Kim et al. found that 10^{th} and 11^{th} grade students perceived their learning environments less constructivist than they preferred.

In the present study, 39% of the variance of the meaningful learning approach in the sample was accounted for by the linear combination of the students' attitude towards science, actual learning environment that offers adequate opportunities for them to relate science with real world, question what is going on in the lesson freely, communicate in the classroom, scientific epistemological beliefs and prior knowledge. Part and partial correlations showed that attitude was the best predictor of meaningful learning approach followed by critical voice and personal relevance. The present study also revealed that 14 % of the variance of the rote learning approach in the sample can be accounted for by the linear combination of attitudes towards science, uncertainty scale of actual form of the constructivist learning environment scale, scientific epistemological beliefs, prior knowledge and gender. Prior knowledge was found to be the best predictor of rote learning approach followed by attitude towards science.

These results revealed that the students who had positive attitude towards science associate new knowledge with the existing ones, question what is going on in the lesson, relate science to real world, communicate in the classroom and had beliefs that science is an evolving process that can be changed by time. Students who had low prior knowledge, positive attitudes towards science, experience the formulation of scientific knowledge and believe in the stableness of scientific knowledge can not associate new knowledge with the existing ones.

In the present study, the attitude towards science became a predictor of the rote learning approaches of the students while predicting their meaningful learning approaches. There was a greater positive correlation between meaningful learning orientation and attitude towards science (r=.486, p<.01) than the positive correlation between rote learning approach and attitude towards science (r=.196, p<.01). This can mean that if the students have greater attitude towards science then the students learn meaningfully and if they have slightly positive attitudes towards science then they learn by rote. As a result the amount of positive attitude towards science becomes important. In a similar vein, BouJaoude (1992) found a positive relationship between learning approaches of the students and their attitudes towards science (r = .56, p<.01). Cavallo and Schafer (1994) claimed that meaningful learning contributed to the students' meaningful understandings of the topics. They also found meaningful learning orientation and prior knowledge as the best predictors of students' meaningful understanding. They concluded that as the prior knowledge of the students about the topic increased their meaningful understandings of the topic increased which supports the result of the present study. Cavallo (1994) stated that there were no difference on students' self reported learning approaches based on gender although the teachers viewed females as more rote learners and the males as more meaningful learners. In the present study, there was a negative correlation between prior knowledge and rote learning approaches (r=-.237, p<.01) which indicates that the students who have low prior knowledge can not associate the new information due to the lack of existing information. Conversely, the positive correlation between prior knowledge and meaningful learning approach (r=.227, p<.01) indicate that the students who have greater existing information can associate the new information with the existing ones. The students who associate new information with the existing ones perceived their learning environment as offering them chance to question what is going on in the lesson freely (r=.458, $p<.01$), relate science to real life (r=.457, $p<.01$) and communicate in the classroom (r=.435, $p<.01$) and believe in the tentative nature of scientific knowledge (r=.140, $p<.01$). The students who memorize the knowledge had learning environments in which they can experience the formulation of scientific knowledge (r=.182, $p<.01$). However, they did not believe in the tentative nature of science (r=-.094, $p<.01$) although they experience it. Since the effect size is small it needs further investigation. The result of the present study is similar to Tsai's (1997) study in which he stated that scientific epistemological beliefs play a significant role in students' learning orientations and how they organize specific information. Tsai (1997) pointed out the interaction between scientific epistemological beliefs of the students and learning approaches. He found out that students holding constructivist epistemological beliefs tended to learn through constructivist–oriented learning activities and employed meaningful learning strategies while learning science, whereas students having empiricist views SEB tended to use rote-learning strategies while learning science. In the literature there are also similar studies and results (Chan, 2003; Cano, 2005). Although the boys had more positive attitudes towards science they were found to have rote learning approaches which can also be further studied.

