Hacettepe Üniversitesi Eğitim Fakültesi Dergisi (H. U. Journal of Education) 37: 72-83 [2009]

INVESTIGATING ELEMENTARY STUDENTS' LEARNING APPROACHES, MOTIVATIONAL GOALS, AND ACHIEVEMENT IN SCIENCE

İLKOKUL ÖĞRENCİLERİNİN ÖĞRENME YAKLAŞIMLARININ, GÜDÜSEL HEDEFLERİNİN VE FEN BAŞARILARININ İNCELENMESİ

Esme HACIEMİNOĞLU[*], Özgül YILMAZ-TÜZÜN[**], Hamide ERTEPINAR[***]

ABSTRACT: This study examined the relationships among students' learning approaches, motivational goals, previous science grades, and their science achievement for the concepts related to atomic theory and explored the effects of gender and sociodemographic variables on students' learning approaches, motivational goals, and their science achievement for the concepts related to atomic theory. The sample constituted 416 seventh grade elementary students. A Science Achievement Test (specifically designed for atomic theory), A Learning Approach Questionnaire, and An Achievement Motivation Questionnaire were administered to the students. Results of the correlation analyses revealed positive relationships among meaningful learning, performance orientation, and self efficacy. Students' previous science grades were positively correlated with achievement, meaningful learning, and self-efficacy and negatively correlated with rote learning and performance orientations. ANOVA results revealed that participants' parents' education level had significant effect on their achievement and meaningful learning, rote learning, and approach performance orientations.

Keywords: elementary students, learning approaches, motivational goals, science achievement

ÖZET: Bu çalışmada öğrencilerin öğrenme yaklaşımları, güdüsel hedefleri, daha önceki fen dersi başarıları ve atom teorisi ile ilgili kavramlardaki başarıları arasındaki ilişki incelenmiştir. Ayrıca cinsiyetin ve sosyodemografik değişkenlerin öğrencilerin öğrenme yaklaşımlarına, güdüsel hedeflerine ve atom teorisi ile ilgili kavramlardaki başarılarına etkisi araştırılmıştır. Çalışmanın örneklemini 416 yedinci sınıf öğrencileri oluşturmaktadır. Fen Başarı Testi (özellikle atom konusuyla ilgili kavramlar için hazırlanmış), Öğrenme Yaklaşımları Ölçeği, ve Başarı Motivasyonu Ölçeği öğrencilere uygulanmıştır. Korelasyon analizlerinin sonucuna göre öğrencilerin anlamlı öğrenme, performans oryantasyonları, ve kendine güvenleri arasında pozitif bir ilişki bulunmuştur. Öğrencilerin daha önceki fen dersi başarıları ile atom teorisi ile ilgili kavramlardaki başarıları, anlamlı öğrenme ve kendine güvenleri arasında pozitif bir ilişki bulunurken, performans oryantasyonları ve ezbere dayalı öğrenme arasında negatif bir ilişki bulunmuştur. ANOVA analizi sonuçlarına göre katılımcıların anne ve babalarının eğitim durumlarının, atom teorisi ile ilgili kavramlardaki başarıları, anlamlı öğrenme, ezbere dayalı öğrenme, ve performans oryantasyonaları yaklaşımları üzerinde anlamlı etkisi bulunmuştur.

Anahtar sözcükler: ilkokul öğrencileri, öğrenme yaklaşımı, güdüsel hedefler, fen başarısı

1. INTRODUCTION

Individual differences play an important role in students' learning (Koran & Koran, 1984). In addition to learning, individual differences are also related to other variables, such as learning approaches, motivation, cognition, and anxiety (Debacker & Nelson, 2000; Zhang, 2000). Since new Turkish elementary science and technology curriculum addressed the importance of learner differences in science courses, in this study specific learner characteristics (learning approaches, motivation, and achievement) were investigated by considering elementary students' gender and socio-demographic variables. For the purpose of this study learning approaches are categorized as (a) meaningful learning approach and (b) rote learning approach (Cavallo, Rozman, & Potter, 2004). Students' meaningful understanding of scientific concepts is an important goal of science education. When a learner integrates the new idea or concept into his/her existing concepts and structures, his/her learning will be more meaningful. During this integration, being aware of the prior knowledge and linking this knowledge with the newly presented knowledge by engaging in a learning task constitute the main ingredients of meaningful learning (Ausubel, 1963). A continuous integration of concepts helps

[*] Araştıma Görevlisi, Selçuk Üniversitesi, e-posta: hesme@metu.edu.tr
[**] Doç.Dr., Orta Doğu Teknik Üniversitesi, e-posta: ozgul@metu.edu.tr
[***] Prof. Dr., Orta Doğu Teknik Üniversitesi, e-posta: hamide@metu.edu.tr

learners form meaningful learning sets. When learners cannot integrate new concepts with their prior knowledge, they tend to use rote learning and express their understanding with the definitions of these concepts as isolated facts (Ausubel, 1963). Researchers have argued that rote learning prevents meaningful learning of new scientific concepts (Cavallo, Rozman, Blickenstaff, & Walker, 2003; Cavallo et al., 2004). However, Reap and Cavallo (1992) have found that students answered multiple choice test items correctly by using their rote knowledge. These studies revealed that students tend to use both rote learning and meaningful learning approaches in their science courses.

