MODELING ELEMENTARY STUDENTS' SCIENCE ACHIEVEMENT: THE INTERRELATIONSHIPS AMONG EPISTEMOLOGICAL BELIEFS, LEARNING APPROACHES, AND SELF-REGULATED LEARNING STRATEGIES

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Submitted by **ŞULE ÖZKAN** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Secondary Science and Mathematics Education, Middle East Technical University** by,

Prof. Dr. Canan Özgen ____________________
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Ömer Geban ____________________
Head of Department, **Secondary Science and Mathematics Education**

Assoc. Prof. Dr. Ceren Tekkaya ____________________
Supervisor, **Elementary Education**

Examining Committee Members

Prof. Dr. Giray Berberoğlu ____________________
Secondary Science and Mathematics Education Dept., METU

Assoc. Prof. Dr. Ceren Tekkaya ____________________
Elementary Education Dept., METU

Assoc. Prof. Dr. Mehmet Fatih Taşar ____________________
Elementary Education Dept., Gazi University

Prof. Dr. Ömer Geban ____________________
Secondary Science and Mathematics Education Dept., METU

Assist. Prof. Dr. Semra Sungur ____________________
Elementary Education Dept., METU

Date: 25. 11. 2008

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Şule ÖZKAN

Signature :

ABSTRACT

MODELING ELEMENTARY STUDENTS' SCIENCE ACHIEVEMENT: THE INTERRELATIONSHIPS AMONG EPISTEMOLOGICAL BELIEFS, LEARNING APPROACHES, AND SELF-REGULATED LEARNING STRATEGIES

Özkan, Şule

Ph.D., Department of Secondary Science and Mathematics Education

Supervisor: Assoc. Prof. Dr. Ceren Tekkaya

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This study aimed to explore the relationships between elementary students' epistemological beliefs, learning approaches, self-regulated learning strategies, and their science achievement. In this investigation, a model of the potential associations among these variables was proposed and tested by using structural equation modeling. It was hypothesized that (a) students' epistemological beliefs would directly influence their learning approaches, self-regulated learning strategies, and science achievement, (b) students' adopted learning approaches and their use of self-regulated learning strategies would be related with science achievement, and (c) students' learning approaches were expected to be related with their use of self-regulated strategies. A total of 1240 seventh graders from 21 public elementary schools throughout the Çankaya district of Ankara completed measures designed to assess students' (a) epistemological beliefs (beliefs about the Certainty of Knowledge, Development of Knowledge, Source of Knowing, and Justification for Knowing) (b) adopted learning approaches (either rote or meaningful), (c) use of self-regulated learning strategies, and (d) science achievement.

Separate confirmatory factor analyses were conducted to determine the structure of students' epistemological beliefs and their adopted learning approaches. While the factor analyses of students' responses to the epistemological beliefs questionnaire supported the multidimensional nature of these beliefs, some features distinct from the findings of the Western countries were identified. Socio-cultural influences were proposed to account for the observed differences in the factor structure obtained with the Turkish sample.

The results of the structural equation modeling while supporting some of the proposed hypotheses, contradicted with others. Epistemological beliefs emerged as a major contributor to learning approaches and science achievement as expected, whereas those beliefs can not be used as a predictor of self-regulated learning strategies. In addition, students' adopted learning approaches were found to be a predictor of their self-regulated learning strategies which in turn influence the science achievement in the model. Contrary to the expectations, learning approaches of the students were not found to be directly related with their science achievement.

Keywords: Epistemological Beliefs, Learning Approaches, Science Achievement, Self-Regulated Learning, Structural Equation Modeling

ÖZ

İLKÖĞRETİM ÖĞRENCİLERİNİN FEN BAŞARILARI İLE İLGİLİ BİR MODELLEME ÇALIŞMASI: EPİSTEMOLOJİK İNANÇLAR, ÖĞRENME YAKLAŞIMLARI VE ÖZ-DÜZENLEME BECERİLERİ ARASINDAKİ İLİŞKİLER

Özkan, Şule

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Bu çalışmada, ilköğretim öğrencilerinin epistemolojik inançları, öğrenme yaklaşımları, öz-düzenleme becerileri ve fen başarıları arasındaki ilişkilerin incelenmesi amaçlanmıştır. Çalışmada söz konusu değişkenler arasındaki olası ilişkileri gösteren bir model öne sürülmüş ve bu model yapısal denklem modellemesi kullanılarak test edilmiştir. Çalışmanın başlangıcında (a) öğrencilerin epistemolojik inançlarının öğrenme yaklaşımları, öz-düzenleme becerileri ve fen başarılarına doğrudan etki edeceği, (b) öğrencilerin öğrenme yaklaşımlarının ve öz-düzenleme becerilerinin fen başarısı ile ilişkili olduğu ve (c) öğrencilerin öğrenme yaklaşımlarının öz-düzenleme becerilerine etki edeceği ileri sürülmüştür. Ankara ili Çankaya ilçesindeki 21 resmi ilköğretim okulunda öğrenim görmekte olan toplam 1240 öğrencinin (a) epistemolojik inançları (Bilginin Kesinliği, Bilginin Gelişimi, Bilmenin Kaynağı ve Bilmenin Doğrulanması), (b) benimsenen öğrenme yaklaşımları (ezberci veya anlamlı öğrenme), (c) öz-düzenleme becerileri ve (d) fen başarıları hakkında bilgi edinebilmek amacıyla örnekleme dört farklı ölçüm aracı uygulanmıştır.

Öğrencilerin epistemolojik inançları ve öğrenme yaklaşımlarının alt boyutlarının belirlenebilmesi için doğrulayıcı faktör analizi kullanılarak veri incelenmiştir. Faktör analizi sonuçları, öğrencilerin epistemolojik inançlarının çok boyutlu doğasını desteklemekle birlikte, Batı ülkelerinde konu ile ilgili yapılan çalışmalardan farklı olan bazı sonuçları da ortaya koymuştur. Gözlemlenen bu farklılıklar, sosyo-kültürel faktörlerin etkisi odağında açıklanmaya çalışılmıştır.

Yapısal denklem modeli sonuçları, çalışmada önerilen hipotezlerden bazılarını desteklemesine rağmen bazıları ile çelişmektedir. Öğrencilerin sahip oldukları epistemolojik inançları, öz-düzenleme becerilerine etki etmezken, öğrencilerin öğrenme yaklaşımları ve fen başarıları ile ilişkili bulunmuştur. Analiz sonuçları, öğrencilerin benimsedikleri öğrenme yaklaşımlarının öz-düzenleme becerilerine etki ettiğini ve öz-düzenleyici öğrenme stratejilerinin de fen başarısını açıklayan bir değişken olarak ön plana çıktığını göstermiştir. Beklentilerin aksine, öğrencilerin öğrenme yaklaşımları ile fen başarıları arasıda doğrudan bir ilişki bulunamamıştır.

Anahtar Kelimeler: Epistemolojik İnançlar, Öğrenme Yaklaşımları, Öz-Düzenleme Becerileri, Fen Başarısı, Yapısal Denklem Modeli

To My Family

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AGFI:	Adjusted goodness-of-fit index
CFA:	Confirmatory factor analysis
DEV:	Development
EBQ:	Epistemological beliefs questionnaire
EFA:	Exploratory factor analysis
GFI:	Goodness-of-fit index
JUST:	Justification
LAQ:	Learning approach questionnaire
LAQ-R:	Learning approach questionnaire – rote
LAQ-M:	Learning approach questionnaire – meaningful
MEARN:	Meaningful learning
MSLQ:	Motivated strategies for learning questionnaire
RLEARN:	Rote learning
RMR:	Root-mean-square residual
RMSEA:	Root-mean-square error of approximation
SACHT:	Science achievement test
SCIACH:	Science achievement
SELFRL:	Self-regulated learning strategies
SEM:	Structural equation modeling
SES:	Socio-economic status
SOU/CER:	Source/Certainty
SRL:	Self-regulated learning
S-RMR:	Standardized root-mean-square residual

CHAPTER 1

INTRODUCTION

The need to comprehend and use science in the workplace and everyday life has been greater today than past, and will continue to increase. The level of science required for scientifically literate citizenship and the scientific knowledge required in the workplace and in professional areas has increased dramatically. Consequently, all students need to receive a high quality science education and learn science in order to guarantee the production of quality in many professional areas ranging from education to health care to technology and to engineering (Yu, 1996). As a result of the need for science in a changing world, recent science education enterprises have directed scientists and science educators to improve teaching and learning science. Educators should strive to understand how students learn science and which learning variables may contribute to students' understanding of the subject (NRC, as cited in Cavallo, Rozman, Blickenstaff & Walker, 2003).

With this ongoing increase in the level of science required in such a scientifically and technologically rapid changing world, a paradigm shift in Turkish educational system became inevitable. Policy makers and educators have attempted to change the adopted approaches in the existing educational system by revising the whole elementary curriculum starting from the year 2003. With this curriculum reform in Turkey, the role of the teacher, the student, and the classroom have been changed dramatically. Historically, the students were used to be seen as empty boxes to be filled by vast of knowledge in the classroom by the teacher through the education process. This type of a perception implied that students lack the control in their own learning. What's more, such a view mostly neglected the learner characteristics and background variables carried into the classroom context by the learners themselves. Instead of taking such variables into consideration for an effective teaching-learning process, the old educational views in Turkey expected every single student in the classroom to "learn" in the same manner and to be able to reach the desired level. However, the expectations generally failed implying that there was something going on wrong. This failure became especially evident in the results of various national and international examinations in which a considerable group of examine took very low points, even no points at all. This alert may be one of the most influential factors in triggering the educational reforms in Turkey. A paradigm shift from a behaviorist to a more constructivist view have enabled educators to place more emphasis on the students themselves as opposed to teacher-centered classrooms where the knowledge is passing from teacher to learners just to fill the "empty boxes". Classrooms have been becoming more student-centered giving opportunity to students to accept more responsibility in their own learning. Therefore, in such learning environments, various student characteristics have been becoming critically important throughout the whole educational process.

In recent years, educational and psychological literature has been emphasizing the role of students' beliefs about knowledge and knowing (i.e., their epistemological beliefs) in the learning process. The last two decades have witnessed an increasing interest in the epistemological beliefs of individuals from different ages (see Hofer & Pintrich, 2002). Dating back to ancient Greeks, philosophical discussions about the nature of knowledge and knowing has remained a taproot of philosophical inquiry for years (Buehl & Alexander, 2001).

The domain of epistemology has long been of interest to philosophers, however the interest of psychologists in epistemology is relatively new (Hofer, 2001). Initiated in the mid-1950s, the psychological research on epistemological beliefs has been concentrated on three intersecting lines of research which cut across the six general models of epistemological development. One line of research has concerned how individuals interpret their own educational experiences (e.g. Baxter Magolda, 2004; Belenky, Clinchy, Goldberger, & Tarule, as cited in Hofer & Pintrich, 1997). The second line of research has been interested in the way epistemological assumptions influence thinking and reasoning processes, focusing on reflective judgment (Kitchener & King, 1981; Kitchener, King, Wood, & Davidson, 1989; Kitchener, Lynch, Fischer, & Wood, 1993) and skills of argumentation (Kuhn, 1993). The third line of research has considered the epistemological ideas as a system of beliefs which may be more or less independent rather than reflecting a coherent developmental structure (Schommer, 1990). In a frequently cited research analyzing the existing epistemological theories extensively, Hofer and Pintrich (1997) proposed a newer theoretical structure for the construct of personal epistemology.

Within this historical development, there has been an increasing interest in the area of the educational psychology in examining students' knowledge beliefs, the contributor variables of the epistemological predispositions, and the way those beliefs affect or mediate the knowledge acquisition. Accordingly, multiple studies have examined those beliefs in relation to specific learner characteristics in an attempt to understand the factors contributing to variations in students' epistemological beliefs (Buehl, 2003). Related research has shown that epistemological beliefs are significantly related to age and education (Schommer, 1998; Schommer, Calvert, Gariglietti, & Bajaj, 1997), gender (Buehl, Alexander, & Murphy, 2002; Chan & Elliott, 2002; Neber & Schommer, 2002; Schommer, 1993b), culture (Chan & Elliott, 2002; Youn, 2000), home environment (Schommer, 1990, 1993b), ability and intelligence (Kardash & Howell, 2000; Schommer, 1993a), domain differences (Hofer, 2001; Paulsen & Wells, 1998), and learning environments (Neber & Schommer, 2002).

Another line of research has investigated how students' beliefs about knowledge and knowing are related to certain learning processes and outcomes. Specifically, different studies intended to explore whether students' epistemological beliefs enhance or constrain their academic performance (Cano, 2005; Conley, Pintrich, Vekiri, & Harrison, 2004; Hofer, 2000; Mori, 1999; Paulsen & Wells, 1998; Ryan, 1984; Schommer et al., 1997; Statopoulou & Vosniadou, 2006), strategy use and learning approaches (Cano, 2005; Chan, 2003; Kardash & Howell, 2000; Lonka & Lindblom-Ylanne, 1996; Schommer, Crouse & Rhodes, 1992; Tsai, 1998), use of self regulated learning strategies (Braten & Stromso, 2005; Dahl, Bals & Turi, 2005; Neber & Schommer, 2002), comprehension and text processing (Kardash & Howell, 2000; Kardash & Scholes, 1996; Rukavina & Daneman, 1996;

Schommer, 1990; Schommer et al., 1992; Schommer & Walker, 1995), and construction of knowledge and conceptual change (Qian & Alverman, 1995; Tsai, 2000; Windschitl & Andre, 1998).

Examined collectively, a review of the related literature suggests that students' epistemological beliefs have been examined in relation to a wide range of learning processes and outcomes and to specific learner characteristics. Much of the current research on epistemological beliefs have focused on the conceptualization and assessment of the construct and also on the relationships of epistemological beliefs with other learner related variables and learning outcomes. While there is a growing body of research related with epistemological beliefs in the literature, such research is rare in Turkey. The current study can be considered as a leading effort in the exploration of students' epistemological beliefs in relation to other variables that are assumed to influence learning and academic performance.

In particular, it is claimed that the learning approaches adopted by the learners is another variable possibly influencing the way how the individual acquires and integrates knowledge. The importance of understanding the nature of the learning process has motivated many researchers to examine the type of the learning approach adopted by the students and the various factors associated with it. One field of study which has received much attention and interest in recent years is the association of epistemological beliefs and learning approaches of the students (Chan, 2003). Research has demonstrated that students' beliefs about the processes of knowing and the nature of knowledge in science may influence the way the student approaches the learning task in science (Saunders, 1998). For example, if a student believes that science knowledge consists of factual information, then the student may believe that recalling the information constitutes knowing. Thus, the student may believe that learning science knowledge consists of memorizing information. A student's choice of using memorization as a mode of learning has been described as reflective of a surface or rote learning orientation (Cavallo & Schafer, 1994; Entwistle & Ramsden, 1983). On the other hand, if a student believes that science knowledge is complex, resulting from interpretation of evidence in light of theories, then the student may believe that learning requires mental effort to understand the interrelationships and complexities of the knowledge (Roth & Roychoudhury, 1994; Schommer & Walker, 1995). When a student prefers to deal with a learning task by trying to understand the relationships among new information and other information, the student's learning orientation has been described as deep or meaningful (Cavallo & Schafer, 1994; Entwistle & Ramsden, 1983). According to Ausubel (1963), in order to achieve sound scientific understandings, students should form interrelationships among information, concepts, and the processes learned. Ausubel proposed that students must use deep learning strategies that allow them to link new ideas to the ones they already know or to engage in meaningful learning. However, it was pointed out that students learn science by memorizing the content and using rote learning strategies believing that rote learning is the only way to learn science (Novak, 1988).

Besides highlighting the associations among learning approaches and epistemological beliefs, the review of literature also suggests that learning approaches adopted by students contribute their academic outcomes (e.g., course and assessment grades, GPA, self-rated academic progress). The relationships between approaches to learning and different learning outcomes have been substantiated in a number of research studies (e.g., Duff, 2003; Heikkila & Lonka, 2006; Trigwell & Prosser, 1991; Watters & Watters, 2007). Studies examining the learning approaches in relation to science achievement indicated that compared to students with rote learning approaches, students adopting meaningful learning approaches accomplished more meaningful understanding of the science concepts (BouJaoude & Giuliano, 1994; Cavallo, 1996; Cavallo & Schafer, 1994; Cavallo, Potter & Rozman, 2004; Hegarty-Hazel & Prosser, 1991a; 1991b). Although the results of these investigations generally revealed that a deep/meaningful learning approach will contribute positively to various learning outcomes, there are also studies indicating that learning approaches do not predict academic achievement of the students (Diseth & Martinsen, 2003; Gibels, Van de Watering, Dochy, & Van den Bossche, 2005). In the light of these varying findings, the way the students approach to learning is considered as another variable to be examined throughout this study. In addition to investigating the relationships among epistemological beliefs and learning approaches and the association of these two variables with the science achievement, the current study also considered that it will be of great value and importance for educational theory and practice to examine whether epistemological beliefs and learning approaches are related to self-regulated learning strategies, and if so, how.

Among student characteristics associated with learning, students' self-regulated strategies are regarded as an important factor and, hence, have been widely investigated. Self-regulated learning (SRL) is regarded as a complex construct which cannot be defined simply and straightforwardly. By focusing on the different aspects of the self-regulation and addressing different components of the construct, educational psychologists have proposed different theoretical models and conducted studies to produce theoretically relevant and pragmatic information about SRL. Accordingly, there are different theories (see Zimmerman & Schunk, 2001 for a review) of self-regulation. Different theoretical perspectives contribute to different models of SRL. Therefore, the field of research on SRL is quite diverse including a number of different models (e.g., Boekaerts & Niemivirta, 2005; Butler & Winne, 1995; Pintrich & De Groot, 1990; Winne, 1995) each of which emphasizing slightly different aspects of SRL.

Besides the efforts to conceptualize self-regulation, the researchers have been concentrated on the learner characteristics that may be associated with the use of self-regulatory learning strategies. The reviewed studies mainly pointed out that motivational beliefs (Pintrich, 1999; Pintrich & De Groot, 1990; Wolters & Pintrich, 1998) and gender (Benbenutty, 2007; Pajares, 2002; Patrick, Ryan, & Pintrich, 1999; Wolters & Pintrich, 1998; Zimmerman & Martinez-Pons, 1986; 1988) are related individually to SRL. There are also other learner related characteristics that may influence SRL such as ethnicity (Bembenutty, 2007), subject area (Wolters & Pintrich, 1998), grade and giftedness (Zimmerman & Martinez-Pons, 1990).

Another line of research on the SRL literature emphasizes the important role that students' use of SRL strategies play in their academic achievement (Zimmerman, 1990). The research on strategy use and achievement examined how students personally activate, alter, and sustain their learning practices in specific contexts (Zimmerman, 1986). Various studies present evidence for the definite relationship between SRL and academic achievement (Eshel & Kohavi, 2003; Hwang & Vrongistinos, 2002; Pintrich & De Groot, 1990; Sink, Barnett, & Hixon, 1991; Wolters, Yu, & Pintrich, 1996; Zimmerman & Martinez-Pons, 1986; 1988).

Taking the related literature into account, it can be proposed that students' epistemological beliefs, learning approaches, and self-regulated learning strategies may be differentially used or related to success in different science subjects and at different grade levels. Therefore, the specific purpose of this study is to explore the possible relationships among seventh grade students' epistemological beliefs, learning approaches, self-regulated learning strategies, and their science achievement. Four main assumptions are provided in the light of the extensive literature review. First, it is assumed that epistemological beliefs will have a direct influence on science achievement. Second, it is assumed that, these beliefs influence science achievement not only directly but also indirectly through their mediating effect on learning approaches and self-regulated learning strategies. Third, learning approaches and self-regulated learning strategies are assumed to influence science achievement directly. Finally, learning approaches are assumed to influence students' use of self-regulated learning strategies. To test these assumptions, a path model defining the relationships among the variables of the study was developed (see Figure 1.1).

In the current study, epistemological beliefs were investigated using the framework of Hofer and Pintrich (1997) that pointed out alternative conceptions of personal epistemology. Pintrich's (2005) conceptual framework for self-regulated learning was adopted for the examination of students' self-regulated learning. Within these theoretical perspectives, the following research questions guided this investigation:

1. What is the nature and the number of factors that comprise the epistemological beliefs of Turkish elementary school students?

2. What is the epistemological belief profile of Turkish elementary school students?
3. What is the learning approach profile of Turkish elementary school students?
4. What is the self-regulated learning strategy profile of Turkish elementary school students?
5. What is the nature of the relations among students' epistemological beliefs, learning approaches, self-regulated learning strategies, and their science achievement?

1.1 Overview of the Proposed Model

The possible relationships between students' epistemological beliefs, learning approaches, SRL strategies, and science achievement are displayed in Figure 1.1. This general model was developed based on the review of the related literature and also by the researcher' views and understanding of the specific constructs enrolled in the study.

The model contains four main components: epistemological beliefs, learning approaches, SRL strategies, and science achievement. Epistemological beliefs and learning approaches are represented by a number of subcomponents in the model. Epistemological beliefs are characterized by the beliefs about the source, justification, development, and certainty of knowledge. The second component of the model, namely learning approaches, includes rote learning and meaningful learning. The current model, however, does not address the components of SRL strategies such as rehearsal, elaboration, organization, critical thinking, and metacognitve self-regulation. Of course, this model do not claim to be the most comprehensive one including all aspects of the related constructs. Instead, it represents an initial effort to identify the associations among epistemological beliefs, learning approaches, SRL strategies, and science achievement. Future investigations can expand this model by including other aspects of the variables and other constructs.

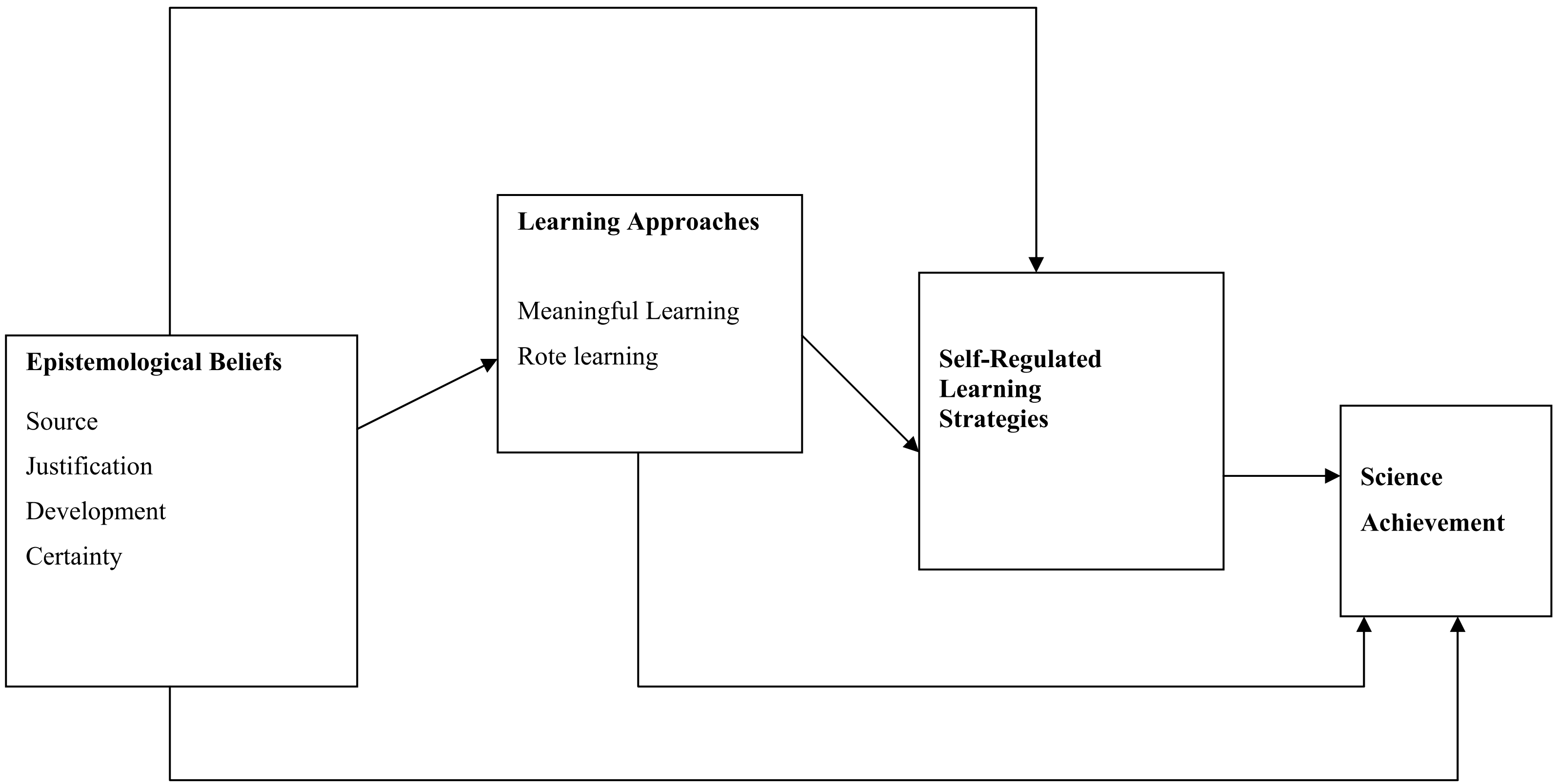

Figure 1.1 Model of the proposed relationships between epistemological beliefs, learning approaches, SRL strategies, and science achievement

1.2 Proposed Relations in the Model

Figure 1.2 displays the various relationships among the components of the proposed model. As shown by the Figure 1.2, there are multiple paths to and from the constructs included in the model. For the current study, this hypothetical model was assessed. The following section explains the paths and potential relationships among the constructs.

First, based on the related literature, it is assumed that students' epistemological beliefs will influence the other constructs included in the model directly. More specifically, it is hypothesized that students' beliefs about the source, justification, development, and certainty will have direct effects on students' learning approaches, SRL strategies, and their science achievement. To put it more clearly, students with more sophisticated epistemological beliefs (i.e., students who believe that knowledge is constructed by the knower through the use of evidence and assessment of expert opinion and who believe that there is more than a single right knowledge having an evolving and changing nature) are thought to adopt a meaningful learning approach and tend to use more self-regulated learning strategies. It is also hypothesized that students having more sophisticated beliefs about the nature of knowledge and knowing will more likely to achieve higher and perform well on their science tasks.

Second, it is suggested that learning approaches adopted by the students will have a direct effect on their strategy use. It is hypothesized that students with a meaningful approach will report more strategy use in the learning process. On the contrary, a negative relationship is expected between the rote learning and SRL strategies. In addition to the association among learning approaches and SRL strategies, learning approaches are assumed to influence science achievement directly. That is, students with a meaningful learning approach will expected to achieve higher in science, whereas students adopting rote learning approach will suggested to be less successful in science.

Third, the hypothesized model includes direct paths from SRL strategies to science achievement implying that the former will have a direct influence on the latter. To put it in a more straight way, students with more strategy use are expected to be more successful learners in science.

Besides the aforementioned direct relations, it is worth to specify the indirect influences of the variables in the model. As depicted in Figure 1.2, students' epistemological beliefs and learning approaches are hypothesized to have direct effect on their science achievement. This model also proposes that epistemological beliefs have an indirect influence on the science achievement via their mediating effect on the learning approaches and SRL strategies. By influencing these two constructs, epistemological beliefs are assumed to effect science achievement indirectly besides their direct effect on the achievement. Similarly, learning approaches have both direct and indirect effects on science achievement. The indirect influence comes from the effect of learning approaches on the SRL strategies.

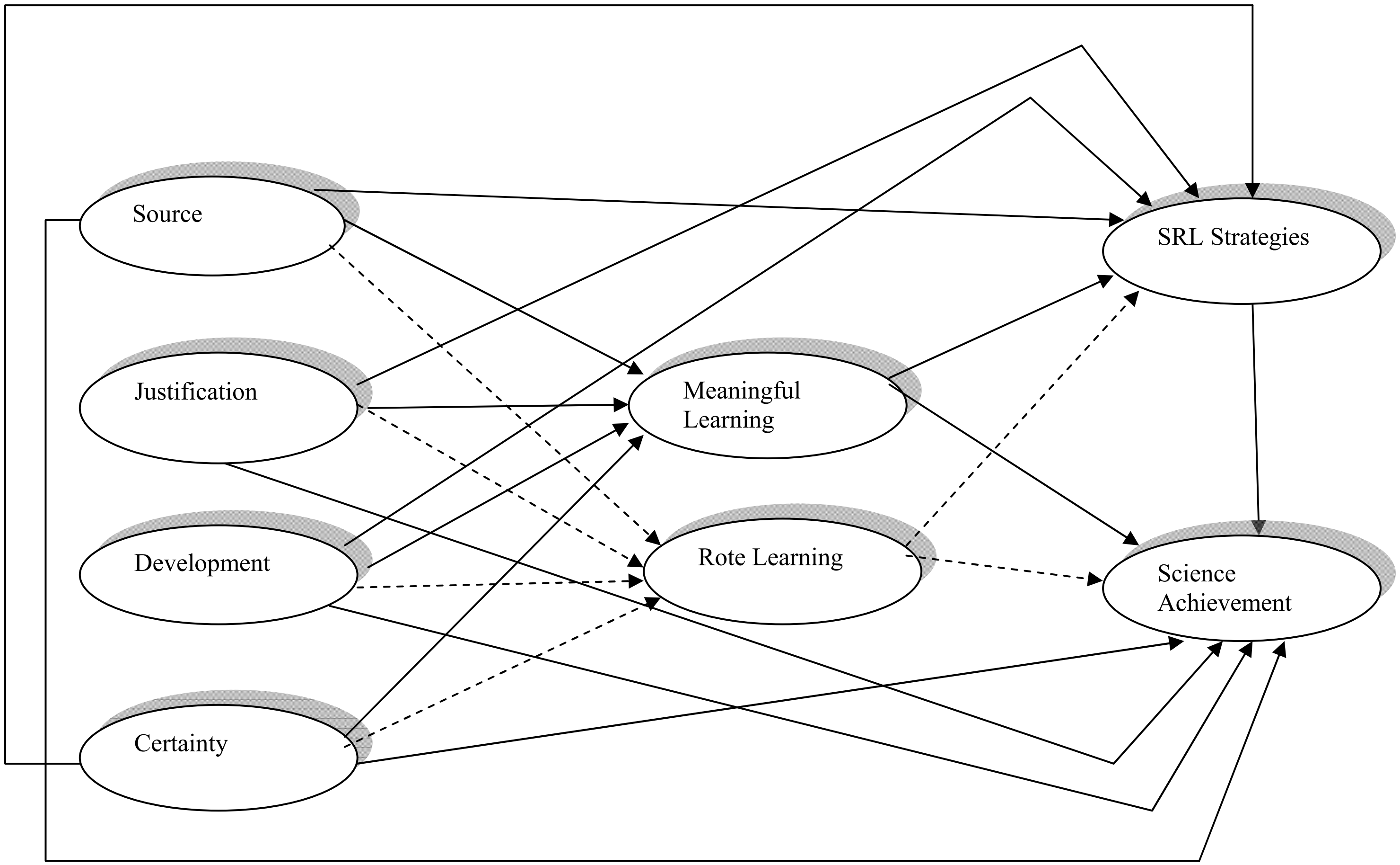

Figure 1.2 The hypothesized structural model
Note. The solid lines indicate paths hypothesized to be positive. The dotted lines indicate paths hypothesized to be negative.

1.3 Conceptual Hypotheses

Based on the hypothesized structural model, the current study examined the following 21 hypotheses on the relationships among the variables.

Hypothesis 1: Sophisticated beliefs about source of knowing is significantly and positively related to meaningful learning.

Hypothesis 2: Sophisticated beliefs about justification of knowing is significantly and positively related to meaningful learning.

Hypothesis 3: Sophisticated beliefs about development of knowledge is significantly and positively related to meaningful learning.

Hypothesis 4: Sophisticated beliefs about certainty of knowledge is significantly and positively related to meaningful learning.

Hypothesis 5: Sophisticated beliefs about source of knowing is significantly and negatively related to rote learning.

Hypothesis 6: Sophisticated beliefs about justification of knowing is significantly and negatively related to rote learning.

Hypothesis 7: Sophisticated beliefs about development of knowledge is significantly and negatively related to rote learning.

Hypothesis 8: Sophisticated beliefs about certainty of knowledge is significantly and negatively related to rote learning.

Hypothesis 9: Sophisticated beliefs about source of knowing is significantly and positively related to SRL strategies.

Hypothesis 10: Sophisticated beliefs about justification of knowing is significantly and positively related to SRL strategies.

Hypothesis 11: Sophisticated beliefs about development of knowledge is significantly and positively related SRL strategies.

Hypothesis 12: Sophisticated beliefs about certainty of knowledge is significantly and positively related to SRL strategies.

Hypothesis 13: Sophisticated beliefs about source of knowing is significantly and positively related to science achievement.

Hypothesis 14: Sophisticated beliefs about justification of knowing is significantly and positively related to science achievement.

Hypothesis 15: Sophisticated beliefs about development of knowledge is significantly and positively related to science achievement.

Hypothesis 16: Sophisticated beliefs about certainty of knowledge is significantly and positively related to science achievement.

Hypothesis 17: Meaningful learning is significantly and positively related to SRL strategies.

Hypothesis 18: Rote learning is significantly and negatively related to SRL strategies.

Hypothesis 19: Meaningful learning is significantly and positively related to science achievement.

Hypothesis 20: Rote learning is significantly and negatively related to science achievement.

Hypothesis 21: SRL strategy is significantly and positively related to science achievement.

1.4 Significance of the Study

The dynamic interaction of students' epistemological beliefs, learning approaches, SRL strategies, to their science achievement in Turkey has not been widely acknowledged by the researchers. Those constructs have not so far clearly emphasized as potential variables which may contribute to students' understanding of the science subjects in the elementary level. Such considerations have been largely ignored in the studies trying to determine the underlying factors of students' science achievement. For the reasons already discussed, it can be confirmed that there is a necessity of specifying the role of students' epistemological beliefs, learning approaches, and SRL strategies in their science achievement. Since those constructs were found as influential variables underlying students' understanding of the science subjects by the previous research and little study exists about them for our culture, current study will attempt to fill the gap in literature related with the topic.

That the study and understanding of the epistemological beliefs is important in academic achievement is undeniable. The reviewed literature suggests the fact that epistemological beliefs and the impacts of these beliefs on other constructs need to be carefully examined. It is thought that studying these beliefs and the associations among the epistemological beliefs and other factors may enable us to better understand and enhance the learning process in science. Since there is not much research examining the range of the beliefs that students hold about nature of knowledge and knowing at particular phases of their educational experience in our country, this research may have implications for planning, development, and implementation of school science programs aimed to achieve more sophisticated epistemological beliefs. By this way, it will be possible to evaluate some of the existing research and assumptions regarding students' epistemological beliefs and how these beliefs develop. Therefore, this research will contribute to the body of research that curriculum developers, publishers, educators, and teachers can utilize in developing learning experiences for the achievement of more sophisticated epistemological beliefs. This research is also important since understanding and developing students' epistemological beliefs may contribute a shifting toward a meaningful learning from a rote learning approach. In addition, efforts to improve the epistemological beliefs may also lead students to use more SRL strategies, hence become more responsible from their own learning. Notwithstanding, all of these possible associations may bring a higher level of academic performance for the science subjects.

The existing literature about the specific variables of this study mainly focused on older age groups and tends to generally ignore elementary graders except a few investigations. Given the potential influence of epistemological beliefs, learning approaches, and SRL strategies on high school and undergraduate students' academic achievement, it is likely that these variables also effect achievement of elementary grade students. However, the literature is mainly dominated with the results coming from high school and undergraduate students, and there is a lack of research focusing on the elementary students. Although this may partly be due to the difficulty of assessing such constructs with younger age groups, this research area should not be ignored. Therefore, current study can provide a framework for the investigation of epistemological beliefs, learning approaches, and SRL strategies of elementary grade students. It is thought that information about these constructs and the possible influence of them on the academic achievement may lead researchers and educators theoretically and practically starting from earlier ages.

One additional contribution of this research to the related literature is that it examines students' epistemological beliefs using the multiple-dimension paradigm in the Turkish context. Since the inconsistent results regarding dimensions or the factor structure of epistemological beliefs of samples from non-Western countries are well documented, current investigation will be one of the leading studies in Turkey about the use of an epistemological instrument designed primarily for the Western countries. The results of the study may, therefore, provide evidence whether a new model or measure to clarify the structure of epistemological beliefs in Turkish cultural context is required or not.

1.5 Definition of the Important Terms

For the purposes of this study, the following definitions are provided.

Epistemological Beliefs: Epistemological beliefs are defined as students' beliefs about the nature of knowledge and knowing (Hofer & Pintrich, 1997).

Nature of Knowledge: Beliefs about nature of knowledge are defined as beliefs about the certainty and development of knowledge (Conley et al., 2004).

Nature of Knowing: Beliefs about nature of knowing are defined as beliefs about the sources of knowledge and the justification for knowing (Conley et al., 2004).

Certainty of Knowledge: Beliefs about certainty of knowledge may range from the belief in a single right knowledge to the belief in the existence of more than one right knowledge (Conley et al., 2004).

Development of Knowledge: Beliefs about development of knowledge may range from the view that knowledge is absolute, certain, and fixed to the understanding that knowledge is tentative, evolving, and contextual (Conley et al., 2004).

Sources of Knowing: Beliefs about sources of knowing may range from the view that knowledge originates outside the self and resides in external authority, from whom it may be transmitted, to an understanding that knowledge is constructed by the knower in interaction with others (Hofer & Pintrich, 1997).

Justification for Knowing: Beliefs about justification for knowing may range from the idea that knowledge requires no justification and individuals just receive the knowledge that others provide to an understanding that knowledge is constructed through use of evidence and assessment of expert opinion (Saunders, 1998).

Learning Approaches: Learning approaches are defined as the individual differences in intensions and motives when facing a learning situation, and the utilization of corresponding strategies (Diseth & Martinsen, 2003). Meaningful learning and rote learning are the two ways in which students go about their academic tasks affecting the nature of their learning outcome.

Meaningful Learning: An approach to learning in which the learner has intention to understand the learning material by constructing the meaning of the content is defined as meaningful learning (Cavallo, 1996).

Rote Learning: An approach to learning in which the learner has the intention to learn by memorizing for the recall of facts is defined as rote learning (Cavallo, 1996).

Self-Regulated Learning Strategies: SRL strategies are defined as the students' metacognitive strategies for planning, monitoring, and modifying their cognition, students' management and control of their efforts on classroom academic tasks, and the actual cognitive strategies that students use to learn, remember, and understand the material (Pintrich & De Groot, 1990).

Science Achievement: Science achievement of students is identified by the students' grades on the science achievement test ranging from 0 to 25.

1.6 Organization of the Dissertation

Current dissertation is divided into five main chapters. The first chapter signifies the importance and significance of the study by summarizing the related theoretical background. The hypothetical model is introduced in this section as well. Chapter 1 ends up with giving the definitions of the important terms that lead the whole study. The second chapter presents a detailed review of literature about the epistemological beliefs, learning approaches, and SRL strategies. The theoretical background of the constructs and support for the proposed paths in the hypothesized model are provided in the second chapter. The methodological issues are presented in chapter three by giving information about the sample, instruments, data analyses, and structural equation modeling. The fourth chapter gives the results of the current investigation in the light of the research questions. Finally, fifth chapter discusses the findings by comparing and contrasting the results with the related literature. The conclusions drawn from the results of the study, implications, limitations, and suggestions for future research are also given in the last chapter.

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

The purpose of this review is to provide a framework for the investigation of the interrelationships among students' epistemological beliefs, self-regulatory learning strategies, learning approaches, and their science achievement. To accomplish this purpose, published works in the psychological and educational literatures are reviewed and presented in three main sections. The first section deals with students' epistemological beliefs by offering a historical perspective, addressing the link between epistemological beliefs and specific learner characteristics, and finally focusing on the relationship between epistemological beliefs and learning outcomes. The second main section presents students' self-regulated learning by focusing on theories and models of self-regulation, identifying the specific factors influencing SRL, clarifying the importance of SRL in academic achievement, and lastly reviewing the characteristics of self-regulated learners. The final section of this review deals with students' learning approaches by mainly considering the contributor variables of different learning approaches and highlighting the link between students' adopted approach to learning and their learning outcomes.

2.1. Research on Students' Epistemological Beliefs

This section provides an overview of the epistemological belief literature by presenting the historical roots of epistemological studies, contemporary issues in the study of students' epistemological beliefs in relation to specific learner characteristics, and the relationships among epistemological beliefs and cognitive learning outcomes.

2.1.1 Epistemological Beliefs within a Historical Perspective

Epistemology, the theory of knowledge and knowing, has been one of the keystones of philosophy. Dating back to ancient Greeks, philosophical discussions about nature of knowledge and knowing has remained a taproot of philosophical inquiry for years (Buehl & Alexander, 2001). The platonic view of knowledge has been influential in shaping the field of epistemology (Buehl, 2003). That is, in his dialogues such as *Theaetus,* Plato postulated that knowledge consists of truth, belief, and justification. According to Plato, a statement must be true in order to be called as knowledge. However, another element needed to qualify a statement as knowledge is the evidence that the individual's belief in the truth and validity of the statement is justified (Buehl & Alexander, 2001). In other words, belief in the truth of a statement must be supported by reason or data. Over centuries, various philosophic approaches on the nature and form of knowledge have emerged. However, each one has addressed the three conditions of knowledge, namely truth, belief, and justification, proposed by Plato (Buehl, 2003).

Although the domain of epistemology has long been of interest to philosophers, the interest of psychologists in epistemology is relatively new (Hofer, 2001). Psychological research on epistemological development began in the mid-1950s, and since then there have been three intersecting lines of research which cut across the six general models of epistemological development. One group of researchers has been interested in how individuals interpret their own educational experiences (Baxter & Magolda, 2004; Belenky, Clinchy, Goldberger, & Tarule, as cited in Hofer & Pintrich, 1997; Perry, as cited in Hofer & Pintrich, 1997). A second group of researchers have been interested in the way epistemological assumptions influence thinking and reasoning processes, focusing on reflective judgment (Kitchener & King, 1981; Kitchener, King, Wood, & Davidson, 1989; Kitchener, Lynch, Fischer, & Wood, 1993) and skills of argumentation (Kuhn, 1993) The third and most recent line of research has considered the epistemological ideas as a system of beliefs which may be more or less independent rather than

reflecting a coherent developmental structure (Schommer, 1990). All of these models have similar origins
and parallel routes, but major points of distinctions as well (Hofer, 2001). The following six subsections outline the central theories and models of epistemological development. Lastly, an alternative conception of personal epistemology is presented within the historical framework of epistemological beliefs.

2.1.1.1 Perry's Scheme of Intellectual and Ethical Development

Earlier conceptions of beliefs about knowledge and knowing have been dominated by the work of William Perry (as cited in Schommer & Walker, 1997). The current developmental models of epistemology also acknowledge some connection to Perry's work (Hofer, 2001). Nearly all the existing psychological work on epistemological beliefs can be traced back to two longitudinal studies by Perry that began in the early 1950s (Hofer & Pintrich, 1997). However, Perry was neither a philosopher nor a psychologist (Buehl, 2003). As being so, Perry never conceptualized his study as the study of students' epistemological belies (Buehl & Alexander, 2001).

In his work, Perry interviewed male students as they progressed through their undergraduate education. Each interview started with the question "Would you like to say what has stood out for you during the year?" As a response to this question students often talked about the challenges they came across during their academic work. They also discussed experiences related to their social life, extracurricular activities, and jobs. After examining students' responses, Perry proposed a scheme for students' intellectual and ethical development (Buehl & Alexander, 2001). The levels of this scheme have been clustered into four sequential categories: *dualism, multiplicity, relativism,* and *commitment within relativism* (see Table 2.1) (Hofer & Pintrich, 1997). According to this scheme, students in the dualistic position view knowledge as either right or wrong and believe that authorities know the truth and convey it to the learners. Multiplicity represents a modification of dualism with the beginning of the recognition of diversity and uncertainty. Individuals at this category believe that all views are equally valid and that each person has a right to his or her own opinion. Relativism is characterized by a shift in the perception of self as an active maker of meaning. Individuals at the relativist category perceive knowledge as relative, contingent, and contextual and begin to realize the need to choose and affirm one's own commitments. Commitment within relativism reflects a focus on responsibility, engagement, and the forging of commitment within relativism. Individuals at this category make and affirm commitments to values, careers, relationships, and personal identity (Hofer & Pintrich, 1997).