The present study also revealed that there was a positive and significant correlation found between scientific epistemological beliefs of the students and the personal relevance, uncertainty, critical voice and student negotiation scales of the learning environment. This finding revealed that the students who perceived their learning environment as offering them adequate opportunities to relate science with the real world, experience the formulation of scientific knowledge, question what is going on in the lesson freely, and communicate in the classroom had tentative scientific epistemological beliefs. In other words these students believed in the changing nature of science by means of relating the knowledge that they face in the lesson with the experiences that they had in their real lives. Moreover these students should have explored the knowledge in their lessons by themselves so that they understood the formation of the scientific knowledge by questioning and discussing it with their friends. However, no relationship was found between taking role in the decision making process of what will go on in the lesson freely and scientific epistemological beliefs.

In the present study, students who perceived their learning environment as offering them adequate opportunities to relate science with the real world, experience the formulation of scientific knowledge, question what is going on in the lesson freely, and communicate in the classroom had tentative scientific epistemological beliefs. This result is in accord with some of the studies conducted in the literature about the interplay between the epistemological beliefs of the students and their perceptions of the learning environment (Tsai, 2000, 2003; Conley et al., 2004; Tolhurst, 2007). Conley et al. (2004) found that students in the constructivist learning environments developed more sophisticated epistemological beliefs compared with the ones in the traditional classrooms. Moreover, Elder (1999) and Conley et al. (2004) reported that the students that had more sophisticated beliefs about the scientific epistemological beliefs had greater achievements in the science lesson.

The findings of the present study revealed that students holding tentative scientific epistemological beliefs had high prior knowledge (r=0.163, $p<0.05$). In other words, the students who believed in the tentative nature of science had high prior knowledge. This result was consistent with the findings of Elder (1999) and Conley et al. (2004) who reported that the students that had more sophisticated beliefs about the scientific epistemological beliefs had greater achievements in the science lesson.

When the relationship between the meaningful learning and rote learning approaches were investigated although small a significant but positive relationship was found (r = .142, $p<0.01$) between the variables. This indicated that the students who learned meaningfully also learned by rote. In other words, the students who can associate new knowledge with the existing one also memorize the information. The relationship between meaningful and rote learning is supported by Entwistle and Ramsden (1983) since they argued that students may use both meaningful and rote learning strategies to manage their understanding. Cavallo et al. (1994) also stated that the students who have rote learning approaches with high prior knowledge attain meaningful understandings. However, in the literature there are studies that stated a negative relationship between meaningful learning approach and rote learning approach (Dart et al., 1999; Dart et. al., 2000). For example, Dart et al. (1999) found a negative relationship between deep approach and surface approaches ($r = -.38$, $p<.01$). On the other hand, Saunders (1998) and Cavallo et al. (2003) found that there were no correlations between the students' meaningful learning approaches and rote learning approaches, and identified them as different constructs.

6.2. Implications of the Study

Based on the findings of this study and the previous research, for the meaningful learning to take place the teachers should be aware of the factors that affect the learning approaches. Science teachers should be aware of the students' prior knowledge and their attitude towards science and should create learning environments in such a way that the students can relate science with the real world, experience the formulation of scientific knowledge, question what is going on in the lesson freely, take role in the decision making process of what will go on in the lesson to be more beneficial for them and communicate in the classroom so that the students learn meaningfully. By this way the students can understand the purpose of science, sources of scientific knowledge, role of evidence and experiments, tentativeness and coherence of scientific knowledge. The current study showed that the students perceived their learning environment as less constructivist than they preferred. Due to the fact that the new Science and Technology curriculum in Turkey is based on constructivism, the result of the present study suggested that science teachers should conduct their instructions more oriented to constructivist approach. The teachers can modify their classroom environment based on the comparisons of the actual and preferred learning environments.

6.3. Recommendations for Further Research

There may be some recommendations for further research studies. For example, the study can be conducted with students in different regions of Turkey; since the classroom learning environments and scientific epistemological beliefs of the students may be different. Moreover, the same study can be conducted with different grade levels to see the interplay between learning approaches, scientific epistemological beliefs and learning environments. Furthermore, the same study can be conducted with the sample of both the teachers and their students in order to fully explore the differences between the teachers' perceptions and the students' perceptions about the students' learning approaches, learning environment. In addition, qualitative data can be collected through interviews and classroom observations to get more accurate results. Another recommendation can be the application of instructional treatment. Besides, the relation of learning approaches should be investigated with other variables like motivation. Scientific epistemological beliefs of the students were investigated in one dimension; however, it should have been investigated with two dimensions separately.