Achieving in both rote learning and meaningful learning depends on learners' willingness and tendency to make connections among concepts. In other words, success in learning depends on learners' motivation to learn. Motivation is defined in this study as "an internal state that arouses directs, and maintains behavior" (Woolfolk, 2004, p.350) and seen as an important individual-difference that influences students' learning and performance (Debacker & Nelson, 2000). The recent approaches investigate motivation regarding goal orientations, interest and emotions, and self perceptions (Woolfolk, 2004). In this study, goal orientations (motivational goals) and self-perceptions were explored to determine students' motivation to learn. According to Pintrich (2000), "goal orientation includes not just the purposes or reasons for achievement, but reflects a type of standard by which individuals judge their performance and success of failure in reaching that goal" (Pintrich & Schunk, 2002, p.214). This quotation indicates that goal orientation consists of two dimensions: (a) one is related to students' interest to learn something new and (b) the other is related to the students' interest to get higher course grades (Cavallo et al., 2004). Dweck (1986) categorized these dimensions as learning oriented versus performance oriented. Learning orientation can be exemplified as learning something new, learning for the sake of learning, or improving oneself. Performance orientation can be exemplified as earning high grades, getting praise or performing better than other students (Ames & Archer, 1988). Recent studies have suggested two additional distinct dimensions for performance orientation. These dimensions were the approach performance goal orientation and the avoidance performance goal orientation (Pintrich, 2000, Elliot & Church, 1997). Students who hold the approach performance goal orientation try to do their best or outperform in the class to show their superiority. Students who hold the avoidance performance goal orientation try to avoid failure and keep away from looking stupid or dump (Pintrich, 2000; Pintrich & Schunk, 2002). As one of the self-perceptions dimensions, we focused on self-efficacy to further investigate its' relationships with other motivational approaches and learning. Self efficacy was defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p.391). Self-efficacy focuses on this particular question "Can I do this task in this situation?" (Pintrinch & Schunk, 2002).

1.1. Learning Approaches, Motivational Goals, Achievement, Gender and Sociodemographic variables (SDV)

In the literature a large amount of information is available about students' learning approaches, motivational goals (goal orientations and self-efficacy), and academic achievement. In some studies, these variables were investigated together to better understand elementary students' academic achievement.

Cavallo et al. (2003) investigated the relationships among college students' learning approaches, motivational goals, and achievement in two different science subject matter courses (biology and physics). Of two physics course classes, one class (physics non-majors) was exposed to an inquiry based physics course; the other class (physics majors) was exposed to an expository based physics course. Biology students received both inquiry and didactic (expository-based) teaching methods. Results indicated that, the biology students employed rote learning approach more than the physics major students did. Learning goal (motivation to learn for the sake of learning) was the most important motivational factor in predicting the biology students' course achievement. While learning goal was positively related to the meaningful learning for all students in three different science courses, performance goal (learning for high grades) was positively related to rote learning only for biology

students. Furthermore, findings revealed a negative correlation between rote learning and course achievement for physics non-majors.

Similarly, the study of Cavallo et al. (2004) focused on the effect of gender on high school students' learning approaches, motivational goals, self efficacy, and their achievement in inquiry-based physic course and investigated the contribution of these variables on these students' understanding of physics concepts. Considering the effect of gender on course achievement, self-efficacy, and performance goal orientation, male students gained higher scores on these measures. While self-efficacy positively contributed to the both male and female students' physics achievement, rote learning had negative contribution to only male students' achievement. Positive relationships were investigated among self-efficacy, meaningful learning, and learning goals for both male and female students. Female and male students who preferred rote learning had low self-efficacy and low achievement.

Reap and Cavallo (1992) explored the gender differences regarding achievement, achievement motivation, which was defined as "need for achievement", and meaningful learning orientation. They assessed 10th grade students' achievement by using both a state biology course exam (the exam mainly included multiple choice questions) and an open-ended (mental-model) test, which was developed by the researchers to assess students' meaningful understanding of biology topics. Gender difference was only observed in achievement motivation factor in favoring boys. There was no significant difference between girls and boys in terms of meaningful learning orientation and achievement assessed by the mental model test.

In the abovementioned studies, gender was generally considered as an important subject characteristic. Gender differences in science have been investigated in terms of students' achievement and motivation for the last two decades. For example, in the literature, it was found that boys performed better than girls in science (Kahlee & Meece, 1994) and girls had more positive perceptions about achievement motivation (Simpson & Oliver, 1990). Researchers have proposed several explanations for the motivational and achievement differences observed between two sexes. These explanations can be listed as girls' limited science-related outside activities, teachers' bias particularly in the way they pose questions, cultural influences including the societal differences and the type of school, background information and socioeconomic status, and parental education (Greenfield, 1997; Kahlee & Meece, 1994). Gender studies also revealed that while investigating science related constructs gender and other socio-demographic variables (SDV), such as the family income and the parents' educational level, should not be considered separately due to their close relationships. In light of research findings, in this study we interested in investigating the effects of gender and SDV -family income and parents' educational level- on learning science and motivational approaches.

Researchers often conducted their studies in the context of different subject matters (chemistry, physics, and biology). In this study, the concepts related to atomic theory were chosen from the Turkish elementary students' science and technology textbook. The concepts related to atomic theory and the nature of matter are generally seen as the important knowledge in science education that is also true for Turkish elementary science and technology curriculum. Furthermore, understanding of atomic theory is dynamic and open to new discoveries and because atoms are not visible to human eyes and not easily observable particles, students often have difficulties in learning the concepts related to atomic theory (Park & Light, 2009; Pringle, 2004). The organization of the elements (i.e., atomic mass and atomic number) in the periodic table is also a complex issue for students to comprehend (Ward & Lee, 2006). Thus, students tend to learn some concepts of atomic theory by simply memorizing (Lin, Hung & Hung, 2002). Consequently, the concepts related to atomic theory were found as an appropriate science subject for this study context. It was assumed that due to its complex nature, the concepts related to atomic theory would help us explore the relationships among students' learning approaches and their motivational goals in their science courses. In other words, the nature of atomic theory concepts provided a good environment for us to understand the students' approaches and motivations to learn science.