It is important to identify that Perry did not explicitly study students' beliefs about academic knowledge. He was primarily concerned about the experiences of college undergraduates. The interviews were conducted in an academic setting, but the open-ended and nondirective nature of the interview questions did not grantee that academic experiences were the only focus (Buehl & Alexander, 2001). Further, Perry also addressed other aspects of academic experiences such as social life, extracurricular activities, and jobs, and included them in his scheme (Buehl, 2003). Regardless of the mentioned theoretical and methodological difficulties, Perry's work formed the base of epistemological research that has been followed for several years.

2.1.1.2 Women's Ways of Knowing

Perry's work was subjected to criticism in the late 1970s because of the limitations of generalizing from an elite male sample to general population of college students (Hofer & Pintrich, 1997). In response to Perry's use of male sample, Belenky, Clinchy, Goldberg, and Traule (as cited in Buehl & Alexander, 2001) examined women's perspectives of truth, knowledge, and authority. In an attempt to determine women's views of knowledge, Belenky *et al*. interviewed a diverse sample of college-educated women having different backgrounds like age, ethnicity, and class (Buehl & Alexander, 2001). The model of beliefs that emerged at the end of these interviews, referred to as "women's ways of knowing", was structured around five positions toward knowledge and knowing (i.e., silence, received knowledge, subjective knowledge, procedural knowledge, and constructed knowledge) (see Table 2.1) (Buehl, 2003).

Table 2.1 Models of epistemological development in late adolescence and adulthood (Hofer & Pintrich, 1997, p.92)

Intellectual and ethical development (Perry)	Women's ways of knowing (Belenky et al.)	Epistemological reflection (Baxter Magolda)	Reflective judgment (King and Kitchener)	Argumentative reasoning (Kuhn)
Positions	*Epistemological perspectives*	*Ways of knowing*	*Reflective judgment stages*	*Epistemological views*
Dualism	Silence	Absolute knowing	Pre-reflective thinking	Absolutists
	Received knowledge			
Multiplicity	Subjective knowledge	Transitional knowing		Multiplists
			Quasi-reflective thinking	
Relativism	Procedural knowledge (a)Connected knowing (b)Separate knowing	Independent knowing		Evaluatists
Commitment within relativism	Constructed knowledge	Contextual knowing	Reflective thinking	

Note. Stages and positions are aligned to indicate similarity across the five models.

According to the proposed model, women who adopt a position of *silence* experience a passive, voiceless existence listening only external authority whereas women with a position of *received knowledge* can reproduce and speak about the knowledge although it is still originating outside the self. In contrast, women in the *subjective knowledge* position believe that self is the source of truth and view knowledge as an intuitive reaction, personally experienced. In the position of *procedural knowledge*, women show reasoned reflection, applying objective and systematic procedures of analysis (Hofer & Pintrich, 1997). There are two distinct epistemological orientations within procedural knowledge: *connected knowing* (an emphatic and caring approach to knowing) and *separate knowing* (impersonal and detached approach to knowing) (Hofer, 2001).

Like Perry, Belenky *et al*. did not intend to asses epistemological beliefs. Further, similar to Perry's work, this model of research was limited to examination of responses from one gender. Therefore, even their model of knowing implies change; Belenky *et al*. did not adopt a strict developmental perspective (Buehl, 2003).

2.1.1.3 Epistemological Reflection Model

In contrast to Perry and Belenky et al., Baxter Magolda (as cited in Buehl, 2003) studied the beliefs of both males and females. In 1986, Baxter Magolda initiated a 5-year longitudinal study in which she conducted annual open-ended interviews with the participants and administered the Measure of Epistemological Reflections (MER). Analysis of the interview data by organizing student responses into categories and themes initially, and reflecting on this process led Baxter Magolda to develop the Epistemological Reflection Model (Hofer & Pintrich, 1997).

Within Baxter Magolda's model, there are four different "ways of knowing": *absolute knowing* (knowledge is certain and authorities have all the answers), *transitional knowing* (knowledge is uncertain and authorities are not all-knowing), *independent knowing* (knowledge is uncertain and authorities are not the only source of knowledge), and *contextual knowing* (knowledge is judged on the basis of contextual evidence) (see Table 2.1) (Hofer & Pintrich, 1997).

By studying both men and women, Baxter Magolda was able to build on the previous work of Perry and Belenky *et al*. both of which were single-sex studies. She did not indicate that ways of knowing differ by gender, but rather reported gender-related reasoning patterns across the ways of knowing (Hofer & Pintrich, 1997). Within absolute knowing, for example, students could be placed along a continuum from *receiving* (used more often by women) to *mastery* (used more often by men). The patterns for transitional knowing were *interpersonal* (common among women) and *impersonal* (common among men). Independent knowing pattern ranged from *interindividual* (more prevalent among women) and *individual* (more prevalent among men) (Buehl, 2003).

Although Baxter Magolda's assessment of beliefs was the one that focused mostly on academical issues, a number of beliefs that were not necessarily epistemological in nature were addressed in her model as well. In her descriptions of the various ways of knowing, for instance, Baxter Magolda included beliefs about the role of the learner, peers, and instructor, and beliefs about evaluation. Even though such beliefs are important and informative in explaining the development of knowledge and learning, it seems misleading to use the term "Epistemological Reflection Model" when many other belief systems are included (Buehl & Alexander, 2001).

2.1.1.4 Reflective Judgment Model

Building on Perry's work, King and Kitchener (as cited in Hofer & Pintrich, 1997) studied the epistemic assumptions that underlie reasoning. In their efforts to understand the individuals' assumptions and beliefs about knowledge, King and Kitchener interviewed more than 1700 individuals from high school students through nonstudent adults over the course of 15 years (Buehl & Alexander, 2001). These individuals were presented with four different ill-structured problems and asked to state and justify their point of view. The participants also responded to follow-up questions designed to assess their beliefs about knowledge and how it is gained (Hofer & Pintrich, 1997). The results of the interview studies indicated that individuals' assumptions and beliefs about knowledge were related to how they chose to justify their beliefs. Their resulting seven-stage Reflective Judgment Model (RJM) focused on the descriptions of individuals' opinions about knowledge and conceptions of justification at each stage (Buehl & Alexander, 2001).

Within the seven-stage model proposed by King and Kitchener (as cited in Hofer & Pintrich, 1997), there are three levels, which are *pre-reflective (stages 1, 2, and 3)*, *quasi-reflective (stages 4 and 5)*, and *reflective (stages 6 and 7)* (see Table 1). Being similar to the initial positions in the other models displayed, in the pre-reflective stage individuals are unlikely to perceive that problems exist for which there may be no correct answer. Quasi-reflective thinking, on the other hand, is marked by a growing realization that individuals cannot know with certainty. The third stage of RJM is reflective thinking in which individuals think that knowledge is actively constructed and must be understood contextually, and judgments are open to reevaluation (Hofer & Pintrich, 1997).

Although the stages proposed by King and Kitchener elaborate the upper levels of Perry's scheme and specifies the dimensions of epistemic cognition, it has some limitations (Hofer & Pintrich, 1997). First of all, the problems used to develop this model did not rely on "schooled" knowledge (Buehl, 2003). Instead, the problems concerned how the pyramids were built, the safety of chemical additives in food, the objectivity of news reporting, and the concepts of creation and evolution (Hofer & Pintrich, 1997). Further, similar to the other researchers, King and Kitchener did not primarily focus on developing a model of epistemological beliefs (Buehl, 2003). It is from individual responses to the interview questions that epistemic assumptions were extrapolated (Hofer & Pintrich, 1997).

2.1.1.5 Argumentative Reasoning

Attention to the epistemological nature of solving ill-structured problems has also been addressed by Kuhn (as cited in Hofer, 2001). In her attempt to understand the reasoning that occurs in everyday lives, Kuhn presented individuals from four age groups, ranging from tens to the sixties, with three ill-structured problems (Buehl & Alexander, 2001). Participants were asked to generate causal explanations and justify their positions for each of these problems: (a) what causes prisoners to return to crime after they are released? (b) what causes children to fail in school? (c) what causes unemployment? Participants were also asked to generate an opposing view, offer a solution to the problem, and discuss their epistemological reflection on the reasoning presented (Hofer & Pintrich, 1997).

Participants' responses uncovered three epistemological views that underlie argumentative reasoning: *absolutist*, *multiplist*, and *evaluatists* (see Table 2.1). Individuals with absolutist view conceive knowledge as certain and absolute, believe that facts and experts are the basis of knowing, and express a high level of certainty about their own beliefs. Multiplists, on the other hand, are skeptical about expertise and believe that all views may have equal legitimacy, and one's own view may be as valid as that of an expert. Although individuals with evaluative view are also skeptical about the possibility of certain knowledge, they recognize expertise and believe that they are less certain than experts. Most importantly, they suppose that viewpoints can be compared and evaluated (Hofer & Pintrich, 1997).

Kuhn's study is notable in its focus on ill-structured problems from daily life and in the use of a broad sample of participants across the life span (Hofer & Pintrich, 1997). However, given the diverse age range of participants, as well as the nonacademic nature of the problems used to uncover individuals' beliefs, Kuhn's classification system is related more with general knowledge beliefs and does not reflect beliefs about academic knowledge (Buehl & Alexander, 2001).

2.1.1.6 Epistemology as a System of Independent Beliefs

Even though empirical study of knowledge beliefs has initiated with the work of Perry and continued with Belenky et al., Baxter Magolda, King and Kitchener, and Kuhn, the research about epistemological research has undergone noteworthy transformations in the last decade. It is the work of Marlene Schommer-Aikins, in part, which results in these significant changes (Buehl, 2003).

Interested in how epistemological beliefs may impact comprehension and academic performance, Schommer (1990; 1993a) has developed a research program that was more quantitative than that of the aforementioned researchers and took a more analytic view of the components of beliefs (Hofer & Pintrich, 1997). Schommer's (1990) interest in how students' beliefs about the nature and acquirement of knowledge affected their approach to learning led her to dispute the unidimensional nature of epistemological beliefs (Buehl & Alexander, 2001). According to Schommer (1994), such a unidimensional conception of epistemological beliefs may fail to capture the complexity of personal epistemology and may mask the multiple links between personal epistemology and different aspects of learning. Therefore, she proposed that epistemological beliefs can be reconsidered as a system of more or less independent beliefs. By system of beliefs, it is meant that there is more than one belief to consider, and by more or less independent, it is meant that learners may be sophisticated in some beliefs, but not necessarily sophisticated in others (Schommer, 1994). For instance, a person may believe that knowledge is very complex and involves a complex network of ideas. Yet, the same person may also believe that knowledge is totally certain and never changes (Schommer & Walker, 1997).

In order to assess the system of epistemological beliefs, Schommer (1990) developed and validated Epistemological Belief Questionnaire (EBQ) consisting of 63 items which enable participants to indicate their level of agreement on a five-point Likert scale. Items of this paper and pencil measure were conceptually grouped into 12 different subscales. Factor analytic techniques, however, indicated that the 12 subscales of this measure loaded onto four independent factors which are *Fixed Ability, Quick Learning, Simple Knowledge,* and *Certain Knowledge* (Schommer, 1990).

Those factors are viewed as a continuum and are labeled according to the most naïve viewpoint they represented. The first factor, Fixed Ability, is related to the individuals' own control over acquisition of knowledge. This factor is conceptualized as a continuum from the belief that intelligence is fixed at birth to the view that it is incremental and can be improved. The second factor, Quick Learning, is about the acquisition of knowledge. This factor ranges from the view that learning occurs quickly or not at all to the belief that learning is gradual. The third factor, Simple Knowledge, is related to the structure of knowledge. Positions on this factor range from the belief that knowledge is a collection of unrelated bits of information to a view of knowledge as a collection of interrelated pieces of information. The fourth factor, Certain Knowledge, concerns beliefs about the certainty of knowledge. Positions range from knowledge is unchanging and absolute to knowledge is evolving, tentative, and conditional (Buehl & Alexander, 2001).

Schommer's this approach to the study of personal epistemology, especially the development of a paper and pencil measuring instrument, has enabled researchers to initiate empirical investigation in the field identifying more explicitly the relationships between epistemology and issues of academic classroom learning and performance (Hofer, 2001). Although Schommer's work was considered as a revolution in the conceptualization and assessment of epistemological beliefs, her work was subjected to criticism as well (Buehl & Alexander, 2001). Qian and Alvermann (1995), for example, questioned the four factors in Schommer's questionnaire. The researchers administered EBQ to 212 students in grades 9 – 12 at a rural public high school, a sample similar to the sample used by Schommer (1993b). In their exploratory factor analysis, Qian and Alvermann (1995) used a four factor solution in order to analyze the EBQ. They adopted this solution since previous studies consistently identified four factors underlying this questionnaire. However, the results of the factor analysis indicated that only 32 of Schommer's 63 items demonstrated significant factor loadings. Additionally, those items were loaded on three different factors, not on four separate factors as identified by Schommer. On that basis, in their study Qian and Alvermann (1995) preferred the three-factor model and identified three dimensions underlying the EBQ. Schommer's Fixed Ability and Quick learning factors were also present in their three factor model; however Simple Knowledge and Certain Knowledge factors were combined to form the third factor which is the Simple – Certain Knowledge.

Concerns regarding Schommer's conceptualization of epistemological beliefs have been also raised in the review of Hofer and Pintrich (1997). Discussed in greater detail in the following section, Hofer and Pintrich (1997) questioned whether some of Schommer's four factors constituted epistemological dimensions.

A summary of the different constructs from the reviewed theories and models is presented in Table 2.2. This table was developed by Pintrich and Hofer (1997) after comparing and contrasting the different aspects of the theories and models and then categorizing these features into a general framework. At the end of their review, Pintrich and Hofer (1997) realized the agreement about ideas that cluster as two core sets of concerns: the nature of knowledge and the nature or process of knowing, although not all of the models reviewed deal fully with both (see Table 2.2).

Table 2.2 Components from existing models of epistemological beliefs and thinking (Hofer & Pintrich, 1997, p.113)

Researcher(s)	Core dimensions of epistemological theories		Peripheral beliefs about learning, instruction, and intelligence	
	Nature of knowledge	Nature of knowing	Nature of learning and instruction	Nature of intelligence
Perry	*Certainty of knowledge:* Absolute ↔ Contextual Relativism	*Source of knowledge:* Authorities ↔ Self		
Belenky et al.		*Source of knowledge:* Received ↔ Constructed Outside the self ↔ Self as maker of meaning		
Baxter Magolda	*Certainty of knowledge:* Absolute ↔ Contextual	*Source of knowledge:* Reliance on authority ↔ Self *Justification for knowing:* Received or mastery ↔ Evidence judged in context	Role of learner Evaluation of learning Role of peers Role of instructor	
King & Kitchener	*Certainty of knowledge:* Certain, right/wrong ↔ Uncertain, contextual *Simplicity of knowledge:* Simple ↔ Complex	*Source of knowledge:* Reliance on authority ↔ Knower as constructor of meaning *Justification for knowing:* Knowledge requires no justification ↔ Knowledge is constructed, and judgments are critically reevaluated		

Table 2.2 (Continued)

Researcher(s)	Nature of knowledge	Nature of knowing	Nature of learning and instruction	Nature of intelligence
Kuhn	*Certainty of knowledge:* Absolute, right/wrong answers ↔ Knowledge evaluated on relative merits	*Source of knowledge:* Experts ↔ Experts critically evaluated *Justification for knowing:* Acceptance of facts, unexamined expertise ↔ Evaluation of expertise		
Schommer	*Certainty of knowledge:* Absolute ↔ Tentative and evolving *Simplicity of knowledge:* Isolated, unambiguous bits ↔ Interrelated concepts	*Source of knowledge:* Handed down from authority ↔ Derived from reason	Quick Learning	Innate Ability

2.1.1.7 Alternative Conceptions of Personal Epistemology

In their informative review of epistemological theories, Hofer and Pintrich (1997) pointed out some concerns about the construct validity of two of Schommer's factors. Although there is empirical evidence for these four factors, Hofer and Pintrich (1997) stated that Fixed Ability and Quick Learning are not epistemological dimensions, but are more indicative of beliefs about intelligence. According to Hofer and Pintrich (1997), these dimensions do not really focus on the nature of knowledge and knowing, but rather on the nature of learning.

Besides the concerns related with Schommer's factors, their extensive analysis of existing epistemological theories led Hofer and Pintrich (1997) propose a theoretical structure for the construct of personal epistemology. Hofer and Pintrich (1997) suggested that two general areas represent the core structure of individuals' epistemological theories: *beliefs about the nature of knowledge and the nature or process of knowing.* There are two dimensions in each of these two general areas of nature of knowledge and the nature of knowing providing a total of four dimensions of epistemological theories (Hofer & Pintrich, 1997). As shown in Figure 2.1, under nature of knowledge, Hofer and Pintrich (1997) suggest that there are two dimensions: *certainty of knowledge* and *simplicity of knowledge*. Within the area of nature of knowing, they propose two other dimensions: *source of knowledge* and *justification for knowing*. According to Hofer and Pintrich (1997), these four dimensions should be considered as the core of an individual's epistemological theory, while the other beliefs about learning, teaching, and intelligence may be related to these core dimensions but are peripheral to the individual's theory.

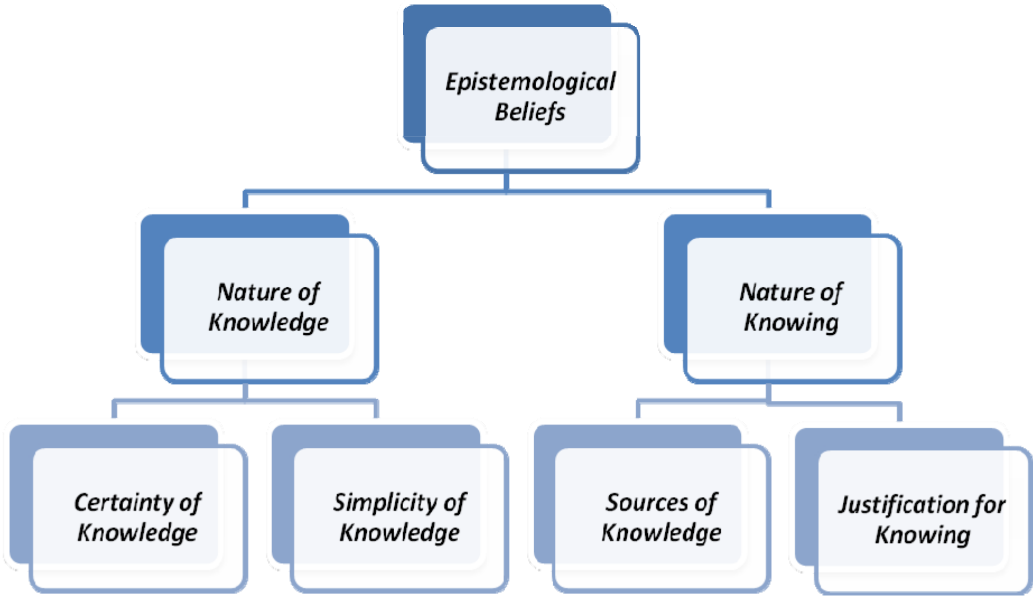

Figure 2.1 Theoretical components of epistemological beliefs

Beliefs about the nature of knowledge are defined in terms of beliefs about the certainty and simplicity of knowledge. Beliefs about the certainty of knowledge may vary from the idea that knowledge is absolute, certain, and fixed to the understanding that knowledge is tentative, evolving, and contextual. Beliefs about the simplicity of knowledge are viewed on a continuum ranging from the ideas that knowledge is composed of isolated bits of information to the understanding that knowledge is an accumulation of highly interrelated concepts (Hofer & Pintrich, 1997).

Beliefs about the nature of knowing include beliefs about the sources of knowledge and the justification for knowing. Beliefs about the sources of knowledge may range from the view that knowledge originates outside the self and resides in external authority, from whom it may be transmitted, to an understanding that knowledge is constructed by the knower in interaction with others. Justification for knowing dimension concerns the way individuals evaluate knowledge claims, including the use of evidence, authority, and expertise, and their evaluation of experts (Hofer & Pintrich, 1997). Beliefs about this dimension may range from the idea that knowledge requires no justification and one just receives the knowledge that others provide, to an understanding that knowledge is constructed through critical assessment of the opinions of experts and the examination of evidence (Saunders, 1998).

Individuals will be portrayed as believing that knowledge is *received* or *reasoned* on the dimensions of the nature of knowledge and nature of knowing (Saunders, 1998). The dimensions of epistemological beliefs and descriptions of contrasting views for each component are presented in Table 2.3.

Table 2.3 The dimensions of epistemological beliefs and descriptions of contrasting views for each sub-dimension (Hofer & Pintrich, 1997)

Dimension of Epistemological Beliefs	Sub-dimensions	Received View	Reasoned View
Nature of Knowledge	Certainty of knowledge	Knowledge is absolute, certain, and fixed.	Knowledge is tentative, evolving and contextual.
	Simplicity of knowledge	Knowledge is simple and composed of isolated pieces of information.	Knowledge is complex, composed of highly interrelated concepts.
Nature of Knowing	Source of knowledge	External authorities are the source of knowledge.	Knowledge is constructed by the knower.
	Justification for knowing	Knowledge requires no justification, one receives knowledge from others	Knowledge is constructed through critical examination of evidence and the opinions of experts

2.1.2 Epistemological Beliefs and Learner Characteristics

An individual's belief system has various aspects, one of them being the epistemological beliefs. Therefore, it can be suggested that beliefs about knowledge and knowing do not develop and function in isolation; instead they are affected from various constructs. Multiple studies have examined epistemological beliefs in relation to a variety of learner characteristics. In the following sections, the results of these investigations are summarized and epistemological beliefs are examined in relation to specific learner characteristics.

2.1.2.1 Gender

Many of the earlier investigations of students' epistemological beliefs focused on how beliefs changed depending on gender. Starting by the early works of Baxter Magolda (as cited in Buehl, 2003) and Belenky, Clinchy, Goldberg, and Traule (as cited in Buehl & Alexander, 2001), researchers have been exploring the different perspectives men and women took towards knowledge (Buehl, 2003). In one of these investigations, Neber and Schommer (2002) addressed gender-related differences in epistemological beliefs. Primarily focused on gender differences in science-related self-regulated learning and causal relations among external and internal variables of self-regulated learning in science/physics, Neber and Schommer examined the students' beliefs about knowledge and knowing with respect to gender. In their study, epistemological beliefs among highly gifted elementary (n=93) and high school (n=93) students' epistemological beliefs were determined using the Schommer's EBQ (1990). The results revealed gender-related differences in epistemological beliefs but those differences were restricted to the belief in quick learning which was stronger for males (M = 2.0, SD = .60) than for females (M = 1.7, SD = .50). In addition, the interaction between school level and gender was found to be significant which indicates that males on both school levels (elementary and high school) hold identical naïve beliefs in quick learning in science/physics, whereas this epistemological belief was significantly weaker with high school females compared to elementary school females. With this finding, Neber and Schommer addressed both the gender difference in epistemological beliefs and potential impact of age and education in these differences for especially females.

Comparing male and female students in their investigation Bendixen, Schraw, and Dunkle (1998) found similar results indicating that female students expressed more sophisticated epistemological beliefs. A total of 154 undergraduates were administered the 32-item questionnaire items of which were constructed based on the criteria for each of the four epistemic factors described by Schommer (1990). An analysis of the epistemological belief factors showed that the certain knowledge variable differed between males (M = 2.09, SD = .66) and females (M = 1.82, SD = .71), whereas the four remaining variables did not. This result also supported the Schommer's (1993b) finding that males were more likely to endorse beliefs in certain knowledge than females.

Consistent with the aforementioned studies, Schommer and Dunnell (1994) reported significant gender differences in epistemological beliefs as well. In an attempt to compare the epistemological beliefs between gifted and non-gifted high school students, an epistemological questionnaire assessing students' beliefs in fixed ability to learn, simple knowledge, quick learning, and certain knowledge was administered to 1165 high school students. Results indicated that female students were less likely to believe in fixed ability and quick learning than males (Schommer & Dunnell, 1994).

Although several studies presented evidence for the potential gender differences in students' epistemological beliefs, other investigations did not identify gender differences in beliefs about nature of knowledge and knowing. In their work with 186 undergraduate students, for example, Buehl, Alexander, and Murphy (2002) examined variations in students' epistemological beliefs by domain and gender. In an attempt to explore potential gender differences such as those reported by other researchers (Neber & Schommer, 2002; Bendixen, Schraw, & Dunkle, 1998; Schommer & Dunnell, 1994; Buehl et al., 2002) Buehl et al. conducted three related studies. Using a four-factor model as an initial framework, the researchers developed and validated the Domain-Specific Beliefs Questionnaire (DSBQ). The repeated measures MANOVA revealed no significant main effect for gender F (2, 283) = .074, p >.05. Based on the existing literature, Buehl et al. (2002) emphasized that the lack of a significant effect for gender may seem surprising and suggested that this result makes a sense for several reasons. First, the researchers indicated that when gender differences are considered without regard to specific domains of knowledge, the explanatory effects of domains can be lost. They argued that when responding to general questions about the nature of knowledge, males and females may reflect on different types of knowledge (e.g., informal knowledge versus academic knowledge) or different domains (e.g., mathematics versus history). According to Buehl et al. (2002), therefore, examining domain-specific knowledge beliefs may eliminate a potential source of variance among males and females. Second, the researchers suggested that presence or absence of gender differences may be related with the specific factors considered in the analysis. In their study, Buehl et al. (2002) focused on students' beliefs about the integration of knowledge and problem solving, whereas prior investigations, as they implied, reported gender differences relative to innateness of ability and the speed of learning.

In another investigation, Chan and Elliott (2002) examined the differences in epistemological beliefs of 385 teacher education students in terms of age, gender, electives, and courses. The participants were asked to complete a questionnaire based around Schommer's 63-item epistemological beliefs questionnaire. Similar to the findings of Buehl et al. (2002), the results of this study also indicated no significant difference in epistemological beliefs of teacher education students in terms of their gender (Wilks' Lambda = .988, F (4, 372) = 1.08, p >.01).

An analysis of these existing studies highlighting the gender differences in epistemological beliefs shows a mixed pattern of results. That is, while the results of some of these studies indicate that there are no differences between males and females in terms of their epistemological beliefs, other studies identify differences in students' beliefs by gender.

2.1.2.2 Home Environment

In addition to the role of gender, researchers have also investigated the relationships between students' epistemological beliefs and their home environment, specifically their socioeconomic background variables. In an early work, Schommer (1990) examined student characteristics and home background variables that predict epistemological beliefs. The results suggested that parents' level of education and parents' expectation of their children to take responsibilities in the home and for their own thinking were significantly related to students' beliefs about simplicity of knowledge and speed of knowledge gaining. That is, the more education parents have and the more the opportunity for independence they provide to their children, the more likely children will develop a sophisticated system of epistemological beliefs (Schommer, 1990).

The results of other investigations appear to support this finding. For instance, in her study comparing postsecondary students' beliefs about nature of knowledge and learning, Schommer (1993b) found that background variables, such as age, gender, and parental education contributed to differences among participants. Two hundred and sixty six students from a junior college and a large university participated in the study. Two group comparisons were made, one between schools (junior college versus university) and one between domains (social science-education majors versus technological science-and physics/engineer majors). For each comparison, differences between groups were investigated. Results of the investigation revealed that the more education parents had and the more encouragement they gave for independent decision making, the less likely students were to believe in simple knowledge. Likewise, the more education parents had, the farther along in school students were, the less likely students were to believe in quick learning (Schommer, 1993b). Similarly, when Trautwein and Lüdtke (2007) conducted a large-scale longitudinal study with high school students to explore the relationship between beliefs in certainty of knowledge, school achievement and future field of study, they investigated that certainty beliefs correlated significantly and negatively with socioeconomic status, cultural capital, final school grade, and cognitive abilities. It can be inferred from this results that the higher the students' socioeconomic status, the more the students believe in the tentativeness of knowledge.

Contrary to these findings, in their investigation of the relationships between epistemological beliefs, parents' social status and school preferences, Brabander and Rozendaal (2007) suggested that although epistemological beliefs were correlated with the level of education, it is not related to status level and status type. Accordingly, the researchers concluded that epistemological beliefs appear to be influenced more strongly by education than by income.

Based on the analysis of the reviewed studies, it appears that the results of the studies examining epistemological beliefs in relation to home environment revealed a mixed pattern. That is, in some investigations home environment related variables were shown to be related with students' epistemological beliefs, whereas in others no such relation was found. Further studies are required for exploring the potential reasons for and implications of such different results.

2.1.2.3 Age and Education Level

Much of the previous research about students' epistemological beliefs focused on how those beliefs changed and developed over time. However, it is not easy to distinguish the internal processes of physical and cognitive maturation from educational experiences that students encounter throughout their maturation and development (Buehl, 2003). In an effort to address this issue, Schommer (1998) examined the contributions of age and education to adults' epistemological beliefs by alternatively controlling for each variable. Four hundred and eighteen adults participated in the study and they completed an epistemological questionnaire that assesses beliefs about the structure and stability of knowledge, and the speed and control of learning. The results of a multiple regression analysis indicated that age and education have unique effects on the development of epistemological beliefs. That is, when education was controlled, age was found to be a significant predictor of an epistemological factor, namely Fixed Ability. This indicated that the older adults were less likely to believe that the ability is fixed at birth. After controlling for age, on the other hand, education emerged as a predictor variable of two epistemological factors, Simple Knowledge and Certain Knowledge. It appeared that the more experience the participants had, the more likely they were to believe that knowledge is highly complex and constantly evolving (Schommer, 1998).

The results of another investigation appear to provide additional evidence that epistemological beliefs become more sophisticated with age and education. In their longitudinal study with secondary school students, Schommer, Calvert, Gariglietti, and Bajaj (1997) found substantial differences in students' epistemological beliefs across the high school years. In order to examine the development of secondary students' beliefs about the nature of knowledge and knowing, 69 high school students were administered an epistemological questionnaire that was developed in the previous research (Schommer, 1990, 1993b) as freshmen in 1992 and as seniors in 1995. Repeated-measures analyses revealed that students became more mature in all four epistemological beliefs by time. Compared with their freshman year, participants in their senior year were less likely to believe in fixed ability to learn, simple knowledge, quick learning, and certain knowledge. This result suggests that secondary school students became more sophisticated in terms of their epistemological beliefs as they progress from their first year to their senior year of secondary school.

Two other investigations, although not primarily concerned with the effects of age and education on the development of epistemological beliefs, may provide additional evidence for the developmental differences in those beliefs. In their study with more than 1,200 students in Grades 7 and 8, Schommer, Mau, Brookhart, and Hutter (2000) identified differences with regard to structure of students' beliefs. Although, prior theory, developed with high school and college students, suggested a four-factor epistemological belief structure, Schommer and her colleagues (2000) identified a three-factor model with middle school students. They argued that middle school students' epistemological beliefs were related to ability to learn, speed of learning, and stability of knowledge but not with the structure of knowledge. Similarly, Qian and Alvermann (1995) attempted to replicate the four hypothetical dimensions underlying the Epistemological Beliefs Questionnaire but ended up with a three-factor model. Exploratory factor analysis in their study revealed that items related with Simple Knowledge and Certain Knowledge were loaded on the same factor resulting in the combinations of these two factors. These results suggest that perhaps younger students do not hold distinct beliefs on some aspects of epistemological beliefs; instead beliefs about each aspect of epistemological beliefs may emerge at earlier ages and later on develop with age and education (Buehl, 2003).

2.1.2.4 Domain Differences

As discussed in previous section, students' epistemological beliefs may show variation depending on age and education. As used in this section, education simply refers to the number of schooling years completed. Some researchers, however, extent the meaning of education and include students' area of study or their academic majors in the study of variations in students' beliefs. According to those researchers, epistemological beliefs may differ depending on the specific body of knowledge under consideration (Buehl, 2003).

In contrast to most of work on personal epistemology which has presumed that the beliefs and theories individuals hold about knowledge and knowing are general and that they go beyond domains, there are studies in which epistemological beliefs vary as a function of field of study (Hofer, 2000). In her work, for example, Hofer (2000) investigated the dimensionality of personal epistemology. A total of 326 first-year college students participated in the study and each participant was given a set of questionnaires that included an adaptation of a domain-general epistemological instrument and a discipline-focused questionnaire. Participants' beliefs about knowledge regarding science and psychology were compared after students responded to two forms of the discipline-focused epistemological beliefs questionnaire, both of which were identical except that one was headed "Psychology" and the other "Science". Results revealed strong disciplinary differences suggesting that first-year college students saw knowledge in science as more certain and unchanging than in psychology. Students were more likely to regard personal knowledge and firsthand experience as a basis for justification of knowing in psychology than in science. They viewed authority and expertise as the source of knowledge more in science than in psychology, and perceive that in science, more than in psychology, truth is achievable by experts (Hofer, 2000).

In another investigation, Paulsen and Wells (1998) examined the differences in epistemological beliefs of 290 college students across major fields of study which were classified first as being soft (e.g., humanities, fine arts, social sciences, education, business) or hard (e.g., natural sciences, engineering) and then as being applied (e.g., education, business, engineering) or pure (e.g., natural sciences, social sciences, humanities). Results revealed that three of the four dimensions of epistemological beliefs, namely Simple Knowledge, Quick Learning, and Certain Knowledge were significantly different across domains. A series of pair-wise comparisons identified the specific pairs of domains of study between which students' epistemological beliefs were significantly different for each dimension of belief. For instance, students majoring in business (a soft and applied field) were significantly more likely to have naïve beliefs in simple knowledge than those majoring in either natural sciences (a hard and pure field) or the humanities and fine arts (soft and pure fields). Education majors (a soft and applied field) were more likely to have naïve beliefs in certain knowledge than students majoring in the humanities and fine arts (soft and pure fields). By examining the results of eight such comparisons, Paulsen and Wells (1998) addressed a clear and consistent pattern. In the domains between which there were significant differences in students' epistemological beliefs, the beliefs of students majoring in pure fields were more sophisticated than the beliefs of students in the applied fields.

A similar result was reported in another investigation in which Jehng, Johnson, and Anderson (1993) examined 386 university students' epistemological beliefs as a function of their educational level and field of study. Results indicated that students who study in the soft fields (e.g., social science and arts, humanities) were more likely to believe that knowledge is uncertain, were more reliant on their independent reasoning ability, and had a stronger feeling that learning is not an orderly process than students in the hard fields (e.g., engineering and business) (Jehng et al., 1993).

These findings suggest that students' epistemological beliefs may show variations depending of the academic majors and on specific body of knowledge under consideration. However, it is not clear how different domains lead to differences in students' knowledge beliefs. Moreover, there is a lack of research focusing on whether epistemological beliefs of elementary students show variation for different classes. Future research may focus on such issues in order to have a deeper understanding about the interrelationship among epistemological beliefs and academic majors for different age groups.

2.1.2.5 Culture

An analysis of existing studies on epistemological beliefs shows that majority of the research has focused on samples from the United States and Western countries. Therefore, the findings of these research are contextually and conceptually related to those countries (Chan & Elliott, 2002). While researchers in the United States and in some Western countries utilize Schommer's (1990) conceptual frame work and instrument in their investigation, other researchers from different cultures have also conducted studies to replicate and verify the factor structure for epistemological beliefs reported by Schommer (Chan & Elliott, 2004). However, inconclusive results from these different culture studies lead researchers to question Schommer's dimensions or the factor structure of epistemological beliefs and the reliability and applicability of her instrument. The contradictory results were generally explained by the inherent weakness of the items in Schommer's questionnaire and the methodology adopted in her studies. Notwithstanding, the different results in different contexts could also be due to cultural effect. The use of an instrument developed in the United States may be problematic when applied in non-western countries (Chan & Elliott, 2004).

Only a few studies about the epistemological beliefs of students in different cultures were reported. A review and analysis of the dimensions of epistemological beliefs reported in these studies suggested that new models and measures may be needed to clarify the structure of epistemological beliefs in different cultural contexts.

In an attempt to determine whether Hong Kong students' epistemological beliefs were represented by the same factor dimensions as reported by Schommer in her American sample, Chan and Elliot (2000) adapted Schommer's 63-item epistemological beliefs questionnaire for the Chinese context. Following the validation process, the Chinese version of Schommer's instrument was administered to 352 teacher education students. Following data analysis based on the varimax rotation structure, three factors were extracted, accounting for 46.5 % of the total variance. When the fourth factor, which had an eigen value of 0.98, was taken into account, then the cumulative percentage of variance would be 54.7%. Examining the scree plot where there was a sharp break indicating a three-factor solution, Chan and Elliot (2000) used a three-factor solution to describe and explain the epistemological belief dimensions held by the Hong Kong students. This investigation revealed a different factor structure in epistemological beliefs of Hong Kong students than their American or Western counterparts. The results of the study illustrated that the 12 independent subscales in Schommer's conceptual system merged into three complex factors with the Hong Kong sample. These three factors were labeled on the basis of high-loading subscales of items. Factor 1 has a loading greater than 0.6 of two subscales representing Fixed/Innate Ability and one subscale representing Quick Learning, with a factor loading of 0.41. Since the two subscales for Fixed/Innate Ability loaded on Factor 1 with considerably higher loading compared with that of Quick Learning, Factor 1 was labeled as Fixed/Innate Ability. This factor structure demonstrated that Schommer's Fixed/Innate Ability factor was also identified in the Hong Kong sample (Chan & Elliot, 2000). Owing to the fact that Fixed/Innate Ability and Quick Learning tended to merge in Factor 1, Chan and Elliot (2000) stated that Factor 1 might be labeled as Ability-Quick, implying that quick learning was associated with fixed/innate ability. The researchers hypothesized that this might be due to cultural factors, in that Hong

Kong students may believe that innate ability determines not only whether one can acquire knowledge or not but also the speed of knowledge acquisition.

Three subscales representing Omniscient Authority, Certain Knowledge, and Quick Learning in Schommer's conceptual system loaded on Factor 2 with loadings equal to and greater than 0.4 in the study of Chan and Elliot (2000). Omniscient Authority, with a loading value of 0.8, was the most obvious one in Factor 2, and the other two subscales had loadings around 0.4. Owing to the higher loading value of Omniscient Authority, Factor 2 was labeled as Omniscient Authority. This factor structure was different from the structure Schommer found in her studies in that Schommer conceptualized a factor on Certain Knowledge but not on Omniscient Authority. Hong Kong student sample on the other hand revealed Omniscient Authority as a prominent factor (Chan & Elliot, 2000). The researchers explained this discrepancy in terms of sociocultural differences in the contexts of two studies. Chan and Elliot (2000) asserted that "authority" is generally respected in Chinese and Asian cultures and there is a tendency to accept the viewpoints of authority figures without much criticizing. They also highlighted respect for elders and authority figures in Asian countries contrary to many Western countries where democracy and liberty are emphasized. This cultural difference can suitably explain the extraction of a factor related to Omniscient Authority with a high loading value for the sample of the study. Factor 3 had two subscales representing Innate Ability and Certain Knowledge with loading values greater than 0.4 in the study of Chan and Elliot (2000). As the two subscales were completely different in nature, it was difficult to name the third factor. Since two other subscales for Innate Ability noticeably loaded on Factor 1, Chan and Elliot (2000) decided to label this factor as Certain Knowledge.

Depending on the results obtained, Chan and Elliot (2000) concluded that it is difficult to interpret the beliefs structure. Instead of simple and relatively independent nature of factors proposed by Schommer, it is likely that some factors are related with each other and the epistemological beliefs structure of Hong Kong students is different from that of the American or Western students. According to

Chan and Elliot (2000) social-cultural factors were suggested to account for the apparent differences in the factor structure obtained with the Hong Kong sample.

Taking the results of their previous study into consideration, two years later Chan and Elliot (2002) developed a specific instrument suitable for the Hong Kong sample based on an adaptation and modification of the Schommer's 63-item questionnaire. They eliminate, reword, and write extra items for the revised instrument in order to replicate the factor structure of Schommer (1990). However, even after these significant modifications, the nature of the dimensions was slightly different from that of Schommer. The results of the factor analysis of the questionnaire resulted in 30 items which loaded on four factors that were labeled as Fixed/Innate Ability, Authority/Expert Knowledge, Certainty Knowledge, and Learning Effort/Process (Chan & Elliot, 2002). The result was similar to that found by Schommer with American Students in that the number of factors was the same however the nature of them varied. Most remarkably, a new factor referred as Learning Effort/Process was identified. The items of this new factor were associated with the belief that knowledge acquisition requires effort and that learning processes are more important than acquired facts at one end and that learning needs little effort and acquired facts are more important at the other hand (Chan & Elliot, 2002). The conclusion that Hong Kong students believed in knowledge acquisition through effort and process was interpreted in terms of traditional Chinese Confucian-heritage culture that places much value on hard working and effort.

In another comparative study, Youn (2000) analyzed the nature of epistemological beliefs in Korea and United states. In order to compare both model and the nature of epistemological beliefs across two countries, Youn (2000) adapted the epistemological beliefs scale which was originally developed by Jehng, Johnnson, and Anderson (1993). Their study was replicated with university students from US (N = 496) and Korea (N = 487). The factor analyses indicated that the factor structure of the US sample confirmed the conceptual model proposed by Jehng et al. That is, the *Knowledge* factor consisted of the items from the three knowledge dimensions (certainty of knowledge, omniscient authority, and orderly process) and the *Learning* factor was composed of items from the two learning dimensions (innate ability and quick process). The factor structure of the Korean sample, on the other hand, showed significant variation in that the items from omniscient authority, which is a knowledge factor and mainly deals with students' attitudes toward teacher-student interactions, were reported to cluster with the items representing learning factor (Youn, 2000). The researcher explained this observed differences between the US sample and the Korean sample in terms of the cultural influences on the development of students' learning beliefs. The teacher-student interaction in the US was summarized as being student-centered in nature, where the relationship between the two parties tends to be freeing and impersonal. Such an impersonal interaction was indicated to be helpful for the achievement of the US learning objectives that stress impartment of objective "truth" to students from any competent person or teachers. Owing to the impersonal nature of the US teacher-student relation, the Omniscient Authority was supposed to be factorized with other impersonal dimensions, namely Certainty of Knowledge and Orderly Process (Youn, 2000). It was discussed, on the other hand, that teacher-student relation in Korea was teacher-centered where the relationship between the two parties tends to be binding and personal. Students are supposed to follow orders or instructions from the teacher. The teacher, not the students, initiates and controls the learning experiences of the students. Such a teacher-student relation was emphasized to be central for the achievement of learning objectives which emphasize the transfer of the teacher's personal understanding to students. Hence, the Omniscient Authority was concluded to be factorized with other impersonal dimensions that are Innate Ability and Quick Process (Youn, 2000).

Evidence regarding cultural impacts on the epistemological beliefs dimensions came from the Turkish culture as well. In their study that discussed preservice elementary science teachers' (PSTs) epistemological beliefs and the relationship among their epistemological beliefs, epistemological world views, and self-efficacy beliefs, Yilmaz-Tuzun and Topcu (2008) portrayed that PSTs' epistemological beliefs supported the multidimensional theory in Turkish culture. The researchers translated the Schommer Epistemological Questionnaire (SEQ) into Turkish and validated it. The adapted version of the SEQ was administered to a total of 429 PSTs from five universities located in three large cities of Turkey. The factor analyses of the Turkish SEQ revealed a four factor structure similar to the factor structure Schommer mostly encountered. In her studies, Schommer mostly found Quick Learning, Certain Knowledge, Simple Knowledge, and Innate Ability. In the Turkish sample, however, Omniscient Authority was found as one of the four factors. Conversely, the Quick Learning factor that Schommer frequently identified in her studies did not appear in the Turkish sample. With these findings Yilmaz-Tuzun and Topcu (2008) underlined the effect of cultural differences in educational contexts in the development of epistemological beliefs.

Confronted with all these issues, the current review draws the conclusion that instruments designed to measure epistemological beliefs of the samples from the Western countries should be used with extreme caution in other cultures. The findings of the research using such instruments are better to evaluate within the specific context of that culture. Cultural effect may be the potential reason of the observed discrepancy between the results of Western countries and other cultures. An epistemological belief instrument designed for the United States or any other Western countries may be problematic when used with other cultures. A review and analysis of the dimensions of epistemological beliefs reported in the studies presented in this section, therefore, suggested that new models and measures may be needed to clarify the structure of epistemological beliefs in different cultural contexts.