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APPENDICES

APPENDIX A
DEMOGRAPHIC CHARACTERISTICS

Sevgili Öğrenciler,
Bu anket sizin bilginin doğası, yapılandırıcı öğrenim ortamı ve öğrenim yolları ile ilgili düşüncelerinizi öğrenmek amacıyla hazırlanmıştır. Bu sorulara vereceğiniz yanıtlar, araştırma amacıyla kullanılacak ve gizli tutulacaktır. Sizlerin görüşleri bizler için çok önemlidir.

Yardımlarınız için teşekkür ederim.

ODTÜ Yüksek lisans öğrencisi
Kudret ÖZKAL

Kişisel Bilgiler

1. Cinsiyetiniz: ❑ Kız ❑Erkek

2. Kardeş sayısı: …………

3. Okulunuzun adı: ……………………………………………….

4. Sınıfınız: 8 ❑ A ❑ B ❑ C ❑ D ❑ Diğer…..

5. Doğum tarihiniz (yıl): …………….

6. Geçen dönemki Fen Bilgisi karne notunuz: ………….

7. Anneniz çalışıyor mu?
   ❑ Çalışıyor ❑Çalışmıyor ❑Düzenli bir işi yok ❑ Emekli

8. Babanız çalışıyor mu?
   ❑ Çalışıyor ❑Çalışmıyor ❑Düzenli bir işi yok ❑ Emekli

9. Annenizin Eğitim Durumu
- ❑ Hiç okula gitmemiş
- ❑ İlkokul
- ❑ Ortaokul
- ❑ Lise
- ❑ Üniversite
- ❑ Yüksek lisans / Doktora

10. Babanızın Eğitim Durumu
- ❑ Hiç okula gitmemiş
- ❑ İlkokul
- ❑ Ortaokul
- ❑ Lise
- ❑ Üniversite
- ❑ Yüksek lisans / Doktora

11. Magazin dergileri, gazete ve okul kitapları **dışında** evinizde kaç tane kitap bulunuyor?
- ❑ Hiç yok ya da çok az (0 – 10)
- ❑ 11 – 25 tane
- ❑ 26 – 100 tane
- ❑ 101- 200 tane
- ❑ 200 taneden fazla

12. Evinizde bir çalışma odanız var mı?
❑ Evet ❑Hayır

13. Ne kadar sıklıkla eve gazete alıyorsunuz?
❑ Hiçbir zaman ❑ Bazen ❑ Her zaman

APPENDIX B

SCENTIFIC EPISTEMOLOGICAL BELIEFS QUESTIONNAIRE

Aşağıda Bilimin Doğası ile ilgili ifadeler göreceksiniz. Bu ifadelere ne derecede katılıp ne derecede katılmadığınızı ilgili seçeneği işaretleyerek belirtiniz