Students' learning approaches and their motivational goals have been rarely investigated in elementary level. In above studies the researchers investigated high school students' motivation, learning orientations, and academic achievement. However, only a handful of studies have been

carried out for the elementary school students. We assumed that elementary students may also possess these learner characteristics and these characteristics needed to be investigated at this age level. It is also necessary to investigate relationships among these variables in different cultures such as Turkey. We assumed that data obtained from Turkey may contribute to the literature on learning and motivation. For example, on the contrary to most western countries, in Turkey girls are generally receiving higher scores than boys in most of the high-stake exams at national level (Eğitim Teknolojileri Genel Müdürlüğü, 2008). We are interested in investigating how gender difference lends itself into elementary students' motivation, learning approaches, and achievement in science. If differences exist, these existing differences were explored by looking at the possible factors such as parents' income and education level because in Turkey it is known that that parents' income and education level disturb the equality of education opportunity among students by creating unfair competition (Tombul, 2008).

Two specific questions of this study were: (1) What are the relationships among students' learning approaches, motivational goals, previous semester science grades, and their science achievement? (2) What are the effects of gender and SDV on students' learning approaches, motivational goals and their science achievement?

2. METHOD

2.1. Sample

A total of 416 seventh grade students were included in this study because the atomic theory concepts included in this study were mainly taught in this grade. Participants were from 16 classrooms of 8 elementary schools located in Ankara, the capital of Turkey. Schools were selected based on their convenience to the researchers. All schools were in the same district of the city. At the time of data collection, two available classrooms from the seventh grades in each school completed the instruments. We could not reach each classroom and which was a limitation for this study in terms of the generalizability of the findings. The demographics of the participated students are presented in Table 1. Parental income was categorized by using the information indicated by the State Statistics Institution (2009).

Table 1. Demographic and Socio-demographic Characteristics of Participants

Demographic Characteristics		**Number**	**% Percent**
Sex	Female	197	47.4
	Male	219	52.6
Parental Income	Low	49	11.8
	Medium	298	71.6
	High	69	16.6
Mother Education Level	Elementary school	58	13.9
	Secondary school	47	11.3
	High school	117	28.1
	Undergraduate	147	35.4
	Graduate	38	9.2
Father Education Level	Elementary school	40	9.6
	Secondary school	29	7.0
	High school	120	28.8
	Undergraduate	165	39.7
	Graduate	60	14.4

2.2. Instruments

Participants completed three different instruments: (1) A Science Achievement Test (SAT-specifically designed for the concepts related to atomic theory), (2) A Learning Approach Questionnaire, and (3) An Achievement Motivation Questionnaire.

The Science Achievement Test (SAT) was developed by the researchers. While constructing the SAT, we followed several structured procedures. The SAT questions were designed based on the objectives specified for teaching atomic theory in seventh grade textbook. To better visualize the unit objectives and the test questions, we developed a table of specification according to strategies described by Millman and Greene (1993). To verify the validity and the reliability of the SAT, we focused on the content and construct validity. For the content validity; two chemistry experts and one science education researcher overviewed the instrument. For the construct validity, a pilot study was carried out to 81 students. According to the results, necessary revisions were made on the questions. Final version of the SAT included 20 items. The Cronbach alpha value that explains the internal consistency for this instrument was found as .72. Figure 1 represents two sample questions from the final version of the SAT.

In order to measure the students' learning approaches The Learning Approach Questionnaire used in Cavallo and Schafer's (1994) study was utilized in this study. The questionnaire was originally translated into Turkish by Caliskan (2003) and used for high school students. For this study a pilot study was carried out to investigate the appropriateness of the items for elementary school students and necessary revisions were made for this age level.

Item 9

Elements	Number of Proton	Number of Neutron
X and Y	Same	Different
X and Z	Different	Same

According to the above table, which of the following statement(s) is/are true?

I. X and Y are isotope.
II. Y and Z are different elements.
III. The number of neutron of Y and Z are different.
IV. The number of electron of Y and Z are same.

A) I and II B) I and III
C) I, II and III D) I, II, III and IV

Item 20

The total number of protons, neutrons and electrons of X^{+2} ion is 69. The proton number of X ion is five points less than its neutron number.

Related with the X atom, which of the following is true?

	p^+	n^o	e^-
A)	22	27	20
B)	20	22	27
C)	27	32	25
D)	20	24	27

Figure 1. Sample questions of the SAT.

The questionnaire included 22 items in a 4-point Likert scale (11 items for rote learning and 11 items for meaningful learning). A sample item to the rote learning dimension is: Item 4, "I tend to remember things best if I concentrate on the order in which they were presented by the instructor" and for the meaningful learning dimension is: Item 1, "I try to relate new material, as I am reading it, to what I have already known about the topic." The Cronbach alpha internal consistency was reported as .81 for the meaningful learning scale and .76 for the rote learning scale (Cavallo et al., 2004). In this study Cronbach's alpha reliability of the test was found as .77 for the meaningful learning scale .71 for the rote learning scale.