2.1.2.6 Instructional Method

In previous sections, epistemological beliefs were examined in relation to various learner characteristics. Several other studies, on the other hand, investigated that the differences in students' epistemological beliefs were due to the type of the instruction they received. Results of these investigations revealed that educational environments and experiences may impact students' epistemological beliefs. However, the nature of this impact may show variations. While some studies reported development in epistemological beliefs due to the specific instruction provided, others found that students' beliefs decreased in sophistication (Buehl, 2003).

Investigations of Tsai (1999) and Brownlee, Purdie, and Boulton-Lewis (2001), for example, examined how specific types of instruction may change students' epistemological beliefs. The results of both studies indicated that depending on the instruction provided, students' epistemological beliefs became more sophisticated. Tsai (1999) examined the epistemological beliefs of 101 Taiwanese female 10th graders who were assigned to either a traditional instruction group or a STS (Science-Technology-Society) treatment group. STS instruction emphasized major concepts in science and explored the relationship between science, technology, and society by using a variety of instructional resources (e.g., newspaper, Internet, lessons from the history of science), providing a learner centered learning environment, incorporating inquiry-based exploration, and addressing epistemological issues. On the other hand, traditional group students mostly followed the fact-based content provided by the nationwide textbook. They were subjected to conventional teaching strategies, such as textbook reading, largely one-way lecturing, and extensive tutorial problem solving exercises. Following an eight month research treatment, Tsai (1999) found that STS group students' epistemological views were more oriented to constructivist views of science than that of traditional group subjects. Further analyses revealed that, among STS group students, those with more empiricist views of scientific knowledge tended to progress more in their epistemological views than students with constructivist views of knowledge (Tsai, 1999).

Similarly, in their work Brownlee et al. (2001) reported differences in the development of sophisticated epistemological beliefs of students enrolled in different sections of an educational psychology course. The researchers designed a teaching program to foster the reflection on and development of more sophisticated epistemological beliefs and implemented it with 29 pre-service graduate teacher education students (the research group). Another group of students who were not engaged in the teaching program functioned as the comparison group. Both groups were required to engage with the same tutorial content, but in different tutorial groups. Research group students were asked to reflect on the content in relation to the epistemological beliefs literature and their own epistemological beliefs. Students in this group also wrote journal reflections and had inquirer feedback on each as key feature of the teaching program. In the comparison group, on the other hand, the inquirer interacted with the students in a way that did not focus on epistemological beliefs and journal reflections, but included features of tutorial work that the inquirer typically used such as small and large group discussions of content and readings, and activities to encourage involvement. The results revealed that research group students demonstrated an increased sophistication of beliefs about Quick learning and Certain Knowledge at the end of year-long course when compared with the comparison group students. An increased sophistication was also noted in both a subscale of Innate Ability and a subscale of Omniscient Authority.

In the study of Clarebout and Elen (2001), however, unexpected changes in students' epistemological beliefs were reported. Prior to their investigation, Clarebout and Elen hypothesized that students' epistemological beliefs would evolve by working in a technologically rich, problem-based collaborative learning environment. A pre-test, post-test design was used and a questionnaire, which also included items on epistemological beliefs, was administered to a total of 124 students just before the beginning and immediately at the end of the project. After eight weeks, working four hours a week on the project, students expressed changes in their epistemological beliefs, however in a direction opposite to the one expected. For the epistemological beliefs scale "effort pays" a significant difference was found between the scores on pre- and post-test indicating that students' beliefs about the necessity of effort to learn something was significantly weakened (Clarebout & Elen, 2001).

In a more recent study, Valanides and Angeli (2005) attempted to explore the effect of instruction on students' epistemological beliefs. One hundred and eight undergraduates were randomly assigned to three different instructional interventions, namely, General, Infusion, and Immersion approaches for the purpose of the study. The three instructional units varied only in the approach they adopted for teaching five general critical-thinking principles, that is analyzing the problem, generating solutions, developing the reason for each solution, deciding the best solution, and using criteria to evaluate thinking. In order to collect data about students' epistemological beliefs, forms A and B of the Epistemic Beliefs Questionnaire (EBQ) were administered before and after the teaching intervention respectively. Repeated Measures of ANOVA was performed where teaching method was the independent variable and participants' pre- and post-performance on the EBQ (Forms A and B) was the dependent variable. The results of the analysis revealed that post-performance on the EBQ (Form B) was significantly higher than pre-performance on the EBQ (Form A), $F(1, 105) = 19.769$, $p = .00$. In order to identify any differences among students' epistemological change as a result of three teaching interventions, post hoc comparisons using the Bonferroni procedure were performed. The post hoc comparisons indicated that students in the Infusion teaching approach outperformed those assigned to General teaching approach ($p = .022$) but not those assigned in the Immersion teaching approach. There was no significant difference between the performance of students in General and the Immersion teaching groups as well. Nevertheless, the researchers pointed out that the findings cannot be easily interpreted without reference to the context and the limitations of the current study. First, it was noted that each intervention consisted of multiple components and changes in epistemological beliefs cannot be attributed to any single variable. Second, the absence of a control group was shown to exclude the possibility that epistemological change occurred spontaneously. Finally, it was stated that the outcomes of the intervention might have been confounded by test – retest effects. However, the researchers concluded that even after considering possible spontaneous growth, test – retest effects, and the controversial nature of the issues, there was enough evidence indicating that one of the instructional approach (Infusion) promoted significantly higher epistemological change than the General approach, but not the Immersion one (Valanides & Angeli, 2005).

One other study examined the impact of school science experiences on epistemological development of six-grade students. This study differs from the aforementioned studies in its nature since it focuses on elementary grade level students' epistemological beliefs and the changing in those beliefs in response to specific type of instruction. In their investigation, Smith, Maclin, Houghton, and Hennessey (2000) tested the claim that even elementary school students can make significant progress in developing a more sophisticated, constructivist epistemology of science given a sustained elementary school science curriculum that is designed to support students' thinking about epistemological issues. To assess the impact of elementary science experiences on epistemological views, two demographically similar groups of sixth-grade students were individually interviewed following a sustained elementary science instruction in which one group was taught from a constructivist perspective and the other group with a more traditional perspective. The study demonstrated that school science experiences can noticeably affect the development of epistemological thinking about science during the elementary school years. More specifically, the sixth grade students in the constructivist classroom had clearly developed a more constructivist epistemology of science than students in the comparison classroom. The researchers argued that the main factor responsible for the two groups' different epistemological stances toward science was the differences in their elementary school science experiences. It was indicated that both groups were the same age (to control for maturationally based development factors) and demographically quite similar (to control for the influence of parents and outside-of-school experiences with science). Furthermore, for students in the constructivist science classroom, other school subjects were taught with a traditional perspective so that the constructivist insights developed by the students were less likely to originate from these other elementary school subjects. Additionally, the amounts of time spent on science in both groups were similar in both elementary classrooms. Considering these factors, Smith et al. (2000) reached to the conclusion that the main difference between the two groups was the epistemology of science that the teachers aimed to help their students develop and applied when designing their science curricula.

Similar to the investigation by Smith et al. (2000), Kaynar (2007) examined the effect of instruction on sixth grade Turkish students. Specifically, the effectiveness of 5E learning cycle approach on students' understanding of cell concept and their scientific epistemological beliefs was explored. Two experimental groups received 5E learning cycle instruction and two control groups were taught by traditionally. A total of 160 students in experimental and control groups were administered the Epistemological Beliefs Questionnaire (EBQ) (Conley et al., 2004) and a cell concept test before and after the three week treatment period. Multiple Analyses of Covariance (MANCOVA) was performed to evaluate the effectiveness of teaching method on students' understanding of cell unit and their scientific epistemological beliefs while controlling the pre-test scores of the related tests were controlled as covariates. The results of the study showed that 5E learning cycle instruction method had a significant effect on students' understanding of the cell unit ($F(1,146) = 21.543$, $p < .05$) and their scientific epistemological beliefs ($F(1,146) = 78.141$, $p < .05$).

2.1.3 Epistemological Beliefs and Learning Outcomes

In previous sections, relationships between epistemological beliefs and various learner characteristics were discussed. The following section describes how students' beliefs about knowledge and knowing are related to certain learning processes and outcomes. The reviewed studies intended to explore whether students' epistemological beliefs enhance or constrain their academic performance, strategy use and learning approaches, use of self regulated learning strategies, comprehension and text processing, and construction of knowledge and conceptual change.

2.1.3.1 Epistemological Beliefs and Academic Performance

Studies in this part of review assessed students' academic performance either by using students' cumulative grade point average (GPA) or grades in a specific course or subject. Generally, these studies revealed significant relationships between students' epistemological beliefs and their academic performance.

However, the nature of these relationships varies in that different belief factors are found to be related with student performance in different studies.

In an earlier study, by using Perry's model, Ryan (1984) classified 90 undergraduate students as either having a dualistic (view knowledge as either right or wrong and believe that absolute truths are only accessible by authorities) or a relativistic (view knowledge as integrated and uncertain array of propositions) conception of knowledge. This investigation described the range of comprehension criteria (knowledge or comprehension and application) that students reported, then examined how these standards were related to the epistemological beliefs and to academic performance. Results indicated that relativists who reported comprehension or application criteria earned better grades than dualists who reported knowledge criteria. Ryan (1984) concluded that one's epistemological beliefs may dictate one's choice of comprehension standards, and these epistemological standards, later on, play role in the academic performance of students. Epistemological beliefs were also shown to be significant predictors of course grades even after the effects of academic aptitude or the amount of college experience was eliminated (r =-.27, p =.01).

In a longitudinal study, Schommer et al. (1997) administered an epistemological questionnaire to 69 students in 1992 and again in 1995 to examine changes in epistemological beliefs and the link between those beliefs and academic performance. Three regression analyses, one using the 1992 epistemological beliefs and 1992 GPAs, the other using 1992 epistemological beliefs and 1995 GPAs, and the last one using 1995 epistemological beliefs and 1995 GPAs, were performed to determine whether epistemological beliefs predict academic performance. The results of these regression analyses revealed that only beliefs in quick learning significantly predicted students' GPAs in 1992 (B = -.45, p < .05) and 1995 (B = -.49, p < .001). The results implied that the less the students believed in Quick Learning, the better GPAs they obtained. None of the other epistemological beliefs dimensions (Fixed Ability, Simple Knowledge, and Certain Knowledge) predicted GPA in both years.

In their study of domain differences in the epistemological beliefs of college students, Paulsen and Wells (1998) (detailed information about this study was presented in section 2.1.2.4) provided another evidence for the relationship between epistemological beliefs and academic performance. Besides giving information about domain specificity of epistemological beliefs, regression analysis also indicated that students with higher GPAs were less likely than those with lower GPAs to believe in Simple Knowledge.

In a separate study, Mori (1999) examined the structure of language learners' beliefs about learning in general and the beliefs specific to language learning. This study also explored the relationship between these beliefs and students' achievement which were measured by using both their self-reported GPA and proficiency test scores. A belief questionnaire was administered to a total of 187 college students learning Japanese as a foreign language. The results of the factor analyses revealed five dimensions of general epistemological beliefs comparable to dimensions reported earlier by Schommer (1990). Statistically significant correlations were observed between learner beliefs and achievement in a foreign language. Specifically, Innate Ability was found to be negatively correlated with proficiency test scores (r = -.31) and with self-reported GPA (r = -.22). These negative correlations indicated that students who mostly believe that the ability to learn is innately fixed tend to show lower proficiency in a foreign language (Mori, 1999).

In another investigation, Schommer et al. (2000) attempted to explore the middle students' beliefs about knowledge and knowing and identify the predictive value of epistemological measures on students' achievement as measured by their GPA. Over 1,200 students in Grades 7 and 8 completed an epistemological beliefs questionnaire. Although prior theory suggested four epistemological beliefs factor (Ability to Learn, Structure of Knowledge, Speed of Learning, and Stability of Knowledge), confirmatory factor analysis indicated that a 3-factor model was a good fit to the data. The Structure of Knowledge factor was deleted when obtaining this 3-factor model which led to a substantial improvement in the goodness-of-fit indexes. Students' GPAs were regressed on epistemological beliefs scores to examine the predictive value of epistemological beliefs. Two factors were found to be significant predictors of students' GPA: belief in fixed ability ($B = -.24$, $p < .01$) and belief in quick learning ($B = -.18$, $p < .01$). The results showed that the less students believed in fixed ability to learn and quick learning, the better GPAs they obtained.

In the same year, in her study of dimensionality and disciplinary differences in personal epistemology, Hofer (2000) (see section 2.1.2.4) also examined the relationship between students' epistemological beliefs and their academic performance. A total of 326 first year college students participated in the study. Both a general epistemological beliefs questionnaire and a discipline-focused epistemological beliefs questionnaire were administered to the participants. Students' psychology course grades, science course grades, and GPAs for the term were used as the measures of academic performance. When these academic performance measures were correlated with each of the dimensions on each of the questionnaires, the overall pattern revealed negative correlations between grades and both discipline-specific and general epistemological beliefs. Regarding discipline-focused beliefs, students' beliefs in Certainty and Simplicity of knowledge in psychology were found to be negatively correlated with both their grades in psychology (r = -. 31) and their GPA (r = -. 22). Beliefs about science were also significantly correlated with students GPAs ($r = -.12$). The Certainty/Simplicity scale from the general epistemological beliefs questionnaire were significantly correlated with students' GPAs (r = -. 28), and their grades on both psychology (r = -. 31) and science (r = -. 17) courses. In the light of these findings, Hofer (2000) confirmed the relationships between beliefs and academic performance, at least regarding the Certainty/Simplicity of knowledge dimension. The results implied that the more the students believed in Certain and Simple knowledge, the lower their academic performance as assessed by GPA and student grades in specific courses.

In another study focused to explore the changes in epistemological beliefs of elementary science students over time, Conley et al. (2004) investigated the relationship between students' epistemological beliefs and their achievement.

Achievement was measured using a combination of mathematic and reading achievement test scores from a standard achievement test. Epistemological beliefs of 187 fifth grade students were measured with a 26-item self-report questionnaire that was administered at the beginning (Time1) and after (Time2) the completion of a nine-week hands-on science unit. The items of the questionnaire were loaded on four factors: Source of Knowledge, Certainty of Knowledge, Development of Knowledge, and Justification of Knowledge. Zero-order correlations revealed significant relationships between achievement and all dimensions of epistemological beliefs at Time 1 and Time 2: source (r = .39 at Time 1 and r = .46 at Time 2), certainty (r = .49 at Time 1 and r = .51 at Time 2), development (r = .29 at Time 1 and r = .27 at Time 2), and justification (r = .28 at Time 1 and r = .22 at Time 2). These positive correlations demonstrated that students who had more sophisticated epistemological beliefs also had higher levels of achievement.

In a recent study (see section 2.1.3.2), Cano (2005) explored the effects of epistemological beliefs on learning approaches and on academic performance. Data about epistemological beliefs, learning approaches, and academic performance were obtained from about 1600 secondary students with a mean age of 15 years. The average of students' grades for all subjects was used as a measure of academic performance. Linear structural equation modeling procedures were employed to evaluate the interrelationships among epistemological beliefs, approaches to learning, and academic performance. The final path model indicated that academic performance was predicted directly by epistemological beliefs, specifically by Quick Learning (r = -. 20) and Simple Knowledge (r = -. 09), and indirectly through their influence on learning approaches. Based on these results, Cano (2005) concluded that the more students believed that learning occurs rapidly and without effort, the less they performed on academic courses.

Another recent study attempted to explore the relationship between physics-related epistemological beliefs and physics understanding revealed similar results with the previous studies indicate. In this study, Stathopoulou and Vosniadou (2006) administered the Greek Epistemological Beliefs Evaluation Instrument for Physics (GEBEP) to 76 students with an approximately mean age of 15. The researchers used the Force and Motion Conceptual Evaluation instrument (FMCE) to measure students' understanding of Newton's three laws. In order to test the effect of separate GEBEP dimensions of epistemological beliefs (Structure of Knowledge, Construction and Stability of Knowledge, Attainability of Absolute Truth, and Source of Knowing) on physics understanding a stepwise regression analysis with FMCE scores as the criterion and GEBEP dimension scores as the predictors was carried out. The analysis yielded a regression model with two components, specifically *Construction and Stability of Knowledge* and *Structure of Knowledge*, which accounted for 19.5% of the variance, $R = .441$, $F(2,73) = 8.827$, $p < .001$. Both dimension scores were statistically significant predictors, with standardized β coefficients .281 and .240, respectively. These results indicated that the students who viewed knowledge as tentative and constantly evolving through various complex procedures, and also as an integrated, complex systems of inter-related theoretical concepts, performed better in the FMCE.

Studies reviewed in this subsection deals with the relationships between students' epistemological beliefs and their general academic achievement as well as their performance on specific courses. The results almost exclusively revealed that students' knowledge beliefs predicted their both general and course specific achievement. More specifically, it was shown that more sophisticated epistemological beliefs were related with higher achievement although there were inconsistencies regarding the belief dimensions associated with the students' achievement. While in one study (Conley et al., 2004) all three belief dimensions (Certain Knowledge, Simple Knowledge, Justification of Knowing) were shown to be associated with achievement, other studies mostly revealed a single belief dimension related with the achievement of students. Moreover, this single dimension showed variation from one study to another. The most frequently reported belief dimensions were Simple Knowledge, Quick Learning, and Innate Ability. The reviewed studies showed that these three belief dimensions were commonly associated with students' general as well as course specific achievement.

Studies about epistemological beliefs and cognitive learning processes and outcomes mostly investigated the specific relationships between beliefs and academic achievement. However, there are other learning constructs that are worth to be discussed like strategy use and learning approaches, use of self-regulated learning strategies, comprehension and text processing, and conceptual change. In the following sections, these constructs are outlined by considering their associations with epistemological beliefs.

2.1.3.2 Epistemological Beliefs and the Way Students Learn: Strategy Use and Learning Approaches

Research on epistemological beliefs also elaborates the significant relationships between students' beliefs and their utilized strategies and hence their learning approaches. The studies reviewed in this section provide evidences for the associations among students' beliefs about knowledge and knowing, their use of learning strategies, and their learning approaches. In addition, the following investigations reveal that the relationship between students' epistemological beliefs and their academic performance may be mediated by their utilized strategies or learning approaches.

In an earlier study, for example, Schommer, Crouse, and Rhodes (1992) attempted to investigate the direct and indirect effects of belief in simple knowledge on mathematical text comprehension. Specifically, they investigated whether epistemological effects on learning are mediated by study strategies. A measure of study strategies and an epistemological belief questionnaire were administered to a total of 138 university students while assessing their understanding of a statistical passage. A path analysis was carried out to test the hypotheses that the belief in simple knowledge has both direct and indirect effect on test performance and that the effect of belief in simple knowledge is mediated by study strategies. The results of the path analysis indicated substantial direct relationship between belief in simple knowledge and test performance (r = -.13). The results also showed that the effect of simple knowledge on test performance was mediated by test preparation strategies (r = -.06). Based on the results of path analysis, Schommer et. al. (1992) concluded that in addition to its direct negative effect on test performance, belief in simple knowledge has an indirect negative effect on performance mediated by test preparation strategies.

In another study, Lonka and Lindblom-Ylanne (1996) examined the study strategies of a total of 175 psychology and medicine students and classified these strategies as rehearsal (repeating, copying, or underlining) or elaborative strategies (creating analogies, summarizing, or using prior knowledge). Students were also classified as dualists (assess their learning on the basis of knowledge standards) or relativists (assess their learning on the basis of comprehension standards). The researchers examined the differences between dualists and relativists in terms of the reported study strategies. It appeared that relativists suggested more elaborative strategies and less rehearsal strategies than dualist students did.

The study by Tsai (1998) that analyzed the Taiwanese eighth graders' science achievement, scientific epistemological beliefs and cognitive structure outcomes provided another evidence for the hypothesized relationship between scientific epistemological beliefs and study strategies. The scientific epistemological beliefs of 48 students were assessed by using an instrument which consisted of bipolar agree-disagree statements on a 5-point Likert scale, ranging from empiricist to constructivist views about science. After interviewing the participants following a treatment on basic atomic structure and analyzing the results of the interviews by using flow map method, Tsai measured some specific dimensions of learners' cognitive structure outcomes. The results revealed that students who held more constructivist-oriented SEB tended to use strategies that allow them to process the material more deeply. These students performed better in terms of the ideas recalled, the number of complex linkages generated, and the correct rate of recalled information when compared with students with more empiricist SEB who tended to use more rote-like strategies.

In another study (see section 2.1.3.4) Kardash and Howell (2000) additionally confirmed the relationship between epistemological beliefs and strategy use. Participants' epistemological beliefs, specifically beliefs about Speed of Learning, were found to be correlated with a number of the cognitive-processing categories. The results revealed that the less that students believed learning to be a quick and effortless process, the more processes and strategies they used.

The two of the reviewed studies (Chan, 2003; Cano, 2005) specifically investigated the relationship between students' epistemological beliefs and approaches to learning. In one of these investigations, Chan (2003) attempted to examine the relationship between epistemological beliefs and study approaches adopted by 292 Hong Kong teacher education students. The participants were administered a modified version of Schommer's epistemological beliefs questionnaire and another instrument designed to measure students' learning approaches classifying them as either surface or deep approach learners. The four dimensions of epistemological beliefs were found to be significantly correlated with surface and deep approach dimensions. Surface approach dimension was found to be significantly correlated with Innate/Fixed Ability (r = .21, $p < .001$), Authority/Expert Knowledge (r = .19, $p < .001$), and Certainty Knowledge (r = .18, $p < .01$). These results imply that students with the unsophisticated (naïve) belief that ability is fixed and innate, knowledge is handed down by authorities or experts, and knowledge is certain and unchanging would treat learning as a simple task of memorization and would adhere to a surface approach to study. Deep approach dimension was found to be correlated with Learning Effort/Process (r = .22, $p < .001$) and Authority/Expert Knowledge (r = -.17, $p < .01$). These associations show that students who believed that learning requires effort and a process of understanding and knowledge is not always handed down by authorities and experts were more likely to adopt a deep approach. The students with such sophisticated beliefs would probably try to learn with a deep motive and strategy rather than relying on rote learning, accounting for a deep approach being adopted instead of a surface one (Chan, 2003).

In the other investigation, Cano (2005) surveyed 1600 Spanish students from several secondary schools to examine the change in epistemological beliefs and approaches to learning through secondary school and their influence on academic performance. The participants were administered the Learning Process Questionnaire in its Spanish version (LPQ; Barca, 1999, as cited in Cano, 2005).

The questionnaire was a 5-point Likert scale with 36 items which were clustered to form two main factors, namely deep-approach and surface-approach scales. An epistemological questionnaire adapted from Schommer's instrument and composed of four dimensions (Quick Learning, Simple Knowledge, Fixed Ability, and Certain Knowledge) was also used to obtain data about the epistemological beliefs of the participants. Linear structural equation modeling procedures were employed to evaluate the hypothesis that epistemological beliefs and learning approaches influence achievement directly and that, furthermore, epistemological beliefs influence academic performance indirectly through their impact on learning approaches. The model accommodated the data reasonably as shown by its overall fit indices (GFI = 1.00; AGFI = 0.99; RMR = 0.01). The model also explained quite a high proportion of the variance in each of the dependent variables: 10% in deep approach, 12% in surface approach, and 17% in academic performance. The results indicated that academic achievement was predicted by approaches to learning, which in turn were predicted by beliefs about knowledge and knowing. The impact of epistemological beliefs occurred in two ways: firstly, directly, through the epistemological beliefs themselves, and second, indirectly, through their influence on learning approaches. The indirect effect was statistically significant for only beliefs about quick and effortless learning (B = -.09). This finding confirms the hypothesis that the more a student believes that learning occurs rapidly and without much effort, the more she/he is likely to adopt a surface learning approach. Furthermore, the results indicated that learning approaches also influenced academic performance directly and significantly. A surface approach was found to be negatively linked to performance, while a deep approach was discovered to be associated positively with it. That is, students with a deep learning approach tended to achieve better than the ones with a surface approach.

Evidences for a relationship between epistemological beliefs and learning approaches come from Turkey as well. In one of these studies, Ozkal (2007) investigated the contribution of various variables including scientific epistemological beliefs to students' approaches to learning. She administered the Learning Approach Questionnaire (LAQ) (Cavallo, 1996) and the Scientific

Epistemological Beliefs Questionnaire (SEBQ) (Saunders, 1998) to a total of 1152 eighth grade students from seven public schools in Ankara. The LAQ classifies the students as meaningful or rote learner and the SEBQ places the respondents on a continuum ranging from fixed to tentative views of knowledge. Correlation analyses and Multiple Regression Analyses were conducted to investigate the relationship among the variables of the study and the variables contributing to the students' meaningful and rote learning approaches. The results revealed significant correlations between SEBQ scores and meaningful learning approach scores (r = .140, $p < .01$) which means that students with meaningful learning orientation tended to have tentative views of epistemological beliefs. Significant but negative correlations between SEBQ scores and rote learning approach scores (r = -.094, $p < .01$) were reported as well. This result indicated that students with rote learning orientation tended to have fixed views of epistemological beliefs. Separate Multiple Regression Analyses were performed in order to investigate the contribution of epistemological beliefs on students' meaningful and rote learning orientations. The results revealed that students' scientific epistemological beliefs significantly contributed to their meaningful learning approaches (β = .048, $p < .05$) and their rote learning approaches (β = -.069, $p < .05$).

In another study by Kizilgunes (2007), similar relationships between students' epistemological beliefs and their learning approaches were reported for the Turkish culture. In an attempt to investigate the predictive influence of learning approaches and epistemological beliefs on the achievement of classification concept, the researcher surveyed 1041 sixth grade students from 25 elementary schools in Ankara. The participants were administered the LAQ (Cavallo, 1996) and the Epistemological Beliefs Questionnaire (Conley et al., 2004) in order to obtain information about their learning orientations and beliefs about knowledge and knowing. The study revealed significant correlations between epistemological beliefs and learning approaches (r = .50, $p < .01$). Similar to the results reported by Ozkal (2007), this positive correlation indicated that the more tentative beliefs about knowledge and knowing the students had, the more meaningfully they tended to learn. The same study also examined the contribution of students' learning approaches and epistemological beliefs to their achievement in classification concepts. The results of the Multiple Regression Correlation analyses revealed that students learning approaches were the best predictors of achievement explaining 12% of the variance in achievement. Students' epistemological beliefs were found to explain an additional 2% of the variance in their achievement in classification concepts.

2.1.3.3 Epistemological Beliefs and Self-Regulated Learning Strategies

The studies reviewed in the previous section suggested that dimensions of students' epistemological beliefs are related with their use of learning strategies and their approaches to learning. Research has also shown that students' beliefs about knowledge and knowing contribute to their self-regulated learning strategies. The findings of the reviewed studies in this section display the role that epistemological beliefs play in self-regulated learning.

In a recent attempt to investigate the relationships between epistemological beliefs and self-regulated learning strategies, Dahl, Bals, and Turi (2005) examined the association between belief dimensions and self-reported use of self-regulated learning strategies (SRLS) among 81 Norwegian university students. Researchers assessed students' beliefs on Simple Knowledge, Certain Knowledge, Innate Ability, and Quick Learning domains by using the Schommer Epistemological Questionnaire (SEQ; Schommer, 1998b). Participants were administered the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991) to collect data about their SRLS, specifically rehearsal, elaboration, critical thinking, organization, and metacognitive self regulation strategies. Full regression model analyses were performed in order to test the predictive value of the four belief dimensions on students' reported use of each of the five cognitive and metacognitive strategies measures by the MSLQ. Results from these regression analyses together with the results of the correlation analyses showed that the simple and fixed beliefs, to some extent, predict the learning strategies used by the students when studying, whereas the quick and certain beliefs predict little. Specifically, the regression analyses indicated that beliefs about simple knowledge contribute significantly to the prediction of students' reported use of rehearsal strategies (β = -.30, R^2 = .11, F(4,76) = 2.33, t = -2.60, $p < .01$), organization strategies (β = -.38, R^2 = .25, F(4,76) = 6.16, t = -3.64, $p < .001$), and metacognitive self regulation strategies (β = -.34, R^2 = .23, F(4,76) = 5.65, t = -3.21, $p < .01$). That is, the more the students believe that the knowledge is simple (the naïve epistemological perspective), the less they tend to report using rehearsal, organization, and metacognitive self regulation strategies. Regression analyses also revealed that students' beliefs in the innate ability contributed significantly to the use of elaboration strategies (β = -.39, R^2 = .22, F(4,76) = 5.24, t = -3.37, $p < .001$), critical thinking strategies (β = -.50, R^2 = .25, F(4,76) = 6.22, t = -2.60, $p < .001$), and metacognitive self regulation strategies (β = -.25, R^2 =.23, F(4,76) = 5.65, t = -2.16, $p < .05$). These results show that the ability to learn is fixed at birth (the naïve epistemological perspective), the less likely they use elaboration, critical thinking, and metacognitive self regulation strategies.

In another investigation, Braten and Stromso (2005) examined the relative contribution of epistemological beliefs and theories of intelligence to motivational and strategic components of self-regulated learning in different academic contexts in Norwegian postsecondary education. The participants (178 business administration students, 108 students at the Faculty of Education) were administered the Norwegian version of the SEQ and the MSLQ in order to collect data about their epistemological beliefs and metacognitive self-regulation strategies. Multiple regression analyses were performed separately for the two academic contexts (business administration and education), to predict motivational and strategic components of self-regulated learning with epistemological beliefs and implicit theories of intelligence. All predictors together explained a significant portion of the variance in students' reported use of self-regulatory strategies for the student teachers (F(7, 98) = 4.48, $p < .001$, R^2 = .24) and for the business administration students (F(7, 164) = 4.01, $p < .001$, R^2 = .15). The results of the study revealed that epistemological beliefs predict self-regulated learning among Norwegian postsecondary students and play more important roles than implicit theories of intelligence. The findings of the study showed that relations between epistemological beliefs and self-regulated learning may vary with academic context. Specifically, belief about knowledge construction and modification was found to be a better predictor of self-regulated learning for student teachers (β = -.40, p < .001), explaining as much as 16% of the variance in reported strategy use alone. For the business administration students, not only beliefs about the control of knowledge acquisition (β = -.22, p < .01) but also beliefs about knowledge construction and modification (β = -.19, p < .05) played a more important role in self-regulated learning.

Contrary to the previous findings indicate, the study of Neber and Schommer-Aikins (2002) revealed that none of the students' epistemological beliefs predict their SRLS. In an attempt to explore the causal roles of epistemological beliefs, epistemological intentions, and variables of the learning environment for the utilization of SRLS, Neber and Schommer-Aikins (2002) studied with a total of 133 students (ninety three elementary school students and 40 secondary school students). Epistemological beliefs (belief in innate inability for knowing, belief that success is unrelated to work, belief in quick learning, belief in seeking single answers, belief in avoiding integration of knowledge, and belief in certain knowledge) were checked by using SEQ and self-regulated learning (regulatory strategy use and cognitive strategy use) was measured by the subscales of the MSLQ. A multivariate regression analysis was performed with self-regulated learning as the criterion and eight variables including six epistemological beliefs dimensions as the predictors. Only two of the six epistemological dimensions (belief that success is unrelated to work and belief in seeking single answers) were chosen for the regression because of their correlational strength (r = -.14 for belief that success is unrelated to work and r = -.15 for belief in seeking single answers) with the criterion. Although a relatively high portion of variance could be explained (R^2 = .49), none of the belief dimensions was found to be statistically significant predictors of self-regulated learning at the end of the regression analysis. In order to further clarify the relationships found in the correlational and regression analyses a path analysis was performed. In the path model no significant direct paths between epistemological beliefs and SRLS could be created as well. The only epistemological belief dimension that can be included in the model was the dimension about the belief that success is unrelated to work. Its indirect effect on SRLS was mediated by self-efficacy in science.

Based on the analysis of the reviewed studies, it appears that the results of the studies examining the relationships between epistemological beliefs and self-regulated learning strategies revealed a mixed pattern. That is, in some investigations epistemological beliefs were shown to be related with students' reported use of self-regulated learning strategies, specifically rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation strategies, whereas in another study no such relation was found. Of the studies revealing associations between epistemological beliefs and self-regulated learning strategies, two of them showed that beliefs about simple knowledge, innate ability, knowledge construction and modification, and control of knowledge acquisition played role in the prediction of self-regulated learning.

2.1.3.4 Epistemological Beliefs and Comprehension and Text Processing

In addition to strategy use, students' epistemological beliefs were shown to be influential on their comprehension and text processing. In the studies investigating the relationship between epistemological beliefs and comprehension, students were typically required to read a text and then complete a test that requires them to remember information learned from the text or to draw conclusions from the text. Students' performances on these tasks were then analyzed in relation to the dimension to their epistemological beliefs (Buehl, 2003).

In an earlier investigation, Schommer (1990) tested the effects of epistemological beliefs on aspects of students' comprehension, including interpretation of information, which was measured with the conclusion task. Of the 86 students enrolled in the study, 41 students read a psychology passage, and 45 of them read a nutrition passage. Both passages did not have concluding paragraphs and students were asked to write concluding paragraphs for the passages. Conclusions for both passages were coded for both simplicity and certainty on a dichotomous scale ranging from simple to complex and certain to uncertain. In order to test the effects of epistemological beliefs on conclusions drawn several regression analyses were performed by controlling the influence of factors known to affect comprehension specifically, verbal ability, prior knowledge, and gender. The results revealed that Quick Learning predicted oversimplified conclusions (*B* = .18). That is, the more the students believed in quick, all-or-none learning, the more likely they were to reach oversimplified conclusions. The results also showed that Certain Knowledge predicted certain conclusions (*B* = -.33). That is, the more the students believed in certain knowledge, the more likely they were to write absolute conclusions. Based on these findings, Schommer (1990) concluded that students' epistemological beliefs affect their comprehension and processing of information.

In an attempt to investigate the relationship between belief in simple knowledge and mathematical text comprehension, Schommer et al. (1992) assessed 138 university students' understanding of a statistical passage and their beliefs about knowledge and learning. Like in the study of Schommer (1990), the researchers controlled both prior knowledge and gender in the regression analysis the results of which indicated that belief in simple knowledge predicted comprehension measured by a mastery test. Specifically, the more students believed that knowledge is simple and composed of isolated bits of facts, the worse they performed in the mastery test. Based on this result, Schommer et al. (1992) concluded that belief in simple knowledge is negatively associated with comprehension.

Schommer and Walker (1995) provided another evidence for the relationship between epistemological beliefs and passage comprehension at the end of their study assessing the domain independency of epistemological beliefs. As a part of this investigation, 91 college students' beliefs about knowledge and learning were assessed by using an epistemological questionnaire. Students were instructed to complete the questionnaire with a specific domain (either social sciences or mathematics) in mind, read a passage (about either social sciences or mathematics), answer a passage test, and finally complete another epistemological questionnaire with the alternative domain in mind. Regression analyses were conducted to determine whether domain-specific epistemological beliefs predict comprehension of passages within domains and between domains. Results of the investigation showed that both domain-specific epistemological beliefs predicted passage performances similarly across both passage conditions. When test performance for the social science passage was used as the criterion variable and social science belief factor scores served as the predictors, belief in certain knowledge in the social sciences predicted the test performance. When mathematical belief factor scores served as predictors, belief in certain knowledge in mathematics predicted the same test performance. The researchers concluded that the less students believed in certain knowledge either in social science or mathematics, the better they performed on the social science test. When test performance for the mathematics passage was used as the criterion variable and mathematical epistemological factor scores served as the predictors, belief in simple knowledge in mathematics predicted the test performance. When social science epistemological factor scores served as predictors, belief in simple knowledge in the social sciences predicted the same test performance. It was asserted that the less the students believed in simple knowledge in either social sciences or mathematics, the better they performed on the mathematics test. In the light of these findings, the researchers concluded that epistemological beliefs about social sciences, as well as mathematics, predicted passage comprehension both within and between domains.

In another investigation, Rukavina and Daneman (1996) examined the effect of the learner's epistemic views about knowledge on successful learning which depends upon a learner's ability to integrate successively encountered ideas in the text. A sample of 122 students of different grade levels (44 tenth grade students, 38 twelfth grade students, and 40 undergraduates) was participated in the study. Participants read texts that presented competing theories for ongoing scientific problems under two conditions: an integrated-text format versus a separate text format. The former one was designed to describe science as inquiry and offered each theory as a possible solution to the scientific problem. The latter one, on the other hand, presented the two theories successively in separate texts and made no mention of their conflicting nature. Participants were also required to complete an epistemological questionnaire designed to measure their beliefs about knowledge, whether they believe knowledge is simple or complex, and whether they believe knowledge consists of facts or integrated ideas. Students were classified as mature or immature depending on their answers to the items in this questionnaire. Results of the study revealed that on all of the measures of comprehension, including the discrete multiple-choice test, students with more mature epistemic beliefs outperformed students with less sophisticated beliefs. According to the results of this investigation, researchers concluded that students' beliefs about the complexity of knowledge underlie successful integration of newly encountered ideas into a coherent and well-integrated knowledge base.

In their study of the effects of epistemological beliefs on interpretation of controversial issues, Kardash and Scholes (1996) also enlightened the relationship between people's beliefs about the certainty of knowledge and the nature of the concluding paragraphs written for the presented text. Specifically, the study examined the influence of individuals' beliefs about the certainty of knowledge, the strength of their beliefs about a controversial issue, and their tendency to enjoy effortful thinking on their interpretation of controversial issues. Seventy eight undergraduates were required to read a text that presented two conflicting views regarding the HIV-AIDS relationship and write a conclusion paragraph for the text. The participants completed an epistemological questionnaire as well. Belief about certainty of knowledge emerged to be one of the predictors of participants' certain conclusions at the end of the regression analysis. Results of the study revealed that the less the students believed in certain knowledge, the more they likely to write conclusions that reflected the inconclusive nature of the mixed evidence they read. In contrast, students with strong beliefs in the certainty of knowledge tended to ignore totally the inconclusive nature of the information that they read and were more likely to misinterpret contradictory evidence (Kardash & Scholes, 1996).

In contrast to previous findings indicate, Kardash and Howell (2000) reported that students' general beliefs about knowledge and learning were unrelated to their learning from text and recall of text information. In their study, Kardash and Howell (2000) investigated the effects of epistemological beliefs and topic-specific beliefs on 40 undergraduates' cognitive and strategic processing of a dual positioning text. The participants were asked to think aloud while reading a text that presented information both consistent and inconsistent with their prior beliefs about the HIV-AIDS relationship. Twenty four hour after each participant completed the think-aloud procedure, he or she was unexpectedly asked to complete a test of free recall of information which had been previously presented in the text. The researchers used a delayed rather than immediate test of free recall since they were interested in participants' memory for controversial information over time. An epistemological beliefs questionnaire was used to assess students' beliefs. The factor analysis resulted in four factors which were labeled as Nature of Learning, Speed of Learning, Certain Knowledge, and Avoid Integration. Students were classified as holding either sophisticated or naïve epistemological beliefs by considering the median of each factor score. Specifically, students with scores below and at the median were classified as holding naïve beliefs, whereas students with scores above the median were classified as holding sophisticated views for the same factor. The results of the study showed that students' epistemological beliefs were not related with the recall of text information assessed by total sentences recalled. Kardash and Howell (2000) hypothesized that one day delay in testing or not telling participants that they would be tested might caused low recall levels in participants.

Studies reviewed in this subsection deals with the relationships between students' epistemological beliefs and their comprehension and text processing. The results almost exclusively revealed that students' knowledge beliefs were associated with their achievement when they learned from a text. More specifically, it was shown that students with less sophisticated epistemological beliefs tended to achieve lower in the knowledge tests assessing comprehension and text processing. Simple Knowledge and Quick Learning are the two belief dimensions that were frequently reported to be significantly related to students' achievement in these tests. The only study that contradicts with these findings belongs to Kardash and Howell (2000) indicating that the relationship between students' epistemological beliefs and their learning from a text was insignificant.

2.1.3.5 Epistemological Beliefs and Construction of Knowledge and Conceptual Change

Previously reviewed studies have documented the relationship between epistemological beliefs and students' learning processes, specifically students' strategy use, comprehension, and text processing. A consistent finding of these studies is that students who believe in fixed intelligence, in simple knowledge, and in quick learning tended to use ineffective learning strategies and to achieved lower in the knowledge tests assessing comprehension and text processing. Given the role of epistemological beliefs in students' learning processes, it is likely that these beliefs are also associated with how students construct new knowledge and change their existing conceptions (Buehl, 2003).

Three studies provide evidence to suggest that epistemological beliefs play role in the construction of knowledge and conceptual change. Of the three studies identified, only one study (Qian & Alvermann, 1995) directly examined the relationship between students' epistemological beliefs and conceptual change learning. In their study, Qian and Alvermann (1995) assessed 212 ninth-through twelfth-grade students' epistemological beliefs as well as their prior knowledge regarding Newton's theory of motion. Two weeks later, the participants were required to read a refutational text about the topic. After reading the text, students completed an achievement test designed to evaluate their conceptual understanding and reasoning. A canonical correlation analysis revealed two important findings. First, Qian and Alvermann (1995) showed that students' epistemological beliefs were moderately associated with their conceptual understanding and reasoning ability. This result indicated that students with immature beliefs about knowledge and learning are less likely to be successful in conceptual change learning. Second, it was shown that beliefs about simple-certain knowledge and beliefs about quick learning were significant predictors of students' conceptual understanding and their reasoning ability. This finding suggested that the more the students believe in simple-certain knowledge and quick learning, the poorer they performed in the achievement test. According to the results of the canonical correlation analyses, beliefs about simple-certain knowledge contribute the most to conceptual change learning, whereas beliefs about innate ability contribute the least.

The two other studies (Windschitl & Andre, 1998; Tsai, 2000) examining the impact of students' epistemological beliefs on their conceptual understanding, also highlighted the interaction between these beliefs and specific learning environments designed to promote students' conceptual understandings. In both of these studies, the researchers designed learning environments for conceptual understanding and examined students' learning and conceptual change by considering their epistemological beliefs. For instance, Windschitl and Andre (1998) explored the effects of a constructivist versus objectivist learning environment on approximately 250 college students' conceptual change, using a computer simulation of the human cardiovascular system as an instructional tool. The study also investigated the interaction between constructivist versus objectivist learning situations and the students' epistemological beliefs. There were two instructional conditions in the study. In one of the instructional conditions designed to represent objectivist learning environment (confirmatory simulation condition), students used the cardiovascular simulation in prescribed steps that led to the resolution of a set of 13 questions. In the other instructional condition designed for constructivist learning environment (exploratory simulation condition), students used the same simulation to hypothesize and test possible answers to the same questions without given a guidance for the specific steps to be followed. The results of the regression analyses revealed that the degree of epistemological sophistication associated more positively with posttest scores in the exploratory group than in the confirmatory group. Specifically, epistemologically more mature students perform better than less mature students in the exploratory condition. In the confirmatory condition, however, students with less sophisticated beliefs perform better than students with more sophisticated beliefs.

An additional investigation by Tsai (2000) also provided evidence for the interaction between students' epistemological beliefs and learning environments in conceptual change learning. In his study, Tsai (2000) investigated the effects of STS (Science-Technology-Society) instruction on 101 Taiwanese female tenth graders' cognitive structure outcomes. The investigation further examined the role of student scientific epistemological beliefs on such effects. The students were assigned to either a STS-oriented instruction group or a traditional teaching group for an eight-month research treatment related with the light topic. Students' conceptual understanding of light was assessed by using flow map method. Four major cognitive structure outcomes (number of linear linkages, number of cross linkages, connection, and correctness) in the flow maps were evaluated. Flow map analyses indicated that STS group students performed better in terms of the extent, richness, and connection of cognitive structure outcomes than did traditional group students. Further analyses revealed that STS instruction was especially beneficial to students with more constructivist view of epistemological beliefs, particularly in the beginning stage of STS instruction. Students with more empiricist view of epistemological beliefs, however, performed better in the traditional group.

Considering the results of abovementioned studies, it can be concluded that there is a relationship between students' epistemological beliefs and conceptual change and understanding. However, this association is not that much simple and requires careful examination within the concept of specific learning environment.