	Kesinlikle katıl**mı**yorum	Katıl**mı**yorum	Katılıyorum	Kesinlikle katılıyorum
Bilimsel bilgi **değişmez.**	❑	❑	❑	❑
Bugünün bilimsel kanunları, teorileri ve kavramları gelecekte bulunabilecek yeni kanıtlar ışığı altında değiştirilebilir.	❑	❑	❑	❑
Bilimsel teoriler keşfedilir, insanlar tarafından meydana **getirilmez.**	❑	❑	❑	❑
Bilimsel bir bilgi hakkındaki kanıt, aynı şartlarda diğer araştırmacılar tarafından da elde edilebiliyorsa, o bilgi doğru olarak kabul edilir.	❑	❑	❑	❑
Bilimsel bilginin doğruluğu şüphe götürmez.	❑	❑	❑	❑
Bilim insanlarının konu hakkındaki düşünceleri, gözlemerini etkiler.	❑	❑	❑	❑
Bilimsel kanun, evren hakkındaki gerçeğin tam bir açıklamasıdır.	❑	❑	❑	❑
Bilim daima somut ve yeni gözlemler ışığında değişime uğrar.	❑	❑	❑	❑
Bilimsel bilgi keşfedilen gerçeklerden oluşur.	❑	❑	❑	❑
Bilimsel bilgi, bilim insanlarının yaratıcılığını yansıtır.	❑	❑	❑	❑
Bilim insanlarının belli bir konu üzerinde farklı görüşlere sahip olmalarının nedeni genellikle tüm gerçekleri **bilmemeleridir.**	❑	❑	❑	❑
Bilimsel bilgi yeniden değerlendirilmeye ve değişime açıktır.	❑	❑	❑	❑
Bilim insanları uyguladıkları farklı metotlar sonucunda farklı bilgilere ulaşamazlar. Çünkü bilimsel metot her zaman geçerlidir, dolayısıyla bilimsel bilgi bilim insanlarının düşüncelerinden etkilenmez.	❑	❑	❑	❑
Bilimsel prolemler, metotlar ve bulgular, tarihsel, kültürel ve sosyal durumlara göre değişir.	❑	❑	❑	❑
Bilimsel gerçekler birkaç uzman tarafından keşfedilir.	❑	❑	❑	❑
Bilim insanları arasındaki anlaşmazlıklar, gerçekleri ya da gerçeklerin önem derecelerini farklı şekilde yorumlamalarından kaynaklanır. Bu görüş ayrılıklarının sebebi ise farklı bilimsel teorilerdir.	❑	❑	❑	❑

APPENDIX C

ACTUAL FORM OF CONSTRUCTIVIST LEARNING ENVIRONMENT SURVEY

Aşağıda Fen Bilgisi dersi ortamına dair ifadeler göreceksiniz. <u>ŞU ANDAKİ DERS ORTAMINIZI DÜŞÜNEREK</u> bu ifadelere ne derecede katılıp ne derecede katılmadığınızı ilgili seçeneği işaretleyerek belirtiniz.

	Hiçbirzaman	Nadiren	Bazen	Sıklıkla	Her zaman
Fen Bilgisi dersimizde okul içindeki ve dışındaki dünya hakkında bilgi ediniyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimin problemlere her zaman bir çözüm getiremediğini öğreniyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde neyin, nasıl öğretildiğini rahatlkla sorguluyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde ne öğreneceğimin planlanmasında öğretmene yardımcı oluyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde problemleri nasıl çözeceğimi diğer öğrenciler ile tartışıyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde ne kadar iyi öğrendiğimin değerlendirilmesinde/ölçülmesinde öğretmene yardımcı oluyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde öğrendiğim yeni bilgilerin okul içinde ve dışında edindiğim deneyimler ile ilişkili olduğunun farkındayım.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde neyin, nasıl öğretildiğini rahatlıkla sorgulamama izin verildiğinde daha iyi öğreniyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimsel açıklamaların zaman içinde değiştiğini öğreniyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde diğer öğrenciler benim fikrimi açıklamamı istiyorlar.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimin okul içindeki ve dışındaki hayatın bir parçası olduğunu öğreniyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde hangi etkinliklerin benim için daha yararlı olacağına karar vermede öğretmene yardımcı oluyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimin, insanların kültürel değerlerinden ve fikirlerinden etkilendiğini öğreniyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde fikirlerimi diğer öğrencilere açıklıyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde karmaşık olan etkinlikler için açıklayıcı bilgi isteyebiliyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde okul içindeki ve dışındaki dünya hakkında ilginç şeyler öğreniyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde diğer öğrencilerin fikirlerini açıklamalarını istiyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde öğrenmeme engel olabilecek durumlar için	❑	❑	❑	❑	❑

düşüncelerimi dile getirebiliyorum.					
Fen Bilgisi dersimizde bilimin, soruların ortaya konması ve çözüm yollarının oluşturulmasında bir yol olduğunu öğreniyorum.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde herhangi bir etkinlik/aktivite için ne kadar zamana ihtiyacım olduğunu öğretmene bildiriyorum.	❑	❑	❑	❑	❑

APPENDIX D

PREFERRED FORM OF CONSTRUCTIVIST LEARNING ENVIRONMENT SURVEY

Aşağıda Fen Bilgisi dersi ortamına dair ifadeler göreceksiniz. <u>FEN BİLGİSİ DERS ORTAMINIZIN NASIL OLMASINI İSTEDİĞİNİZİ DÜŞÜNEREK</u> bu ifadelere ne derecede katılıp ne derecede katılmadığınızı ilgili seçeneği işaretleyerek belirtiniz.