The Achievement Motivation Questionnaire, used in Cavallo et al. (2004) was utilized to measure students' motivational goals. This questionnaire was also translated into Turkish by Caliskan (2003) for high school students. Similar to The Learning Approach Questionnaire, a pilot study was

carried out to make the scale appropriate for elementary students. The questionnaire included 14 items in a 5-point Likert scale. It consists of three scales measuring students' learning-goal orientation, performance goal orientation, and students' self-efficacy in science courses. Among these scales performance goal orientation consists of two scales: avoidance performance orientation (AvPO) and approach performance orientation (ApPO) (Elliot & Church, 1997). Sample items for each scale are presented in Table 2. The Cronbach alpha reliability was reported as .94 for learning goals, .82 for performance goals, and .89 for self-efficacy. In this study Cronbach's alpha reliability of the test was found .83 for the learning goals, .73 for the performance goals, and .75 for the self-efficacy scales.

Table 2. Sample Items of the Achievement Motivation Questionnaire

Scales	Sample Items
Approach PO	One of my primary goals in this class is to do better than other students.
Avoidance PO	One of my primary goals is to not look foolish or stupid when doing science activities in this class.
Learning Orientation	One of my primary goals in this class is to try to improve my knowledge.
Self Efficacy	I am confident I can do well on the science problems we are given in this class.

2.3. Data Collection and Data Analysis

Data were collected during the course of Spring 2006 semester. The data was collected by the first author of this study. In this study three instruments were administered to the students. All of the instruments were administered to the students after they learned the concepts related to atomic theory. Three of the instruments were applied at the same time. The students were given a period of a class meeting to complete the instruments. The researcher explained the purpose of the study to the students in each class and invited them to participate in the study voluntarily. Anonymity of participants was achieved by assigning numbers to each form and the students were told that they did not need to write their names on the forms. We explicitly informed participants that their responses would not affect their science grades or any of their credentials at school.

In the first part of the data analysis, we performed correlation analysis to determine the relationships among students' learning approach, motivational goal, and achievement. In the second part of the data analysis, one–way ANOVA was computed to explore the effects of gender and SDV differences on students' learning approach, motivational goals, and their science achievement for the concepts related to atomic theory.

3. RESULTS

3.1. Correlation Analysis

Correlation coefficients were computed to explore the relationships among students' learning approaches, motivational goals, previous semester science grades, and their science achievement for the concepts related to atomic theory. The results are presented in Table 3.

Table 3. Intercorrelations among Learning Approaches, Motivational Goals, Previous Semester Science Grades, and The Science Achievement Test

	A	RL	LO	AvPO	ApPO	ML	PO	SE
RL	-.222*	____						
LO	.009	.021	____					
AvPO	-.044	.144*	.477*	____				
ApPO	-.163*	.331*	.083	.326*	____			
ML	.092	.037	.336*	.077	.037	____		
PO	-.122*	.285*	.358*	.838*	.788*	.071	____	
SE	.094	-.123*	.139*	.007	-.126*	.044	-.069	____
SG	.492*	-.236*	.068	-.107*	-.167*	.175*	-.166*	.215*

* Correlation is significant at the 0.05 level (2-tailed)

A: The Science Achievement Test Scores, Learning Approaches (RL: Rote Learning, ML: Meaningful Learning), Motivational Goals (LO: Learning Orientation, AvPO: Avoidance Performance Orientation, ApPO: Approach Performance Orientation, PO: Performance Goal Orientation, SE: Self-efficacy), and SG: Previous Semester Grade.

Results showed that meaningful learning, performance orientation, and self efficacy were positively correlated with the learning goal orientation. Regarding the dimensions of the performance goal orientation, only avoidance performance orientation was related to the learning goal orientation but not to the approach performance orientation. While the students' previous semester science grades were positively correlated with science achievement, meaningful learning, and self- efficacy, they were negatively correlated with rote learning and both the approach and avoidance performance orientations. In terms of self efficacy, this variable was negatively correlated with not only rote learning but also approach performance orientations. Moreover, there was a positive relationships between rote learning and both avoidance and approach performance orientations. On the other hand, the students' achievement was negatively correlated with performance orientation and two sub-dimensions of performance orientation.

3.2. ANOVA Analysis

Analysis of variance was conducted to explore the effects of gender and SDV differences on students' learning approaches, motivational goals, and their scores in the SAT. Results (Table 4) revealed that there was a significant main effect of gender on students' achievement, $F(1, 414) = 4.61$, $p = .32$, in favor of girls ($M = 11.05$, $SD = 3.54$; $M = 10.23$, $SD = 4.14$).

Table 4. Effect of Gender and SDV on Learning Approach, Motivational Goals, and SAT

	df	F	Partial Eta squared (η_p^2)	p
Achievement (SAT Scores)				
Gender	1	4.61	.011	.032*
Income	2	4.57	.011	.011*
Mother Education Level	6	9.60	.124	.000*
Father Education Level	6	7.64	.101	.000*
Meaningful Learning				
Mother Education Level	6	3.44	.026	.001*
Father Education Level	6	2.90	.049	.009*
Rote Learning				
Mother Education Level	6	2.64	.037	.016*
Father Education Level	6	4.52	.062	.000*
Approach PO				
Gender	1	6.11	.015	.014*
Mother Education Level	6	2.50	.035	.022*
Father Education Level	6	2.20	.042	.042*

* $p < 0.05$

As for SDV, family income, mother education, and father education had a significant main effect on students' science achievement, $F(2, 413) = 4.57$, $p < .011$; $F(6, 409) = 9.60$, $p <. 000$; $F(6, 409) = 7.64$, $p <.000$, respectively. Family income was treated as a categorical variable as low income family, medium income family, and high income family. Post-hoc comparisons using the Tukey HSD test indicated that the mean scores of the students with low income family ($M = 9.32$, $SD = 3.39$) was significantly different from those students with high income family ($M = 11.50$, $SD = 3.58$). The mean scores of the students with medium income family ($M = 10.62$, $SD = 3.98$) did not differ significantly from other students. This result showed that the students who had high income family performed better in the SAT.