2.1.4 Summary of the Literature on Students' Epistemological Beliefs

Within its historical development, epistemological beliefs, the beliefs about knowledge and knowing, have long been the interest of many researchers. One continuous line of research has dealt with the conceptualization of personal epistemology by developing different models of epistemological development. The second line of research has been interested in the variables contributing to the development of epistemological beliefs in the adolescence and adulthood. Research has revealed that age and education, gender, culture, home environment, ability and intelligence, domain differences, and learning environments are the specific learner characteristics that contribute to the development of personal epistemology. Another line of research has investigated how students' beliefs about knowledge and knowing are related to certain learning processes and outcomes. Specifically, different studies intended to explore whether students' epistemological beliefs enhance or constrain their academic performance, strategy use and learning approaches, use of self regulated learning strategies, comprehension and text processing, and construction of knowledge and conceptual change. Generally, the reviewed studies revealed significant relationships between students' epistemological beliefs and their learning outcomes. Although the nature of these relationships shows variation in different studies and different belief factors are found to be related with different learning outcomes, it can be concluded that individuals with more sophisticated epistemological beliefs tend to achieve higher, use more strategies, approach learning in a more meaningful way, and comprehend the reading texts more deeply than less sophisticated individuals.

2.2 Research on Self-Regulated Learning

This section provides an overview of the literature on self-regulated learning (SRL) by presenting different theories and some of the models of SRL, factors affecting SRL, relationship between SRL and academic achievement, and a brief review of the characteristics of self-regulated learners.

2.2.1 Theories of Self-Regulated Learning

Self-regulated learning has emerged as an important construct in education (Boekaerts, 1999). Recently, researchers have progressively more emphasized the importance of self-regulation in learning (Heikkila & Lonka, 2006). There is a growing body of literature on theoretical conceptualization of self-regulation. Over the past decade, a great deal of research has been conducted on the construct of self-regulation. Many educational psychologists have proposed theoretical models and conducted studies to produce theoretically relevant and pragmatic information about SRL (Boekaerts, 1999). Despite the efforts to conceptualize and operationalize the self-regulatory capacity, the researchers came to the conclusion that there is no simple and straightforward definition of the construct of SRL (Boekaerts & Corno, 2005).

Winne (1995) defined SRL as an inherently constructive and self-directed process. Howard-Rose and Winne (1993) described SRL as a multifaceted construct that theoretically accounts for students' active participation in and goal-directed governance of learning processes in dynamically unfolding instructional settings. According to Pekrun, Goetz, Titz, and Perry (2002), SRL is the process of planning, monitoring, and evaluating one's own learning. Winne and Perry (2005) used the term "self-regulated" to describe learners who are metacognitively, intrinsically motivated, and strategic. Pintrich and De Groot (1990) included three components while making the definition of SRL, namely students' metacognitive strategies for planning, monitoring, and modifying their cognition, students' management and control of their efforts on classroom academic tasks, and the actual cognitive strategies that students use to learn, remember, and understand the material.

In an earlier definition, Zimmerman and Martinez-Pons (1986) stated that SRL strategies are the actions directed at acquiring information or skill that involve agency, purpose (goals), instrumentality, and self-perceptions by a learner. According to Zimmerman (1986), students are self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process. Later, Zimmerman (1998) defined self-regulation as self-generated thoughts, feelings, and actions in order to achieve academic goals. SRL was identified as the self-directive process through which learners transform their mental abilities into task-related academic skills (Zimmerman, 2001). In line with the definition of SRL provided in 1986, Zimmerman (2001) attempted to explain the meaning of becoming metacognitively, motivationally, and behaviorally self-regulated as a learner and identified the five common underlying issues: (1) what motivates students to self-regulate during learning? (2) through what process or procedure do students become self-reactive or self-aware? (3) what are the key processes or responses that self-regulated students use to attain their academic goals? (4) how does the social and physical environment affect student self-regulated learning? (5) how does a learner acquire the capacity to self-regulate when learning? (Zimmerman, 2001, p. 8). The following subsections present different theories of SRL in terms of these five common issues.

2.2.1.1 Operant Views of Self-Regulated Learning

Mace, Belfiore, and Hutchinson (2001) define SRL in terms of operant theorists and refer to SRL as a systematic application of behavior change strategies that result in the alteration of one's own behavior. According to Mace et al. (2001), the critical features of self-regulation from an operant perspective involve choosing among alternative actions, reinforcing value of the consequences for all alternatives, and temporal locus of control for the alternatives.

Table 2.4 presents the answers of the five questions asked by Zimmerman (2001) to address the underlying issues of theories of SRL. From an operant perspective, the ultimate source of *motivation* during self-regulation is the external reinforcing stimuli. Self-regulation responses are therefore viewed as inter-response control links, which are chained together to achieve the external reinforcement.

Self-awareness is not generally discussed by the operant researchers since it cannot be observed directly. Instead the operant researchers are interested in self-reactivity, an important demonstration of self-awareness. These researchers use a behavioral-environmental method in order to stimulate self-awareness. This method involves a recording action that produces an environmental stimulus and meets operant criteria since it involves observable events (Zimmerman, 2001).

Mace and his colleagues (2001) identify the *key self-regulation processes* as self-monitoring, self-instruction, self-evaluation, and self-reinforcement. Self-monitoring involves two steps: discriminating the occurrence of the target response to be controlled and self-recording some dimensions of the target response like frequency, duration, and latency. The second self-regulative process, self-instruction, leads to reinforcement by providing discriminative stimuli that causes specific behaviors or behavioral sequences. Self-evaluation process requires the individual to compare some dimension of his or her behavior with that of some set standard or criteria (Belfiore & Hornyak, 1998). During this process students can evaluate the self-monitoring accuracy (e.g., number of steps completed correctly), performance improvement over time (e.g., rate, percentage, duration), and/or the overall performance (Belfiore & Hornyak, 1998). Self-correction then follows which requires students to modify or adjust the strategies and responses. Finally, self-reinforcement is described as the process by which the probability of the occurrence of the response increases as a result of meeting a criteria and identifying the stimulus following the occurrence of a response (Mace et al., 2001).

Operant researchers are the most explicit about linkages between self-functioning and the *social and physical environment*. Internal processes are defined in terms of their expression in overt behavior and the relationship between such behavior and environment is the focus of the operant perspective (Zimmerman, 2001).

Instead of devoting attention on the *acquiring capacity* to self-regulate, operant theorists have emphasized the role of external factors in learning to self-regulate. According to the operant perspective, external cues and contingencies are imposed initially, then self-regulation responses are gradually shaped, and finally external cues are faded and reinforcers are thinned gradually (Zimmerman, 2001).

Table 2.4 A comparison of theoretical views regarding common issues in self-regulation of learning (Zimmerman, 2001, p.9)

	Common Issues in Self-Regulation of Learning				
Theories	Motivation	Self-Awareness	Key Processes	Social and Physical Environment	Acquiring Capacity
Operant	Reinforcing stimuli are emphasized	Not recognized except for self-reactivity	Self-monitoring, self-instruction, and self-evaluation	Modeling and reinforcement	Shaping behavior and fading adjunctive stimuli
Phenomenological	Self-actualization is emphasized	Emphasize role of self-concept	Self-worth and self-identity	Emphasize subjective perceptions of it	Development of the self-system
Information Processing	Motivation is not emphasized historically	Cognitive self-monitoring	Storage and transformation of information	Not emphasized except when transformed to information	Increases in capacity of system to transform information
Social Cognitive	Self-efficacy, outcome expectations, and goals are emphasized	Self-observation and self-recording	Self-observation, self-judgment, and self-reactions	Modeling and enactive mastery experiences	Increases through social learning at four successive levels
Volitional	It is a precondition to volition based on one's expectancy/values	Action controlled rather than state controlled	Strategies to control cognition, motivation, and emotions	Volitional strategies to control distracting environments	An acquired ability to use volitional control strategies
Vygotskian	Not emphasized historically except for social context effects	Consciousness of learning in the ZPD	Egocentric and inner speech	Adult dialogue mediates internalization of children's speech	Children acquire inner use of speech in a series of developmental levels
Constructivist	Resolution of cognitive conflict or a curiosity drive is emphasized	Metacognitive monitoring	Constructing schemas, strategies, or personal theories	Historically social conflict or discovery learning are stressed	Development constrains children's acquisition of self-regulatory processes

2.2.1.2 Phenomenological Views of Self-Regulative Learning

From the phenomenological perspective, enhancing or actualizing one's self-concept is the eventual source of *motivation* to self-regulate during learning. McCombs (2001) identifies the basic role of the self during learning as generating motivation in order to approach and persist in learning tasks. In McCombs's model, affective reactions play an important role in motivation. It is hypothesized that if self-perceptions are unfavorable, negative affects results and reduces motivation. When self-perceptions are favorable, on the other hand, students display confidence during the learning process and show intrinsic motivation (Zimmerman, 2001).

Phenomenologists emphasize the role of self-concept while explaining the process through the students become *self-aware*. They assume that self-awareness in a pervasive condition of human psychological functioning and people do not have to be taught to be self-aware or self-reactive because they are actually so by the nature of their self-concept. According to McCombs (2001), students are recommended to engage in self-monitoring and self-evaluation to keep track of what they are thinking and feeling while learning so that they can increase their subjective awareness of their accomplishment.

The phenomenological perspective stresses the importance of perceptions of self-worth and self-identity as the *key processes* in psychological functioning (Zimmerman, 2001). McCombs (2001) categorizes self-worth and self-identity as self-system structures. According to McCombs (2001), self-structures represent personalized and self-defined conceptualizations of self-attributes and they in turn affect specific self-regulation processes like self-evaluation, planning, goal setting, monitoring, processing, encoding, retrieval, and strategies.

Phenomenologists give less emphasis to the nature of the *social and physical environment* but rather they stress learners' subjective perceptions of this environment (Zimmerman, 2001). Regarding the *acquiring capacity to self-regulate*, phenomenological perspective highlights the importance of the development of the self system. According to McCombs (2001), self-regulated learning is dependent on the development of underlying self-system processes.

2.2.1.3 Information Processing Views of Self-Regulated Learning

Information processing (IP) theory has been used to describe and explain general aspects of human cognitive functioning and self-regulation across a wide range of actions (Zimmerman, 2001). Winne (2001) differentiates SRL from the IP perspective by defining it as adaptive to different conditions that unfold when the products do not meet the standards.

The five common underlying issues of SRL identified by Zimmerman (2001) are discussed from an IP perspective as well. As indicated in Table 2.4, IP theory historically has not given much attention to the role of *motivation* to self-regulate learning but rather it has focused on learner's knowledge states or methods of reasoning. Zimmerman (2001) underlines this point of view by providing a striking example. He argued that "After all, computers need no a prior motivation to perform (just electricity!)" (Zimmerman, 2001, p. 16).

From an IP perspective, cognitive self-monitoring, which provides the window of *self awareness* on one's functioning, plays an important role in self-regulation. According to Zimmerman (2001) self-awareness can assist in making adaptations but it occupies mental capacity, and as a result, has to be limited when seeking to attain optimum performance. IP theorists therefore assume that when performances become highly automatized, learners can self-regulate without direct awareness which frees individuals to self-regulate at a higher level in a hierarchy of goals and feedback loops. Accordingly more proficient performance can be achieved (Zimmerman, 2001).

Based the theoretical views of IP, *key self-regulation processes* are memory, different forms of information, and information processes. According to Zimmerman (2001), there are three types of *memories* that are utilized during self-regulation: sensory buffer memory, short-term or working memory, and long-term memory. Individuals store a huge amount of information in their long-term memory and all the stored information has a pattern. An image of that pattern is labeled as a network (Winne, 2001). Information can be collected and arranged to form complex pattern, known as chunks. *Different forms of information* in SRL are three kinds of chunks which are schemas, tactics, and strategies. Schemas are generalized slots or categories for sorting incoming information. Strategies and tactics are “if-then” rules that are used to transform information into more usable forms.

Winne (2001) indicated that self-regulation occurs when five fundamental types of *information processes* are used. These information processes are: Searching, Monitoring, Assembling, Rehearsing, and Translating. Using the first letter of each process’s name Winne (2001) formulated the acronym S.M.A.R.T to refer to the set of information processes. Searching refers to the ways individuals retrieve information. Monitoring is the process of comparing two chunks of information. Assembling accounts for adding a useful new chunk of information to long-term memory. Rehearsing is a repetitive process that keeps the information in memory. Translating is the process of using one existing format as a basis for creating another (Winne, 2001).

Like motivation, IP theory has given little attention to the effects of *social and physical environment* in self-regulation. From an IP perspective, the social and physical environmental factors have little impact on self-regulation unless they are transformed into information to be processed. If these factors are converted into information, they can be self-regulated like other sources of information (Zimmerman, 2001).

From an IP perspective, learning involves a permanent increase in the capacity of an individual to process information and respond in a self-regulative manner (Zimmerman, 2001). Winne (2001) suggested that rule systems for processing information which develop with age and experience from the basis for self-regulation of learning.

2.2.1.4 Social Cognitive Views of Self-Regulated Learning

Bandura’s (1986) social cognitive theory proposes a triadic account of human functioning, which focuses on the individual and at the same time interdependent contributions of personal, behavioral, and environmental influences.

Applying this triadic account to self-regulated learning, Schunk (2001) states that students' efforts to self-regulate during learning are not only determined by personal processes like cognition and affect but also by the environmental and behavioral events in a reciprocal fashion.

According to the social cognitive views of SRL, *motivation* to self-regulate involves two cognitive sources: self-efficacy and outcome expectations and goals. Learners are provided with representations of future consequences by the help of outcome and self-efficacy expectations. These presentations, in turn, help learners set goals for themselves. These goals are not the source of self-motivation themselves; instead serve as standards against which future performance is evaluated (Zimmerman, 2001).

From a social cognitive perspective, *self-awareness* involves one or more self-perspective states, such as self-efficacy, that come out from specific self-observation responses (Zimmerman, 2001). Schunk (2001) indicates that self-observation is especially helpful when it concentrates on specific conditions under which learning occurs such as the time, place, and duration of performance. According to Zimmerman success in SRL is dependent on the accuracy of self-observation since this process provides the necessary information required to guide the efforts for self-regulation.

Bandura (1986) identified self-observation, self-judgment, and self-reaction as the three *key self-regulation processes*. It is assumed that self-observations prompt learners to self-evaluate and the cognitive self-judgments, in turn, are supposed to direct the learner to a variety of personal and behavioral self-reactions (Zimmerman, 2001). Self-observation is a process that can inform the individual about how well one is progressing towards one's goals and that can motivate behavioral change. Self-judgment refers to comparing the present performance with one's learning goals. Self-reactions can be personal or environmental. Students who judge goal progress as acceptable may anticipate satisfaction from goal accomplishment may feel efficacious about continuing to improve and motivated to complete the task. Self-reactions also include self-administered stimuli or consequences, like work breaks, food, or new clothing, which are dependent on the completion of a task or success (Schunk, 2001).

Social cognitive theorists focused on the effects of social *and environment effects*. They systematically studied special social processes like modeling and environmental factors, such as the nature of the task and the setting. Modeling and enactive mastery experiences were pointed out to be influential on students' perceptions of self-efficacy achievement (Zimmerman, 2001).

According to social cognitive view of SRL, self-regulation neither develops as people get older, nor it is passively acquired through environmental interactions. Social cognitive researchers suggest that a learner acquires *the capacity to self-regulate* at four successive levels. From a social cognitive perspective, a learner's acquisition of skills or strategy to self-regulate comes initially from social sources and shifts subsequently to self-sources in a series of levels (Zimmerman, 2001).

2.2.1.5 Volitional Views of Self-Regulated Learning

From a volitional perspective, SRL is defined as an effort put forth by students to deepen and manipulate the content areas and to monitor and improve that deepening process (Corno, 2001). According to Corno (2001), this definition made some assumptions. Firstly, It was assumed that students look for understanding subject matter content rather than simply committing it to memory. By giving meaning to the subject and monitoring their own understanding, students engage volitional functions. Another assumption of this definition was that students vary in their knowledge of and tendencies to use SRL in school learning. By this definition, Corno (2001) argued that SRL cannot be completely cognitive or motivational; it has volitional aspects as well.

Volition theorists assume that there exists covert psychological force or forces that control action. *Motivation to self-regulate* is viewed as a precondition to volition based on one's expectancies and values. Corno (2001) suggests that motivational processes mediate the formation of decisions and promote decisions, while volitional processes mediate the acting out of these decisions and protect them. According to Zimmerman (2001), once learners are adequately motivated for committing in a particular task, volitional processes operate to sustain functioning on the task.

Self-awareness plays a key role in volitional perspective. However, it is stated that not all types of self-awareness contributes to volitional control (Zimmerman, 2001). Rather than state-controlled cognitions, action-controlled ones are identified as contributors of such control. Whereas action-oriented cognitions allow the learner to monitor competing-action tendencies and remain focused on the present intention, state-oriented cognitions are preoccupied emotional states or feeling of doubt (Zimmerman, 2001).

The *key processes of SRL* from a volitional perspective are control of cognition, motivation control, and emotional control. Motivational control strategies involve enhancing an individual's intent to learn by imagining positive or negative outcomes of success or failure. Emotional control strategies help individuals sustain intention so that difficult parts of a task can be learned (Zimmerman, 2001).

Corno (2001) points out the importance of *social and physical environment* in SRL from a volitional point of view. According to Corno (2001), students' volition to learn can be increased by changes in the task itself or in the setting where the task is completed. These changes may involve, for example, asking permission to move away from noisy peers, using a calculator, word processor, or any other equipment for efficiency, surrounding themselves with hard working peers, or asking a good friend to provide social support. Such changes help students control distracting environments and gain control of the task (Corno, 2001).

Volitional theorists view *learners' acquiring capacity to self-regulate* as an acquired ability to use the volitional control strategies. They suggest using volitional processes involved in self-regulation as a way of increasing volition.

2.2.1.6 Vygotskian Views of Self-Regulated Learning

Vygotsky's approach to teaching and learning differs from other views of self-regulation in that it emphasizes linguistically mediated social agents in children's development and the role of inner speech (Zimmerman, 2001). The model of co-regulation represents the Vygotskian perspective of SRL. Co-regulation is based on three fundamental concepts. First, the basic unit of analysis is viewed as the relationship with and among the individuals, objects, and settings. Second, coordination of multiple social worlds, expectations, and goals is considered to be the basic task of students. Third, goal coordination is supposed to be learned. In this model, SRL is viewed as instrumental to socially meaningful activity since it not only empowers the individual but also enriches the culture (McCaslin & Hickey, 2001).

Motivation to self-regulate is not emphasized historically in the Vygotskian perspective of SRL. Instead, little formal description of the processes that motivate learners to self-regulate is provided. In a Vygotskian point of view, task-involved and self-involved types of inner speech can influence motivation. Self-involved inner speech includes motivational and affective statements that are utilized to improve self-control. Task-involved inner speech, on the other hand, refers to problem-solving strategic statements that are used to increase the task control (Zimmerman, 2001).

The Vygotskian perspective views *self-awareness* as a subarea of consciousness. Thus, consciousness of learning in the zone of proximal development is emphasized (Zimmerman, 2001). Vygotsky described this zone as a kind of gap or the difference between what a learner cannot do alone and can do with the guidance from someone more knowledgeable, like a teacher or more capable peer. The basic principle is that tasks that learners can initially do only with guidance start to be performed independently as they incorporate the structure or the scaffolding of the assistance. It is emphasized that relationship between the co participants develops when the learner receives guidance and support. The relationships are also developed by using the strategy of scaffolding that suggests moveable and malleable supports that are faded when not required anymore (McCaslin & Hickey, 2001).

From a Vygotskian perspective, egocentric speech is viewed as a *key process in self-regulation.* Egocentric speech is considered to be a transition from external to internal speech where external speech includes turning thoughts into words and inner speech involves turning words into thoughts (Zimmerman, 2001).

In terms of this perspective, *social and physical environment* has impact on the development of children. Adult dialogue is emphasized to mediate the internalization of the children's speech which is thought to play an important role in children's adaptation to and control of the sociohistorical context that they develop within. A child's internalization of speech is assumed to emerge initially from social encounters, especially with adults, but internalized, inner speech is supposed to have its own dynamics (Zimmerman, 2001).

The development of the capacity of self-regulation is described in terms of internalization in Vygotskian views of SRL. According to this view, children acquire inner use of speech in a series of developmental levels. Self-regulation begins at an interpersonal level through contact with adults, and then it is gradually internalized by the children (Zimmerman, 2001).

2.2.1.7 Cognitive Constructivist Views of Self-Regulated Learning

Cognitive constructivist views of SRL assume that a cognitive conflict or a curiosity is the drive of *motivation* to self-regulate. In either cases, an unpleasant state forces learner to make cognitive accommodations so that they reach their cognitive equilibrium again (Zimmerman, 2001). In an attempt to answer questions of motivation to self-regulate, Paris, Byrnes, and Paris (2001) include a theory of "agency and control" in their constructivist theory.

Self-awareness plays a central role in the formation of schemas according to the constructivists. The highest level of self-awareness related to self-regulation occurs when the child enters the formal operation period of development.

After reaching this period, children are aware of their own thoughts and can treat these thoughts as hypotheses to be tested. This level of functioning is regarded as metacognitive monitoring to indicate that cognitive functions are being monitored and controlled at a higher cognitive level (Zimmerman, 2001).

Constructing schemas, strategies, and personal theories are considered as the *key self-regulation processes* in the cognitive constructivist perspective. SRL is described as a multifaceted process where students are hypothesized to regulate four components of their learning: self-competence, agency and control, schooling and academic tasks, and strategies (Paris et al., 2001). Students' theory of self-competence involves perceptions of personal academic ability. Students' theory of agency and control concentrates on their interpretations of success and failure also their intentions and actions. Students' theory of schooling and academic tasks involves students' beliefs about key task properties and their influence on the students' goal orientation. Finally, students' theory of strategies involves knowledge what strategies are, how they are used, and when and why they should be used (Zimmerman, 2001).

Regarding the effects of *social and physical environment* on SRL from a cognitive constructivist perspective, social conflict or discovery learning are emphasized. According to Paris et al. (2001) students' conceptions of the self and use of self-regulatory methods can adapt to social and historical contexts, including the tools, values, and customs of local communities. The constructs of discovery learning, cognitive conflict, and equilibrium have been mainly replaced by constructs like cooperative learning, personal theories, identities, and adaptive actions in Paris and colleagues' formulation of constructivism.

From a constructivist perspective, it is emphasized that changes in children's stage of cognitive development is essential for increasing their *self-regulatory capacity* to learn (Zimmerman, 2001). However, Paris et al. (2001) suggest that there are significant developmental constraints on children's acquisition of self-regulatory processes. Paris and colleagues hypothesize developmental changes in children's perceived self-competence, understanding of the role of ability and effort in academic performance, estimates of the amount of control that can be exerted, and understanding of the nature of the tasks. The researchers assume that these changes combine to produce developmental changes in children's theories about the self. These emerging theories are hypothesized to influence the direction of learning and self-regulatory methods (Zimmerman, 2001).

2.2.2 Models of Self-Regulated Learning

Different theoretical perspectives contribute to different models of SRL. Therefore, the field of research on SRL is quite diverse including a number of different models (e.g., Boekaerts & Niemivirta, 2005; Butler & Winne, 1995; Pintrich & De Groot, 1990; Winne, 1995). In the following subsections, four of those models that have been noticeably developed during the past decade and have been supported by several empirical studies are reviewed.

2.2.2.1 Zimmerman's Social Cognitive Model of Self-Regulation

Zimmerman's (1989, 1990, 1998, 2005) social cognitive model of self-regulation is based on Bandura's (1986) social cognitive theory. A social cognitive perspective views self-regulation as an interaction of personal, behavioral, and environmental triadic processes (Bandura, 1986). That is, besides including behavioral skills in self-managing environmental contingencies, this perspective also entails knowledge and the sense of personal agency to perform this skill in appropriate contexts (Zimmerman, 2005).

According to Zimmerman (2005) self-regulation refers to "self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" (p.14). Zimmerman's model of self-regulation is described as a triadic process involving three types of self regulation (see Figure 2.2). Behavioral self-regulation consists of self-observing and strategically adjusting performance processes. Environmental self-regulation includes observing and adjusting environmental conditions or outcomes. Finally, covert self-regulation concerns monitoring and adjusting cognitive and affective states (Zimmerman, 2005).

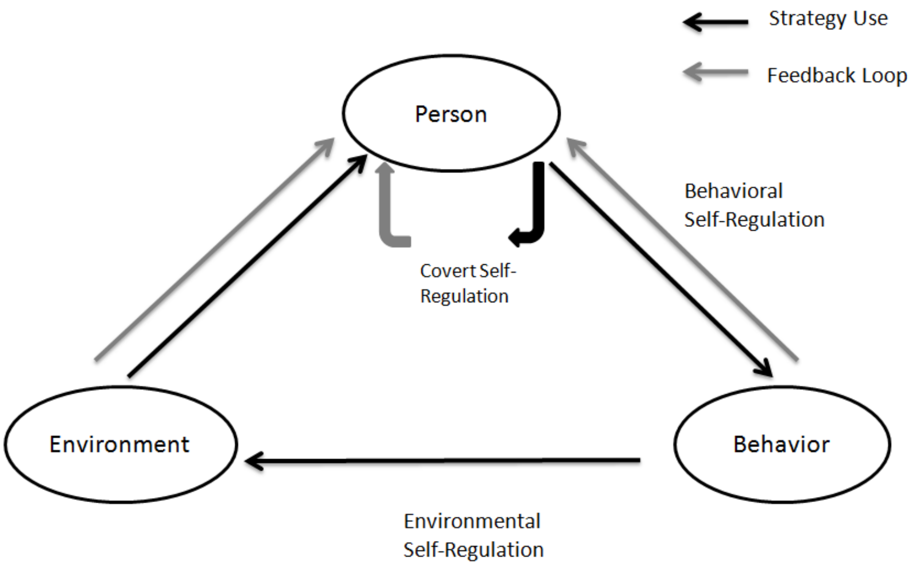

Figure 2.2 Triadric forms of self-regulation (Zimmerman, 2005, p. 15)

From a social cognitive perspective, Zimmerman (2005) described self-regulation as being cyclical in nature. In the cyclical nature of self-regulation, feedback obtained from prior learning experiences is used to make adjustments during current efforts. These adjustments are necessary because personal, behavioral, and environmental factors constantly change during learning. The cyclical phases of self-regulation include a forethought phase, a performance or volitional control phase, and a self-reflection phase (see Figure 2.3). The forethought phase is the planning phase which includes processes that precede efforts to act and set the stage for it. The performance or volitional control phase entails processes that occur during motoric efforts and affect attention and action. Two major types of performance or volitional control processes have been studied, namely self-control and self-observation. Self-control processes like self-instruction, attention focusing, and task strategies, help learners to concentrate on the task and optimize their efforts. Self-observation processes, on the other hand, refer to a learner's tracking of the specific aspects of their own performance. The last phase, self-reflection, includes processes that occur after performance efforts and influence the response to that experience. Due to the cyclical nature of self-regulation, self-reflection, in turn, influences the forethought phase completing a self-regulatory cycle (Zimmerman, 2005).

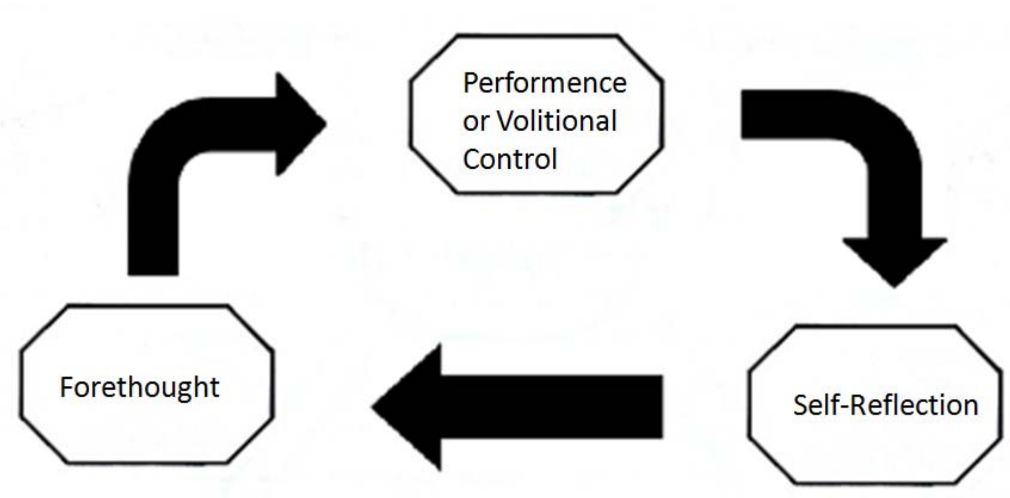

Figure 2.3 Cyclical phases of self-regulation (Zimmerman, 2005, p. 16)

2.2.2.2 Self-Regulated Learning Model of Winne and Hadwin

Winne (1996) defined self-regulation as metacognitively guided behavior enabling learners to adaptively regulate their use of cognitive tactics and strategies in the face of a task. According to this definition, self-regulated learning is associated with metacognitively guided, at least partly intrinsically motivated, and strategic forms of learning (Winne, 1995). Winne & Perry (2005) further elaborated this definition by separately describing the terms of metacognition, intrinsic motivation, and strategic. Metacognition is defined as the awareness that learners have about their general academic strengths and weaknesses, cognitive resources, and knowledge about how to regulate engagements in tasks to optimize learning. Intrinsic motivation is described in terms of the learners' belief in incremental learning, a high value placed on personal progress and deep understanding, high efficacy for learning, and attributions that link outcomes to factors under their control. Finally, strategic form of learning is considered as the way in which learners approach challenging tasks and problems by choosing among tactics that they believe are best suited to the situation, and applying those tactics properly (Winne & Perry, 2005).

The self-regulated learning model by Winne and Hadwin (1998) (see Figure 2.4) includes four different phases: defining the task, setting goals and planning how to reach them, enacting tactics, and adapting metacognition. The first phase of the model, defining the task, is characterized by the perceptions that the learner generates about the task at hand. There are two sources of information that contribute to these perceptions. Task conditions give information about the task in the environment and cognitive conditions are memorial representations of some characteristics of the similar past tasks. The second phase includes decision making to frame goals and assembling a plan for approaching them. Application of tactics and strategies identified in the second phase indicates a transition into third phase. The fourth phase is dedicated to adaptation of metacognition where students critically examine the outcomes of the preceding stages and makes major adaptations (Winne & Perry, 2005).

Each phase in the model is supposed to share the same general structure, referred as the COPES, the acronym formed by the first letter of the terms conditions, operations, products, evaluations, and standards (Winne & Hadwin, 1998). Conditions consist of information about the task conditions and cognitive conditions that influence how the task will be employed. Operations are the tactics and strategies students engage in when faced with a task. Operations produce particular type of product. Evaluations include internal and external feedback about the products. Finally, standards are the criteria against which the products are monitored. Metacognitive monitoring and metacognitive control are the two events critical to SRL in this model.

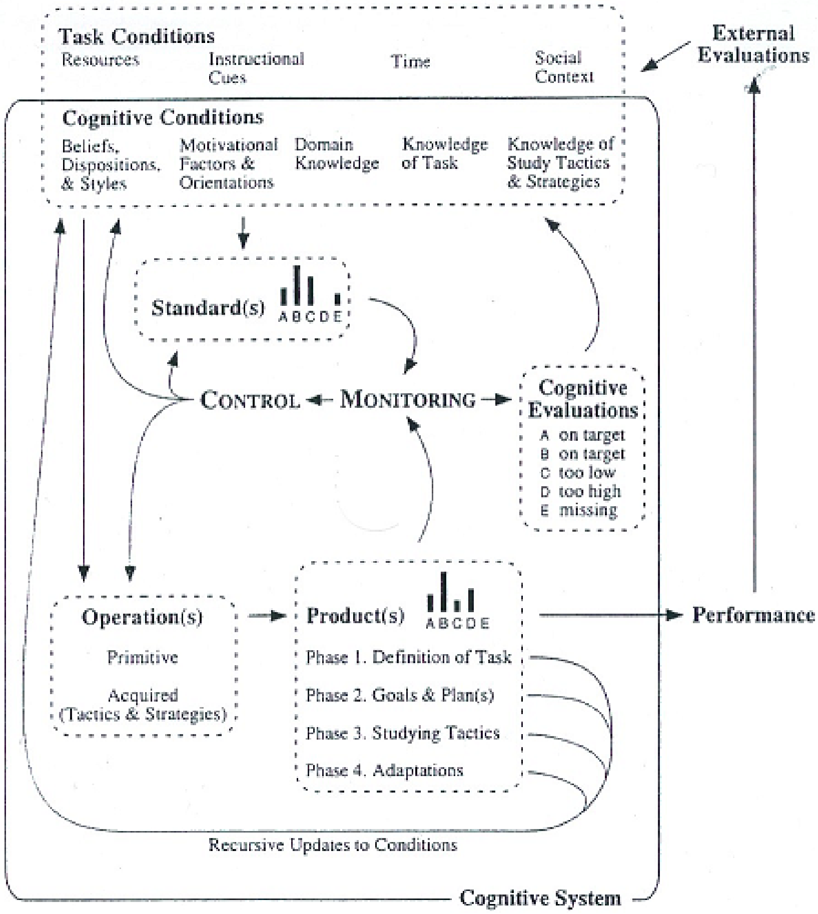

Figure 2.4 A four-stage model of self-regulated learning (Winne & Perry, 2005, p. 531)

2.2.2.3 Boekaerts' Model of Adaptable Learning

The Model of Adaptable Learning is a holistic framework that explores the interaction between intertwined aspects of SRL. An important assumption of the model is that individuals self-regulate their behavior in terms of two basic priorities: extending their knowledge and skills so that they can enlarge their personal resources and maintaining their available resources by preventing loss, damage, and distortions of well being. It is further assumed that the information processing modes which underlie these two priorities coexist, however may struggle for being dominant in the goal hierarchy of the learner. In this model, a central role is given to the construct of appraisal. This important role is represented by links between the appraisal process and the contents of a dynamic internal working model (WM). Three main sources of information appear to influence this WM (See Figure 2.5). The first source of information is the perception of the learning situation which entails the task, the instructions provided by the teacher, and the physical and social context. The second source of information is the knowledge and skills that involves declarative and procedural knowledge, cognitive strategies, and metacognitive knowledge related with the learning situation. The third source concerns the aspects of learners' self-system, including their goal hierarchy, values, and motivational beliefs (Boekaerts & Niemivirta, 2005).

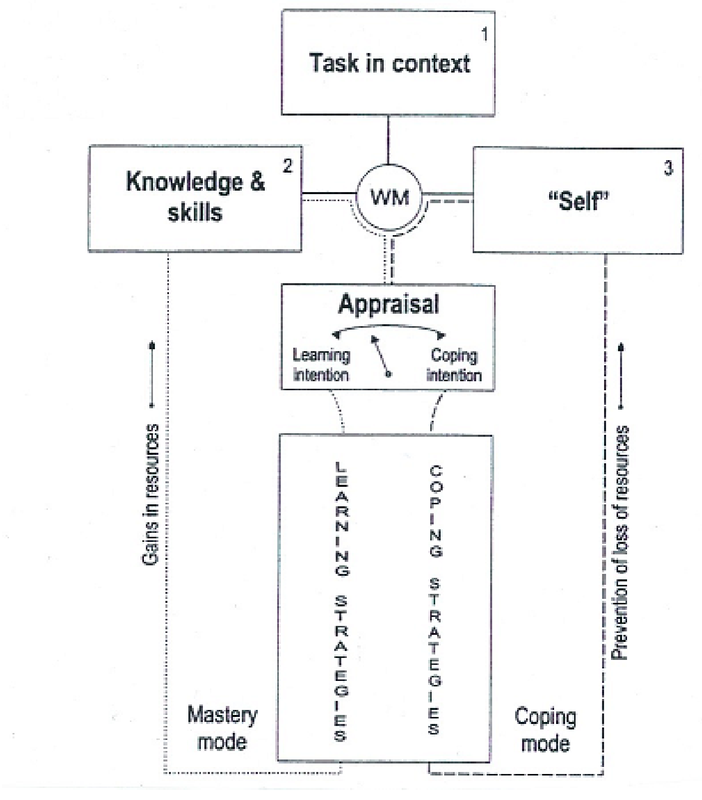

Figure 2.5 The model of adaptable learning (Boekaerts & Niemivirta, 2005, p. 429).

Boekaerts and her colleagues hypothesized that positive appraisals are evoked when the information in the dynamic WM is positive due to either availability of the relevant scripts or the link between the activity to be performed and personal goals and gains. On the contrary, it was suggested that negative appraisals arise when no relevant scripts can be located or when the learner is not inclined to spend energy for the task. The Model of Adaptable Learning further assumes that appraisals can direct students' behavior in the classroom. That is, positive appraisals are suggested to extent the subject knowledge and skill whereas negative appraisals are supposed to result in ego protection in order to prevent the loss of resources or to restore well-being (Boekaerts & Niemivirta, 2005).

Recently, Boekaerts and Niemivirta (2005) extended and refined the Model of Adaptable Learning. They defended the view that in order to develop effective self-regulation, students should be allowed to work in a learning context in which they are able to create their own learning episodes based on their own goals. The authors argued that the origins of the SRL trace back to identification, interpretation, and appraisal processes. Therefore, the refined model of adaptable learning was extended to include an identification process, two interpretation processes (task-focused and self-focused, and two appraisal (primary and secondary) processes. Boekaerts and Niemivirta (2005) focused on the hypothetical relationships between these five processes and theorized how these processes may affect goal setting and goal striving both of which are considered as the steps in the SRL process. In the refined version of the model, Boekaerts and Niemivirta (2005) also emphasized that SRL is not a unitary construct, rather it is a generic term used for a number of phenomena, each of which is captured by a different control system. Accordingly, they defined self-regulation as a system that refers to the overall management of one's behavior through interactive processes between these different control systems including attention, metacognition, motivation, emotion, action, and volition control. Finally, the authors suggested that SRL does not proceed in a linear way through the different phases of the model. Students may backtrack several times to a previous phase or they may bypass some of the phases.

2.2.2.4 Pintrich's Conceptual Framework for Self-Regulated Learning

Although different models of SRL, including the abovementioned models, are based on different perspectives or theories of SRL, they all share four general assumptions. The first assumption is the *active, constructive assumption* which views learners as active participants in the learning process. Learners are assumed to construct their own meanings, goals, and strategies from the information available in their external and internal environment. The second assumption is the *potential for control assumption* which assumes that learners can have the possibility and potential to monitor, control, and regulate certain aspects of their own cognition, motivation, behavior, and some features of their environments. The third assumption is the *goal, criterion, or standard assumption*. According to this assumption, there is some type of goal, criterion, or standard against which comparisons are made to assess whether to continue the process as it is or change it. The fourth assumption states that self-regulatory activities *are mediators between personal and contextual characteristics and actual achievement or performance*. By this assumption, it is hypothesized that it is not just individuals' cultural, demographic, or personality characteristics and the contextual characteristics of the classroom environment that directly influences achievement and learning, but the individuals' self-regulation of their cognition, motivation, and behavior that mediate the relations between the person, context, and achievement (Pintrich, 2004).

Given these assumptions, Pintrich (2005, p. 453) defines SRL as "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment". Based on the four assumptions outlined previously, Pintrich (2005) developed a conceptual framework for SRL. Table 2.5 presents this framework by classifying the different phases and areas for regulation. According to Pintrich's conceptual framework, SRL is composed of four different phases, which are forethought, monitoring, control, and reaction. These four phases make up the rows of the Table 2.5. For each phase in the Table 2.5, self-regulatory activities are listed in four different areas, which are cognition, motivation/affect, behavior, and context. The four columns in Table 2.5 represent these different areas for regulation.

The forethought phase involves planning and goal setting and also activation of perceptions and knowledge of the task and context and the self in relation to the task. The monitoring phase entails a number of monitoring processes that indicate metacognitive awareness of different aspects of the self or task and context whereas the control phase includes efforts to control and regulate them. Finally, reaction and reflection phase concerns various kinds of reactions and reflections on the self and the task or context (Pintrich, 2005). Defining these four phases underlying his conceptual framework of SRL, Pintrich (2005) also indicated that not all academic learning follows these phases; there are many circumstances in which students learn academic material in more tacit or implicit or unintentional ways without self-regulating their learning. Pintrich (2005) additionally stated that although these four phases represent a general time-ordered sequence that learners would go through as they perform a task, there is no strong assumption that the phases are hierarchically or linearly structured and earlier phases should always occur before the later phases.

The four columns in the Table 2.5 represent different areas for regulation. The first three areas in the table, namely cognition, motivation/affect, and behavior, reflect the aspects of psychological functioning of the individuals, whereas the context column reveals the importance of including social context in the SRL model (Pintrich, 2004). The cognition column involves the different cognitive strategies individuals can use to learn and perform a task. The metacognitive strategies that individuals may use to control and regulate their cognition, the content knowledge, and the strategic knowledge are included in the cognitive column as well. The motivation/affect column entails the various motivational beliefs that individuals may have about themselves in relation to the task. In addition, interest and liking of the task, positive and negative affective reactions to the self or the task, and any strategies that individuals may use to control and regulate their motivation and affect are included in this column. The behavior column concerns the general effort that may be exerted on the task by the individuals including persistence, help seeking, and choice behavior. The context column represents the attempts to control or regulate the external environment. Various aspects of the task environment or general classroom or cultural context where the learning is taking place are included in the context column (Pintrich, 2005).

Table 2.5 Phases and areas for self-regulated learning (Pintrich, 2005, p. 454)

	Areas for regulation			
Phases	Cognition	Motivation/Affect	Behavior	Context
1. Forethought, planning, and activation	Target goal setting	Goal orientation adoption	[Time and effort planning]	[Perceptions of task]
	Prior content knowledge activation	Efficacy judgments	[Planning for self-observations of behavior]	[Perceptions of context]
	Metacognitive knowledge activation	Ease of learning judgments (EOLs); perceptions of task difficulty Task value activation Interest activation		
2. Monitoring	Metacognitive awareness and monitoring of cognition (FOKs, JOLs)	Awareness and monitoring of motivation and affect	Awareness and monitoring of effort, time use, need for help Self-observation of behavior	Monitoring changing task and context conditions
3. Control	Selection and adaption of cognitive strategies for learning, thinking	Selection and adaption of strategies for managing motivation and affect	Increase/decrease effort	Change or renegotiate task
			Persist, give-up Help-seeking behavior	Change or leave context
4. Reaction and reflection	Cognitive judgments	Affective reactions	Choice behavior	Evaluation of task
	Attributions	Attributions		Evaluation of context

2.2.3 Factors Influencing Self-Regulated Learning

There are some factors related to students' SRL skills. The quality of these skills depends in part largely on particular characteristics related with the learner. Key among these characteristics are the students' motivational beliefs and gender. The following studies revealed that motivational beliefs and gender are related individually to SRL. There are also other learner related characteristics that may influence SRL such as ethnicity (Bembenutty, 2007), subject area (Wolters & Pintrich, 1998), grade and giftedness (Zimmerman & Martinez-Pons, 1990). The following section, however, deals only with gender and motivational beliefs as they are the most frequently reported ones.

The research related with gender differences with respect to SRL yielded conclusive results. When gender differences in the use of SRL strategies or in confidence to use them were examined, the results typically favor female students (Pajares, 2002). In a recent study, Bembenutty (2007) investigated whether students from diverse gender and ethnic groups differed with regard to their use of self-regulation, motivation, delay of gratification, and academic performance of 364 college students. The cognitive strategy (rehearsal, elaboration, organization, and critical thinking), metacognition, and resource management scales of the MSLQ were utilized in order to assess participants' SRL strategies. The results of the MANOVA indicated a significant main effect for gender, $\lambda = .88$, $F(1,320) = 2.47$, $p < .001$, $\eta^2 = .12$. Among the cognitive strategies, the group comparisons indicated that males had lower rehearsal and organization scores than females. Bembenutty explained these differences by considering gender socialization process. It was suggested that the way the educators respond to males and females in the class may lead students to behave accordingly. For example, Bembenutty indicated that females may be expected to display more organization skills than males, or males may believe that it is not socially acceptable for males to have high organization skills. Such gender socializations may then affect the behavior patterns of males and females.

In an earlier study, Wolters and Pintrich (1998) also assessed differences in students' cognitive strategy use and regulatory strategy use by gender and across areas of mathematics, social studies, and English. A total of 545 seventh and eighth grade students with a mean age of 12.6 years participated in the study by responding an adapted version of the MSLQ. Resembling to the reportings of Bembenutty, the results of this study also suggested that females reported higher levels of cognitive strategy use than males across all three subject areas. In contrast, the reported levels of regulatory strategy use were indicated to be very similar among all subject areas for both males and females.