	Hiçbirzaman	Nadiren	Bazen	Sıklıkla	Her zaman
Fen Bilgisi dersimizde okul içindeki ve dışındaki dünya hakkında bilgi edinmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimin problemlere her zaman bir çözüm getiremediğini öğrenmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde neyin, nasıl öğretildiğini rahatlkla sorguluyabilmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde ne öğreneceğimin planlanmasında öğretmene yardımcı olmayı isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde problemleri nasıl çözeceğimi diğer öğrenciler ile tartışabilmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde ne kadar iyi öğrendiğimin değerlendirilmesinde/ölçülmesinde öğretmene yardımcı olmayı isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde öğrendiğim yeni bilgilerin okul içinde ve dışında edindiğim deneyimler ile ilişkili olduğunun farkında olabilmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde neyin, nasıl öğretildiğini rahatlıkla sorgulayabilmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimsel açıklamaların zaman içinde değiştiğini öğrenmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde diğer öğrencilerin fikrimi açıklamamı istemelerini isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimin okul içindeki ve dışındaki hayatın bir parçası olduğunu öğrenmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde hangi etkinliklerin benim için daha yararlı olacağına karar vermede öğretmene yardımcı olmayı isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimin, insanların kültürel değerlerinden ve fikirlerinden etkilendiğini öğrenmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde fikirlerimi diğer öğrencilere açıklamayı	❑	❑	❑	❑	❑

isterim.					
Fen Bilgisi dersimizde karmaşık olan etkinlikler için açıklayıcı bilgi isteyebilmeliyim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde okul içindeki ve dışındaki dünya hakkında ilginç şeyler öğrenmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde diğer öğrencilerin fikirlerini açıklamalarını isteyebilmeliyim	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde öğrenmeme engel olabilecek durumlar için düşüncelerimi dile getirebilmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde bilimin, soruların ortaya konması ve çözüm yollarının oluşturulmasında bir yol olduğunu öğrenmeyi isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersimizde herhangi bir etkinlik/aktivite için ne kadar zamana ihtiyacım olduğunu öğretmene bildirmeyi isterim.	❑	❑	❑	❑	❑

APPENDIX E

LEARNING APPROACH QUESTIONNAIRE

Aşağıda Fen Bilgisi konularını öğrenme yolları ile ilgili ifadeler göreceksiniz. Bu ifadelere katıldığınızı ya da katılmadığınızı ilgili seçeneği işaretleyerek belirtiniz.