Mother education and father education were categorized under seven levels namely: no formal education, primary school, middle school, high school, undergraduate, and graduate. Since we have a few responses to no formal education category, this category was excluded from the analyses. In terms

of effect of mother education on students' scores on SAT, the students, whose mother had primary (M = 8.32, SD = 3.01) and middle school education (M = 8.74, SD = 3.32) had lower science achievement mean scores than other students whose mothers had high school (M = 10.79, SD = 3.56), undergraduate (M = 11.73, SD = 3.96), and graduate (M = 12.34, SD = 3.55) degrees. Similarly, in terms of father education, the students, whose fathers had primary (M = 8.20, SD = 3.48), middle (M=8.55, SD = 2.69), and high school (M = 10.15, SD = 3.78) degrees had lower science achievement mean scores than other students whose fathers had undergraduate (M = 11.33, SD = 3.76) and graduate degrees (M = 12.26, SD = 3.73). These results suggest that while education levels of parents increase the students' achievement scores also increase.

Father education level had significant main effect on meaningful learning and rote learning, $F(6,409)= 2.90$, $p<.009$; $F(6,409)= 4.52$, $p<.000$, respectively. The students, whose fathers had graduate degree preferred meaningful learning (M = 3.06, SD = .73) than students whose fathers had undergraduate (M= 2.82, SD = .45), high school (M = 2.80, SD = .46), and middle school (M = 2.64, SD = .37) degrees and did not to use rote learning (M = 2.24, SD = .40) than those students whose fathers had high school (M = 2.47, SD = .39) and elementary school degrees (M = 2.50, SD = .46). Mother education level had also significant main effect on meaningful learning and rote learning, $F(6, 409) = 3.44$, $p<.047$, $F(6, 409) = 2.64$, $p<.016$ respectively. Students whose mothers completed graduate school had more meaningful learning (M = 3.02, SD = .86) than those students whose mothers had high school degree (M = 2.69, SD = .44) and less rote learning (M = 2.24, SD = .30) than the other students whose mothers had high school (M = 2.51, SD = .36) and middle school degrees (M = 2.48, SD = .42).

In terms of motivational goals; mother education level and father education level had significant main effects on the students' approach performance orientation scores, $F(6, 409) = 2.50$, $p < .022$, $F(6, 409) = 2.50$, $p < .042$, respectively. Among the students whose mothers (M = 2.92, SD = .65) and fathers (M = 2.97, SD = .76) accomplished high school education; had more approach performance orientation than those students whose mothers had graduate degrees (M = 2.64, SD = .65) and whose fathers had undergraduate degrees (M = 2.59, SD = .70).

Results revealed that there was a significant main effect of gender on students' approach performance orientation, $F(1, 414) = 6.11$ $p < .014$ in favor of boys (M = 2,58, SD = .67; M = 2.75, SD = .68). Results also showed that there were no significant effect of gender and SDV (income, father education level and mother education level) on the students' learning orientation, avoidance performance orientation, and self-efficacy. According to effect sizes defined by Green, Salkind, and Akey (2000) (.01 for small, .06 for medium, and .14 for large), most of the effect sizes in ANOVA were found as small and some of them were found as medium and large. Thus the results could be interpreted as they were reflecting both practical and significant results.

4. DISCUSSION

Correlation analysis revealed that students' previous semester science grades were positively correlated with their achievement for the concepts related to atomic theory, self-efficacy, and meaningful learning and negatively correlated with rote learning and performance orientation. This result can be used as a predictive validity evidence of the SAT. Correlational analysis also revealed that the students who had high achievement in the SAT preferred to do meaningful learning rather than rote learning. Having good science background might also enable these students to be aware of their capabilities to better learn new science topics about atomic theory. Similarly, Cavallo et al. (2004) found positive correlations among students' meaningful learning, self efficacy, and their achievement. Furthermore, this current study revealed that performance oriented students, who study for receiving higher grades, had lower achievement in the SAT. This finding is consistent with the findings of Cavallo et al. (2003) in which they found that rote learning and performance orientation predicted science course achievement negatively. These correlation analyses suggested that in order to get better science achievement, students should be encouranged to do meaningful learning rather than rote learning. Attaining meaningful learning may also increase their self-efficacy toward learning science. Both negative correlations that were found in this study among self-efficacy rote learning and

approach performance orientation and positive correlation between rote learning and performance orientation also support the above suggestions. Rote learning and studying for higher grades are not helpful in retaining the learned science concepts in the long term due to memorization of concepts (Cavallo et al., 2003; Cavallo et al., 2004).

In different countries gender studies in science generally revealed that boys outperformed the girls (e.g. Greenfield, 1997). Generally in Turkey, the female students perform better and receive higher science scores than male students throughout the nation in high stake exams (Eğitim Teknolojileri Genel Müdürlüğü, 2008). Our study revealed that girls' achievement for the concepts related to atomic theory was higher than the boys' achievement. Thus, we further supported the gender trend in Turkish context. However, similar to Reap and Cavallo (1992), we could not obtain significant effect of gender on students' learning approach.

The other factor influencing students' science achievement was parents' income. Level of family income had an impact on the students' achievement. The students from families with high income had higher achievement scores than the students from families with low income. Although our finding is similar to the findings of Boogs (2003), it was not consistent with Nuttall and Hell's (2001) findings. Nuttall and Hell (2001) found that income does not have a strong influence on students' mathematics and science achievement. However, considering the socio-economic conditions in Turkey, it is reasonable to state that students from families with high income are provided with additional educational opportunities, such as special courses after school, personal computers at home, books and materials in rich and comfortable home environment. Thus, in our study context these opportunities might help the advantageous students improve their understanding about science concepts. On the contrary, students from families with low income study their courses at home by themselves even some of these students need to work after school for providing financial support to their families' income. Most of the time it is difficult for these working students to find time to study their courses at home.