Another evidence for the potential gender difference in SRL came from the study by Patrick, Ryan, and Pintrich (1999). In an attempt to investigate the associations between males' and females mastery and extrinsic goal orientations and their SRL and performance, the researchers surveyed 445 seventh and eighth grade students from a junior high school. Students' cognitive strategy use and regulatory strategy use were measured with the scales of the MSLQ. The results of the independent samples *t*-tests performed to investigate the gender differences in the cognitive and regulatory strategy use indicated that females reported higher levels of cognitive strategy use than males in mathematics, social studies, and English.

Females' superiority regarding the use of SRL strategies is supported by the study of Zimmerman and Martinez-Pons (1990) as well. Using the same self-regulated learning interview schedule (Zimmerman & Martinez-Pons, 1986; 1988), the investigators examined the SRL strategies of 90 students from fifth, eighth, and eleventh grades. The results of MANOVA analysis revealed a main effect for students' gender $F(15, 154) = 2.09$, $p < .02$. Univariate tests examining gender differences in the use of SRL strategies indicated that females reported significantly more record keeping and monitoring, environmental structuring, and goal-setting and planning than did males.

In addition to gender differences, the recent research on students SRL has stressed the importance of considering motivational beliefs that students hold about themselves. Although there are a number of important motivational components, three of them have been constantly reported to be related with SRL: beliefs about students' judgments of their capability to accomplish a task, value for the task, and the affective or emotional reactions to the task (Pintrich & De Groot, 1990). In their study of motivational and SRL components of classroom academic performance, Pintrich and De Groot (1990) examined how the three motivational components (task value, self-efficacy, and test anxiety) related to the components of SRL (cognitive strategy use and self-regulation). The zero-order correlations among motivational and SRL components revealed associations among the variables. According to the results, higher levels of self-efficacy ($r = .33$) and intrinsic value ($r = .63$) were correlated with higher levels of cognitive strategy use. Test anxiety was not related with cognitive strategy use. Parallel with these findings, higher levels of self-efficacy ($r = .44$) and intrinsic value ($r = .73$) were correlated with higher levels of self-regulation. Test anxiety was found to be negatively related with self-regulation ($r = -.13$). The two cognitive scales were then used as dependent variables in a multivariate analysis of covariance with prior achievement (first semester grade) as a covariate. The results from the MANCOVA revealed significant main effects for self-efficacy, $F(1, 164) = 4.24$, $p < .04$, and intrinsic value, $F(1, 164) = 45.93$, $p < .0001$, but not for the test anxiety. These results showed that students who believed they were capable of doing the task were more likely to report use of cognitive strategies and self-regulatory strategies than students low in self-efficacy. Intrinsic value was reported to be very strongly related to use of cognitive strategies and self-regulation, independent of initial performance levels. Students who were motivated to learn the material and believed that their school work was interesting and important were more likely to use cognitive strategies and to be self-regulating than students low in intrinsic value.

Following the general strategy of the abovementioned investigation, Wolters and Pintrich (1998) assessed the relations among the motivational, strategy use, and performance measures by using multiple regressions. More specifically, motivational beliefs (task value, self-efficacy, and test anxiety) were used to predict the cognitive outcomes (cognitive strategy use, regulatory strategy use, and academic performance) in mathematics, English, and social studies. Wolters and

Pintrich reported that gender, task value, self-efficacy, and test anxiety together accounted for a significant portion of the variance in cognitive strategy use in mathematics, $F(4,540) = 61.66$, $p < .001$, English, $F(4,540) = 75.12$, $p < .001$, and social studies, $F(4,540) = 62.77$, $p < .001$. Task value had the greatest individualized standardized coefficient in the analyses predicting cognitive strategy use in mathematics ($\beta = .49$), English ($\beta = .39$) and social studies ($\beta = .40$). This result indicates that students who valued and were interested in the subject area reported higher levels of cognitive strategy use in all three subject areas. Self-efficacy and test anxiety were also found to be significant predictors of students' cognitive strategy use in mathematics ($\beta = .13$ and $\beta = .14$, respectively), English ($\beta = .30$ and $\beta = .16$, respectively), and social studies ($\beta = .25$ and $\beta = .15$, respectively). It was suggested that students who reported greater self-efficacy and higher levels of test anxiety were more likely to report using cognitive strategies in three different subject areas than students who were less efficacious and less anxious.

The results of the regression analysis also showed that gender, task value, self-efficacy, and test anxiety together accounted for about one-third of the variance in regulatory strategy use in mathematics, $F(4,540) = 74.81$, $p < .001$, English, $F(4,540) = 63.87$, $p < .001$, and social studies, $F(4,540) = 63.87$, $p < .001$. Similar to the results with cognitive strategy use, task value was found as the single best predictor of regulatory strategy in mathematics ($\beta = .47$), English ($\beta = .36$) and social studies ($\beta = .39$). It was suggested that students who reported greater task value for the three subject areas reported using regulatory strategies more often than students with lower task value. Self-efficacy and test anxiety were also found to be significant predictors of students' regulatory strategy use in mathematics ($\beta = .11$ and $\beta = -.13$, respectively), English ($\beta = .19$ and $\beta = -.16$, respectively), and social studies ($\beta = .16$ and $\beta = -.17$, respectively). These results indicated that while greater levels of self-efficacy were associated with greater use of regulatory strategies, students who reported higher levels of test anxiety were less likely to report regulatory strategy use across all three subject areas.

Another evidence for the relationships among motivational constructs and SRL came from the study by Pintrich (1999). In a research program designed to describe how different motivational beliefs help to promote, sustain, or facilitate SRL, data from approximately 1000 middle school and over 3000 college students have been collected over the years by using the MSLQ. The relations between motivation and self-regulation have been examined using correlational analyses. The results revealed positive relations between self-efficacy and SRL for both middle school and college students. Students who felt more efficacious about their ability to do well in the course were reported to be more likely to use all three types of cognitive strategies (rehearsal, elaboration, and organization strategies). The correlation coefficients between self-efficacy and cognitive strategy use ranged between .26 and .61 for middle school and between .10 and .36 for college students. Self-efficacy was also found to be related to self-regulatory strategies with correlations ranging between .29 and .67 for middle school and between .12 and .58 for college students.

Pintrich (1999) also reported that in addition to self-efficacy, task value beliefs were correlated positively with cognitive strategy use. The correlation coefficients between task value and cognitive strategy use ranged between .11 and .63 for middle school and between .03 and .55 for college students. Task value was also found to be related to self-regulatory strategies with correlations ranging between .02 and .73 for middle school and between .03 and .67 for college students.

The research reviewed in this section clearly suggests that gender and certain types of motivational beliefs play role in students' SRL. The reviewed studies generally favored female students in the use of cognitive and self-regulatory strategies. According to the related investigations, females were more likely to use SRL strategies during learning process than males. The studies repeatedly revealed the positive associations between self-efficacy and task value beliefs and SRL as well. Accordingly, it can be concluded that students who believe their capabilities to perform the learning task and who believe that the task is interesting, important, and useful are more likely to report the use of self-regulatory strategies. Test anxiety was also reported to be related with the use of SRL strategies, however, the nature of this relationship showed variation. That is test anxiety was reported to be both positively and negatively related with SRL. These findings highlighted the need and importance of examining the relationship between test anxiety and SRL in depth.

2.2.4 Self-Regulated Learning and Academic Achievement

There is a growing body of research indicating the important role that students' use of SRL strategies play in their academic achievement (Zimmerman, 1990). The research on strategy use and achievement examined how the use of subject-matter-specific and general and metacognitive strategies influence achievement (Pokay & Blumenfeld, 1990). Specifically, self-regulation theory focuses on how students personally activate, alter, and sustain their learning practices in specific contexts (Zimmerman, 1986). The studies reviewed in this section presents evidence for the definite relationship between self-regulated learning and achievement as revealed by this research.

In one of the earlier studies, Zimmerman and Martinez-Pons (1986) highlighted the association between self-regulated learning and achievement or performance. The researchers interviewed forty tenth grade students from a high achievement track and forty from lower achievement track of a high school concerning their use of self-regulated strategies during class, homework, and study. The interview procedure involved presenting a series of common learning problems or contexts and asking students to describe the methods they used in different learning contexts and to rate their consistency in using each method. Fourteen categories of self-regulation strategies were identified from student answers. These strategies included self-evaluation, organizing and transforming, goal-setting and planning, seeking information, keeping records and monitoring, environmental structuring, self-consequences, rehearsing and memorizing, seeking peer, teacher, or adult assistance, reviewing notes, tests, or text books. The results indicated that a structured interview procedure designed to assess students' use of SRL strategies in classroom and non-classroom contexts displayed considerable correlation with academic achievement. Of the 14 identified categories of SRL strategies, the high achievement group of students reported significantly greater use than the low achievement group for 13 of these categories. Another impressive finding was that students' achievement track in school was predicted with 93% accuracy using these self-reports, and these reports were highly correlated with their standardized test performance, $r = .61$. The results of the regression analysis revealed that students' use of SRL strategies yielded a substantial increase in the prediction of standardized test scores after the effects of gender and socioeconomic status were removed. When these three variables were considered together, only SRL strategy measures produced a significant regression coefficient. The correlation of SRL scores with English and mathematics achievement were .56 and .55, respectively.

In a complementary study, Zimmerman and Martinez-Pons (1988) validated a strategy model of student SRL as a theoretical construct. In this study, a sample of 80 tenth-grade students was asked to describe their use of fourteen SRL strategies in different learning contexts and their teacher were requested to rate these students for their SRL during class. A high canonical correlation ($R = .70$) was found between the teacher ratings and students' reports of SRL strategies. Factor analyses of the teachers' ratings along with students' scores on a standardized test of mathematics and English revealed a single SRL factor that accounted for nearly 80% of the variance in achievement. The correlation between student SRL and achievement was found as .43 at the end of the study.

In an attempt to explore the relations between motivation, SRL, and student performance on classroom academic tasks, Pintrich and De Groot (1990) administered the MSLQ that included 56 items on student motivation, cognitive strategy use, metacognitive strategy use, and management of effort to a total of 173 seventh graders. Academic performance was measured by collecting data on student performance on classroom tasks and assignments. The zero-order correlations between SRL variables and performance revealed that higher levels of cognitive strategy use and self-regulation were associated with higher levels of achievement on all assignments (correlations ranging from .18 to .36), with the exception of seatwork performance and cognitive strategy use. The relations among motivation, learning strategy use, and achievement were examined in another study by Pokay and Blumenfeld (1990) as well. A total of 283 high school students in geometry classes were administered questionnaires early and late in the semester. Students' grades from the first and third geometry tests were used as a measure of achievement. Path analyses were performed in order to determine the effects of motivation (ability perceptions, expectancies, and perceived value) and use of learning strategies (metacognitive, general cognitive, geometry specific, and effort) on achievement both in the early and late semester. The results revealed that the use of geometry-specific strategies (β = .17) and effort management strategies (β = .14) positively influenced the early geometry test grades while the use of general cognitive strategies was unrelated and the metacognitive strategy use (β = -.14) was related negatively to early achievement. Later in the semester, however, only the use of metacognitive strategies had positive influence on later geometry test grade (β = .14). According to the researchers, the finding that the use of specific geometry strategies predicted initial achievement whereas metacognitive strategies predicted later achievement suggested that students may be able to make effective use of metacognitive strategies only after they become skilled at the use of specific strategies. As students become more skillful at selecting and using specific strategies, their thinking about strategies become more important and students who use metacognitive strategies are more successful at that time.

In another study, Sink, Barnett, and Hixon (1991) investigated specific components of self-regulated learning and their relationship to various measures of academic achievement of 62 sixth grade students. The researchers examined particular components of SRL, namely planning behavior, including organization, direction of actions, and efficient solutions to problems, in relation to two indicators of achievement–classroom performance as shown by teachers' grades in mathematics, reading, and science and achievement as demonstrated by scores on standardized tests. Sink et al. (1991) found significant correlations among metacognitive and achievement measures. Planning was found to be significantly related to teachers' grades and achievement scores in mathematics, reading, and science, with correlations ranging from .35 to .59. Planning behavior correlated moderately with teachers' grades (r = .35) and achievement scores (r = .43) in science. Multiple regression analyses relating metacognitive variables to teacher-made and standardized achievement tests showed that planning was a strong predictor of the both achievement measures.

Another study of SRL and achievement on elementary grade students by Wolters, Yu, and Pintrich (1996) supported the findings of Sink et al. (1991). In this study, the relations between students' goal orientations, motivational beliefs, SRL, and academic performance were examined in a correlational study of 434 seventh and eighth grade students. Data were collected over two time periods, at the beginning and at the end of the school year. The MSLQ was utilized to collect data about students' motivational beliefs (task value, self-efficacy, test anxiety) and SRL (cognitive strategy use and self-regulation). Students' grades within each subject area (mathematics, English, and social studies) from the first and second semesters were collected from school records as the measures of classroom academic performance. Zero-order correlations between students' SRL and performance for the three subject areas at Time 1 and Time 2 revealed significant associations among the variables. SRL was significantly and positively related with mathematics performance (*r*'s between .17 and .25, $p < .05$), with English performance (*r*'s between .10 and .22, $p < .05$), and with social studies (*r*'s between .19 and .30, $p < .05$).

Relations between self-regulation strategies and academic achievement of elementary level students were further investigated in the study of Eshel and Kohavi (2003). This study examined whether measures of SRL strategies, self-efficacy, and intrinsic motivation were positively and significantly related to sixth grade students mathematics achievement or not. The cognitive strategy use scale of the MSLQ consisted of 13 items describing methods of organizing and rehearsing the learned materials was administered to 302 sixth grade students. Mathematics achievement was measured by a national test consisted of five subsets covering the related curriculum. The association among SRL strategies and mathematics achievement was examined by means of Pearson correlations. The results revealed that cognitive strategy use was significantly and positively correlated with four of the five mathematics subsets, correlations ranging from $r = .17$ to $r = .24$. These associations indicated that higher math scores were positively associated with use of SRL strategies.

Three of the reviewed studies examined SRL strategies of the university students from different majors in relation to specific learning outcomes. In one of these investigations, Ridley, Schutz, Glanz, and Weinstein (1992) examined the multidimensional model of SRL empirically. The researchers investigated the interactive influence of two self-regulatory processes, namely goal-setting and metacognitive awareness, on students' performance in a novel decision-making task. The subjects for the study were 89 undergraduate education majors with a mean age of 23.5 years. Participants were placed into one of the four experimental groups based on their metacognitive awareness (high or low) and goal-setting behavior (set goals or not). The results of analysis of covariance (ANCOVA) revealed that only metacognitive awareness - goal intervention interaction was significant, $F(1,81) = 4.17$, $p < .04$. There was no main effect either for goal intervention or for metacognitive awareness. This result indicated that the interaction of being asked to set clearly defined goals and a tendency to develop a high degree metacognitive awareness best facilitated individuals' performance on the decision-making task.

The study of Hwang and Vrongistinos (2002) examined the differences and similarities in using SRL strategies between high and low achieving elementary teacher education students. Self-report data were collected from 41 elementary in-service students by using a SRL Likert-type questionnaire adopted from the MSLQ. Besides measuring other constructs, the questionnaire was composed of items related to rehearsal, elaboration, organization, critical thinking, metacognition, and regulatory process constructs. A one-way MANOVA was conducted across all constructs, with academic performance level (high and low) as the grouping factor. The results revealed statistically significant differences for the academic performance factor, $F(1, 38) = 2.637$, $p < .05$. This result indicated that high achieving in-service teacher students were more likely to use various SRL strategies than the low achievers. The MANOVA showed a significant group main effect, $F(1, 38) = 8.908$, $p < .01$, for elaboration indicating that the high achievers were significantly more likely to apply what they learned in the class to real situations than the low achievers. The results also showed a significant group main effect, F (1, 38) = 13.844, $p < .001$, for metacognition. According to this result, the high academic performers were significantly more likely to use metacognitive strategies, such as planning ahead, thinking through the main ideas of the course materials, and skimming a project to see how it is organized, than the low academic performers. Finally, the MANOVA showed a significant group main effect, F (1, 38) = 34.056, $p < .001$, for regulatory process suggesting that the high academic achievers were significantly more likely to think that they planned, monitored, and evaluated their study than the low academic achievers. Hwang and Vrongistinos (2002) concluded that these results strengthen the evidence that using SRL strategies was closely related to elementary in-service teacher students' academic performance.

In another study, Valle, Cabanach, Nunez, Gonzalez-Pienda, Rodriguez, and Pineiro (2003) analyzed the viability of a general cognitive-motivational model to explain the principal cognitive, motivational, and volitional variables involved in academic learning and performance of 614 university students. Structural equation analysis was employed and the analysis of the effects between the variables of the model revealed some important aspects of academic achievement. Students' predisposition to feel responsible for the results of their academic behavior (internal attribution) was related to positive self-image (academic self-concept) (β = .131), both of which were important for the development of learning-oriented motivation (learning goals) (β = .113 and β = .147, respectively). All of this involved selection and use of learning strategies for deep information processing (deep learning strategies) (β = .270), which leads students to assume responsibility with high levels of persistence to achieve goals defined by the motivational orientation (β = .121). This persistence and effort to achieve the proposed goals has in turn a positive and significant effect on academic achievement (β = .128).

2.2.5 Characteristics of Self-Regulated Learners

The researchers from different theoretical perspectives characterize self-regulated learners differently. However, there are certain features most often attributed to self-regulated learners. Table 2.6 summarizes the characteristics of learners using SRL strategies proposed by different authors.

Table 2.6 Characteristics of self-regulated learners

Characteristics	Author
• hold a collection of adaptive beliefs and attitudes that drive their willingness to engage in and persist at academic tasks • have the cognitive strategies that they can readily and skillfully organize to accomplish different academic tasks	Wolters, 2003
• are highly self-efficacious and view the learning task as valuable, interesting, and useful to know	Pintrich, 2005
• view achievement as a systematic and controllable process and accept greater responsibility for their own achievement outcomes	Zimmerman & Martinez-Pons, 1986; 1990
• display confidence in their ability and hard-work in their efforts • are aware whether they have or do not have knowledge about a fact or process • approach educational tasks carefully in confidence and resourcefulness • seek out information when required and take the necessary steps to master it • find a way to be successful when they encounter obstacles • are self-aware, knowledgeable, and influential in their approach to learning • are self-starters who demonstrate high effort and persistence during learning process	Zimmerman, 1990

Table 2.6 (Continued)

Characteristics	Author
• are metacognitively, motivationally, and behaviorally active participants in their own learning	Zimmerman, 1986
• are metacognitively skilled in the use of cognitive strategies	Butler & Winne, 1995 & Zimmerman, 1989
• plan, set goals, organize, self-monitor, and self-evaluate during the learning process	Corno, 1986
• are capable of monitoring their learning and creating internal feedback about their cognitive processing	Butler & Winne, 1995
• analyze task demands and select, adapt, or invent strategic approaches to achieve task objectives • monitor outcomes associated with strategy use, self-evaluate performance, and interpret externally provided feedback	Butler, 2002
• select, structure, and create environments that optimize learning • self-initiate activities for promoting self-observation, self-evaluation, and self-improvement	Zimmerman & Martinez-Pons, 1986

2.2.6 Summary of the Literature on Students' Self-Regulated Learning

SRL is regarded as a complex construct which cannot be defined simply and straightforwardly. By focusing on different aspects of the self-regulation and addressing different components of the construct, educational psychologists have proposed different theoretical models and conducted studies to produce theoretically relevant and pragmatic information about SRL. Accordingly, there are different theories and models in SRL each of which emphasizing slightly different aspects of SRL. Besides the efforts to conceptualize self-regulation, the researchers have been concentrated on the learner characteristics that may be associated with the use of self-regulatory learning strategies. The reviewed studies mainly pointed out that motivational beliefs and gender are related individually to SRL. There are also other learner related characteristics that are reported to influence SRL such as ethnicity, subject area, grade, and giftedness. The literature on SRL also emphasizes the association between use of self-regulated strategies and academic achievement. The studies reviewed in this section presents evidence for the definite relationship between self-regulated learning and achievement.

2.3 Research on Approaches to Learning

The previous sections reveal the importance of considering epistemological beliefs and self-regulated learning as important determinants of student success in different learning contexts. There are, of course, many other interacting variables influencing academic achievement or performance. One such variable that has been the focus of educational research in recent years is the way students approach to their learning task, or their learning approaches.

Diseth and Martinsen (2003) defines students' approaches to learning or learning approaches as "the individual differences in intensions and motives when facing a learning situation, and the utilization of corresponding strategies" (p.195). Research on learning approaches derives much from the work of Marton and Saljö (1976) on reading from texts using phenomenographic methods, where learning is studied from the perspective of the learner, based on qualitative analysis of interview data and descriptive analyses of differences between the learning behaviors of small numbers of students. Marton and Saljö (1976) identified two different levels of processing of the reading materials by students which were labeled as deep and surface approaches to learning. According to Marton and Saljö, students with a deep approach have intention to understand and extract meaning from the reading text, while those with a surface approach only memorize the facts and remember it word for word. The general framework and defining features of the deep and surface approaches were described by Biggs (as cited in Leung & Kember, 2003). As Biggs identified, a student who adopts a deep learning approach (a) is intrinsically motivated, is interested in the academic task and derives enjoyment from carrying it out, (b) searches for the meaning inherent in the task, (c) personalizes the task, making it meaningful to own experience and to the real world, (d) integrates aspects or parts of task into a whole, sees relationships between this whole and previous knowledge, and (e) tries to theorize about the task, forms hypothesis.

A students adopting a surface approach, on the other hand, (a) is extrinsically motivated, (b) sees the task as a demand to be met, a necessary imposition if some other goal is to be reached, (c) sees the aspects or parts of the task as discrete and unrelated either to each other or to other tasks, (d) is worried about the time the task is taking, (e) avoids personal or other meanings the task may have, and (f) relies on memorization, attempting to reproduce the surface aspects of the task.

The most important aspect of the distinction between the two approaches lies in the intention, or the absence of intention, to understand (Kember, 1996). Using a surface approach there is no intention to understand. As Biggs puts it the student "avoids personal or other meanings the task may have" (1987, p.15). Without the attempt to seek understanding, the student is forced to rely upon memorization as a strategy for learning the set material. The approach, therefore, utilizes rote-learning or memorization without understanding. A surface approach, then, is characterized by the intention to memorize without any attempt to understand. The outcome of such learning approach can be little or no understanding. When using a deep approach, a student has the intention of seeking the inherent meaning of the area of study. Using a deep approach, a student has the intention to understand and the result is meaningful learning.

According to Ausubel (1968), for meaningful learning to take place (a) the concepts presented to the learner must be potentially meaningful and hence must provide opportunity for the learner to form non-arbitrary relationships with existing conceptual frameworks, (b) the learner must have a conceptual framework to which the new concepts can be linked, and (c) the learner must manifest the meaningful learning set. To fulfill this last criterion, the learner must actively attempt to form connections between newly learned concepts and prior knowledge (Ausubel, 1963; Novak, 1988).

2.3.1 Factors Influencing Students Approaches to Learning

Numerous studies that have been conducted to assess students' use of learning approaches since 1970s have constantly shown that students approaches to learning (SAL) dependent on or influenced from a number of factors. Zeegers (2001) categorized these factors as contextual (e.g., teaching/learning activities, assessment procedures, institutional values) and as personal factors (e.g., gender, age, prior experiences). It is also well documented that SAL is not a stable characteristics; instead it is dynamic and changeable with students' perception of the learning context and the needs of the task (Trigwell & Prosser, 1991).

Key among the personal characteristics that are influential on learning approaches are the students' age and gender. The following studies revealed that age and gender are related the students' adoption of a specific learning approach. There are also other learner related and contextual factors that may influence approaches to learning. There are various studies investigating the possible relationships between learning approaches and different factors such as discipline type (Elley, 1992; Sadler-Smith, 1996), nature of the assessment (Minbashian, Huon, & Bird, 2004; Scouller, 1998; Scouller & Prosser, 1994), prior academic achievement (Snelgrove & Slater, 2003; Young, 1993), learning context and learning environment (Dart & Clarke, 1991; Entwistle, 1991; Entwistle & Tait, 1990; Hayes & Richardson, 1995; Laurillard, 1979; Ramsden, 1979; Vermetten, Lodewijks, & Vermunt, 1999), conceptions of learning (Trigwell & Prosser, 1991; Van Rossum & Schenk, 1984), ability (Thomas & Rohver, 1986), and developmental differences (Brown & Day, 1983). The following review concentrates on the influence of age and gender on students' learning approaches.

Research constantly shows that age is positively related with the use of a deep approach and negatively related with the adoption of a surface approach. The majority of the investigations concentrating on the gender differences on the learning approaches, on the other hand, reported no gender differences in the adoption of either deep or surface approaches to learning. In an effort to evaluate the relationships between student age, gender, and university entry mode on SAL and to evaluate the predictive validity of learning approaches on students' GPA, Zeegers (2001) administered a self-report Likert instrument to a total of 200 commencing science students in a university. With its 42 items, the instrument was designed to measure three dimensions of students learning; a deep approach which is characterized by an intention to understand the material by relating it to a wider context, a surface approach which is characterized by an intention to complete the requirements of the task by memorizing; and an achieving approach which is characterized by an intention to be successful and to obtain high grades. The questionnaire was administered in a first-year class and repeated at intervals of 4 and 8 months. This was followed by post administrations 16 and 30 months. The results revealed that students' age was a major factor in the SAL, but no gender effect was evident. The younger students tended to consistently have higher mean score for the surface approach and lower mean score for achieving approach and deep approach. The older students, on the other hand, generally displayed a higher deep approach and achieving approach and a lower surface approach.

Additional investigation by Duff (2003) produced evidence concerning the effects of background variables on approach to learning. In a study examining the relationship between approaches to learning and background variables of age, gender, and prior experience, Duff (2003) administered a 30-item self-report questionnaire to assess the learning approaches of 75 university students. The analyses of variance were conducted to determine the impact of gender, age, and prior education on students' scores on the three approaches to learning scales (i.e., deep approach, surface approach, strategic approach). The results revealed that male and female students showed no overall difference in their scores on the three approaches to learning dimensions, except that females obtained higher scores on the surface approach scale. The study also reported the likelihood of the adoption of a deep approach increasing monotonically across the three age groups. Specifically, the older students were more likely to adopt a deep approach and less likely to adopt a surface approach than younger students.

The study by Chan (2003) also supports the results of the abovementioned two investigations. In an effort to identify the differences in the study approaches of students in terms of age and gender, Chan (2003) administered a three sub-scaled (surface, deep, and achieving) instrument to a total of 292 teacher education students. The three study dimensions were regressed across age and gender by using the multivariate analysis of variance (MANOVA). The results suggested that there was a significant effect of age on only deep approach which indicated that as students grows older they tend to adopt an increasingly deep approach to study. Chan (2003) discussed that as students grow older they tend to rely on the process of understanding rather than memorization of the facts. The MANOVA, on the other hand, indicated that there was no significant difference in the study approaches at either the .05 or the .01 level across the gender. This result implies that male and female students did not differ in their study approaches, a result supporting the findings of Duff (2003) and Zeegers (2001).

Of the studies identified, the majority of them highlighted the influence of age on SAL whereas constantly showed that SAL was gender independent. However, the following two studies provided evidence for the possible gender differences in SAL. In their study of the relationship between SAL and the learning outcomes of 133 university students, Gijbels, Van de Watering, Dochy, and Van den Bossche (2005) identified both gender and age influences on surface and deep surface approaches. Specifically, the researchers found that the mean score of females in surface approach (M = 2.07, SD = .59) differs significantly from the scores of males (M = 2.43, SD = .53, $F(1,129) = 12.03$, $p < .01$) suggesting that male students adopted a significantly higher level of surface approaches. The results of the study also indicated that the deep approach to learning had a statistically significant relationship with students' ages (r = .22, p = .01). This relationship revealed that the older the students, the more deep approaches to learning are used.

Another evidence for the gender differences in SAL was provided by the study of Smith and Miller (2005). In an attempt to investigate the learning approaches with respect to examination type, discipline of study, and gender, the researchers administered a Likert-type 42-item questionnaire to a total of 248 university students to measure their learning approaches. A 2X2X2 MANOVA between-subject design was performed with assessment type (multiple-choice and essay), discipline of study (psychology and business), and gender being the independent variables and subscales of the questionnaire (deep motive, deep strategy, surface motive, surface strategy, achieving motive, and achieving strategy) being the dependent variable. The results revealed that female students obtained higher scores than male students on achieving strategy. It was suggested that female students reported themselves to be consistent and regular in their study habits, regular in monitoring their understanding, and organized in note taking and assignment preparation (Smith & Miller, 2005).

Other than age and gender, there are additional contributor variables to SAL reported by different studies in the related literature. To begin with, differences in learning approaches according to assessment type were observed in different studies. Evidence suggested that students adopting one learning approach may change that approach according to situational factors, one of which has been documented to be the nature of assessment (Scouller, 1998). The importance of the assessment type in influencing SAL has been clearly documented in Scouller (1998) and Scouller and Prosser (1994). It was suggested that assessment has been found to influence how much, by which learning approach, and what the students learn. It was also implied that two methods of assessment, that is multiple choice question examination and the essay type examination, were worth to be considered (Scouller, 1998). Scouller mentioned that students generally view essay type of examinations and assignments as measuring high levels of cognitive processing, therefore tend to adopt deep approaches while preparing essay type assessments. Students, on the other hand, consider multiple-choice examinations as assessing lower levels of cognitive processing, thus they are more likely to employ surface approaches when preparing that type of examinations. Inconsistent with the reporting of Scouller, however, it was indicated by Smith and Miller (2005) that assessment type had no significant influence on how students approach their learning. The researchers hypothesized that the variability in students' ability and maturity might have moderated the influence of multiple-choice examination on surface learning strategy to bring about a non-significant effect. It was also suggested that pressure and time constraints associated with performing under an examination condition might have moderated the level of students' deep learning strategy resulting in the lack of significant influence of essay examination in promoting deep learning.

2.3.2 Approaches to Learning and Academic Achievement

The relationship between approaches to learning and different learning outcomes has been substantiated in a number of research studies (Trigwell & Prosser, 1991). The relationship between learning approach and academic outcomes (e.g., course and assessment grades, GPA, self-rated academic progress) reveals inconsistent results, although it is generally believed that a deep approach/meaningful learning will contribute positively to various learning outcomes (Zeegers, 2001).

A number of studies on students' learning science suggest that a student's learning approach is a factor influencing his or her learning outcome (Chin & Brown, 2000). The study by Cavallo and Schafer (1994) on 140 tenth grade students' understanding of genetics topics showed that the more meaningful the students' learning orientation was, the more meaningful was the understanding they tended to attain. This study used a 50-item Likert questionnaire addressing students' meaningful or rote approach to learning, students' self-ratings and teachers' observations to identify each student's general approach to learning. It was a pretest-treatment-posttest design with random assignment of students to the two treatment groups. The results of the stepwise multiple regression analysis indicated that meaningful learning orientation was one of the significant predictors of students' meaningful understanding of the genetics topics. Another important finding of this study was that the learning orientation (meaningful or rote) is a variable of learning that is distinct from aptitude and achievement motivation.

Another study by Cavallo (1996) provided additional evidence for the apparent relationship between meaningful learning orientation and science topics. Specifically, she explored the associations among tenth grade students' meaningful learning orientation, reasoning ability and acquisition of meaningful understandings of genetics topics, and ability to solve genetics problems. Regression analyses were conducted to examine the predictive influence of the selected variables on students' performance on the different test. The results showed that meaningful learning orientation best predicted students' understanding of genetics interrelationships and performance on all except one of the open-ended test questions.

In their study of the relationship between students' conceptual knowledge and study strategies, Hegarty-Hazel and Prosser (1991a, 1991b) reported that deeper and more meaningful strategies were associated with better developed propositional knowledge and more surface strategies were related with less developed propositional knowledge both in electricity and photosynthesis concepts in first-year university courses. Another study by BouJaoude (1992) investigated the relationship between high school students' learning approaches, prior knowledge and attitudes toward chemistry and performance on a misunderstanding test. The results of this investigation revealed that students' learning approaches accounted for a statistically significant proportion of the variance on their performance on a misunderstandings posttest in chemistry. It was also reported that the relatively meaningful learners performed significantly better than the relatively rote learners on the misunderstandings posttest.

In an attempt to investigate the relationships between selective variables and students' performance in a college chemistry course, BouJaoude and Giuliano (1994) surveyed 220 university students. the results of a stepwise multiple regression showed that prior knowledge, test of logical thinking scores, and meaning orientation accounted for 32% of the variance in the final examination scores. As revealed by the results of regression analysis, meaning orientation computed by averaging students' scores on the deep approach, relating ideas, and intrinsic motivation subscales, allowed a significant, although small, improvement over predicting of chemistry final examination scores only by previous test and test of logical thinking scores.

In another investigation designed to explore relationships and predictive influences of learning approaches, other selective variables, and physics course achievement among male and female students, Cavallo, Potter, and Rozman (2004) worked with 290 college students enrolled in a yearlong physics course at a large university. Besides, other questionnaires students were administered a learning approach questionnaire, a Likert instrument measuring students' approaches to learning as meaningful or rote. Course grades were used to obtain a composite score representing overall physics achievement in the study. According to the results of the regression analyses, rote learning negatively predicted both physics concept understanding and course achievement for only male students. The findings revealed that different variables of learning and motivation might be important for females' success in the physics course compared to males.

Additional investigations majority of which were performed with university students also supported the view that deep learning approach is most of the time associated with higher academic achievement in different subject areas other than science. In a recent study, Heikkila and Lonka (2006) explored the relations between learning approaches, regulation of learning, cognitive strategies, and academic achievement. The researchers assumed that a deep approach to learning, self-regulation, and success expectations would be related to each other and additionally to study success. A total of 366 university students of various subjects were administered a questionnaire measuring students learning approaches together with other constructs of interest. The three scales of the questionnaire measured the deep approach, surface approach, and the achievement motivation. Academic achievement was operationalized as the mean of all grades a participant received during the academic years. In order to explore the relationships among variables, Pearson correlation coefficients were calculated. The results supported the well established relationship between deep approach and achievement. More specifically, the results showed that deep approach was correlated significantly and positively with GPA ($r = .16, p < .05$) and with self-regulation ($r = .61, p < .01$). On the other hand, as expected, surface approach was found to be negatively related with GPA ($r = -.09$) and self-regulation ($r = -.34, p < .01$). The results also revealed that self-regulation was positively and significantly related with the GPA ($r = .18, p < .05$).

Snelgrove and Slater (2003) conducted another study about the learning approaches of higher education students. The participants (N = 300) were administered a 42-item questionnaire measuring surface, deep, and achieving approaches to learning. The relationships between the learning approaches factors and academic performance in Biology, Psychology, Sociology and Nursing examinations and GPA were assessed by zero-order correlations. Similar to the findings of Heikkila and Lonka (2006), the results of this study also revealed that deep approaches to learning was correlated positively to both GPA (r = .17, p < .05). and sociology examination performance (r = .18, p < .05). Likewise, the surface approach was found to be significantly and negatively related to the nursing examination (r = -.22, p < .05).

Examining the relationships between learning approaches and background variables like age, gender, and prior educational experiences, Duff (2003) also investigated the relationship between scores on the three dimensions (deep approach, surface approach, strategic approach) of the learning approaches questionnaire and academic performance. As a measure of the academic performance, final assessment marks are computed by differentially weighting the scores of two assignments, a final examination, a report, and an oral presentation. The analysis of the data by using structural equation modeling showed that learning approaches were good predictors of academic performance in continuous assessment tasks but poor predictors of performance in examinations and oral presentations. Specifically, the study revealed a model that is a good predictor of coursework performance, with scores obtained on the questionnaire accounting for 34.6% of the variance in the two assignments and 26.1% of the variance in the project. However, scores obtained by the learning approach questionnaire were not good predictors of examination performance or performance in the oral examination, accounting for only 1.7% and 8.5% of the variance respectively.

Further evidence for the relationship between learning approaches and academic performance of college students was provided by Bernardo (2003). In an effort to examine how students' learning approaches were related to their academic achievement, 404 college freshmen with a mean age of 17.19 years were administered a 5-point Likert type instrument for assessing their learning approaches. This instrument is a self-report one consisting of 36 items for the six subscales (surface motive, deep motive, achieving motive, surface strategy, deep strategy, achieving strategy). The students' GPA for all academic subjects during their freshman year was taken as a measure of participants' academic achievement. The results of the correlational analysis indicated that achievement was correlated significantly and positively with deep strategy (r = .12, p < .05) and achieving strategy (r = .17, p < .05) even when prior academic achievement was controlled. Contrary to the previous studies, this study did not replicate the negative association between surface approach and achievement. Instead, surface approach was found to have a very small but positive relation (r = .04) with GPA after the prior academic achievement was controlled. However, this relation was not statistically significant.

In a longitudinal study to approaches to learning in science, Zeegers (2001) also supported the previous findings indicate (see section 2.3.1).

Particularly, Zeegers pointed out the positive correlation between the deep approach and assessment outcomes while revealing the negative association among surface approach and achievement. The results indicated a consistent positive correlation between annual GPA and the deep approach correlations ranging from .11 to .42. A consistent but negative correlation was found for the surface approach and GPA with correlations ranging from -.13 to -.19.

In their study of addressing relations between a student's learning orchestration and their learning outcomes, Hazel and Prosser (2002) reported the relations between learning approaches and achievement as well. Studying with 272 university students, the researchers identified significant (p < .05) negative correlations between surface approach to learning and different indicators of learning outcome. The results also revealed that the deep approach variable correlated positively with all outcome measures, but statistically significant (p < .05) with only the analysis of open-ended questions.

In more recent study which was interested in the relationships between students' epistemological beliefs about learning and knowledge, approaches to learning, and achievement, Watters and Watters (2007) surveyed 85 university students by administering a questionnaire to identify their approaches to learning. Individuals' course and GPAs were collected as the measures of academic performance. Examination of the Spearman correlations revealed that surface approach had strong negative correlations ($p < .01$) with scores on Biochemistry, Biological Chemistry, Statistics and Computing, and overall GPA. In contrast, deep strategies were reported to be positively correlated with all of the academic performance measures except Statistics and Computing. Based on these findings, Watters and Watters (2007) suggested that students who achieved well on Biochemistry and Biological Chemistry approached their study driven by motivation to comprehend the learning task and adopted appropriate strategies to achieve this understanding.

As discussed earlier in this section, prior investigations mainly pointed out that academic performance is positively related to deep approach, but negatively with surface approach. Contrary to these findings, three investigations revealed that learning approaches did not predict academic achievement of university students. In one of these studies, Gijbels et al. (2005) examined the relationship between students' approaches to learning and the assessment of learning outcomes as a function of the different components of problem-solving that were measured by the multiple-choice exam. Opposed to the expectations, the results of the correlational analysis indicated no relationships between students' approaches to learning and the components of problem-solving being measured by the multiple choice examination. The findings of the Diseth and Martinsen (2003) were in parallel with Gijbels et al. (2005) with a slight difference. In an effort to analyze the relationship between approaches to learning (deep, strategic, and surface), cognitive styles, motives, and academic achievement, Diseth and Martinsen (2003) studied with a sample of 192 undergraduate students with a mean age of 21.7. Participants were administered questionnaires to obtain related data and examination grades were used as the measure of academic achievement. The results of the study indicated that among the approaches to learning, the deep approach unexpectedly did not predict achievement ($r = .06$), while the surface approach as expected significantly predicted achievement ($r = -.19$, $p < .05$). The total set of variables was further analyzed by using structural equation modeling. As evident in the correlational analysis, deep approach did not significantly predicted achievement. The structural model indicated that surface approach predicted academic achievement (β = -.23).

In another study, Williams and Cavallo (1995) asserted that students' learning approaches were not significant predictors of students' physics understanding. Forty one university students were administered a learning approach questionnaire to classify each participant as a meaningful or rote learner. A multiple choice instrument designed to determine the number of misconceptions of physics concepts of the students was also administered. To determine the variable that best explains students' performance on this misconception instrument, a stepwise multiple regression analysis was performed. The results of the regression analysis indicated that learning approach was not a significant predictor of students' physics understanding and therefore was not included in the model.

2.3.3 Summary of the Literature on Approaches to Learning

Learners have fundamental differences while engaging in learning tasks. The two concepts that have been widely used in educational research are the deep and surface approaches to learning. The concept of deep approach is associated with the intention to understand the learning material by constructing the meaning of the content. The concept of surface approach, on the other hand, is related to different forms of rote learning and the intention to learn by memorizing. It was reported that students' adoption of either deep or surface approach in learning is dependent on or influenced from a number of factors which can be either personal or contextual. Key among the personal characteristics that are influential on learning approaches are the students' age and gender. Research constantly shows that age is positively related with the use of a deep approach and negatively related with the adoption of a surface approach. The majority of the investigations concentrating on the gender differences on the learning approaches, on the other hand, reported no gender differences in the adoption of either deep or surface approaches to learning. Research has also revealed that factors such as discipline type, nature of the assessment, prior academic achievement, learning context, conceptions of learning, ability, and developmental differences may be important determinants of students' adoption of a specific type of learning approach. The relationship between learning approach and academic outcomes generally reveals that a deep approach/meaningful learning will contribute positively to various learning outcomes, whereas surface/rote learning associated negatively with achievement.

CHAPTER 3

METHOD

In the previous chapters, purpose and significance of the study were presented and related literature was reviewed accordingly. In the following chapter, major characteristics of the population and sample, instruments of the study, procedure followed in order to collect data and methods used to analyze data will be explained briefly.

3.1 Population and Sample

All seventh grade public elementary students in Turkey were identified as the target population of this study. However, it is appropriate to define an accessible population since it is not possible to come into contact with this target population. Therefore, the accessible population was determined as all seventh graders in public schools in the Çankaya district of Ankara. This is the population which the results of the study will be generalized. Since the relationships between various learner characteristics and science achievement were investigated, the selected sample of students was required to take science courses before the course of the intended study. That is why seventh grade elementary students were the focus of this research. The seventh graders involved in the current study were assessed regarding the sixth grade science curriculum together with the some other learner related constructs.

Cluster random sampling integrated with convenience sampling method was used to obtain the representative sample from the accessible population. The Çankaya district of Ankara, from which the sample was chosen, was selected by convenience sampling method. The schools, which were thought as clusters, were randomly selected from the district. The number of elementary schools throughout the Çankaya district and the number of participant elementary schools were 103 and 21, respectively.

Detailed information about the characteristics and socio-economic status of the sample were provided in Table 3.1 and Table 3.2, respectively. A total of 1240 seventh grade students (51.4% boys, 47.8% girls) attending to 21 public elementary schools throughout the Çankaya district were enrolled in the study. Approximately two thirds of the sample performed good in science in the sixth grade as indicated by their science GPA scores equal to and above three over five.

Table 3.1 Characteristics of the sample

	Frequency (*f*)	Percentage (%)
Gender		
Male	637	51.4
Female	593	47.8
Missing	10	.80
Science GPA		
1	65	5.20
2	192	15.5
3	338	27.3
4	319	25.7
5	293	23.6
Missing	33	2.70

Educational level of the parents, monthly family income, pocket money opportunity, computer and daily newspaper at home, and presence of a separate study room were regarded as indicators of socio-economic status (SES) of the sample (see Table 3.2). The general moderate-to-high SES property of the Çankaya district was also represented by the sample of the study. That is, approximately two thirds of the parents were either high school or university graduates with half of the families having a monthly family income above 1000 YTL. Most of the participants indicated that they had pocket money opportunity (%75.5) and computer at home (%70.1). Similarly, a high percentage of the students (%76.8) reported that they have separate study rooms. Approximately half of the students indicated that they had daily newspaper at home while the remaining half pointed out that they did not have such an opportunity.

Table 3.2 Socio-economic status of the sample

Educational Level	Mother		Father	
	f	%	*f*	%
Illiterate	31	2.50	6	.50
Primary school	313	25.2	170	13.7
Secondary school	196	15.8	204	16.5
High school	372	30.0	367	29.6
University	316	25.5	480	38.7
Missing	12	1.00	13	1.00
Monthly Family Income				
No income	29	2.30		
Up to 250 YTL	43	3.50		
250 – 499 YTL	123	9.90		
500 – 1000 YTL	364	29.4		
Above 1000 YTL	631	50.9		
Missing	50	4.00		
Pocket Money Opportunity				
Yes	936	75.5		
No	299	24.1		
Missing	5	.40		
Computer at Home				
Yes	869	70.1		
No	369	29.8		
Missing	2	.20		
Daily Newspaper				
Yes	668	53.9		
No	567	45.7		
Missing	5	.40		
Separate Study Room				
Yes	952	76.8		
No	282	22.7		
Missing	6	.50		

The students' responses to the questions assessing SES were converted to standardized scores and added up to obtain a total SES score. The students were then grouped as having low, medium, and high SES based on these scores. The cut off points in the data set were considered while deciding different SES groups. That is, the students below the 33 percentile were grouped as having low SES, whereas the students above the 66 percentile were classified as high SES students.