	Kesinlikle katıl**mı**yorum	Katıl**mı**yorum	Katılıyorum	Kesinlikle katılıyorum
Genellikle ilk başta zor gibi görünen konuları anlamak için çok çaba sarf ederim.	❑	❑	❑	❑
Konuları en iyi, öğretmenin anlattığı sırayı düşündüğümde hatırlarım.	❑	❑	❑	❑
Bir konuya çalışırken, öğrendiğim yeni bilgileri eskileriyle ilişkilendirmeye çalışırım.	❑	❑	❑	❑
Öğrenmek zorunda olduğum konuları ezberlerim.	❑	❑	❑	❑
Ders çalışırken, öğrendiğim konuları günlük hayatta nasıl kullanabileceğimi düşünürüm.	❑	❑	❑	❑
Öğretmenler, öğrencilerden, sınavda sorulmayacak konular üzerinde çok fazla zaman harcamalarını **beklememelidirler.**	❑	❑	❑	❑
Önemli konuları tam olarak anlayana kadar tekrar ederim.	❑	❑	❑	❑
Bir konu hakkında çok fazla araştırma yapmanın zaman kaybı olduğunu düşündüğümden, sadece sınıfta ya da ders notlarında anlatılanları ciddi bir şekilde çalışırım.	❑	❑	❑	❑
Bir kez çalışmaya başladığımda her konunun ilgi çekici olacağına inanırım.	❑	❑	❑	❑
Gerçek olaylara dayanan konuları, varsayıma dayanan konulardan daha çok severim.	❑	❑	❑	❑
Derslerde duyduğum ya da kitaplarda okuduğum bazı bilgiler hakkında sık sık düşünürüm.	❑	❑	❑	❑
Benim için teknik terimlerin ne anlama geldiğini anlamanın en iyi yolu ders kitabındaki tanımı hatırlamaktır.	❑	❑	❑	❑
Konuların birbirleri ile nasıl ilşikilendiğini anlayarak, yeni bir konu hakkında genel bir bakış açısı edinmenin benim için faydalı olduğunu düşünürüm.	❑	❑	❑	❑
Genelde okumam için verilen materyalin bana sağlayacağı faydayı **düşünmem.**	❑	❑	❑	❑
Anladığımdan iyice emin olana kadar dersten ya da laboratuardan sonra notlarımı tekrar tekrar okurum.	❑	❑	❑	❑
Konuları ezberleyerek öğrenirim, yani öğrendiğime inanana kadar ezberlerim.	❑	❑	❑	❑
Okumam için verilen materyalleri, anlamını tam olarak anlayıncaya kadar okurum.	❑	❑	❑	❑

Çoğunlukla, konuları gerçekten anlamadan okurum.	❑	❑	❑	❑
Bir konuda öğrendiğim bilgiyi başka bir konuda öğrendiğimle ilişkilendirmeye çalışırım.	❑	❑	❑	❑
Bir konuyla ilgili verilen fazladan okumalar kafa karıştırıcı olabileceğinden sadece derste öğrendiklerimize paralel olarak tavsiye edilen birkaç kitaba bakarım.	❑	❑	❑	❑
Bulmaca ve problemler çözerek mantıksal sonuçlara ulaşmak beni heyecanlandırır.	❑	❑	❑	❑
Ekstra birşeyler yapmanın gereksiz olduğunu düşündüğüm için, çalışmamı genellikle derste verilen bilgiyle sınırlarım.	❑	❑	❑	❑

APPENDIX F

SCIENCE ATTITUDE SCALE

Aşağıda Fen Bilgisine yönelik tutumlarla ilgili ifadeler göreceksiniz. Bu ifadelere ne derecede katılıp ne derecede katılmadığınızı ilgili seçeneği işaretleyerek belirtiniz.

	Kesinlikle katıl**mı**yorum	Katıl**mı**yorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
Fen Bilgisi çok sevdiğim bir alandır.	❑	❑	❑	❑	❑
Fen Bilgisi ile ilgili kitapları okumaktan hoşlanırım.	❑	❑	❑	❑	❑
Fen Bilgisinin günlük yaşantıda çok önemli bir yeri yoktur.	❑	❑	❑	❑	❑
Fen Bilgisi dersi ile ilgili ders problemlerini çözmekten hoşlanırım.	❑	❑	❑	❑	❑
Fen Bilgisi konuları ile ilgili daha çok şey öğrenmek isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersine girerken sıkıntı duyarım.	❑	❑	❑	❑	❑
Fen Bilgisi dersine zevkle girerim.	❑	❑	❑	❑	❑
Fen Bilgisi dersine ayrılan ders saatinin daha fazla olmasını isterim.	❑	❑	❑	❑	❑
Fen Bilgisi dersine çalışırken canım sıkılır.	❑	❑	❑	❑	❑
Fen Bilgisi konlarını ilgilendiren günlük olaylar hakkında daha fazla bilgi edinmek isterim.	❑	❑	❑	❑	❑
Düşünce sistemimizi geliştirmede fen bilgisi öğrenimi önemlidir.	❑	❑	❑	❑	❑
Fen Bilgisi çevremizdeki doğal olayların daha iyi anlaşılmasında önemlidir.	❑	❑	❑	❑	❑
Dersler içinde fen bilgisi dersi önemsiz gelir.	❑	❑	❑	❑	❑
Çalışma zamanımın önemli bir kısmını fen bilgisi dersine ayırmak isterim.	❑	❑	❑	❑	❑
Fen Bilgisi konuları ile ilgili tartışmalara katılmak bana cazip gelmez.	❑	❑	❑	❑	❑

APPENDIX G

PERMISSION TAKEN FROM THE MINISTRY OF EDUCATION

ÖĞRENC... İ DAİRESİ BAŞ... LIĞI ... Md ...