Parents' education level was another important factor in students' SAT scores. Results showed that when education level of parents' (both mothers and fathers) increased, their children' SAT scores also increased. This result is consisted with the previous studies. For example, Ercikan, McCreith, and Lapointe (2005) found that parents' education level had strong effect on students' achievement. Based on this finding, it can be argued that parents with higher educational degrees may better in comprehending and responding to the difficulties their children have in science learning. Based on their knowledge and experiences, they could better coach their children's learning. However, Hortaşsu (1995) found that in Turkey, mothers' education level was a significant predictor of students' general achievement rather than that of fathers' education level. The author argued that in Turkey mothers take more responsibility for their children and devote more time to their children's lesson and homework, thus, mothers with higher level of education can be more helpful in their children learning. Our study revealed that this situation might have changed over the last decade. Both fathers and mothers have started to take turns to help their children's academic success.

In this study, it was also found that the students whose parents' had high educational level preferred to do more meaningful learning than rote learning. Zhang (2000) also found similar relationship between parents' education levels and meaningful learning approach among the U.S. students. In light of our findings related to learning approaches and achievement, we suggest that increasing students' achievement may related to parents' encouragement of their children to do meaningful learning. In other words, the direction of the relationship among these variables could be as parents' education level → meaningful learning → students' science achievement. Findings related to approach performance orientation also enhanced this relationship, because it was found that the students whose parents had lower educational degrees tended to learn their courses to do best or outperform in the class. These students were not interested in learning the concepts for their interest and achieving meaningful learning. The student's gender was also a significant factor in their approach performance orientation. Boys had more supportive of approach performance orientation than girls.

5. CONCLUSION AND IMPLICATIONS

Close examination of the gender, income and parents' educational level revealed that these variables had considerable effects on students' achievement in science. This study indicated that only students who did meaningful learning received higher scores from both the SAT and the previous science course. Researchers pointed out that student's learning approaches had been changed according to teachers' assessment methods and assessment instruments (Zhang, 2000). If teachers asked memorization questions, students will prefer rote learning. In order to better measure students' meaningful learning, teachers should construct tests by asking conceptual questions to measure students' understanding of the scientific concepts rather than their memorization. Gender differences were found regarding science achievement in favoring girls. Both boys and girls should be taught science by considering their learner differences. This study revealed that boys preferred to do rote learning and study for merely receiving high grades. We suggested that in our science classrooms, we should provide opportunities to boys to learn science meaningfully. As one of the socio-demographic variables; income level had a significant effect on students' achievement and their learning approach. We suggest that schools may offer different opportunities to their students with governmental support. Counseling service should inform parents to improve their children success in science.

REFERENCES

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Student's learning strategies and motivation processes. *Journal of Educational Psychology, 80*, 260-270.

Ausubel, D.P. (1963). *The psychology of meaningful verbal learning*. New York: Grune & Stratton.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Boggs, O. M. (2003). *Community and institutional correlates of academic achievement in Georgia schools*. Research reports (ERIC Document Reproduction Service No. ED 482 910).

Caliskan, İ. S. (2003). *The effect of inquiry-based chemistry course on students' understanding of atom concept, learning approaches, motivation, self-efficacy, and epistemological beliefs*. Unpublished master thesis, The Middle East Technical University, Ankara.

Cavallo, A. M. L., Rozman, M., Blickenstaff, J., & Walker, N. (2003). Learning, reasoning, motivation, and epistemological beliefs. *Journal of College Science Teaching, 33,* 18-23.

Cavallo, A. M. L., Rozman, M., & Potter, W. H. (2004). Gender differences in learning constructs, shifts in learning constructs, and their relationship to course achievement in a structured inquiry, yearlong college physic course for life science majors. *School Science and Mathematics, 104*(6), 288-301.

Cavallo, A. M. L., & Schafer, L. E. (1994). Relationships between students' meaningful learning orientation and their understanding of genetic topics. *Journal of Research in Science Teaching, 31*(4), 393-418.

DeBacker, T. K., & Nelson, R. M. (2000). Motivation to learn science: Differences related to gender, class type, and ability level. *Journal of Educational Research, 93*(4), 245-254.

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist, 41,* 1040-1048.

Eğitim Teknolojileri Genel Müdürlüğü. (2008). *The mean scores of OKS in Turkey with respect to gender*. Retrieved 11 June 2008 from http://egitek.meb.gov.tr/Sinavlar/Istatistikler/ook/ook2006/OksIlPuanOrt.pdf

Elliot, A. J., & Church, M. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology, 72*, 218-232.

Ercikan, K., McCreith, T., & Lapointe, V. (2005). Factors associated with mathematics achievement and participation in advanced mathematics courses: An examination of gender differences from an interpersonal perspective. *School Science and Mathematics, 105* (1) 5-14.

Greenfield, T. A. (1997). Gender and grade level differences in science interest and participation. *Science Education, 81,* 259-276.

Hortaşsu, N. (1995). Parents' education levels, parents' beliefs, and child outcomes. *The Journal of Genetic Psychology, 156*(3), 373-383.

Kahle, J. B., & Meece, J. (1994). Research on gender issues in the classroom. In Gabel, D. L. (Eds.), *Handbook of research on science teaching and learning,* pp (542-554*).* New York, NY: National Science Teachers Association.