The students between 33 and 66 percentiles, on the other hand, were considered as medium SES group. The frequencies and percentages of students in each group (low, medium, and high SES) were presented in Table 3.3.

Table 3.3 The frequencies and percentages of students in three SES groups

SES Group	*f*	%
Low	412	33.2
Medium	405	32.7
High	425	34.1

3.2 Data Collection Instruments

The data collection instrument used in this study has five distinct parts. The first part of the instrument known as the Demographical Questionnaire designed to provide information about students' gender, final report card grade for science, and socio-economic status. The second part contains the Turkish version of the Epistemological Beliefs Questionnaire (EBQ). The third and fourth parts of the instrument consist of the Turkish versions of the Learning Approach Questionnaire (LAQ) and the Motivated Strategies for Learning Questionnaire (MSLQ), respectively. The last part of the instrument contains the Science Achievement Test (SACHT). In the following subsections, each data collection instrument is explained in detailed.

3.2.1 The Demographical Questionnaire

This questionnaire was designed primarily to provide information about the socio-economic status of the participants. SES was measured by asking six separate questions about (1) the mother's educational level, (2) the father's educational level,

(3) the family income, (4) presence of computer at home, (5) daily newspaper at home, and (6) presence of separate study room at home. Information about gender and GPA were also obtained by using this questionnaire. A total of six written science examinations and six oral science examinations in a year contributed to a student's yearly GPA. The GPA scores may range from 1 to 5 in which a high GPA indicates a high level of science achievement.

3.2.2 The Epistemological Beliefs Questionnaire (EBQ)

It is a self-report questionnaire developed by Conley et al. (2004) that requires students' responses to the items in a five point Likert scale (5 = strongly agree to 1 = strongly disagree). The questionnaire measures epistemological beliefs along four dimensions, namely Source, Certainty, Development, and Justification. The developers stated that four dimensions with a total of 26 items represent two general areas that Hofer and Pintrich (1997) argued at the core of individuals' epistemological theories: beliefs about the nature of knowing and beliefs about the nature of knowledge. According to Conley et al. (2004), the Source and Justification dimensions reflect beliefs about the nature of knowing. The Source subscale consists of items concerning beliefs about knowledge residing in external authorities. The Justification subscale, on the other hand, is concerned with the role of experiments and how individuals justify knowledge.

The two other dimensions, namely Certainty and Development, reflect beliefs about the nature of knowledge. The Certainty subscale has items regarding a belief in a right answer. The Development subscale measures beliefs about science as an evolving and changing subject. Table 3.4 presents the descriptions of contrasting views for each dimension in the EBQ and the internal consistencies of the dimensions as reported by Conley et al. (2004). The two Cronbach alpha coefficients in Table 3.4 reflect the internal consistencies of the dimensions after two administration periods (Time1 and Time 2). The Turkish version of the EBQ (see Appendix A) was used to collect data about the epistemological beliefs of seventh grade students in this study.

For the present study, the EBQ was translated and adapted into Turkish by the researcher of the current study. The Turkish version of the questionnaire was checked out by a group of elementary level students in terms of clarity and the meanings of the items. The next step involved a back translation of the Turkish version into English by a qualified, bilingual Turkish instructor.

The Turkish version of the EBQ was initially pilot tested with 156 seventh graders from three elementary schools in the Çankaya district. For the data analysis, the items of the Source and Certainty dimensions were recoded so that a higher score represented more sophisticated epistemological beliefs. The pilot study data was examined in terms of the factor structure through exploratory factor analysis (EFA). Since the EBQ theoretically has four distinct factors, the pilot study data was initially analyzed for four factors. As presented in Table 3.5, the results of this initial factor analysis indicated that Factor 1 mainly consisted of items belonging to Justification dimension. Factor 2 largely included items of the Source and Certainty dimensions. Most of the items of the Development dimension were found to be loaded on Factor 3. As identified by the factor analysis results in Table 3.5, only two items were loaded on the fourth factor.

Table 3.4 Descriptions of the dimensions of EBQ: General area, sample item, number of the items, and internal consistencies per dimension

Dimension	Description	General area	Sample item	n of items	Cronbach alphas (Conley et al., 2004)
Source	Knowledge originating outside the self, residing in external authority ⟷ Knowledge constructed by the knower.	Nature of knowing	Whatever the teachers says in science class is true.	5	.81 (t1), .82 (t2)
Justification	Knowledge requiring no justification, receiving the knowledge that others provide ⟷ Knowledge constructed through use of evidence and assessment of expert opinion.		Good answers are based on evidence from many experiments.	9	.65 (t1), .76 (t2)
Development	Absolute, fixed nature of knowledge ⟷ Evolving and changing nature of knowledge	Nature of knowledge	Sometimes scientists change their minds about what is true in science.	6	.57 (t1), .66 (t2)
Certainty	Single right knowledge ⟷ More than a single right knowledge		All questions in science have one right answer.	6	.78 (t1), .79 (t2)

Note. t1: Cronbach alphas obtained in Time 1, t2: Cronbach alphas obtained in Time 2

Table 3.5 Loadings for four factors (EFA: Varimax Rotation) in descending order (Pilot study)

Items	Factor 1	Factor 2	Factor 3	Factor 4
14	.780			
5	.699			
24	.699			
26	.690			
22	.629			
13	.603			
3	.565			
18	.533			
7	-.475			
11	.436			
17	.434			
16		.653		
15*		.638		
23		.610		
12		.565		
6*		.565		
19*		.564		
10*		.525		
1*		.444		
25			.597	
21			.584	
8			.557	
4			.493	
9			.473	
2				.584
20				.488

*Items belonging to Source dimension in the original questionnaire

The total reliability of the EBQ with its 26 items was found to be .78 as measured by the Cronbach alpha coefficient in the pilot study. Each item in the questionnaire was then analyzed in terms of item reliability. As presented in Table 3.6, there were two items (item2 and item7) in the EBQ having negative item-total correlation. The total reliability of the questionnaire increased to .82 after removing these two items.

Table 3.6 Item-total statistics for the EBQ (Pilot study)

Items	Scale mean if item deleted	Scale variance it item deleted	Corrected item-total correlation	Alpha if item deleted
1	87.76	102.43	.170	.776
2*	88.67	108.75	-.138	.795
3	87.43	99.03	.358	.766
4	87.72	100.08	.330	.768
5	87.10	97.77	.376	.765
6	87.69	99.60	.320	.768
7*	89.34	112.02	-.273	.802
8	88.03	100.17	.299	.769
9	87.54	98.90	.414	.764
10	88.11	98.73	.332	.768
11	87.75	96.98	.472	.761
12	87.72	95.56	.414	.762
13	87.39	93.93	.498	.757
14	87.26	97.63	.438	.762
15	88.48	101.99	.217	.773
16	88.33	101.51	.197	.775
17	87.60	98.06	.442	.763
18	87.28	99.55	.317	.768
19	88.07	96.94	.415	.763
20	88.19	101.27	.184	.776
21	88.00	100.51	.294	.769
22	87.51	94.80	.499	.756
23	88.32	97.33	.373	.765
24	87.64	96.87	.487	.759
25	87.80	100.59	.321	.769
26	87.33	98.61	.306	.769

*Items with negative item-total correlation

Since it was difficult to describe the factor structure of the EBQ according to the initial factor analysis results, a second factor analysis was performed with the pilot data for three factors after removing item2 and item7. The results of the second factor analysis were shown in Table 3.7. As presented in Table 3.7, the results of the second factor analysis indicated that Factor 1 mainly consisted of items belonging to Justification dimension except item13 that originally belongs to Development dimension. Factor 2 largely included items of the Source and Certainty dimensions with only one missing item (item20). Most of the items of the Development dimension were found to be loaded on the third factor with one missing (item13) and one extra (item20) items.

The results of these two factor analyses and the item-total statistics results provided an insight about the factor structure and the reliability of the EBQ before the main study.

Table 3.7 Loadings for three factors (EFA: Varimax Rotation) in descending order (Pilot study)

	Factor 1	Factor 2	Factor 3
14	.736		
5	.797		
13	.807		
24	.621		
18	.648		
26	.723		
3	.537		
22	.617		
11	.480		
9	.385		
16		.690	
23		.704	
12		.738	
19*		.635	
15*		.515	
6*		.549	
10*		.527	
1*		.418	
8			.665
20			.705
17			.528
25			.315
4			.314
21			.275

*Items belonging to Source dimension in the original questionnaire

The EBQ data obtained in the main study was initially analyzed in terms of item reliability and discrimination power. Similar to the results of the pilot study, two items (item2 and item7) were found to have negative item-total correlation in the main study data; hence they were excluded from the subsequent analysis.

Exploratory factor analysis (EFA) using varimax rotation was then conducted for the validation of the questionnaire. An eigen value of 1.00 was taken as the cut-off point and three factors were extracted explaining 45.5% of the total variance. When the fourth factor with an eigen value of 0.934 was taken into account, the four factors accounted for 49.1% of the total variance. The scree plot indicated a sharp break after the third point; therefore a three factor structure was used to describe the epistemological dimensions held by the Turkish elementary school students. The two factors, namely Development (Factor3) and Justification (Factor1), were also encountered with the Turkish sample. The Justification factor differs from the original one in that above-mentioned two items were missing since they were excluded from the factor analysis at the beginning. The items of the other two factors, Source and Certainty, were merged into a single factor (Factor 2) according to the results of the EFA (See Table 3.8). This factor structure was conceptually different from the Conley et al.'s (2004) model in that items from the *Nature of Knowledge* domain (Certainty) united with the items of the *Nature of Knowing domain* (Source). Based on the nature of the loaded items, this factor was labeled as Source/Certainty. The reliability analysis yielded sufficient Cronbach alpha coefficients for the three factor model of epistemological beliefs. Information regarding reliabilities of the three dimensions of epistemological beliefs was presented in Table 3.13. The total reliability of the EBQ with 24 items was .76 as indicated by the Cronbach alpha coefficient.

Table 3.8 Loadings for three factors (EFA: Varimax rotation) in descending order (Main study)

Items	Factor 1	Factor 2	Factor 3
5	.666		
14	.633		
18	.583		
3	.574		
11	.572		
26	.567		
24	.478		
9	.455		
22	.445		
6*		.725	
23		.668	
12		.567	
19*		.555	
10*		.552	
20		.498	
1*		.498	
16		.492	
15*		.390	
17			.683
8			.660
25			.555
21			.444
4			.400
13			.400

*Items belonging to Source dimension in the original questionnaire

The three-factor structure was further examined with the confirmatory factor analysis (CFA) approach by using the structural equation modeling (SEM) technique. The fit indexes to be used for evaluating the proposed model were goodness-of-fit index (GFI = 0.92), adjusted goodness-of-fit index (AGFI = 0.91), root mean square error of approximation (RMSEA = 0.06), and standardized root mean square residuals (S-RMR = 0.06). According to Jöreskog and Sörbom (1993) GFI and AGFI should be greater than .90 for a good model fit. Values of 0.08 or less in RMSEA and S-RMR claim a good model data fit as well (Schreiber, Stage, King, Nora, & Barlow, 2006). Considering the values obtained for the discussed fit indexes as adequate, the fit of this model was proved to be good. Thus, in this study, three factors instead of four were identified, which indicates that Conley et al.'s (2004) four-factor model was not completely replicated with the Turkish sample.

3.2.3 The Learning Approach Questionnaire (LAQ)

The Learning Approach Questionnaire (LAQ), modified and used by Cavallo (1996), was utilized to measure the students' learning orientations in this study. The 22-item questionnaire was designed to measure students' approaches to learning ranging from meaningful to rote on a four point Likert scale. The questionnaire consists of two subscales: the Learning Approach Questionnaire-Rote (LAQ-R) measuring the degree of rote learning orientation, and the Learning Approach Questionnaire-Meaningful (LAQ-M) measuring the degree of meaningful learning orientation.

Table 3.9 Descriptions of the subscales of the LAQ with sample item

Subscale	Description	n of items	Sample item
LAQ-R	Measures the degree to which the learner has the intention to learn by memorizing for the recall of facts.	11	The best way for me to understand what technical terms mean is to remember the textbook definition.
LAQ-M	Measures the degree to which the learner has intention to understand the learning material by constructing the meaning of the content.	11	I try to relate new material, as I am reading it, to what I already know on that topic.

Like the EBQ, the LAQ was initially translated and adapted into Turkish by the researcher of the current study. The Turkish version of the questionnaire (see Appendix B) was then checked out by a group of elementary level students in terms of clarity and the meanings of the items. The next step involved a back translation of the Turkish version into English by a qualified, bilingual Turkish instructor. The Turkish version of the LAQ was initially pilot tested with 156 seventh graders from three elementary schools in the Çankaya district. The data was examined in terms of the factor structure through exploratory factor analysis. Two factors were extracted with pilot study data (see Table 3.10). The results revealed that Factor 1 mainly consisted of items belonging to LAQ-M and Factor 2 included some of the items of the LAQ-R. As identified by the factor analysis results in Table 3.10, four items of the LAQ-R were loaded on the LAQ-M.

Table 3.10 Loadings for two factors (EFA: Varimax rotation) in descending order (Pilot study)

Items	Factor 1	Factor 2
6	.755	
9	.684	
23	.675	
19*	-.666	
2	.621	
11	.615	
10	.608	
1	.600	
17	.582	
13	.546	
3	.542	
8	.512	
14*	-.490	
4*	-.479	
15	.452	
24	.423	
16*	-.343	
22		.716
21		.688
20		.617
5		.546
18		.465
12		.333
7		.281

*Items belonging to LAQ-R in the original questionnaire

The total reliability of the LAQ with its 24 items was found to be .67 as measured by the Cronbach alpha coefficient in the pilot study. Each item in the questionnaire was then analyzed in terms of item reliability. As presented in Table 3.11, there are four items (item4, item14, item16, item19) in the LAQ that have negative item-total correlation. The total reliability of the questionnaire increased to .82 after removing these four items. Both the results of the factor analysis and the item-total statistics provided an insight about the factor structure and the reliability of the LAQ before the main study.

Table 3.11 Item-total statistics for the LAQ (Pilot study)

Items	Scale mean if item deleted	Scale variance it item deleted	Corrected item-total correlation	Alpha if item deleted
1	62.51	45.27	.259	.658
2	62.60	43.19	.484	.639
3	62.63	43.91	.413	.645
4*	63.44	50.38	-.221	.701
5	62.95	45.75	.151	.668
6	62.29	42.70	.493	.636
7	63.32	45.37	.156	.668
8	62.79	43.92	.361	.648
9	62.73	44.04	.404	.646
10	62.80	43.25	.462	.640
11	62.54	43.01	.416	.642
12	63.25	47.33	.015	.682
13	62.59	43.99	.341	.650
14*	63.64	53.07	-.405	.721
15	62.90	43.91	.375	.647
16*	63.23	49.06	-.112	.691
17	62.52	42.45	.453	.637
18	62.68	42.13	.453	.636
19*	63.69	54.77	-.546	.729
20	62.43	41.73	.528	.630
21	62.75	42.81	.409	.642
22	62.63	43.67	.300	.652
23	62.81	42.71	.488	.636
24	62.89	44.11	.301	.653

* Items with negative item-total correlation

The LAQ data obtained in the main study was initially analyzed in terms of item reliability and discrimination power. Item-total statistics revealed that a few items in the LAQ had negative item-total correlations similar to the results of the pilot study. In addition to the four items discussed in the pilot study, one more item (item12) was found to have negative item-total correlation in the main study.

Exploratory factor analysis (EFA) using varimax rotation was then conducted for the validation of the questionnaire. An eigen value of 1.00 was taken as the cut-off point and two factors were extracted explaining 42% of the total variance. When the third and fourth factors with eigen values greater than 1 were taken into account, the four factors accounted for 47% of the total variance. The scree plot indicated a sharp break after the second point; therefore a two factor structure was used to describe the learning approaches of the Turkish elementary school students.

The results of the exploratory factor analysis (EFA) in the main study for two factors were shown in Table 3.12. The results revealed that Factor 1 mainly consisted of items belonging to LAQ-M and Factor 2 included some of the items of the LAQ-R. As identified by the factor analysis results in Table 3.12, five items of the LAQ-R were loaded on the LAQ-M. Based on the results of pilot and main studies, it can be concluded that same items of the LAQ-R constantly loaded on the LAQ-M with a slight difference: although loaded on the LAQ-R in the pilot study, item 12, which theoretically belongs to LAQ-R, loaded on the LAQ-M in the main study.

Table 3.12 Loadings for two factors (EFA: Varimax rotation) in descending order (Main study)

Items	Factor 1	Factor 2
11	.570	
6	.557	
23	.546	
9	.545	
19*	-.544	
2	.532	
10	.516	
24	.513	
8	.512	
3	.498	
17	.489	
1	.477	
4*	-.476	
13	.474	
15	.465	
16*	-.316	
14*	-.284	
12*	-.261	
22		.668
20		.643
21		.611
18		.492
5		.469
7		.263

*Items belonging to LAQ-R in the original questionnaire

Theoretical background, the factor loadings of each item, the results of pilot and main studies, and the item-total statistics were considered to define the LAQ-M and LAQ-R for the subsequent analyses. More specifically, the five items labeled with asterisks (*) in Table 3.12 were excluded when defining the first factor (LAQ-M). Since those items originally belong to LAQ-R and have negative item-total correlations, they were not included in the LAQ-M subscale for the following analyses. While defining the second factor (LAQ-R), two items with lowest factor loadings were excluded as well. After these modifications, the two-factor structure was further examined with the confirmatory factor analysis (CFA) approach by using the structural equation modeling (SEM) technique. The fit indexes to be used for evaluating the proposed model were goodness-of-fit index (GFI = 0.95), adjusted goodness-of-fit index (AGFI = 0.93), root mean square residuals (RMR =

0.043), and standardized root mean square residuals (S-RMR = 0.043). According to Jöreskog and Sörbom (1993) GFI and AGFI should be greater than .90 for a good model fit. Values of 0.08 or less in RMR and S-RMR claim a good model data fit as well (Schreiber, Stage, King, Nora, & Barlow, 2006). Considering the values obtained for the discussed fit indexes as adequate, the fit of this model was proved to be good. The reliability analysis yielded sufficient Cronbach alpha coefficients for the two dimensions of LAQ (See Table 3.13). The total reliability of the LAQ with 17 items in the main study was .79 as indicated by the Cronbach alpha coefficient.

Table 3.13 The dimensions of EBQ and LAQ, corresponding items, and the internal consistencies

Items	Dimensions	Cronbach alphas	n
3, 5, 9, 11, 14, 18, 22, 24, 26	Justification	.77	9
4, 8, 17, 21, 25, 13	Development	.59	6
1, 6, 10, 12, 15, 16, 19, 20, 23	Source/Certainty	.70	9
1, 2, 3, 6, 8, 9, 10, 11, 13, 15, 17, 23, 24	LAQ-M	.79	13
18, 20, 21, 22	LAQ-R	.62	4

3.2.4 The Motivated Strategies for Learning Questionnaire (MSLQ)

It is a self-report questionnaire developed by Pintrich, Garcia, and McKeachie (1991) in order to assess students' motivational orientations and their use of different learning strategies. Students rate themselves on a seven point Likert scale ranging from "not at all true of me" to "very true of me".

There are basically two sections in the MSLQ, a motivation section, and a learning strategies section. The motivation section consists of 31 items that assess students' goals and value beliefs for a course, their beliefs about their skill to be successful in a course, and their anxiety about tests in a course. These items were loaded on six factors, namely intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs about learning, self-efficacy for learning and performance, and test anxiety. The learning strategy section also includes 31 items regarding students' use of different cognitive and metacognitive strategies. These items were loaded on five factors which are rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation. Additionally, the learning strategies section includes 19 items about student management of different resources. These items fell on four factors which are time and study environment management, effort regulation, peer learning, and help seeking. The questionnaire as a total has 81 items and 15 different scales which can be used together or singly. For the purposes of this study, items of the five scales (rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation) of the learning strategy section were utilized in order to assess the participants' use of SRL strategies. The students were administered the Turkish version of these scales that were translated and adapted by Sungur (2004) (see Appendix C).

The rehearsal strategies involve reciting or naming items from a list that is to be learned. These strategies are best suitable to use for simple tasks and activation of information in working memory rather than gaining of new information in long-term memory. Rehearsal strategies are suggested to influence the attention and encoding processes. However, they do not seem to help students construct internal connection among the information or integrate the information with prior knowledge. The elaboration strategies help students store information into long-term memory as a result of assembling internal connections between the items to be learned. These strategies involve paraphrasing, summarizing, creating analogies, and generative note taking all of which are assumed to help the learner integrate and connect new information with the prior knowledge. The organization strategies help the learner select proper information and construct connections among the information that has to be learned. These strategies include clustering, outlining, and selecting the main idea in reading passages. Organizing is supposed to be an active and effortful endeavor. The learners utilizing the organization strategies are assumed to be closely involved in the task which in turn results in better performance. The critical thinking strategies enable students to apply previous knowledge to new circumstances in order to solve problems, reach decisions, or make critical evaluations with respect to the standards of excellence (Pintrich et al., 1991).

Metacognition refers to the awareness, knowledge, and control of the cognition. The MSLQ focuses on the control and self-regulation aspects of metacognition, but not the knowledge aspect. The three general processes that make up metacognitive self-regulatory activities are planning, monitoring, and regulating. Planning activities such as goal setting and task analysis help to activate the appropriate aspects of prior knowledge so that the organization and comprehension of the material become easier. Monitoring activities involve tracking of one's attention as one reads, and self-testing and questioning all of which assist the learner in understanding the material and integrating it with the previously learned material. Regulating means the fine-tuning and continuous adjustment of one's cognitive activities. Regulating activities are suggested to improve performance by supporting learners in checking and correcting their behavior while they proceed on a task (Pintrich et al., 1991).

Table 3.14 presents the brief descriptions of the rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation scales and the internal consistencies of them as reported by Pintrich et al. (1991) and Sungur (2004). The total reliability of the MSLQ with 31 items was found as .90 as indicated by the Cronbach alpha coefficient in the current study.

Table 3.14 Descriptions of the scales of the MSLQ: Sample item, number of the items, and internal consistencies per dimension

Scales	Description	Sample item	n of items	Cronbach alphas (Pintrich et al., 1991)	Cronbach alphas (Sungur, 2004)
Rehearsal	Reciting or naming items from a list.	I memorize key words to remind me of important concepts in this class.	4	.69	.73
Elaboration	Storing information into long term memory by building internal connections between the items.	When reading for this class, I try to relate the material to what I already know.	6	.76	.78
Organization	Selecting appropriate information, constructing connections among the information.	I make simple charts, diagrams, or tables to help me organize course material.	4	.64	.71
Critical Thinking	Application of previous knowledge to new situations.	I try to play around with ideas of my own related to what I am learning in this course.	5	.80	.81
Metacognitive Self-Regulation	Planning, monitoring, and regulating activities.	If the course materials are difficult to understand, I change the way I read the material.	12	.79	.81- -

3.2.5 The Science Achievement Test (SACHT)

The science achievement of the students was assessed by using the SACHT (see Appendix D). It is a 25 multiple-choice item test covering the science content taught in sixth grade curriculum which is the same in all elementary schools due to the settings of the Ministry of Education. Since the sample was required to take science courses before the data collection period started at the beginning of the first semester of the educational year, seventh graders were administered a science test covering the sixth grade science content.

The questions in the SACHT were chosen in accordance with the content of the sixth grade curriculum. The number of questions representing each unit in the test was decided according to the number and percentage of that unit in the curriculum. In order to prepare the test, a multiple-choice question pool was initially formed by making use of the science questions taken from the national examinations for accessing to secondary education between years 2000-2005 and also from different text books. Neither the body nor the distracters of the questions obtained from national examinations were modified during the preparation of the test. The researchers adapted some of the questions taken from other test books by considering the appropriateness of the questions to the units, the content, and the grade level of the participants. This adaptations and modifications were done with the coordination of an elementary science teacher. Of the 25 questions included in the test, 13 of them required students to make inferences and draw conclusions (Questions 1, 2, 3, 4, 6, 8, 9, 11, 14, 18, 19, 20, 21) and two of them asked them to propose hypothesis (Questions 16 and 17). The remaining 10 questions in the test simply assessed knowledge by just requiring to recall factual information about science concepts. The units, the number of the objectives and the percentage of each unit, and the number of questions representing these units in the SACHT were given in Table 3.15. The total reliability of the SACHT with 25 items was found as .66 as indicated by the Cronbach alpha coefficient in the current study.

Table 3.15 The units, the number and percentage of their objectives in the curriculum, and the number of questions representing each unit in the SACHT

Name of the unit	Number of objectives	Percentage in the curriculum	Number of questions in the SACHT
The Structure of Living Things	28	19	5
The Human Body and the Systems	66	45	12
The Electricity	30	20	4
The Discovery of the Space	23	16	4

3.2.6 Validity and Reliability of the Measuring Tools

For the present study, the EBQ and LAQ were translated and adapted into Turkish by the researcher of the current study. To establish face and content validity of the instruments, the adaptations were performed by the researcher, one instructor from the Department of Modern Languages, and one instructor from the Department of Foreign Languages. Regarding the same validity concerns, the adapted instruments were then checked by instructors from the Faculty of Education at METU according to the content and format of instruments. In addition, a Turkish instructor evaluated the Turkish versions of the items according to the grammar, content, and punctuation. The Turkish version of the questionnaire was finally examined by a group of elementary level students in terms of clarity and the meanings of the items. The next step involved a back translation of the Turkish version into English by a qualified, bilingual Turkish instructor. After all necessary modifications were done accordingly; the final versions of the instruments were obtained.

The EBQ and the LAQ were pilot tested prior to the main study. To provide additional evidence for the construct validity of the questionnaires, factor analyses were conducted to check whether the expected dimensions of the instruments are confirmed with the results of both the pilot and the main studies or not. Reliability analysis was also performed and internal reliability coefficients of the instruments were obtained by using Cronbach alpha coefficients. The observed and latent variables and the alpha reliability coefficients were provided in Table 3.16.

3.3 Procedure

The study initiated by defining the research problem specifically and formulating the search terms pertinent to the problem of interest. Next, the related literature was reviewed in detail. Previous studies done abroad were searched systematically from Educational Resources Information Center (ERIC), International Dissertation Abstracts, Ebscohost, Social Science Citation Index (SSCI), Kluwer Online and Science Direct databases. Studies done in Turkey were also searched from YÖK, Eğitim ve Bilim Dergisi, MEB Dergisi and Hacettepe Eğitim Dergisi. Photocopies of available documents were obtained from the libraries of METU, Bilkent University, Hacettepe University, Gazi University, and TUBITAK-ULAKBIM. Moreover, some of the documents that could not be reached were requested from abroad. All of the relevant documents were organized and read carefully by the researcher. After finishing the review of literature, the hypothesized structural model was proposed followed by the selection and preparation of the measuring instruments. Following the selection of the elementary schools which will be involved in the study, necessary permission was taken from the Ministry of Education for the administration of the measuring instruments (see Appendix E for the letter of permission).

The pilot and main studies were conducted in the 2006-2007 educational year. For the ease of administration and data entry, optical forms were designed and prepared by a private firm. The data was collected by using these optical forms (see Appendix F).

Before the administration, participants, teachers, and administrators were informed about the purpose of the study and the directions and the necessary information were explained. All students were assured that any data collected will be held in confidence and names of the schools and subjects will not be used in any kind of publication. Also, the participants were informed that the results of the study would not affect any of their grades in the school. In order to ensure confidentiality of the research data, numbers were assigned to the optical forms instead of using participants' names and any access to the data was prevented. The participants were also given the grantee that the study will not give any physical and psychological harm or discomfort to them. The participants were informed about the actual purposes and procedures of the study.

In this study, a location threat was possible since different schools in the same district, hence at different locations were involved in the study. Testing conditions were tried to be controlled and standardized by monitoring the lightening and ventilation of the classrooms and keeping the class silent throughout the administration for minimizing this effect. In order to control data collector characteristics threat, the same researcher administered the instruments by her own throughout the data collection period. The students should have scores for each variable being measured. If a student lacks one of those scores, he or she was directly excluded from the study. In case of a very much decrease in the sample size, the predetermined sample size was kept as large as possible. Testing was not a problem in terms of internal validity for the current study because subject responses to the instruments did not influence one another. The instruments were designed to choose completely different constructs. Therefore, student response to one of the instruments did not have an impact on the responses to the remaining questionnaires.

Other than the variables of this study, there are a variety of cognitive and affective factors (other than variables of this study) which the students bring with him/her into the classroom and which may be influential on student performance. School achievement can be attributed to how students felt toward what they are studying, their school environment, and their concept of self (attitudinal characteristics), motivational variables, home and school related variables, socio-economic status, and some cognitive constructs as well. However, it is not possible to control all of these confounding variables when investigating the relationship between the variables of the current study.

3.4 Analysis of Data

The data analysis consists of three main parts. In the first part, labeled as preliminary data analysis, missing data analysis was performed; the data was checked for outlier and influential data points and normality. The second part included the factor analyses and the descriptive statistics. In the final part of the data analysis, Structural Equation Modeling (SEM) was conducted to test if hypothesized model fitted the sample data.

Two statistical packages, i.e. SPSS 11.0 for Windows and LISREL 8.30 for Windows, were utilized in the current study to analyze the data. Missing data, normality, outlier and influential data points were checked by using SPSS. The same statistical package was also used for factor analysis and descriptive statistics parts. Confirmatory factor analysis (CFA) and SEM were conducted by using the second statistical package, i.e. LISREL.

3.4.1 Missing Data Analysis

Missing data values in the variables possibly affect the statistical analysis of data. There are different options for dealing with missing data such as deleting subjects who have missing values or replacing the missing data. Schumacker and Lomax (2004) stated that list wise and pair wise deletion of cases are not very much recommended due to the possibility of losing a large number of subjects and likelihood of reduction in the sample size. According to the Schumacker and Lomax (2004), mean substitution works best when the missing data number is not very large.

Missing data analysis was performed before analyzing the data of the current study. All of the items in the data collection instruments were analyzed to identify the missing data percentages. Missing data of students that are less than or equal to 5% of the answers of any of the items in any of the questionnaires were replaced by the series mean of that item. Missing data in students' SACHT scores were replaced by zero provided that the missing values constitute a range smaller that 5% of the whole data. There were missing values in the data regarding gender, GPA, and socio-economic status as well. However, these missing data were regarded as missing without doing any replacement.

Each student involved in the study should have scores on each of the variable (epistemological beliefs, approaches to learning, SRL strategies, and science achievement) in order to be included in the analysis. Anyone who has a missing score from one of the instruments (anyone who did not answer the items in one of the questionnaires and left it completely empty or anyone who did not return one of the questionnaires back) was excluded from the analysis.

3.4.2 Normality

Like the rest of the other inferential statistics, SEM also relies on the assumption that the data is normally distributed. It is ideal to check multivariate normality prior to the data analysis. However, as Stevens (2002) identified that there is no available statistical test for assessing multivariate normality on SPSS. According to Stevens (2002), assessing univariate normality and checking bivariate normality are the two ways to decide whether multivariate normality is almost reasonable or not. Therefore, univariate normality was checked prior to the data analysis in the current study. In order to assess univariate normality, Skewness and Kurtosis values were assessed. George and Mallery (2003) identified that Skewness and Kurtosis values between -1 and +1 can be considered excellent for most psychometric purposes, however values between -2 and +2 are also acceptable.

3.4.3 Outlier and Influential Data Points

Outliers and influential data points can affect the interpretation of the results. Therefore, it is important to detect outliers and influential data points prior to the subsequent data analysis. Outliers can be defined as the data values that are different from the rest of the points in the data set. An influential data point, however, is the one that when deleted from the data set, substantial change in at least one of the regression coefficients is produced. However, it is important to note that a point that is an outlier will not necessarily be influential in affecting the regression equation (Stevens, 2002).

In order to measure outliers on endogenous variables in the model, the standardized residuals were used. Any standardized residual greater than about three in its absolute value are unusual and named as an outlier (Stevens, 2002). The Leverage values were utilized for detecting outliers on exogenous variables. Stevens suggested that any Leverage value greater than 3p/n, where p=k+1 and k is the number of predictors, may be considered as unusual and called as an outlier. In order to check whether the outliers on either variable were influential or not, Cook's distances were considered. Cook's distances greater than 1 are generally considered as large and address influential outliers which should be excluded from the subsequent analysis (Stevens, 2002). The data set in the current study was examined in terms of outliers and influential data points by considering these criteria.

3.4.4 Effect Size

Effect size can be defined as the proportion of variance in the dependent variable accounted for by the independent variables (George & Mallery, 2003). Effect size measures differ depending on the type of statistical technique utilized. For example, multiple correlation indices are used in multiple regression analysis as the measures of effect size. Multiple correlation (R), squared multiple correlation (R^2), and an adjusted squared multiple correlation (R^2_{adj}) are the three indices that can be possibly used in the multiple regression to assess how well the linear combination of predictor variables in the regression analysis predicts the criterion variable. Among these three indices, squared multiple correlation (R^2) is the most frequently utilized one as a measure of the effect size (Green, Salkind, & Akey, 2000).

The multiple correlation (R), which can range in value from 0 to 1, is a Pearson product-moment correlation coefficient between the predicted criterion scores and the actual criterion scores. The multiple correlation coefficient may be squared and multiplied by 100 to make “a percent variance accounted for” interpretation (R^2). The adjusted multiple correlation (R^2_{adj}) is calculated as a measure of effect size when sample size is small and the number of predictors is large (Green et al., 2000). As Schumacker and Lomax (2004) pointed out, structural equation modeling is closely related with multiple regression. Therefore, measures of squared multiple correlation (R^2) were used as an index of effect size in the current study. Cohen’s (as cited in Weinfurt, 1995) classification of effect sizes has been widely used in social sciences. According to this classification scheme that measures effect sizes in terms of R^2, 0.01, 0.09, and 0.25 represents small, medium, and large effect sizes respectively. For the current study, R^2 values were interpreted according to Cohen’s classification scheme.

3.4.5 Data Analyses

After the data was examined in terms of missing values, normality, and outlier and influential data points, principle component analysis with varimax rotation was performed for the EBQ and the LAQ data by using SPSS 11.0 for Windows in order to confirm the theoretical factor structure of the questionnaires. The factor structures were also confirmed by performing confirmatory factor analysis. Based on these analyses, highly loaded observed variables for each dimension of the questionnaires were identified in order to formulate the latent variables (see Table 3.16). The final data file consisting of the items to be included in the subsequent analyses was imported from SPSS to PRELIS that is followed by the data screening which aims to output the distributions of the variables and at the same time check their normality.

Descriptive statistics including mean, minimum and maximum values, mode, and standard deviation were used for explaining the profiles of the students’ epistemological beliefs, learning approaches, and SRL strategies by gender and socio-economic status. Descriptive statistics were also provided for the SACHT scores of the students.

Table 3.16 The observed and latent variables and the internal consistencies of the latent variables

Observed Variables	Latent Variables	Internal consistencies
BELBOOK (item 6) NOMORE (item 12) SCTKNOW (item 19) AGTRUE (item 23)	SOU/CER	.50
IDEBOOK (item 8) IDESCIENCE (item 17) CHAMIND (item 25)	DEV	.50
BEFSTART (item 5) DOEXPER (item 14) MOREXPER (item 18)	JUST	.61
RELATENEW (item 2) GOOVER (item 6) QUESTION (item 9) REREAD (item 11) NEWANS (item 23)	MLEARN	.64
NOTUNDERS (item 20) LOOKSOME (item 21) RESTSTUDY (item 22)	RLEARN	.61
SELFTOT	SELFRL	.90
SCIENTOT	SCIACH	.66

3.5 Structural Equation Modeling

The data obtained in the study was analyzed by using structural equation modeling, a statistical procedure which enables a researcher to examine the patterns of relationships among variables. LISREL 8.30 for Windows with SIMPLIS command language was utilized for formulating and estimating the LISREL models of the factors contributing the science achievement of the seventh grade students.

3.5.1 Definition of Terms

1. Path Diagrams: A path diagram is a diagram that depicts the structural relations forming the model by linking the variables by arrows. The unidirectional arrows symbolize the causal relationships while the bi-directional curved arrows represent the noncausal or correlational relationships (Kelloway, 1998).

2. Observed, Measured, or Indicator Variable: Observed variables are directly observed or measured variables. They are used to define or infer the latent variable or construct (Schumacker & Lomax, 2004).

3. Latent or Unobserved Variable: Latent variables are the variables that are not directly observed or measured, but can be indirectly observed or measured by using several observed variables (Schumacker & Lomax, 2004).

4. Latent Dependent or Endogenous Variable: Latent dependent variable is the one that is predicted by other latent variables in the model. A latent dependent variable should have at least one arrow leading into it from another latent variable (Schumacker & Lomax, 2004).

5. Latent Independent or Exogenous Variable: Latent independent variable is the one that is not influenced by any other latent variable in the model. A latent independent variable does not have an arrow leading to it in a structural equation model (Schumacker & Lomax, 2004).

6. The Measurement Model: A measurement model is a confirmatory factor model that defines the relationships between the latent variables and the observed variables. Confirmatory factor analysis methods reflect measurement models in which observed variables determine latent

variables. The relationships between the observed variables and the latent variables are shown by the factor loadings. The factor loadings provide information about the extent to which a given observed variable is able to measure the latent variable. In addition to determining the latent variables, the measurement models describe the measurement properties of the latent variables such as reliability and validity (Schumacker & Lomax, 2004).

7. The Structural Model: A structural model examines the relationships between latent variables. The structural equation model is specified by allowing for certain relationships among the latent variables represented by the direction of arrows. The structural model also indicates the amount of explained and unexplained variance. Each structural equation contains a prediction error or disturbance term that indicates the portion of the latent dependent variable that is not explained or predicted by the latent independent variable in the same equation (Schumacker & Lomax, 2004).

8. Structural Equation Modeling: This is an approach to develop measurement models to identify the latent variables and structural models to specify direct and indirect relationships among the latent variables (Schumacker & Lomax, 2004).

9. The Measurement Coefficients: The λ_y (lowercase lambda sub y) and λ_x (lowercase lambda sub x) values point out the relationships between latent variables and observed variables. These two measurement coefficients are also known as factor loading. They serve as validity coefficients as well (Schumacker & Lomax, 2004).

10. The Structure Coefficients: There are two structure coefficients, namely β (lowercase beta) and γ (lowercase gamma). The former indicates the strength and direction of the relationship among latent dependent variables while the latter refers to the strength and direction of the relationship among latent dependent variables and latent independent variables (Schumacker & Lomax, 2004).

11. The Measurement Errors: Measurement error refers to the portion of the observed variable score that is measuring something other than what the latent variable is hypothesized to measure. It also indicates the observed variable score reliability. An observed variable that is measuring some other latent variable, unreliability, or a higher order factor can result in measurement error. The measurement errors are represented by ε (lowercase epsilon) and δ (lowercase delta) for Ys and Xs, respectively (Schumacker & Lomax, 2004).

12. Direct Effect: It is defined as the effect between two latent variables when a single directed line and arrow connects them. Direct effect is measured by a structure coefficient (Schumacker & Lomax, 2004).

13. Indirect Effect: It is defined as the effect between two latent variables when no single straight line or arrow directly connects them but when the first latent variable is reached from the second latent variable through one or more other latent variables via their paths (Schumacker & Lomax, 2004).

3.5.2 Steps in Structural Equation Modeling

The following steps were followed when analyzing the data using structural equation modeling.

1. Model Specification: This step involves using all the available relevant theory, research, and information in order to formulate an initial theoretical model. Thus, before any data collection or analysis, a specific model that is going to be confirmed with the data should be specified. This involves determining every relationship and parameter in the model that is interested in (Schumacker & Lomax, 2004). In the current study the theoretical model was based on the relevant literature review.

2. Model Identification: It refers to the designation of parameters as fixed, free, or constrained. Each potential parameter in a model has to be specified as a free parameter, a fixed parameter, or a constrained parameter. A free parameter is a parameter that is unknown and needs to be estimated. A fixed parameter is a parameter that is not free, instead fixed to a specified value, either 0 or 1. A constrained parameter is the unknown parameter that is constrained to equal one or more other parameters. There are three possible methods for avoiding identification problems. The first method concerns the measurement model, where the researcher decides which observed variables measure each latent variable. All the observed variables have to be constrained to load on only one latent variable. The second method is concerned where reciprocal or nonrecursive structural models are used. In nonrecursive models, a reciprocal or bidirectional relationship is included. For such models, ordinary least squares is not a suitable method of estimation. The third method involves beginning with a simple model with a minimum number of parameters which are considered to be absolutely crucial. Once this simple model is identified, then other parameters can be included in subsequent models (Schumacker & Lomax, 2004).

3. Model Estimation: It involves knowledge about different methods for estimating the parameters in a structural equation model. Several estimation procedures are available including maximum likelihood (ML), unweighted or ordinary least squares (ULS or OLS), and generalized least squares

(GLS). The ML estimation is the default and most widely used method in many model-fitting programs (Kline, 1998). If the observed variables are multivariately normally distributed, then ML estimates, standard errors, and chi-square test are appropriate. When the data is generated from nonnormally distributed populations, one of the distribution free or weighted procedures should be used (Schumacker & Lomax, 2004).

4. Model Testing: It involves the evaluation of the extent to which the theoretical model is supported by the sample data. A number of goodness-of-fit criteria have been proposed and reported in the literature to interpret the model fit (Jöreskog & Sörbom, 1993).

5. Model Modification: It refers to the respecification of the model when the fit indices suggest a poor fit. If the fit of the implied theoretical model is not satisfying, then the next step is to modify the model and subsequently evaluate the newly proposed model (Schumacker & Lomax, 2004). This step involves improving the model by removing non-significant paths from the model, adding new paths to the model, or modifying the existing paths based on empirical evidence and suggested modifications given by LISREL output.

3.5.3 The Goodness-of-Fit Criteria for Structural Equation Modeling

There are three main criteria in judging the statistical significance and substantive meaning of a theoretical model according to Schumacker and Lomax (2004). The first criterion is the non-statistical significance of the chi-square test and the root-mean-square error of approximation (RMSEA) both of which are indicated to be global fit measures. A non-significant chi-square value indicates the similarity between the sample covariance matrix and the reproduced model-implied covariance matrix. A RMSEA value less than or equal to .05 can be regarded as an evidence for the model fit. The second criterion is the statistical significance of individual parameter estimates for the paths included in the model which are the values computed by the division of the parameter estimates by their respective standard errors. This is known as *t* value which should be greater than 1.96 at α = .05 for the significance of the relationships between variables. The third criterion is related with the magnitude and direction of the parameter estimates, paying attention to whether a positive or negative coefficient is meaningful for the parameter estimate (Schumacker & Lomax, 2004).

In addition to abovementioned three criteria, Kline (1998) suggested that the squared multiple correlation (R^2) calculated for each indicator is another fit statistics that is used for measurement models. Squared multiple correlation gives the proportion of the explained variance and values less that .50 mean that more than half of an indicator's variance is unexplained by the factors it is specified to measure (Kline, 1998).

There are various goodness-of-fit criteria reported in the LISREL 8.30 with SIMPLIS command language. The commonly used criteria and their interpretations were given below. These model fit criteria and their acceptable fit interpretation were also presented in Table 3.17.

1. Chi-Square (χ^2): A significant χ^2 value indicates that the observed and estimated variance-covariance matrices differ whereas a nonsignificant χ^2 value reveals that the matrices are similar. Therefore, a nonsignificant χ^2 value with associated degrees of freedom should be obtained as an evidence for the model fit. The chi-square is sensitive to sample size in that as sample size increases (generally above 200), the χ^2 statistics has a tendency to indicate a significant probability level (Schumacker & Lomax, 2004). Since the sample size of this study is large, chi-square is not an appropriate goodness-of-fit criterion, hence will not be considered in the current study.

2. Goodness-of-Fit Index (GFI): It is based on the ratio of the sum of the squared differences between the observed and reproduced matrices to

the observed variances. The GFI ranges from 0 (no fit) to 1 (perfect fit) in which values exceeding .95 indicates a good fit to the data (Schumacker & Lomax, 2004).