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

BÖLÜM : Kültür
SAYI : B.08.4.MEM.4.06.00.11.070/ 4032
KONU : Araştırma.

08.12.2005

ORTA DOĞU TEKNİK ÜNİVERSİTESİ REKTÖRLÜĞÜNE
Öğrenci İşleri Dairesi Başkanlığı

İLGİ: 26.10.2005 tarih ve 9055-16946 sayılı yazınız.

Üniversitenizin İlköğretim Fen ve Matematik Eğitimi EABD Yüksek Lisans Programı öğrencilerinden Kudret ÖZKAL'ın ilgi yazınız ekinde isimleri belirtilen okullarda anket uygulayabilmesine ilişkin Bakanlığımız Planlama ve Koordinasyon Kurulu Başkanlığı'nın 28.112005 tarih ve 7578 sayılı yazısı ekte gönderilmiştir.

Bilgilerinizi rica ederim.

Erol ORTAKAYA
Vali a.
Milli Eğitim Müdür Yardımcısı

EKLER:
EKİ. 1-Bakanlık Emri

12.12.05 020537

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T.C.
MİLLÎ EĞİTİM BAKANLIĞI
Araştırma, Planlama ve Koordinasyon Kurulu Başkanlığı

Sayı : B.08.0.APK.0.03.05.01-01/ 1578 — 28 /11/2005

Konu : Araştırma İzni

ANKARA VALİLİĞİNE
(İl Millî Eğitim Müdürlüğü)

İlgi : Ankara Valiliği İl Milli Eğitim Müdürlüğü'nün 10.11.2005 tarih ve 12357 sayılı yazısı.

Orta Doğu Teknik Üniversitesi İlköğretim Fen ve Matematik Eğitimi Anabilim Dalı, Yüksek Lisans programı öğrencisi Kudret ÖZKAL'ın "**İlköğretim 6., 7. ve 8. Sınıf Öğrencilerinin Bilginin Doğası ile İlgili Düşünceleri, Yapılandırıcı Öğrenim Ortamları ve Öğrenim Yılları Arasındaki İlişkiyi İnceleme**" konulu araştırma çalışmasını EK-2 listede yer alan okullarda uygulama izin talebi incelenmiştir.

Gazi Üniversitesi Eğitim Bilimleri Enstitüsü Müdürlüğü tarafından kabul edilen ve ekte gönderilen 6 sayfa 78 sorudan oluşan anketin araştırmacı tarafından uygulanmasında Bakanlığımızca sakınca görülmemektedir.

Bilgilerinizi ve gereğini rica ederim.

Cevdet CENGİZ
Bakan a.
Müsteşar Yardımcısı

EK :
EK – 1 Anket (6 Sayfa)
EK – 2 Okul Listesi (2 Sayfa)

T. C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü
Gelen Evrakın K... : 3678
Gelen Evrakın Tarihi : 05.12.2005
... Birimi Bölümü : Kalite

1753
07.12.2005

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Sayı/Ref. : B.30.2.ODT.0.70.72.00/ 10001 -1225

14.12.2005

SOSYAL BİLİMLER ENSTİTÜSÜ MÜDÜRLÜĞÜ'NE

İLGİ : 20.10.2005 tarih ve B.30.2.ODT.0.E1.00.00/2005-1327-9897 sayılı yazınız.

İlgi yazınız Ankara Valiliği Milli Eğitim Müdürlüğü'ne iletilmiş olup, Ankara Valiliği Milli Eğitim Müdürlüğü'nden alınan yazı ilgisi nedeni ile ilişikte sunulmuştur.

Gereğini bilgilerinize arz ederim.

Saygılarımla.

Nesrin ÜNSAL
Öğrenci İşleri
Dairesi Başkanı