Koran, M. L., & Koran, J. J. (1984). Aptitude- treatment interaction research in science education. *Journal of Research in Science Teaching 21*(8), 793-808.

Lin, H., Hung, J., & Hung, S. (2002). Using the history of science to promote students' problem solving ability. *International Journal of Science Education, 24*(5), 453-464.

Millman, J., & Greene, J. (1993). The specification and development of tests of achievement and ability. In Robert Linn (Ed.), *Educational measurement* (pp. 335-366). Phoenix: American Council on Education and Oryx Press.

Nuttall, R., & Hell, R. J. (2001). *Poverty, courses taken and MCAS test scores in mathematics and science.* Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, WA.

Park, E. J., & Light, G. (2009). Identifying atomic structure as a threshold concept: Students mental models and troublesomeness. *International Journal of Science Education, 31*(2), 133-258.

Pintrich, P. R. (2000). An achievement goal theory perspective on issues in motivation terminology, theory, and research. *Contemporary Educational Psychology, 25*, 92-104.

Pintrinch, P., & Schunk, D. (2002). *Motivation in education.* Merrill Prentice Hall.

Pringle, R. M. (2004). Making it visual: Creating a model of the atom. *Science Activities, 40*(4), 30-33.

Reap, M. A., & Cavallo, A. L. (1992). *Students' meaningful understanding of science concepts: Gender differences.* Paper presented at a poster session at the annual conference of the National Association for Research in Science Teaching, Boston, MA.

Simpson, R. D., & Oliver, J. S. (1990). A summary of major influences on attitude toward achievement in science among adolescent students. *Science Education, 74*, 1-18.

State Statistics Institution (2008). *Gelir dağılımı 2005.* Ankara, Turkish Republic State. Retrieved 11 June 2008 from http://www.tuik.gov.tr/PreHaberBultenleri.do?id=408

Tombul, E. (2008). The relative effects of family socio-economic characteristics on participation in education in Turkey. *Eurasian Journal of Educational Research*, 30, 153-168.

Ward, R. E., & Lee, W. D. (2006). Understanding the periodic table of elements via iconic mapping and sequential diagramming: The roundhouse strategy. *Science Activities, 42*(4), 11-19.

Woolfolk, A. (2004). *Educational psychology (9th ed.).* Boston, MA, Allyn & Bacon.

Zhang, L. (2000). University students' learning approaches in three cultures: An investigation of Biggs's 3P model. *The Journal of Psychology, 134*(1), 37-55.

GENİŞLETİLMİŞ ÖZET

Bu çalışmada öğrencilerin öğrenme yaklaşımları, güdüsel hedefleri, daha önceki fen dersi başarıları ve atom teorisi ile ilgili kavramlardaki başarıları arasındaki ilişki incelenmiştir. Ayrıca cinsiyetin ve sosyodemografik değişkenlerin öğrencilerin öğrenme yaklaşımlarına, güdüsel hedeflerine ve atom teorisi ile ilgili kavramlardaki başarılarına etkisi araştırılmıştır. Çalışmanın örneklemini yedinci sınıfta okumakta olan 416 öğrenci oluşturmaktadır.

Öğrencilerdeki bireysel farklılıklar onların fen konularını öğrenmelerinde önemli bir rol oynamaktadır (Koran & Koran, 1984). Öğrenmenin yanında bu farklılıklar öğrencilerin diğer karakterleriyle de örneğin onların öğrenme yaklaşımları, güdüleri, algıları ve kendine güvenleri gibi karakterlerle de ilgilidir (Debacker & Nelson, 2000; Zhang, 2000). Türkiye'de yeni Fen ve Teknoloji dersi müfredatı geliştirilirken öğrenci farklılıkları da göz önünde tutulmaya çalışılmıştır. Dolayısıyla, öğrenci farklılıklarının -öğrencilerin öğrenme yaklaşımları, güdüleri, algıları ve kendine güvenleri- fen eğitimimize olan katkıları araştırılması gereken bir konudur. Bu araştırmalara fen araştırmacılarının sık sık kullandıkları değişkenlerden olan cinsiyet ve sosyal durumların katılması daha verimli sonuçlar elde edilmesi açısından önem taşımaktadır. Daha önce yapılan çalışmalar cinsiyet yönünden kızların daha çok güdüsel başarılarının olduğunu ortaya koymuştur (Kahlee & Meece, 1994). Cinsiyetin yanı sıra diğer soysodemografik değişkenlerinde öğrenme yaklaşımlarında, güdüsel hedeflerde ve kendine güvende etkili rol oynadığı belirtilmiştir (Greenfield, 1997; Kahlee & Meece, 1994). Bu çalışmada sosyo-demografik değişkenler olarak ailenin geliri ve anne babanın eğitim durumu alınmıştır.

Araştırmacılar tarafından öğrenme yaklaşımları, güdüsel hedefler ve kendine güven farklı disiplinlerde (kimya, fizik ve biyoloji) incelenmiştir. Bu çalışmada öğrencilerin fen ve teknoloji dersinin konularından olan atom teorisi ile ilgili kavramlardaki başarıları araştırılmıştır. Atom teorisi ile ilgili kavramların seçilmesinin önemli nedenleri vardır. Atom teorisi ve maddenin doğası fen ve teknoloji dersinin ana konularından birini oluşturmaktdır. Atomun yapısı ve modeli hakkında sahip olunan bilgiler yeni keşiflere açık olup sürekli gelişmektedir. Aynı zamanda atomun gözle görülememesi de öğrencilerin atomun yapısını anlamalarında zorluk yaratmaktadır (Park & Light, 2009; Pringle, 2004). Atomların periyodik cetveldeki organizasyonunu anlamak yine öğrenciler için kolay olmamaktadır (Ward & Lee, 2006). Bu nedenlerden dolayı öğrenciler atom konusunu öğrenirken genelde ezbere öğrenmeyi tercih etmektedirler (Lin, Hung & Hung, 2002). Bu yüzden öğrencilerin atom teorisi ile ilgili kavramlardaki başarıları ile genel fen ve teknoloji dersi başarıları, öğrencilerin öğrenme yaklaşımları, güdüsel hedefleri ve kendine güvenleri ile nasıl bir ilişkide olduğu incelenmiştir. Diğer bir açıdan da öğrenme yaklaşımları, güdüsel hedefler ve kendine güven