3. Adjusted Goodness-of-Fit Index (AGFI): This index is adjusted for the degrees of freedom of a model relative to the number of variables. Like the GFI index, AGFI ranges from 0 (no fit) to 1 (perfect fit), with values .95 indicating a good model fit to the data (Schumacker & Lomax, 2004). Values of both fit indexes (GFI and AGFI) are more standardized and are less sensitive to sample size than chi-square statistics (Kline, 1998).

4. Root-Mean-Square Residual Index (RMR): The RMR index uses the square root of the mean-squared differences between the estimated and observed covariance matrices. The lower bound of RMR is 0 and the lower the RMR, the better the model fit (Schumacker & Lomax, 2004). The standardized-root-mean-square residual (S-RMR) is also provided by the LISREL output. The S-RMR is another widely used index which is a standardized summary of the average covariance residuals. Covariance residuals are the differences between the observed and estimated covariance. Values of the S-RMR theoretically range from 0 (perfect fit) to 1 (poor fit). As the difference between the observed and predicted covariances increases, the value of the S-RMR increases as well. A favorable value of the S-RMR is less than .05 in order to indicate a good fit to the data (Kline, 1998).

Table 3.17 Model fit criteria and accepted fit interpretation (Schumacker & Lomax, 2004, p. 82)

Model fit criterion	Acceptable level	Interpretation
Chi-square	Tabled χ^2 value	Compares obtained χ^2 value with tabled value for given df
Goodness-of-fit index (GFI)	0 (no fit) to 1 (perfect fit)	Value close to .95 reflects a good fit
Adjusted Goodness-of-fit index (AGFI)	0 (no fit) to 1 (perfect fit)	Value adjusted for *df*, .95 a good model fit
Root-mean-square residual (RMR)	< .05	Value less than .05 indicates a good model fit
Standardized-root-mean-square residual (S-RMR)	< .05	Value less than .05 indicates a good model fit
Root-mean-square error of approximation (RMSEA)	< .05	Value less than .05 indicates a good model fit

CHAPTER 4

RESULTS

This chapter presents the results of preliminary data analysis, the descriptive and the inferential statistics. In the preliminary analysis part, the data was first checked for outliers and influential data points. Then, normality was verified before subsequent data analyses. In the descriptive statistics part, the variables were investigated descriptively and factor analyses were conducted to examine the factor structure of the questionnaires. Finally, in the inferential statistics part the model was tested and explained.

4.1 Preliminary Data Analysis

4.1.1 Outlier Analysis

There are two parts in the outlier analysis, namely outliers on the endogenous variables and outliers on the exogenous variables. As Stevens (2002) suggested any standardized residual greater than about three in its absolute value are unusual and considered as an outlier for the exogenous variables. Table 4.1 presents standardized residuals descriptive statistics. The range of standardized residuals was between -3.25 and 3.66. According to these values, there were identifiable outliers in the exogenous variables.

The outliers on the endogenous variables were checked by using Leverage values. For the current study, any Leverage value greater than 0.027 was considered as an outlier for the endogenous variables. As seen from Table 4.1 the maximum Leverage value was 0.083, which indicated the presence of outliers on the endogenous variables.

Table 4.1 Residuals statistics

	Min.	Max.	*M*	*SD*
Standardized Residual	-3.25	3.66	.000	.996
Cook's Distance	.000	.040	.001	.002
Centered Leverage Value	.000	.083	.008	.006

In order to check whether these outliers on the endogenous and exogenous variables were influential or not, Cook's distances were checked. Cook's distances greater than 1 are generally considered as large and address influential outliers which should be excluded from the subsequent analysis. Table 4.1 presents the Cook's distances that ranged from 0.000 to 0.040. Since the entire Cook's distances were less than 1, it can be concluded that the outliers on the endogenous and exogenous variables were not influential and they could be retained in the analysis.

4.1.2 Normality

The Skewness and Kurtosis values were used to get an insight about the normality of the variables included in the model. As Table 4.2 indicates, all the variables except justification had Skewness and Kurtosis values between -1 and +1, hence can be considered as normally distributed. The Skewness and Kurtosis values for the justification dimension were not in the abovementioned range, but in between -2 and +2 which is also acceptable for a normal distribution (George & Mallery, 2003).

Table 4.2 Univariate normality statistics

	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
SCIACH	.437	.069	-.042	.139
JUST	-1.18	.069	1.98	.139
DEV	-.710	.069	.840	.139
SOU/CER	-.162	.069	-.155	.139
MLEARN	-.544	.069	.866	.139
RLEARN	-.553	.069	-.079	.139
SELFRL	-.199	.069	-.134	.139

4.2 Descriptive Statistics

Descriptive statistics were used to answer the first three research questions. Specifically, factor analysis was conducted to identify the nature and the number of factors that comprise the epistemological belief profile of the elementary students. In order to identify the epistemological belief, learning approach, and self-regulated learning strategy profiles of the sample, mean scores, the modal values, and the range were primarily utilized.

4.2.1 Factor Analysis of EBQ

Research Question 1: What is the nature and the number of factors that comprise the epistemological beliefs of Turkish elementary school students?

As discussed in detail in Chapter 3, a slightly different factor structure was obtained with Turkish data. Both the nature and the number of factors that comprise the epistemological beliefs of Turkish elementary students showed variation when compared with Conley et al.'s (2004) model. Instead of the four factor structure reported by Conley et al., the results of the pilot and main studies constantly signified a three factor structure. The development and justification factors were also encountered in the Turkish sample. However, the source and certainty factors tended to merge into a single factor which is labeled as source/certainty factor in the current investigation. Besides the factor number, the nature of the factors was conceptually different from Conley et al.'s (2004) model as well. That is, items from the Nature of Knowledge domain (Certainty) united with the items of the Nature of Knowing domain (Source). As a result it can be concluded that, the current study revealed a three factor structure that comprise the epistemological beliefs of Turkish students. These factors were labeled as source/certainty, development, and justification in this study.

4.2.2 Descriptive Statistics for Epistemological Beliefs

Research Question 2: What is the epistemological belief profile of Turkish elementary school students?

The mean subscale scores, the modal values, and the range were primarily used to explain the epistemological beliefs profile of the sample. Descriptive statistics results revealed that the seventh grade students generally had sophisticated epistemological beliefs as indicated by the mean scores ranging from 3.28 to 3.99 on a five point scale. For the Justification dimension ($\alpha = .77$), the mean score was 3.99 (*SD* = .64) which is very close to 4 on a five-point scale. The position of the mean score of this dimension at the higher end of the five-point scale implies that students most of the time believed that knowledge is constructed through critical examination of evidence and the opinions of experts. A mode of 4.00 can be considered as an additional evidence for this interpretation. It is interesting to note that, however, there was a quite large range of beliefs represented by the sample for this dimension, from a maximum of 5 to a minimum of 1. This result revealed that while a large proportion of students (75.3%) tended to believe the importance of evidence and evaluating claims for justifying knowledge, some students (10.6%) tended to disagree.

For the Development dimension ($\alpha = .59$), the mean score was 3.60 (*SD* = .61). This result suggests that students tended to believe that science is an evolving and changing subject. This is also evidenced by a modal value of 3.83. Like the range of the Justification dimension, the range of this dimension was fairly large implying that although more than half of the students (59.9%) tended to believe the evolving and changing nature of science, a smaller percentage of students (14.8%) tended to disagree with this belief.

The mean value for the Source/Certainty dimension (α = .70) was 3.28 (*SD* = .63) which is slightly higher than the middle point of the five-point scale. The position of the mean score of this dimension on the five-point scale implies that students tended to be slightly more closer to the view that knowledge is constructed by the knower and there may be more than one right answer than to the belief about single right knowledge residing in external authorities. According to the modal value, however, it can be inferred that students were undecided whether to believe in a single right answer provided by external authorities or not. This dimension also had a quite large range, from a maximum of 5 to a minimum of 1.33. In other words, while nearly half of the students (46.7%) believed that knowledge is constructed by the knower and there may be more than one right answer, a lower percentage of the students (27.3%) believed the existence of single right knowledge residing in external authorities

The descriptive statistics results with respect to gender and SES were presented in Table 4.3 and Table 4.4 respectively. According to Table 4.3, there is a clear difference in the mean scores of Justification dimension among boys and girls. Girls' mean score (*M* = 4.09, *SD* =.56) is higher than that of boys (*M* = 3.89, *SD* =.68) implying that girls tended to have more sophisticated views in Justification dimension when compared with boys.

Table 4.3 Descriptive statistics for the epistemological beliefs dimensions across gender

Gender	Dimension	N	*M*	*SD*	Item Mean	Item SD	Min.	Max.
Girls	Source/Certainty	593	29.37	5.73	3.26	.64	1.56	4.88
	Development	593	21.60	3.56	3.60	.59	1.33	5.00
	Justification	593	36.86	5.04	4.09	.56	1.67	5.00
Boys	Source/Certainty	637	29.72	5.63	3.30	.63	1.33	5.00
	Development	637	21.57	3.70	3.59	.62	1.00	5.00
	Justification	637	34.99	6.16	3.89	.68	1.00	5.00
Total	Source/Certainty	1230	29.54	5.67	3.28	.63	1.33	5.00
	Development	1230	21.58	3.63	3.60	.61	1.00	5.00
	Justification	1230	35.88	5.74	3.99	.64	1.00	5.00

Table 4.4 reveals the increase in the mean scores for each dimension as SES increases from low to high. Accordingly, there is an apparent discrepancy among low and high SES groups in each dimension of epistemological beliefs.

Table 4.4 Descriptive statistics for the epistemological beliefs dimensions across socioeconomic status (SES)

SES	Dimension	N	*M*	*SD*	Item Mean	Item SD	Min.	Max.
Low	Source/Certainty	409	28.56	5.16	3.17	.57	1.56	4.78
	Development	409	21.07	3.71	3.51	.62	1.33	5.00
	Justification	409	34.54	5.64	3.84	.62	1.67	5.00
Medium	Source/Certainty	402	29.59	5.71	3.29	.63	1.67	5.00
	Development	402	21.54	3.67	3.59	.61	1.00	5.00
	Justification	402	35.96	5.59	3.99	.61	1.00	5.00

Table 4.4 (Continued)

SES	Dimension	N	M	SD	Item Mean	Item SD	Min.	Max.
High	Source/Certainty	419	30.45	5.97	3.38	.67	1.33	5.00
	Development	419	22.11	3.45	3.67	.58	1.50	5.00
	Justification	419	37.10	5.72	4.12	.64	1.33	5.00

Means and standard deviations were also computed for the 24 items in the EBQ. The results of the item analysis for the source/certainty, development, and justification dimensions were listed in Table 4.5. The respondents scored higher on item 5 (It is good to have an idea before you start an experiment), item 18 (It is good to try experiments more than once to make sure of your findings), and item 26 (A good way to know if something is true is to do an experiment) all of which belong to justification dimension. On the other hand, students scored lower on item 15 (If you read something in science book, you can be sure it’s true) and on item 16 (Scientific knowledge is always true) both of which reflect beliefs about the source/certainty of knowledge.

Table 4.5 Item descriptive summary for the dimensions of the EBQ

Dimensions	Item number	*M*	*SD*
Source/Certainty	1*	3.45	1.15
	6*	3.58	1.18
	10*	3.07	1.25
	12*	3.69	1.23
	15*	2.91	1.02
	16*	2.95	1.13
	19*	3.48	1.17
	20*	3.25	1.17
	23*	3.15	1.16

Table 4.5 (Continued)

Dimensions	Item number	M	SD
Development	4	3.49	1.06
	8	3.42	1.05
	13	4.05	1.17
	17	3.72	1.03
	21	3.39	1.04
	25	3.51	1.00
Justification	3	3.92	1.07
	5	4.25	1.17
	9	3.88	1.04
	11	3.70	1.02
	14	4.07	1.05
	18	4.16	1.07
	22	3.97	1.13
	24	3.78	1.00
	26	4.16	1.11

* Reversed Item

Percentages of responses to the items of the EBQ were presented in Table 4.6. In general, students tended to agree or strongly agree the items in the EBQ. The percentage of agreement was higher in the development and justification dimensions compared to the percentages obtained for source/certainty items (see Table 4.5). For example, 79% of the seventh graders indicated that they either agree or strongly agree the item 13 (There are some questions that even scientists cannot answer) in the development dimension. Likewise, approximately 70% percent of the students agreed or strongly agreed the item 17 (Ideas in science sometimes change) in same dimension. The percent of agreement was also high in the justification dimension with 84% of the students rating their agreement with the fifth item as 4 or 5. Similarly, more than 80% of the participants reported that they either agreed or strongly agreed the item 18 in the justification dimension. The percent of agreement with the items of the source/certainty dimension was somehow lower than the development and justification dimensions. For instance, nearly 63% of the students rated their agreement as 4 or 5 to the item 12 (Scientists pretty much know everything about science; there is not much more to know) in the source/certainty dimension.

Table 4.6 Percentages of responses to the items of the EBQ

Dimensions	Item number	SD (%)	D (%)	U (%)	A (%)	SA (%)
Source/Certainty	1*	6.50	15.2	23.7	35.4	19.0
	6*	6.60	13.5	19.1	36.4	24.3
	10*	12.7	22.8	22.6	28.6	13.2
	12*	6.30	14.0	16.2	30.9	32.6
	15*	8.00	25.8	39.2	20.7	6.30
	16*	11.3	24.0	31.3	25.2	8.30
	19*	6.40	15.0	24.8	32.3	21.5
	20*	8.90	18.1	27.6	30.6	14.8
	23*	8.10	22.1	30.9	24.1	14.8
Development	4	5.90	9.80	30.4	37.8	16.1
	8	6.30	11.4	29.3	40.2	12.7
	13	6.90	5.60	8.30	34.2	45.0
	17	5.00	7.30	18.9	48.6	20.3
	21	5.60	11.4	35.7	33.5	13.8
	25	4.90	9.50	28.2	43.8	13.5
Justification	3	4.70	5.80	15.8	40.2	33.5
	5	6.70	4.80	3.80	26.3	58.3
	9	3.70	6.50	19.0	39.7	31.0
	11	4.30	7.30	23.5	43.3	21.5
	14	4.00	5.10	12.9	36.1	42.0
	18	4.00	6.00	8.20	33.8	47.9
	22	4.90	8.10	11.5	36.0	39.4
	24	3.10	6.90	24.0	41.0	25.1
	26	5.10	5.20	8.6	31.1	49.9

* Reversed Item

Note. SD = strongly disagree, D = disagree, U = undecided, A = agree, SA = strongly agree

4.2.3 Descriptive Statistics for Learning Approaches

Research question 3: What is the learning approach profile of Turkish elementary school students?

The mean subscale scores, the modal values, and the range were primarily used to explain the learning approaches profile of the sample. Descriptive statistics results showed that the participants had an obvious preference for the meaningful learning approach. The seventh graders generally pointed out to adopt meaningful learning approaches as indicated by the mean score of 3.05 on a four-point scale (see Table 4.7). The position of the mean score for the meaningful learning dimension at the higher end of the scale implies that students generally had the intention to understand the learning material by constructing the meaning of the content rather than learning through memorization by simply recalling the facts. A mode of 3.08 can be accepted as an additional evidence for this interpretation. It is interesting to note that, however, there was a quite large range for this dimension, from a maximum of 4.00 to a minimum of 1.00. This result showed that while a large portion of the respondents (77.3 %) agreed the items representing meaningful approaches to learning, some students (22.7 %) did not.

For the rote learning dimension, the mean score was obtained as 1.99 (*SD* = .64) on a four-point scale which suggested that students generally did not agree to the items related with rote learning. This result was also supported by the modal value of 2.00 for the rote learning dimension. These descriptive statistics results indicated that seventh graders generally disagree the items favoring memorization during learning. Like the range of the meaningful learning dimension, the range of this dimension was fairly large implying that while more than half of the students (72.9 %) tended to disagree the items representing rote learning, a smaller percentage of them (27.1 %) agreed these items, hence adopted a rote learning approach.

The descriptive statistics results for the learning approaches dimensions according to gender and SES were given in Table 4.7 and Table 4.8 respectively. As displayed in Table 4.7, the difference among boys and girls in terms of the mean scores for the meaningful learning dimension was not very high. The mean score for the rote learning dimension, however, slightly differ among boys and girls. Girls' lower mean score on the rote learning dimension (*M* = 1.91, *SD* = .59) implies that compared to boys (*M* = 2.07, *SD* = .67) girls were less likely to rely on memorization while learning.

Table 4.7 Descriptive statistics for the learning approaches dimensions across gender

Gender	Dimension	N	*M*	*SD*	Item Mean	Item SD	Min.	Max.
Girls	Meaningful learning	593	40.33	5.49	3.10	.42	1.54	4.00
	Rote learning	593	12.31	2.39	1.91	.59	1.00	3.75
Boys	Meaningful learning	637	39.02	5.94	3.00	.46	1.00	4.00
	Rote learning	637	11.71	2.69	2.07	.67	1.00	4.00
Total	Meaningful learning	1230	39.64	5.77	3.05	.44	1.00	4.00
	Rote learning	1230	11.98	2.57	1.99	.64	1.00	4.00

As far as students' SES was considered, Table 4.8 indicated that the mean scores for the meaningful learning dimension across the three SES groups were very similar to each other. The mean scores for the rote learning dimension indicated a decrease as SES increases from low to high as shown in Table 4.8. The mean score for rote learning in high SES group (*M* = 1.91, *SD* = .64) was lower than that of low and medium SES groups.

Table 4.8 Descriptive statistics for the learning approaches dimensions across socio-economic status (SES)

SES	Dimension	N	*M*	*SD*	Item Mean	Item SD	Min.	Max.
Low	Meaningful learning	412	39.43	5.48	3.03	.42	1.00	4.00
	Rote learning	412	11.68	2.49	2.07	.62	1.00	3.75
Medium	Meaningful learning	405	39.45	5.81	3.03	.45	1.15	4.00
	Rote learning	405	11.90	2.62	2.01	.65	1.00	4.00
High	Meaningful learning	423	40.03	5.98	3.08	.46	1.38	4.00
	Rote learning	423	12.35	2.57	1.91	.64	1.00	4.00

Means and standard deviations were also computed for the 17 items in the LAQ. The results of the item analysis for the meaningful learning and rote learning dimensions were depicted in Table 4.9. The respondents scored higher on item 1 (I generally put a lot of effort into trying to understand things that initially seem difficult), item 6 (I go over important topics until I understand them completely), and item 11 (After a lecture or lab, I reread my notes to make sure that I understand them) all of which belong to meaningful learning dimension. On the other hand, the lowest mean scores belong to item 20 (Often, I read things without really having a chance to understand them) and item 22 (I generally restrict my study to information that is specifically given, as I think it is unnecessary to do anything extra) of the rote learning dimension.

Table 4.9 Item descriptive summary for the dimensions of the LAQ

Dimensions	Item number	*M*	*SD*
LAQ-M	1	3.14	.83
	2	3.09	.78
	3	3.08	.81
	6	3.35	.80
	8	2.94	.85
	9	2.84	.84
	10	3.02	.78
	11	3.11	.85
	13	3.06	.85
	15	2.90	.85
	17	3.17	.91
	23	2.96	.78
	24	2.99	.91
LAQ-R	18	2.07	.99
	20	1.83	.93
	21	2.18	.88
	22	1.90	.94

Percentages of responses to the items of the LAQ were presented in Table 4.10. In general, students tended to agree or strongly agree the items in the LAQ. It is interesting to note that more than 70% of the seventh graders indicated that they either strongly agree or agree to all of the items of the meaningful learning dimension. For example, nearly 88% of the respondents indicated that they either agree or strongly agree the item 6 in the meaningful learning dimension. Likewise, percentage of agreement with the item 2 (I try to relate new material, as I am reading it, to what I already know on the topic) in the same dimension was quite high (80.9%). Contrary to the high percent of agreement with the meaningful learning items, students generally tended to disagree the items in the rote learning dimension. More than 60% of the respondents indicated that they either strongly disagree or disagree the items representing rote learning. For instance, 79% of the students rated their agreement with the item 20 as either 1 or 2.

Table 4.10 Percentages of responses to the items of the LAQ

Dimensions	Item number	SD (%)	D (%)	A (%)	SA (%)
LAQ-M	1	4.90	13.4	44.8	36.9
	2	3.40	15.7	49.2	31.7
	3	4.10	17.2	45.5	33.2
	6	4.20	8.10	36.8	51.0
	8	5.40	22.7	44.4	27.5
	9	6.60	24.6	46.6	22.2
	10	3.80	18.2	50.0	28.0
	11	5.20	16.0	41.9	36.9
	13	5.40	17.2	43.7	33.7
	15	6.50	21.9	46.5	25.2
	17	6.60	14.5	34.3	44.6
	23	4.60	18.8	52.4	24.2
	24	7.80	18.3	41.0	32.8
LAQ-R	18	34.6	35.4	18.7	11.3
	20	45.1	34.3	13.1	7.50
	21	23.7	42.7	25.6	8.00
	22	41.7	34.2	16.0	8.10

Note. SD = strongly disagree, D = disagree, A = agree, SA = strongly agree

4.2.4 Descriptive Statistics for Self-Regulated Learning Strategies

Research question 3: What is the self-regulated learning strategy profile of Turkish elementary school students?

Measured on a seven point Likert scale ranging from "not at all true of me" to "very true of me", total item mean was obtained as 4.85 (*SD* = .90) which revealed that seventh grade students generally rated themselves as self-regulated learners. The mean score of girls for SRL strategies was slightly higher than that of boys implying that girls tended to rate themselves somewhat more as self-regulated learners (see Table 4.11).

Table 4.11 Descriptive statistics for the SRL strategies across gender

Gender	N	*M*	*SD*	Item Mean	Item SD	Min.	Max.
Girls	593	153.27	28.51	4.94	.92	2.23	6.97
Boys	637	147.35	26.97	4.75	.87	1.58	7.00
Total	1230	150.31	27.88	4.85	.90	1.58	7.00

The results of descriptive statistics with respect to SES were presented in Table 4.12. As the mean scores of the SRL strategies increases, SES also increases. The mean score of SRL strategies in high SES group (M = 5.00, SD = .89) was higher than that of low (M = 4.73, SD = .88) and medium SES (M = 4.81, SD = .91) groups.

Table 4.12 Descriptive statistics for the SRL strategies across socio-economic status (SES)

SES	N	*M*	*SD*	Item Mean	Item SD	Min.	Max.
Low	412	146.74	27.32	4.73	.88	2.03	6.74
Medium	405	149.15	28.19	4.81	.91	1.58	6.81
High	423	154.88	27.56	5.00	.89	2.16	7.00

Means, standard deviations, and percentages of responses to the items were also computed for the 31 items in the MSLQ. The results of the item analysis for the items representing SRL strategies were listed in Table 4.13. The seventh graders comparatively scored higher on item 5 (When I studying this course, I practice saying the material to myself over and over) and 76% of them rated their agreement with this item as 5, 6, or 7. Item 6 (When I become confused about something I'm reading for this class, I go back and try to figure it out) had the same mean score with item 5 with nearly 78% of the students rated their agreement as 5, 6, or 7. Of the all items, item 7 (When I studying this course, I go through the readings and my class notes and try to find the important ideas) had the highest mean score. Approximately 77% of the respondents rated their agreement with this item as 5, 6, or 7. On the other hand, the lowest mean scores belong to item 1 (When I studying the readings for this course, I outline the material to help me organize my thoughts) and item 11 (I make simple charts, diagrams, or tables to help me organize course material). Forty seven percent of the students rated their agreement with those items as 5, 6, or 7.

Table 4.13 Item descriptive summary and percentages of responses to the items of the MSLQ

Items	*M*	*SD*	1 %	2 %	3 %	4 %	5 %	6 %	7 %
1	4.25	1.99	14.2	8.10	11.6	19.0	16.5	12.3	18.2
2*	5.39	1.96	7.90	4.80	6.70	8.20	11.3	16.4	44.2
3	4.56	1.86	8.30	7.20	13.7	17.1	17.9	15.8	20.1
4	4.72	1.83	7.10	6.60	11.5	18.3	16.8	17.5	22.2
5	5.54	1.64	2.70	4.30	6.50	10.2	14.8	21.8	39.8
6	5.54	1.63	3.50	3.30	5.90	9.70	15.6	23.6	38.4
7	5.56	1.59	2.80	2.60	7.00	11.0	13.6	24.9	38.1
8	4.75	1.81	7.30	6.70	9.30	17.7	18.1	21.1	19.8
9	4.98	1.74	4.60	6.40	9.80	14.4	19.3	21.7	23.8
10	4.61	1.73	6.30	7.00	11.9	19.6	21.0	17.5	16.8
11	4.31	1.92	10.2	11.1	13.3	17.6	16.8	13.5	17.5
12	4.71	1.70	5.80	5.70	12.1	17.5	21.9	20.1	16.9
13	5.11	1.73	4.10	6.00	8.40	15.5	15.8	23.1	27.2
14	4.73	1.78	6.90	6.50	10.6	17.0	19.4	20.6	19.0
15	4.86	1.81	5.80	6.70	12.8	12.3	17.5	21.8	23.1
16	4.54	1.81	8.50	7.00	11.5	19.4	18.9	18.1	16.8
17*	4.72	1.96	9.30	7.40	10.4	14.3	17.1	15.6	25.8
18	4.84	1.96	9.20	6.00	10.3	13.6	15.2	17.7	28.0
19	5.24	1.64	3.40	4.40	7.40	14.3	19.2	23.1	28.3
20	4.30	1.89	11.5	8.20	13.4	19.4	17.0	14.7	15.8
21	4.77	1.86	7.10	7.60	11.1	13.6	19.0	18.1	23.5
22	4.69	1.79	6.10	7.60	12.3	16.1	19.8	18.7	19.4

Table 4.13 (Continued)

Items	*M*	*SD*	1 %	2 %	3 %	4 %	5 %	6 %	7 %
23	4.88	1.59	4.00	4.00	11.1	17.2	24.8	21.6	17.2
24	4.85	1.80	5.40	7.30	11.2	14.8	19.1	18.8	23.5
25	4.87	1.70	5.30	5.50	10.3	15.3	21.1	24.0	18.5
26	4.54	1.68	6.50	6.70	11.1	20.6	24.6	16.9	13.8
27	4.28	1.88	9.90	11.3	13.2	18.5	15.8	16.6	14.7
28	5.26	1.64	3.60	3.40	8.50	13.9	18.4	23.2	29.0
29	5.11	1.69	3.70	5.10	9.40	15.3	19.1	20.4	27.0
30	85.02	1.80	5.80	6.50	9.00	11.0	19.5	22.5	25.7
31	4.76	1.89	9.20	6.50	8.90	12.6	21.4	19.1	22.3

*Reversed item
Note. 1 = not very true of me, 7 = very true of me

4.2.5 Descriptive Statistics for Science Achievement

The descriptive statistics results revealed that the seventh graders enrolled in the current study had low science achievement as measured by the SACHT (see Table 4.14). Of a possible 25 correct responses on the test, the relatively low mean score of 9.00 was attained by the students. This means that, the participants responded correctly to less than 50% of the questions indicating a low level of achievement in science. The mean scores of girls (M = 8.98, SD = 3.34) and boys (M = 9.04, SD = 3.54) did not show much variation with girls performing slightly lower than boys.

Table 4.14 Descriptive statistics for the science achievement scores across gender

Gender	N	Min.	Max.	*M*	*SD*
Girls	593	0	22	8.98	3.34
Boys	637	1	21	9.04	3.54
Total	1230	0	22	9.00	3.44

As displayed in Table 4.15, approximately 60% of the students had SACHT scores between 6 and 11. Of the 1230 respondents, only three of them (.3 %) scored equal to or above 20. Eighty six students obtained SACHT scores of five or less with two of them having no true answers at all.

Table 4.15 Frequency and percentage of SACHT scores

SACHT scores	*f*	%	Cumulative %
0	2	.2	.2
1	1	.1	.2
2	13	1.0	1.3
3	19	1.5	2.8
4	66	5.3	8.1
5	86	6.9	15.1
6	123	9.9	25.0
7	141	11.4	36.4
8	140	11.3	47.7
9	144	11.6	59.3
10	123	9.9	69.2
11	113	9.1	78.3
12	71	5.7	84.0
13	61	4.9	89.0
14	43	3.5	92.4
15	32	2.6	95.0
16	33	2.7	97.7
17	20	1.6	99.3
18	4	.3	99.6
19	2	.2	99.8
20	1	.1	99.8
21	1	.1	99.9
22	1	.1	100.0

The descriptive statistics regarding SACHT scores in three different SES groups were reported in Table 4.16. As shown in the table, the mean SACHT scores tended to increase as SES increases. There is an apparent discrepancy among low (M = 7.78, SD = 2.95) and high (M = 10.13, SD = 3.62) SES groups in terms of mean SACHT scores although both groups performed low in the test.

Table 4.16 Descriptive statistics for the science achievement scores across socio-economic status (SES)

SES	N	Min.	Max.	*M*	*SD*
Low	412	1	18	7.78	2.95
Medium	405	2	21	9.06	3.30
High	423	0	22	10.13	3.62

4.3 Inferential Statistics

In the inferential statistics part, first the final science achievement model for the total sample was introduced. Then, the science achievement model for boys and girls were presented respectively.

4.3.1 The Final Science Achievement Model for the Whole Sample

After the latent variables were identified through factor analysis, the actual model presented in Chapter 1 was tested with the main study data. In the initial model paths between SOU/CER and SELFRL, DEV and SELFRL, JUST and SELFRL, DEV and SCIACH, JUST and SCIACH, and MLEARN and SCIACH were found to have nonsignificant t-values. Accordingly, these nonsignificant paths were deleted in the model. The final SIMPLIS syntax for the structural model was provided in Appendix G. Figure 4.1 presents the structural model with estimates. The t-values that are significant at .05 level were shown in Figure 4.2. The basic model with estimates and t-values was given in Appendix H.

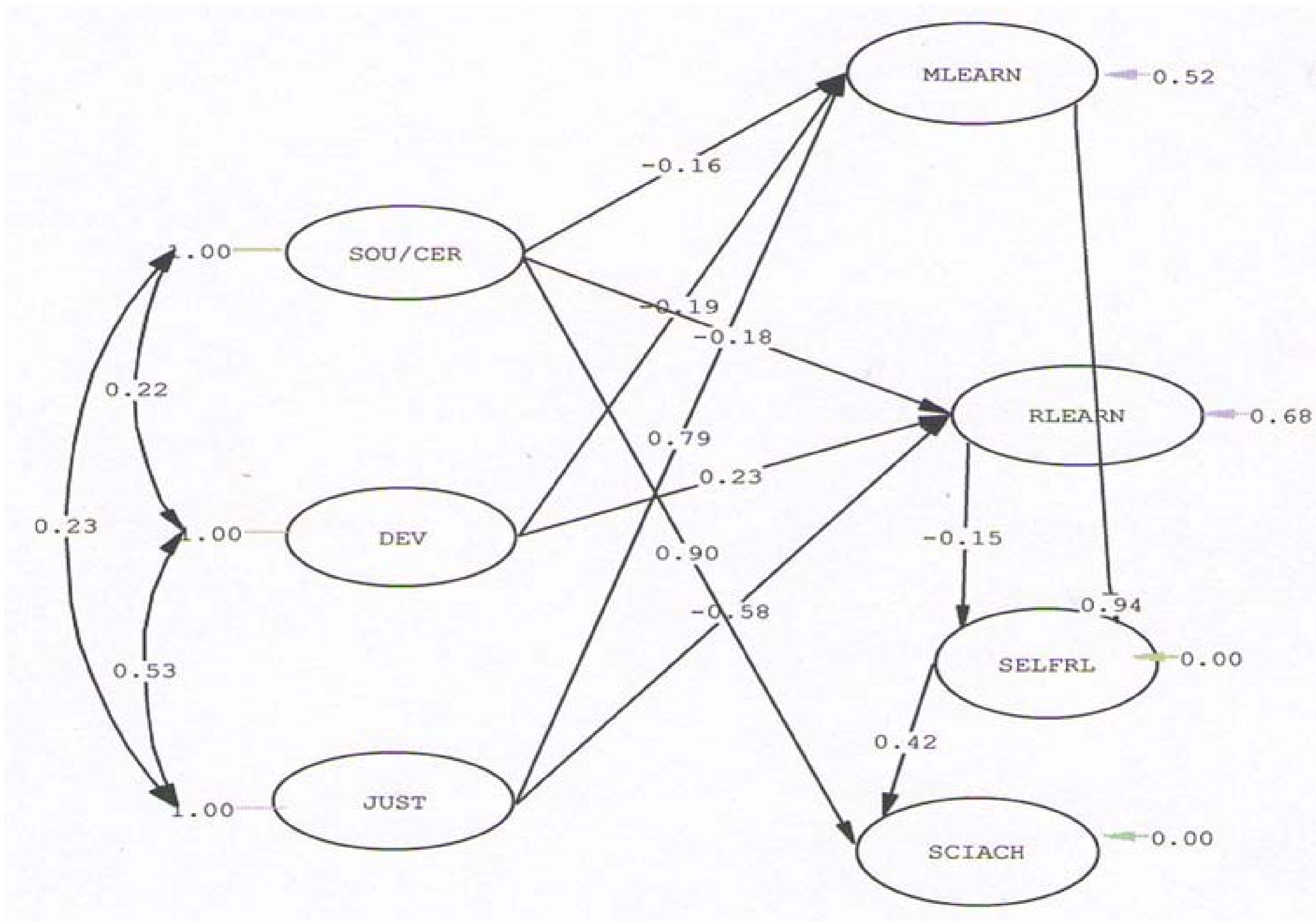

Figure 4.1 Science achievement model with estimates

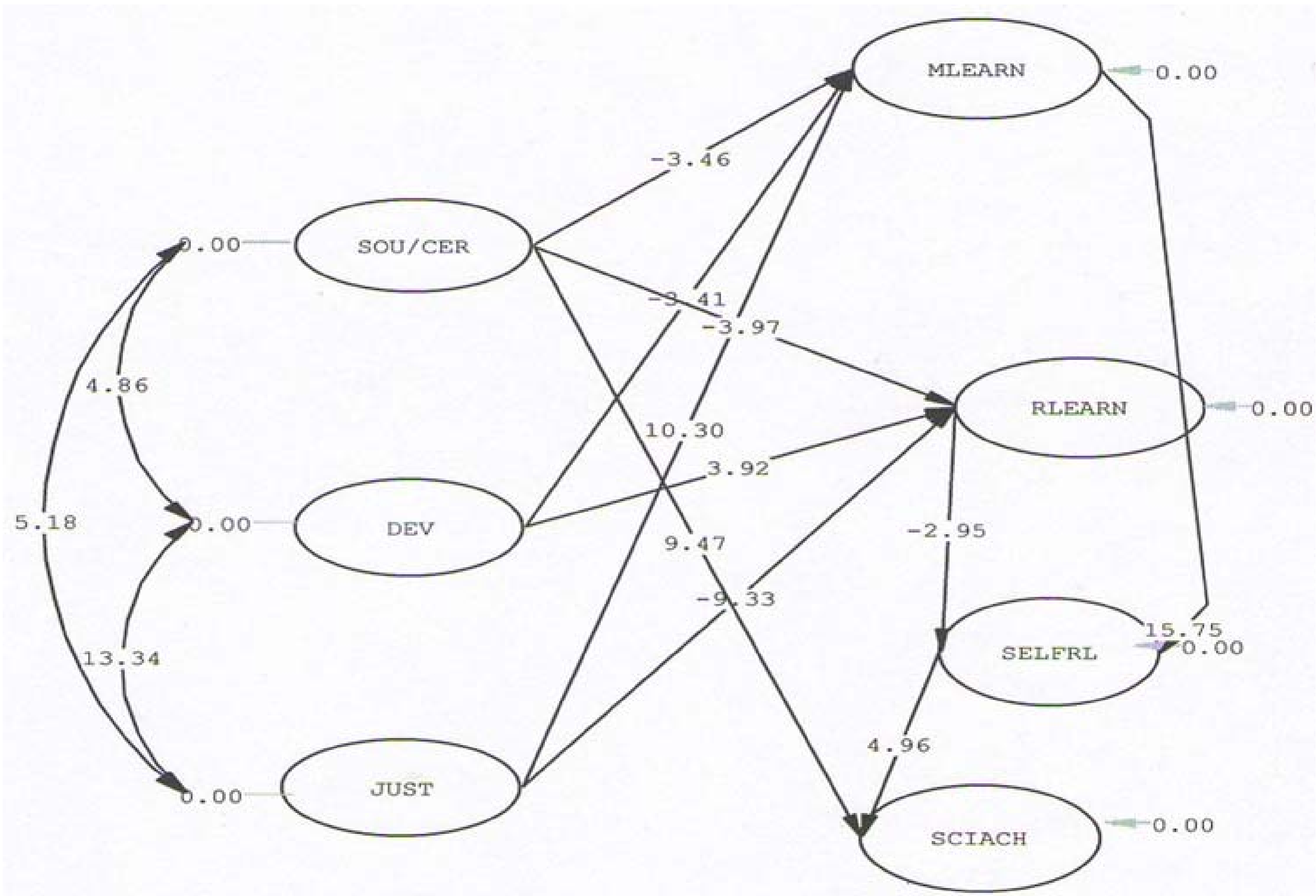

Figure 4.2 Science achievement model with t-values

The measurement coefficients (λ) and measurement errors of the final model were listed in Table 4.17. As defined previously in Chapter 3, measurement coefficients (λ) points out the relationships between latent variables and observed variables. The relationships between exogenous variables (SOU/CER, DEV, JUST) and observed variables (X-variables) were shown by λ_x (lowercase lambda sub x). The relationships between endogenous variables (MLEARN, RLEARN, SELFRL, SCIACH) and the observed variables (Y-variables) were presented by λ_y (lowercase lambda sub y) in Table 4.17. The measurement errors were also listed for X-variables and Y-variables in Table 4.17. The δ (lowercase delta) and ε (lowercase epsilon) were the measurement errors for X and Y variables, respectively.

Table 4.17 Measurement coefficients (λ) and measurement errors of the science achievement model

Latent Variables	λ	Observed Variables	Measurement Errors
SOU/CER	.34 (λ_x)	Belbook	.89(δ)
	.58(λ_x)	Nomore	.66(δ)
	.52(λ_x)	Sctknow	.73(δ)
	.52(λ_x)	Agtrue	.73(δ)
DEV	.48(λ_x)	Idebook	.77(δ)
	.74(λ_x)	Idescience	.45(δ)
	.40(λ_x)	Chamind	.84(δ)
JUST	.55(λ_x)	Befstart	.70(δ)
	.63(λ_x)	Doexper	.60(δ)
	.68(λ_x)	Morexper	.57(δ)
MLEARN	.58(λ_y)	Relatenew	.67(ε)
	.60(λ_y)	Goover	.64(ε)
	.54(λ_y)	Question	.71(ε)
	.62(λ_y)	Reread	.62(ε)
	.50(λ_y)	Newans	.75(ε)
RLEARN	.68(λ_y)	Notunders	.53(ε)
	.55(λ_y)	Looksome	.70(ε)
	.71(λ_y)	Reststudy	.50(ε)
SELFRL	.63(λ_y)	Selftot	.60(ε)
SCIACH	.37(λ_y)	Scientot	.86(ε)

As defined in Chapter 3, the structure coefficients (β and γ) values indicate the strength and direction of the relationships among exogenous and endogenous variables. The strength and direction of the relationships among endogenous variables were identified by β (lowercase beta) in Table 4.18. The γ (lowercase gamma) values indicated the strength and direction of the relationships among exogenous and endogenous variables (See Table 4.19).

Table 4.18 β (lowercase beta) values of the science achievement model

Endogenous Variables	β	Endogenous Variables
MLEARN	.94	SELFRL
RLEARN	-.15	SELFRL
SELFRL	.42	SCIACH

Table 4.19 γ (lowercase gamma) values of the science achievement model

Exogenous Variables	γ	Endogenous Variables
SOU/CER	-.16	MLEARN
DEV	-.19	
JUST	.79	
SOU/CER	-.18	RLEARN
DEV	.23	
JUST	-.58	
SOU/CER	.90	SCIACH

The significant paths in the final model were presented Table 4.20 with their structure coefficient and t-values. As indicated before, paths to SELFRL from SOU/CER, from DEV, and from JUST, and paths to SCIACH from DEV, from JUST, and from MLEARN were found to have nonsignificant t-values; therefore excluded from the model. All remaining paths in the final model as revealed in Table 4.20 had significant t-values.

Table 4.20 Structure coefficients and t-values of the paths in the science achievement model

Paths			
From	To	Structure coefficients	t-values
SOU/CER	MLEARN	-.16	-3.46
	RLEARN	-.18	-3.97
	SCIACH	.90	9.47
DEV	MLEARN	-.19	-3.41
	RLEARN	.23	3.92
JUST	MLEARN	.79	10.30
	RLEARN	-.58	-9.33
MLEARN	SELFRL	.94	15.75
RLEARN	SELFRL	-.15	-2.95
SELFRL	SCIACH	.42	4.96

The goodness-of-fit indices used to evaluate the model were given in Table 4.21. Goodness of fit index (GFI), adjusted GFI (AGFI), root mean square residual (RMR), standardized RMR (SRMR), and root mean square error of approximation (RMSEA) indicated a good model fit. The Chi-Square, χ^2 = 548.45, was significant with degrees of freedom, *df* = 159, and the significance level, *p* = 0.00. As Schumacker and Lomax (2004), χ^2 criterion tends to indicate a significant probability level with large sample sizes, generally with sample size above 200. The model in the current study was tested with 1240 students; therefore, a significant χ^2 was obtained. When χ^2 is divided by df, the Normed Chi-Square (NC) is obtained. A NC value less than five can be regarded as an additional evidence for the good model fit. The NC was calculated as 3.45 indicating a good fit to the data. The values for the whole goodness-of-fit statistics were provided in Appendix I.

Table 4.21 Goodness-of-fit indices of the science achievement model

Index	Value	Criterion
GFI	.958	≥.95
AGFI	.944	≥.95
RMR	.048	<.05
SRMR	.048	<.05
RMSEA	.044	<.05

The squared multiple correlations (R^2) calculated for each observed variable were presented Table 4.22 as an additional fit statistics. As suggested by Kline (1998), squared multiple correlation gives the proportion of the explained variance and values less than .50 mean that more than half of an indicator's variance is unexplained by the factors it is specified to measure.

Table 4.22 Squared multiple correlations for the science achievement model

Variable	R^2	Variable	R^2
Belbook	.12	Relatenew	.33
Nomore	.34	Goover	.37
Sctknow	.27	Question	.29
Agtrue	.27	Reread	.38
Idebook	.23	Newans	.26
Idescience	.55	Notunders	.47
Chamind	.16	Looksome	.30
Befstart	.30	Reststudy	.50
Doexper	.40	Selftot	.40
Morexper	.43	Scientot	.14

According to the final science achievement model, the hypotheses introduced in the first chapter were evaluated. Since the two factors (source and certainty) merged into a single dimension in the current study, the hypotheses related to these two factors were assessed together. Therefore, the number of hypotheses presented in the first chapter decreased to 17.

Hypotheses 1 & 4: Sophisticated beliefs about source of knowing/certainty of knowledge is significantly but negatively related to meaningful learning ($\gamma = -0.16$, $t = -3.46$, $p < .05$).

Hypothesis 2: As hypothesized, sophisticated beliefs about justification of knowing is significantly and positively related to meaningful learning ($\gamma = 0.79$, $t = 10.30$, $p < .05$).

Hypothesis 3: Sophisticated beliefs about development of knowledge is significantly but negatively related to meaningful learning ($\gamma = -0.19$, $t = -3.41$, $p < .05$) .

Hypotheses 5 & 8: As proposed, sophisticated beliefs about source of knowing/certainty of knowledge is significantly and negatively related to rote learning ($\gamma = -0.18$, $t = -3.97$, $p < .05$).

Hypothesis 6: As expected sophisticated beliefs about justification of knowing is significantly and negatively related to rote learning ($\gamma = -0.58$, $t = -9.33$, $p < .05$).

Hypothesis 7: Unexpectedly, sophisticated beliefs about development of knowledge is significantly and positively related to rote learning ($\gamma = 0.23$, $t = 3.92$, $p < .05$).

Hypothesis 9 & 12: Surprisingly, sophisticated beliefs about source of knowing/certainty of knowledge is not significantly related to self-regulated learning strategies.

Hypothesis 10: Surprisingly, sophisticated beliefs about justification of knowing is not significantly related to self-regulated learning strategies.

Hypothesis 11: Unexpectedly, sophisticated beliefs about development of knowledge is not significantly related self-regulated learning strategies.