kavramlarının literatürde hangi yaş gruplarında çalışıldığı araştırıldığında genelde bu kavramların lise ve üniversite düzeyinde incelendiği bulunmuştur. Bu bağlamda bu kavramların ilkokul öğrencileri düzeyinde de incelenmesine ihtiyaç duyulmaktadır.

Bu çalışmanın iki ana araştırma sorusu vardır: (1) Öğrencilerin öğrenme yaklaşımları, güdüsel hedefleri, kendilerine güvenleri, daha önceki fen dersi başarı notları ve atom teorisi ile ilgili kavramlardaki başarıları arasındaki ilişki nasıldır? ve (2) Cinsiyetin ve sosyodemografik değişkenlerin öğrencilerin öğrenme yaklaşımlarına, güdüsel hedeflerine, kendilerine güvenlerine ve atom teorisi ile ilgili kavramlardaki başarılarına olan etkisi nedir?

Çalışmaya katılanlara araştırmacılar tarafından geliştirilen Fen Başarı Testi (özelikle atom teorisi ilgili kavramlara yönelik hazırlanmış test), Öğrenme Yaklaşımı Ölçeği ve Başarı Güdüsü Ölçeği uygulanmıştır. Çalışmanın bulgularının analizi için korelasyon analizi ve ANOVA analizi yapılmıştır. Korelasyon analizlerinin sonucuna göre öğrencilerin anlamlı öğrenme, performans oryantasyonları, ve kendine güvenleri arasında pozitif bir ilişki bulunmuştur. Öğrencilerin daha önceki fen dersi başarıları ile atom teorisi ile ilgili kavramlardaki başarıları ve anlamlı öğrenme ile kendine güvenleri arasında pozitif bir ilişki bulunurken, performans oryantasyonları ile ezbere öğrenme arasında negatif bir ilişki bulunmuştur. Daha önceki dönem fen dersi başarısı ile atom teorisi konusu ile ilgili kavramlara yönelik başarıları arasındaki ilişki bu çalışma için geliştirilen fen başarı testinin öğrenci başarısını ölçebildiği yönünde önemli bir bulgudur. Ayrıca bu sonuçlar başarılı öğrencilerin anlamlı öğrenmeyi ezbere öğrenmeye tercih ettiklerini de göstermiştir. Bu sonuçlar ışığında, anlamlı öğrenmenin yanında fen ve teknoloji dersinde genelde başarılı olan öğrencilerin konuları daha iyi not almak için değil daha iyi anlamak için öğrendikleri de anlaşılmıştır. Cinsiyete göre analiz sonucunda kız çocuklarının geliştirilen fen başarı testinde elde ettikleri başarıları erkek çocuklarınkinden daha iyi bulunmuştur.

ANOVA analizi sonuçlarına göre anne babasının eğitim durumu yüksek olan ve ailesinin geliri iyi olan çocukların atom teorisi ile ilgili kavramlara yönelik hazırlanmış testeki başarıları yüksek olduğu bulunmuştur. Bizim bulgumuza benzer bulgular literatürde olmasına rağmen (Boogs, 2003) bizim bulguları desteklemeyen bulgular da literatürde vardır (Nuttall & Hell, 2001). Fakat Türkiye'deki eğitim sistemi ve ekonomik durum göz önünde tutulduğunda sosyoekonomik durumun öğrencilerin başarısında etkili bulunması anlamlı karşılanabilir. Ekonomik yönden ailesi iyi durumda olan çocuklar okuldaki eğitimlerinin yanı sıra aldıkları özel dersler, evde sahip oldukları olanaklar (bilgisayar, kitap, dergi) ve rahat öğrenme ortamlarının olmasından dolayı daha başarılı olma ihtimalleri çok yüksektir. Ailenin eğitim durumunun başarıya olan etkisi bizim çalışmamıza paralel olarak başka araştırmacılar tarafındanda desteklenmiştir (Ercikan, McCreith, & Lapointe, 2005; Hortaşsu, 1995). Belirli bir eğitim düzeyine sahip olan anne babalar, çocuklarının karşılaşacakları sorunları yakından bildikleri ve onlara bu süreçte gereken desteği zamanında verebildikleri için çocuklarının başarısını olumlu yönde etkilemektedirler. Hortaşsu (1995) çalışmasında sadece annenin eğitim durumunun çocukların başarısına etkili olduğunu bulmuştur, fakat bizim çalışma geçen son 10 yıllık süre içerisinde babaların da çocuklarının kaliteli bir eğitim sürecinden geçmelerine önem verdiklerini ortaya çıkarmıştır. Anne babanın eğitim durumunun çocukların öğrenme yaklaşımlarında da önemli rol oynadığı bulunmuştur. Bu bulguda daha önceki bulgularla benzerlik göstermektedir (Ercikan, McCreith, & Lapointe, 2005; Zhang, 2000). Eğitimli anne babalar çocuklarının anlamlı öğrenmesini de daha çok teşvik etmektedirler.