Hypothesis 13 & 16: As predicted, sophisticated beliefs about source of knowing/certainty of knowledge is significantly and positively related to science achievement ($\gamma = 0.90$, $t = 9.47$, $p < .05$).

Hypothesis 14: Unexpectedly, sophisticated beliefs about justification of knowing is not significantly related to science achievement.

Hypothesis 15: Unexpectedly, sophisticated beliefs about development of knowledge is not significantly related to science achievement.

Hypothesis 17: As expected, meaningful learning is significantly and positively related to self-regulated learning ($\beta = 0.94$, $t = 15.75$, $p < .05$).

Hypothesis 18: As predicted, rote learning is significantly and negatively related to self-regulated learning ($\beta = -0.15$, $t = -2.95$, $p < .05$).

Hypothesis 19: Unexpectedly, meaningful learning is not significantly related to science achievement.

Hypothesis 20: Unexpectedly, rote learning is not significantly related to science achievement.

Hypothesis 21: As predicted, self-regulated learning is significantly and positively related to science achievement ($\beta = 0.42$, $t = 4.96$, $p < .05$).

4.3.2 The Final Science Achievement Model for Boys

The final science achievement models with estimates and t-values for boys are presented in Figure 4.3 and Figure 4.4, respectively.

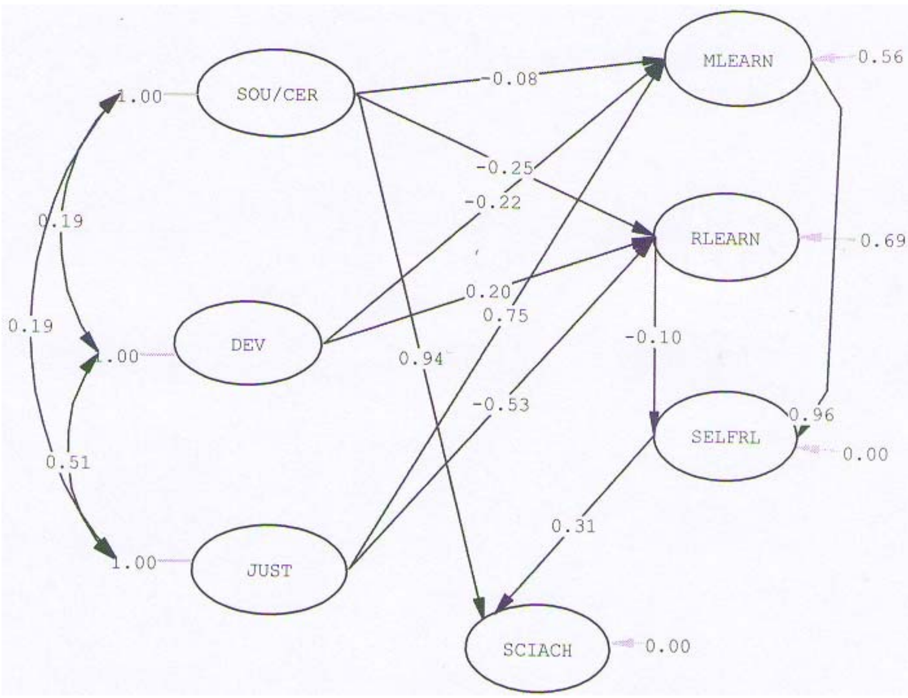

Figure 4.3 Science achievement model with estimates (Boys)

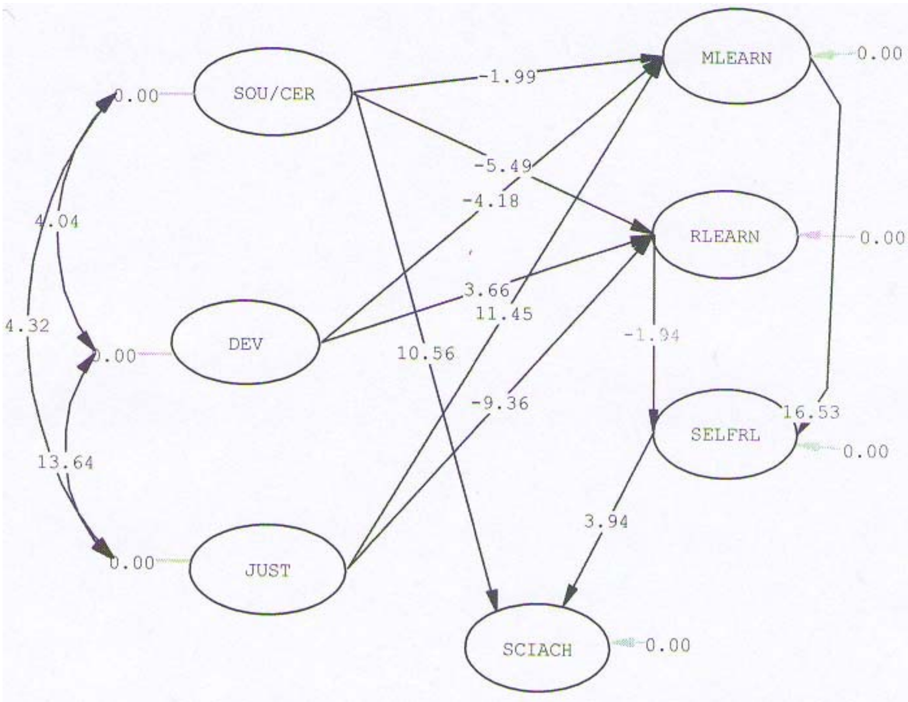

Figure 4.4 Science achievement model with t-values (Boys)

The measurement coefficients (λ) and measurement errors of the science achievement model for boys were listed in Table 4.23.

Table 4.23 Measurement coefficients (λ) and measurement errors of the science achievement model (Boys)

Latent Variables	λ	Observed Variables	Measurement Errors
SOU/CER	.28(λ_x)	Belbook	.92(δ)
	.59(λ_x)	Nomore	.66(δ)
	.46(λ_x)	Sctknow	.79(δ)
	.54(λ_x)	Agtrue	.54(δ)
DEV	.52(λ_x)	Idebook	.73(δ)
	.73(λ_x)	Idescience	.47(δ)
	.40(λ_x)	Chamind	.84(δ)

Table 4.23 (Continued)

Latent Variables	λ	Observed Variables	Measurement Errors
JUST	.58(λ_x)	Befstart	.66(δ)
	.66(λ_x)	Doexper	.57(δ)
	.73(λ_x)	Morexper	.47(δ)
MLEARN	.66(λy)	Relatenew	.56(ε)
	.60(λy)	Goover	.64(ε)
	.57(λy)	Question	.67(ε)
	.66(λy)	Reread	.57(ε)
	.53(λy)	Newans	.72(ε)
RLEARN	.70(λy)	Notunders	.51(ε)
	.58(λy)	Looksome	.66(ε)
	.69(λy)	Reststudy	.53(ε)
SELFRL	.60(λy)	Selftot	.64(ε)
SCIACH	.40 (λy)	Scientot	.84(ε)

The structure coefficients (β and γ) indicating the strength and direction of the relationships among latent variables in the model with their associated t-values were shown in Table 4.24. All paths in the model were significant except path from RLEARN to SELFRL. This nonsignificant path is the only difference between the model for the whole sample and the model for boys.

Table 4.24 Structure coefficients and t-values of the paths in the science achievement model (Boys)

Paths			
From	To	Structure coefficients	t-values
SOU/CER	MLEARN	-.08(γ)	-1.99
	RLEARN	-.25(γ)	-5.49
	SCIACH	.94(γ)	10.56
DEV	MLEARN	-.22(γ)	-4.18
	RLEARN	.20(γ)	3.66
JUST	MLEARN	.75(γ)	11.45
	RLEARN	-.53(γ)	-9.36
MLEARN	SELFRL	.96(β)	16.53
RLEARN	SELFRL	-.10(β)	-1.94*
SELFRL	SCIACH	.31(β)	3.94

*Nonsignificant path (γ) (β)

The goodness-of-fit indices used to evaluate the model for boys were given in Table 4.25. Since the values of goodness of fit index (GFI), adjusted GFI (AGFI), root mean square residual (RMR), standardized RMR (SRMR), and root mean square error of approximation (RMSEA) were approaching to unity, the model had a good fit to the data. The Chi-Square, χ^2 = 727.43, was significant with degrees of freedom, df = 159, and the significance level, p = 0.00. When χ^2 is divided by df, the Normed Chi-Square (NC) is obtained. A NC value less than five can be regarded as an additional evidence for the good model fit. The NC was calculated as 4.58 indicating a good fit to the data. Another evidence for the model fit was the RMSEA value which was in the 90 percent confidence interval ranging from 0.049 to 0.057.

Table 4.25 Goodness-of-fit indices of the science achievement model (Boys)

Index	Value	Criterion
GFI	.945	≥.95
AGFI	.928	≥.95
RMR	.052	<.05
SRMR	.052	<.05
RMSEA	.053	<.05

The squared multiple correlations (R^2) calculated for each observed variable were presented Table 4.26 as an additional fit statistics.

Table 4.26 Squared multiple correlations for the science achievement model (Boys)

Variable	R^2	Variable	R^2
Belbook	.08	Relatenew	.44
Nomore	.34	Goover	.36
Sctknow	.21	Question	.33
Agtrue	.30	Reread	.43
Idebook	.27	Newans	.28
Idescience	.53	Notunders	.49
Chamind	.16	Looksome	.34
Befstart	.34	Reststudy	.47
Doexper	.43	Selftot	.36
Morexper	.53	Scientot	.16

4.3.3 The Final Science Achievement Model for Girls

The final science achievement models with estimates and t-values for girls were presented in Figure 4.5 and Figure 4.6, respectively.

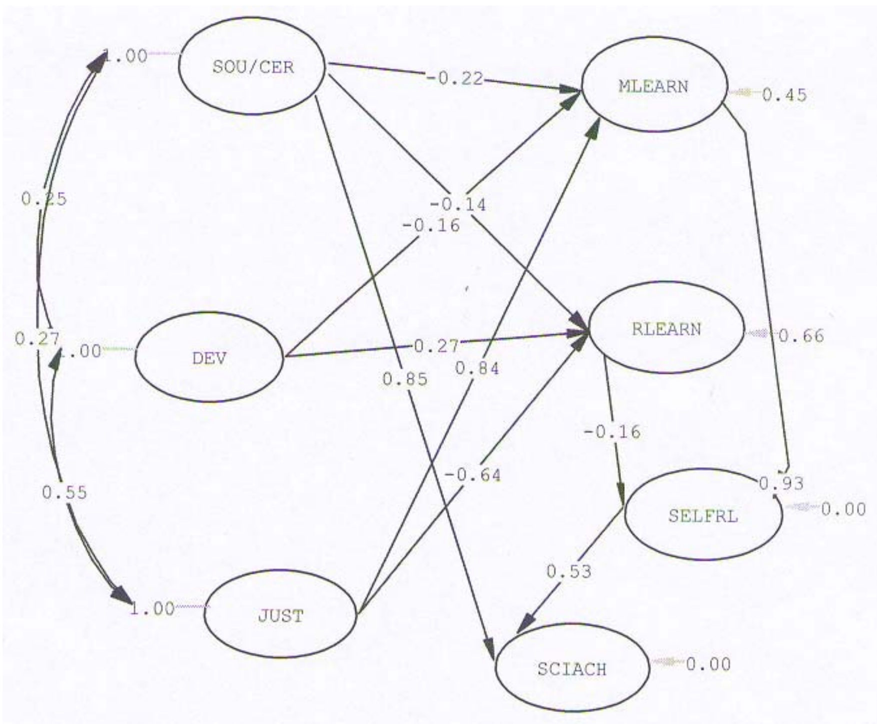

Figure 4.5 Science achievement model with estimates (Girls)

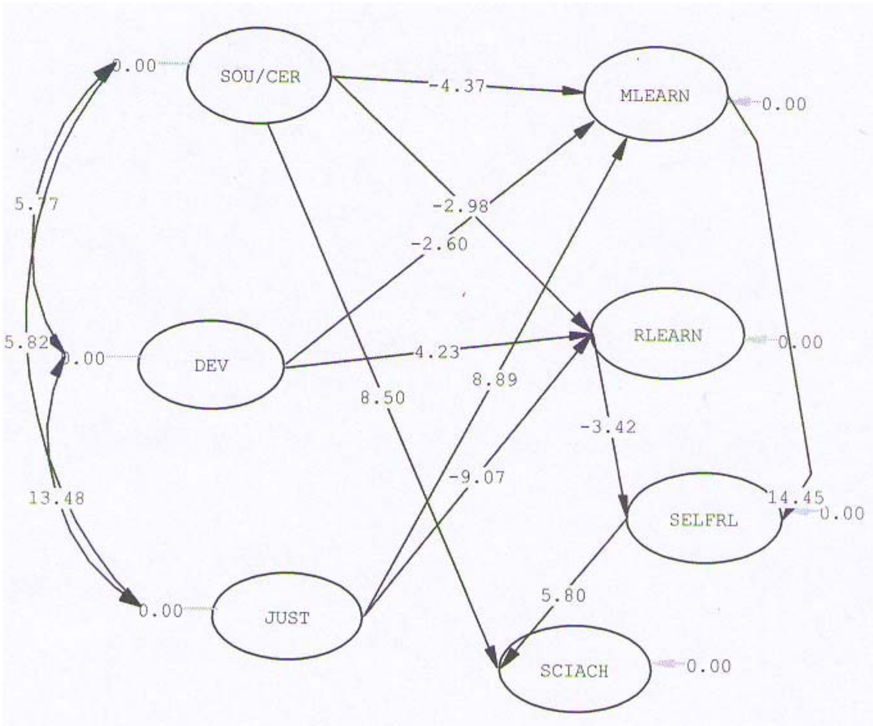

Figure 4.6 Science achievement model with t-values (Girls)

The measurement coefficients (λ) and measurement errors of the science achievement model for girls were listed in Table 4.27.

Table 4.27 Measurement coefficients (λ) and measurement errors of the science achievement model (Girls)

Latent Variables	λ	Observed Variables	Measurement Errors
SOU/CER	.38(λ_x)	Belbook	.85(δ)
	.57(λ_x)	Nomore	.66(δ)
	.58(λ_x)	Sctknow	.70(δ)
	.50(λ_x)	Agtrue	.75(δ)
DEV	.44(λ_x)	Idebook	.80(δ)
	.77(λ_x)	Idescience	.40(δ)
	.42(λ_x)	Chamind	.83(δ)

Table 4.27 (Continued)

Latent Variables	λ	Observed Variables	Measurement Errors
JUST	.51(λx)	Befstart	.74(δ)
	.59(λx)	Doexper	.65(δ)
	.57(λx)	Morexper	.68(δ)
MLEARN	.46(λy)	Relatenew	.79(ε)
	.61(λy)	Goover	.63(ε)
	.48(λy)	Question	.77(ε)
	.56(λy)	Reread	.67(ε)
	.49(λy)	Newans	.76(ε)
RLEARN	.67(λy)	Notunders	.56(ε)
	.51(λy)	Looksome	.74(ε)
	.74(λy)	Reststudy	.46(ε)
SELFRL	.68(λy)	Selftot	.53(ε)
SCIACH	.35(λy)	Scientot	.88(ε)

The structure coefficients (β and γ) indicating the strength and direction of the relationships among latent variables in the model with their associated t-values were shown in Table 4.28. All paths in the model were significant similar to the model for the whole sample.

Table 4.28 Structure coefficients and t-values of the paths in the science achievement model (Girls)

Paths			
From	To	Structure coefficients	t-values
SOU/CER	MLEARN	-.22(γ)	-4.37
	RLEARN	-.14(γ)	-2.98
	SCIACH	.85(γ)	8.50
DEV	MLEARN	-.16(γ)	-2.60
	RLEARN	.27(γ)	4.23
JUST	MLEARN	.84(γ)	8.89
	RLEARN	-.64(γ)	-9.07
MLEARN	SELFRL	.93(β)	14.45
RLEARN	SELFRL	-.16(β)	-3.42
SELFRL	SCIACH	.53(β)	5.80

The goodness-of-fit indices used to evaluate the model for boys were given in Table 4.29. Since the values of goodness of fit index (GFI), adjusted GFI (AGFI), root mean square residual (RMR), standardized RMR (SRMR), and root mean square error of approximation (RMSEA) were approaching to unity, the model had a good fit to the data. The Chi-Square, χ^2 = 929.48, was significant with degrees of freedom, df = 159, and the significance level, p = 0.00. When χ^2 is divided by df, the Normed Chi-Square (NC) is obtained. A NC value less than five can be regarded as an additional evidence for the good model fit. The NC was calculated as 5.85 indicating a fair fit to the data. Another evidence for the model fit was the RMSEA value which was in the 90 percent confidence interval ranging from 0.058 to 0.066.

Table 4.29 Goodness-of-fit indices of the science achievement model (Girls)

Index	Value	Criterion
GFI	.931	≥.95
AGFI	.908	≥.95
RMR	.058	<.05
SRMR	.058	<.05
RMSEA	.062	<.05

The squared multiple correlations (R^2) calculated for each observed variable were presented Table 4.30 as an additional fit statistics.

Table 4.30 Squared multiple correlations for the science achievement model (Girls)

Variable	R^2	Variable	R^2
Belbook	.15	Relatenew	.21
Nomore	.34	Goover	.37
Sctknow	.33	Question	.24
Agtrue	.25	Reread	.33
Idebook	.20	Newans	.24
Idescience	.60	Notunders	.44
Chamind	.17	Looksome	.26
Befstart	.26	Reststudy	.55
Doexper	.35	Selftot	.47
Morexper	.32	Scientot	.12

The strength and the direction of the relationships among the variables for the three groups (ST, G, and B) were compared in Table 4.31. The directions of the relationships were all the same across three groups, however the strength showed variation. All the paths had significant t-values in the comparison groups, except the t-value for the path from RLEARN to SELFRL in the structural model of the boys.

When the structure coefficients of the groups were compared, girls were found to have greater coefficients for six paths than either boys or the total sample. Specifically, girls had greater coefficients for the paths from SOU/CER to MLEARN ($\gamma = -.22$, $p < 0.05$), from DEV to RLEARN ($\gamma = .27$, $p < 0.05$), from JUST to MLEARN ($\gamma = .84$, $p < 0.05$), from JUST to RLEARN ($\gamma = -.64$, $p < 0.05$), from RLEARN to SELFRL ($\beta = -.16$, $p < 0.05$), and from SELFRL to SCIACH ($\beta = .53$, $p < 0.05$). For the remaining four paths in the model, the boys had greater structure coefficients than either girls or the total sample. Specifically, boys had greater coefficients for the paths from SOU/CER to RLEARN ($\gamma = -.25$, $p < 0.05$), from SOU/CER to SCIACH ($\gamma = .94$, $p < 0.05$), from DEV to MLEARN ($\gamma = -.22$, $p < 0.05$), and from MLEARN to SELFRL ($\beta = .96$, $p < 0.05$).

Table 4.31 Structure coefficients and t-values for the three groups (TS, B, G)

Paths							
From	To	Structure coefficients			t-values		
SOU/CER	MLEARN	-.16(TS)	-.08(B)	-.22(G)	-3.46(TS)	-1.99(B)	-4.37(G)
	RLEARN	-.18(TS)	-.25(B)	-.14(G)	-3.97(TS)	-5.49(B)	-2.98(G)
	SCIACH	.90(TS)	.94(B)	.85(G)	9.47(TS)	10.56(B)	8.50(G)
DEV	MLEARN	-.19(TS)	-.22(B)	-.16(G)	-3.41(TS)	-4.18(B)	-2.60(G)
	RLEARN	.23(TS)	.20(B)	.27(G)	3.92(TS)	3.66(B)	4.23(G)
JUST	MLEARN	.79(TS)	.75(B)	.84(G)	10.30(TS)	11.45(B)	8.89(G)
	RLEARN	-.58(TS)	-.53(B)	-.64(G)	-9.33(TS)	-9.36(B)	-9.07(G)
MLEARN	SELFRL	.94(TS)	.96(B)	.93(G)	15.75(TS)	16.53(B)	14.45(G)
RLEARN	SELFRL	-.15(TS)	-.10(B)	-.16(G)	-2.95(TS)	1.94(B)*	-3.42(G)
SELFRL	SCIACH	.42(TS)	.31(B)	.53(G)	4.96(TS)	3.94(B)	5.80(G)

(TS): Total sample
(B): Boys
(G): Girls
*Nonsignificant path

CHAPTER 5

DISCUSSION, CONCLUSIONS AND IMPLICATIONS

The current investigation was designed to test the model proposed in the first chapter based on an extensive review of the related literature. In this section, the results from the previous chapter will be summarized and discussed. The conclusions will also be presented together with limitations, implications, and recommendations for future research.

5.1 Discussion of the Results

This study explored the nature of Turkish elementary school students' epistemological beliefs and the relationships among students' epistemological beliefs, learning approaches, self-regulated learning strategies, and their science achievement. The results of the current study revealed some issues of critical importance that are worth to be discussed.

5.1.1 Results of the Factor Analysis of the Epistemological Beliefs Questionnaire

Concerning epistemological beliefs, the factor analysis results of the EBQ revealed some differences in the Turkish context compared to Western countries. As reported by Chan and Elliott (2004), the results of this study also support the idea that use of an epistemological instrument developed in the United States may be problematic when applied in non-Western countries. The findings of the current study are of great value when the cultural features and the critical location of the Turkey are considered. Turkey has a unique characteristic of acting as a bridge between Western and Eastern countries due to its geographic location, thus has been under the influence of both cultures for centuries. Owing to that, the epistemological data from Turkish culture provides additional information for the related literature dominated by the findings from mainly western and to some extent from the eastern countries.

What was obvious in this study was that both the number and the nature of the epistemological beliefs dimensions showed differences from the previous findings indicate. The specific epistemological dimensions found by Conley et al. (2004) in US actually could not be entirely replicated by the sample of this study. Instead of Conley et al.'s four factor model, a three-factor model was identified as the underlying factor structure of the Turkish elementary students. Although two of the hypothetical dimensions, namely Development and Justification, were also identified at the end of factor analyses, Source and Certainty dimensions tended to merge in the same factor resulting in a new labeling of the third factor as Source/Certainty dimension. These three extracted factors, Development, Justification, and Source/Certainty, represented the three epistemological beliefs held by Turkish seventh grade students. Beside the number of dimensions, the nature of the dimensions indicated a mixed pattern. The factor structure that emerged from the Turkish sample did not display the conceptual consistency reported by Conley and his colleagues. That is, with our sample one of the dimensions belonging to the *Nature of Knowledge* domain united with a dimension from the *Nature of Knowing* domain. According to developers, the four dimensions of epistemological beliefs investigated in their study represented two general areas that Hofer and Pintrich (1997) argued which were beliefs about the nature of knowing and beliefs about the nature of knowledge. The Source and Justification dimensions reflect beliefs about the nature of knowing, whereas the Certainty and Justification dimensions reflect beliefs about the nature of knowledge (Conley et al., 2004). On the contrary, current study revealed that Source and Certainty dimensions, which theoretically belong to two different areas of epistemological theories, merged into a single dimension.

The following explanations were considered in order to account for the discrepancy among the nature and the number of epistemological beliefs held by the Turkish sample and by the samples of the other related studies. This variation might be first due to the different socio cultural contexts within which the epistemological studies were conducted. As in the case of the Chinese/Asian cultures, as reported by Chan and Elliot (2000, 2002), in the Turkish culture, teachers are also considered as the authority and respected. Accordingly, the students tend to accept what the teachers teach and generally do not criticize much especially in the earlier grades. Turkish culture highlights the respect to teachers, parents or any other authority figures similar to Asian countries. Considering these facts, it is probable that Turkish students believed that Certain Knowledge is associated with the source of knowing. That is, Turkish students might think that source of knowing (the authority or the knower) determines not only the knowledge is external to the self or not, but also determines whether there is a single or more than one right answer. Students with more sophisticated views in this dimension tended to believe that knowledge is constructed by the knower and there may be more than one right answer. Students with naïve view of epistemological beliefs, on the other hand, believed the existence of single right knowledge residing in external authorities. Another possible explanation for the unique characteristic of the epistemological belief structure of the Turkish sample might be related with the age, education, and maturation issues. Various studies suggested that students become more sophisticated in terms of their epistemological beliefs as they progress in their education (Schommer, 1990, 1998). Therefore, in the earlier grades a complete and deep understanding of epistemological beliefs is very difficult. For this reason, different belief dimensions may merge into a single factor especially in the earlier grades (see Schommer, Mau, Brookhart & Hutter, 2000; Qian & Alvermann, 1995). In their study with more than 1,200 students in Grades 7 and 8, Schommer et al. (2000) identified differences with regard to the structure of students' beliefs. Although, prior theory, developed by high school and college students, suggested a four-factor epistemological belief structure, Schommer and her colleagues (2000) identified a three-factor model with middle school students. They argued that middle school students' epistemological beliefs were related to ability to learn, speed of learning, and stability of knowledge but not with the structure of knowledge. Similarly, Qian and Alvermann (1995) attempted to replicate the four hypothetical dimensions underlying the Epistemological Beliefs Questionnaire but ended up with a three-factor model. Exploratory factor analysis in their study revealed that items related with Simple Knowledge and Certain Knowledge were loaded on the same factor resulting in the combinations of these two factors. These results suggest that perhaps younger students do not hold distinct beliefs on some aspects of epistemological beliefs; instead beliefs about each aspect of epistemological beliefs may emerge at earlier ages and later on develop with age and education (Buehl, 2003). Confronted with these issues, it is possible that younger Turkish students also do not hold distinct beliefs about the Source and Certainty dimensions of epistemological beliefs; instead the beliefs about these dimensions may be united into a single factor and possibly will develop with age and education at later ages.

In spite of this observed variation in the nature and number of epistemological belief dimensions, the identification of the three distinct belief factors in the current study tended to support that multidimensional theory as proposed by Schommer (1990) is more appropriate than unidimensional theory in explaining Turkish elementary school students' epistemological beliefs. The unidimensional theory argues that one factor at a time defines the development of individuals' epistemological beliefs. The results of the factor analyses, however, revealed three distinct factors indicating that epistemological beliefs in the Turkish culture can be considered as "as a set of more or less independent beliefs" (Schommer, 1990, p. 500).

5.1.2 Results of the Model Testing

The current study represents one of the preliminary steps in understanding how science achievement relates to epistemological beliefs, learning approaches, and self-regulated learning strategies. In discussing the results, first the direct relationships among the latent variables are considered. Next, the indirect relationships among the variables are discussed.

The final science achievement model revealed that students' epistemological beliefs predicted directly their science achievement and learning approaches, but not their self-regulated learning beliefs. Since the epistemological beliefs were scored in such a way that higher scores on this variable represented more sophisticated epistemological predispositions, students' beliefs about the source/certainty, justification, and development were hypothesized to be positively related with the science achievement and meaningful learning approach to learning and to be negatively related with the rote learning approach. Although the results supported the proposed hypotheses in some instances, contradicted with some of them in other cases.

Specifically, the belief in the source/certainty dimension of the EBQ positively predicted students' science achievement, as expected. That is, the more the learners believe in the existence of more than one right answer that can be constructed by the knower (a sophisticated belief), the higher their science achievement. As predicted, sophisticated beliefs in the source/certainty dimension was negatively related with the rote learning. That is, the more the learners believe in the existence of more than one right answer that can be constructed by the knower, the less they rely on memorization and simply recalling of facts as a learning mode. Contrary to the expectations, however, students' beliefs about source/certainty negatively predicted meaningful learning approach. That is, the more the learners believe in the existence of more than one right answer that can be constructed by the knower, the less they adopt a meaningful learning approach to learning.

The model also predicted that belief in the development of knowledge exerted influence on students' learning approaches. However, the nature of these influences was not in line with the expectations. More specifically, belief in the development of knowledge was found to be negatively associated with meaningful learning approach as opposed to the research hypothesis. In other word, the more the students believe in the evolving and changing nature of science (a sophisticated belief), the less they adopt a meaningful learning approach. Despite the existing literature supporting the negative relationships between epistemological beliefs and rote learning, the belief in the development of knowledge was found to be positively related with the rote learning. Specifically, it appears that more sophisticated beliefs about the development of knowledge are associated with the use of memorization and recall of simple facts. The relation between the beliefs about the development of knowledge and science achievement did not emerge as a significant path at the end of this investigation.

Based on the final science achievement model obtained at the end of current investigation, it can be concluded that Justification for Knowing exerted influence on the learning approach in line with the initial expectations. Justification was found to be positively related to meaningful learning approach, but negatively to the rote approach to learning. This means that the more the learner believe that knowledge is constructed through critical examination of evidence and the opinions of experts, the more they adopt meaningful learning approach, and tend to avoid rote learning approach. Like the development, beliefs about justification did not emerge as a factor influencing science achievement of seventh graders. The hypotheses that development and justification are positively related to science achievement were, therefore, not confirmed.

The previous studies intended to explore whether students' epistemological beliefs enhance or constrain their academic performance generally revealed that more sophisticated epistemological beliefs were associated with higher achievement. However, it was apparent that there were inconsistencies regarding the number and nature of belief dimensions that were reported to be associated with the students' achievement in different studies. Regarding the number of belief dimensions shown to be related with achievement, only Conley et al. (2004) reported that all three belief dimensions confirmed in their study with elementary science students were associated with the achievement. Despite the nature showed variation, only a single or two dimensions of epistemological beliefs was found to be related with the achievement of students in the most of these studies. For instance, only beliefs in Quick Learning (Schommer, et al., 1997), Simple Knowledge (Paulsen & Wells, 1998), and Innate Ability (Mori, 1999) were found to be significantly related with students' GPAs. However, Schommer et al. (2000) indicated that belief in fixed ability and quick learning emerged as the two factors predicting students' GPAs. Similarly, Hofer (2000) identified that certainty and simplicity of knowledge were significantly correlated with achievement scores. To sum up, there are a number of evidences varying in nature about the relationship between students' performance and their epistemological beliefs in the related literature. Consistent with the findings of some of these studies (Mori, 1999; Paulsen & Wells, 1998; Schommer, et al., 1997), only a single dimension of epistemological beliefs (source/certainty) was found to be significantly related with elementary students' science achievement in this study.

Research on epistemological beliefs also pointed out significant relationships between students' beliefs about knowledge and knowing and their adopted learning approaches. The results of the studies generally implied that students with the unsophisticated (naïve) epistemological beliefs will adhere to a surface approach to study, whereas students with more sophisticated beliefs are more likely to adopt a deep approach (Cano, 2005; Chan, 2003). To put it more straightfully, Chan (2003) identified that students with the naïve belief that ability is fixed and innate, knowledge is handed down by authorities or experts, and knowledge is uncertain and unchanging would treat learning as a simple task of memorization and would adopt a surface approach to study. It was also reported that students who believed that learning requires effort and knowledge is not always handed down by authorities and experts, were more likely to adopt a deep approach (Chan, 2003). The findings of Cano (2005) also supported the impact of epistemological beliefs on the learning approaches of the students. Specifically, Cano reported a negative link between a surface approach and achievement, while a deep approach was discovered to be associated positively with performance. In line with these findings, source/certainty and justification were found to be negatively related with rote learning approach at the end of this study. Justification was emerged as a positive predictor of meaningful learning dimension as expected. However, contrary to the predictions based on the previously reviewed studies, source/certainty and development dimensions were discovered to be negatively related with meaningful learning. Further, it was interesting to note that Development of knowledge was a positive indicator of the rote learning approach. From the findings of this study, it is apparent that epistemological beliefs of seventh graders were related with their adopted learning approaches, either rote or meaningful. However, inconsistent with the findings of the prior studies (Cano, 2005; Chan, 2003), the direction of the relationship between epistemological beliefs and the two dimensions of the learning approaches showed differences in this investigation. Interpreting this finding is somewhat difficult, but it will be of great importance to consider the Turkish educational system and the cultural identities while discussing the apparent relationships among epistemological beliefs and learning approaches. Based on especially the results of the factor analyses of the LAQ, it was obvious that some of the items of the rote learning have a tendency to combine with the items of the meaningful learning. Therefore, it can be inferred that Turkish elementary students have confusion about what it means to be a "meaningful" learner and a "rote" learner. It is reasonable to accept that our elementary students most of the time treat learning as a simple task of memorization to answer the questions asked in the examinations. By doing so, however, the students may think that they are learning meaningfully because within the boundaries of Turkish educational system, being able to give correct answers to the questions in various examinations is generally considered enough to be a meaningful learner. Without really understanding the actual meaning of adopting a meaningful learning approach, intentionally or unintentionally, the society label the students as meaningful learners provided that they obtain good examination marks. At that point, we, as educators, teachers, policy makers, and parents, have to question our educational system, especially the nature of examinations, both national and school wide. Answering most of the questions correctly in a multiple choice examination consisting of typically knowledge and comprehension type of questions never means that the students are learning meaningfully. As Zeegers (2001) pointed out contextual (e.g., teaching/learning activities, assessment procedures, institutional values) and personal factors (e.g., gender, age, prior experiences) may influence students' adopted learning approaches. It is also well documented that a student's learning approach is not a stable characteristics, instead it is dynamic and changeable with students' perception of the learning context and the needs of the task (Trigwell & Prosser, 1991). Accordingly, it is probable that the nature of the learning context, teaching/learning activities in the school, assessment procedures, and examination type in Turkey shape the learning approaches of the elementary students. Unfortunately, they all lead the students towards a rote learning mode until the recent educational reforms in our country. Students may, therefore, use rote learning approaches; however claim that they are learning meaningfully. Accordingly, their epistemological beliefs, specifically Development and Source/Certainty dimensions may be related negatively with the meaningful learning approach.

Concerning the relationships between learning approach and academic outcomes like course and assessment grades and GPA, there are inconsistent results in the literature, although it is generally believed that a deep approach/meaningful learning will contribute positively to various outcomes (Zeegers, 2001). While various studies (e.g., Cavallo et al., 2004; Heikkila & Lonka, 2006; Snelgrove & Slater, 2003; Waters & Waters, 2007) support the well established relationship between meaningful learning approach and academic achievement, others reported that learning approaches did not predict academic achievement (Diseth & Martinsen, 2003; Gibels et al., 2005). When subjected to structural equation modeling in the current study, a somewhat unexpected picture emerged for the hypothesized relationship between students' learning approaches and their science achievement. Even though approaches to learning, specifically the meaningful learning approach, were reported to be a strong predictor of academic achievement in numerous studies, this variable did not contribute to elementary graders' science achievement in this study. It can be concluded that, for this sample and within the context of this investigation, students adopting either a meaningful or a rote learning approach did not show much variation in their Science Achievement Test scores. When predicting achievement, it is surprising at first glance that the meaningful approach did not predict students' science achievement as measured by a multiple-choice test. One possible explanation for the lack of association among the two can be attributed to with the students' perceptions of the method of assessment employed in our educational system. A number of studies indicated that nature of the assessment and students' perceptions of the assessment type have considerable impact on students' approaches to learning (Minbashian, Huon, & Bird, 2004; Scouller, 1998; Scouller & Prosser, 1994). For example, Scouller (1998) indicated that assessment has been found to shape how much, how (their learning approach), and what (the content) the students learn. According to Scouller, students are more likely to perceive the multiple-choice questions as assessing lower levels of cognitive process, hence to employ more surface learning approaches. In contrast, students tend to employ deep learning approaches when preparing their assignment essays which they perceive as assessing higher levels of cognitive processing. It is very well known that Turkish students have been exposed to mainly multiple-choice examinations both in schools and in national selection examinations. It is possible that our students also believe the knowledge-based and lower level nature of multiple-choice examinations and do not need to employ meaningful learning approach.

The lack of a relationship between meaningful learning approach and science achievement may be also ascribed to the learning environment and the nature of the year 2000 national science curriculum. This curriculum had such an overloaded nature that it used to force the students to adopt short-term learning strategies and to focus on the rote learning of the task just to simply remember the content in the examinations to take good marks. Seen in this way, the nature of the learning environment does not necessarily require students to demonstrate a deeper understanding of the learning material and to adopt meaningful learning approaches. Consequently, it is reasonable to think that meaningful learning approach did not contribute to the elementary students' science achievement in the present study.

When predicting science achievement with structural equation modeling, self-regulated learning (SRL) strategies, along with epistemological beliefs, emerged as a significant variable influencing science achievement. The previous research with elementary students (Eshel & Kohavi, 2003; Pintrich & De Groot, 1990; Sink et al., 1991; Wolters et al., 1996) and university students (Hwang & Vrongistinos, 2002; Ridley et al., 1992; Valle et al., 2003) have constantly signified the important role that students' use of SRL strategies play in their academic achievement. Consistent with these studies, students' SRL strategies were identified as a contributor variable to elementary students' science achievement in this investigation. That is, students making use of SRL strategies were more successful and obtained higher scores in the Science Achievement Test. In line with the expectations, SRL was predicted by learning approaches in the model as well. Specifically, meaningful learning exerted a positive influence on the use of SRL strategies, whereas the rote learning was found to be a negative predictor of the SRL. This result indicated that, students having the intention to understand the learning material by constructing the meaning of the content and by making connections between the concepts tended to use more cognitive strategies to learn, remember, and understand the material. However, the students having the intention to learn by memorizing for the recall of facts were not that much skillful at using specific learning strategies during the course of learning.

The inclusion of epistemological beliefs in the prediction of SRL strategies in the present study led to unanticipated results. Contrary to the initial expectations, SRL strategies utilized by the students seemed to be independent of their beliefs about knowledge and knowing. The relationship between epistemological beliefs and SRL strategies reported in previous research (Braten & Stromso, 2005; Dahl et al., 2005) was not confirmed at the end of this study. Rather, current investigation provided support to the suggestions in the literature that epistemological beliefs are not related to SRL strategies (see Neber & Schommer-Aikins, 2002). There can be several reasons for the lack of association among epistemological beliefs and SRL strategies. As reported by Neber and Schommer-Aikins (2002), this may be due to the nature of the utilized measuring instruments. The epistemological beliefs questionnaire used in the present study was independent of the context, measuring general beliefs about the nature of knowledge and knowing rather than specifically focusing on science. However, the MSLQ was explicitly related to science. As identified by Neber and Schommer-Aikins, epistemological beliefs should also be measured directly related to domain of science in order to be able to make inferences about whether the existing beliefs about knowledge and knowing are utilized for the regulation of learning in science or not.

Beside the direct relationships in the science achievement model, there may be also indirect relationships among the variables in the model that are worth to be considered. As discussed previously in this section, only source/certainty dimension of the EBQ was identified to have a direct relationship with students' science achievement. It can be inferred that epistemological beliefs may influence SRL strategies indirectly through their impact on learning approaches. Although students' adopted learning approach does not have a direct relationship with science achievement, those approaches to learning may influence achievement indirectly through their impact on SRL as well. This means that students who intent to understand the learning material by constructing the meaning of the content and by making connections between the concepts tended to use more cognitive strategies to learn, remember, and understand the material and may, in turn, perform better in the achievement test. On the other hand, the students having the intention to learn by memorizing for the recall of facts were less likely to use specific learning strategies during the course of learning, hence tended to be less successful in the achievement test.

Taken together, the results of the present study suggested that the selected variables of the study have direct and indirect relationships in the model. These relations are somehow in line with the predictions although there are unexpected results as well. Epistemological beliefs have been emerged as the major contributor to learning approaches and science achievement, whereas those beliefs do not predict SRL strategies in the model. However, it is still possible that students' beliefs about knowledge and knowing may influence SRL strategies through their mediating influence on approaches to learning. SRL strategies have been emerged as another contributor to students' science achievement. Although not related with achievement directly, learning approaches may also influence science achievement through their effect on SRL strategies.

5.2 Conclusions

The following conclusions can be drawn according to the results of the present study:

1. A three-factor model underlies the factor structure of epistemological beliefs of Turkish elementary students. These factors are labeled as Development, Justification, and Source/Certainty.
2. Students' epistemological beliefs predict science achievement directly. Source/certainty is the only dimension predicting science achievement significantly. Beliefs about justification and development do not have significant relationships with science achievement. Sophisticated beliefs about source/certainty dimension are related positively with science achievement. It means that the more the students believe in the existence of more than one right answer that can be constructed by the knower, the higher their science achievement.
3. Students' epistemological beliefs predict their adopted learning approach directly. As students' beliefs in the existence of more than one right answer that can be constructed by the knower (Source/Certainty) increase, their reliance on rote learning decrease. More sophisticated belief in this dimension is also associated with a decrease in the tendency to adopt meaningful learning approach.
4. As students' beliefs in the construction of knowledge through critical examination of evidence and expert opinion (Justification for Knowing) increase, their tendency to use meaningful learning approaches increase and their reliance on memorization and simply recalling of facts as a learning mode decrease.
5. As students' beliefs in the evolving and changing nature of science (Development of Knowledge) increase, their reliance on rote learning increases. More sophisticated belief in this dimension is also associated with a decrease in the tendency to adopt meaningful learning approach.

6. Students' epistemological beliefs do not predict their use of SRL strategies. However, the beliefs about knowledge and knowing may influence SRL strategies indirectly through their impact on learning approaches.
7. Students' learning approaches while may influence science achievement indirectly through their possible impact on SRL strategies, are not related with their science achievement directly. Moreover, students' learning approaches predict their use of SRL strategies. Compared to rote learners, students' adopting a meaningful learning approach tend to use more SRL strategies. As students rely on memorization during learning, their reported use of SRL strategies decrease.
8. Students' SRL strategies predict their science achievement in the model. The more the students use strategies to learn, remember, and understand the material, the higher grades they obtain in science.

5.3 Implications

Based on the findings of the study and the related literature review, the following suggestions can be offered:

1. The primary implication offered by this investigation is the consideration of the importance of the epistemological beliefs in the elementary schools. This study indicated that students' beliefs about knowledge and knowing can be regarded as one of the important components of science learning. Therefore, educators and researchers should be aware of these beliefs and their importance in science achievement.
2. Teachers, although may be very busy and overloaded in the classroom, should also be aware of the importance of considering epistemological beliefs in their classrooms for better science achievement.
3. Teachers should be informed about the meaning and importance of epistemological beliefs, and also how to measure those beliefs in the classroom. Teachers, educators, researchers, and policy makers may

collaborate for this purpose organizing small workshops and meetings as a part of their in-service trainings.

4. The students' beliefs in the existence of more than one right answer that can be constructed by the knower (Belief in the Source/Certainty dimension) emerged as a very influential variable contributing to elementary students' science achievement. Therefore, teachers should emphasize these beliefs while designing the classroom activities and choosing the instructional methods for science lessons. One possible way of doing this is to plan learning activities in such a way that students are able to reach one of the possible correct solutions or answer by themselves when faced with a divergent type of classroom activity. Discovery and inquiry oriented classroom activities, and a constructivist learning environment may help to achieve this. Another practical implication drawn this finding is that teachers should deemphasize their dominant role in the classroom as a knowledge provider, but instead encourage the students for constructing knowledge themselves. Teachers should also encourage students to believe that there can be more than one right answer and one true solution in science especially for divergent activities.
5. Teachers and classroom environment can influence the development of beliefs about knowledge and knowing by adopting hands-on and inquiry-oriented science instruction. Therefore, researchers can work to improve students' epistemological beliefs toward a more sophisticated view by using appropriate instructional strategies.
6. Teachers should be provided with seminars about the special teaching methods and instructional strategies and how to use them in the classroom for developing the students' epistemological beliefs.
7. Self-regulated learning was identified as an important predictor of science achievement in the elementary level. Therefore, this construct should be handled more seriously in the future attempts to increase the students' science achievement. As an initial step, teachers should be educated about the self-regulated strategies and how to measure these strategies and make students use them in the classroom context in order to increase science achievement.

8. Teachers, as well as parents, should try to promote students' use of the self-regulated learning strategies by using the suggestions below:
   (a) Help the students use paraphrasing, summarizing, creating analogies, and generative note-taking strategies to integrate and connect new information with the existing ones when learning science.
   (b) Encourage students to be involved in the learning task by suggesting them to cluster the ideas, to organize the learning task by making simple charts, diagrams, or tables, and to select the main idea and concepts in reading materials.
   (c) Support the students for applying their previous knowledge about science concepts to new situations to solve problems, make decisions, and make critical evaluations.
   (d) Promote students to use planning, monitoring, and regulating activities in science lessons. Students can set goals and make a task analysis in planning activities to organize and understand the material much easier. Self-testing and self-questioning may be used by students as monitoring activities to assist themselves in understanding the material. Students can use regulating activities for checking and modifying their behavior as they are learning science.
9. Although students' learning approaches do not tend to influence their science achievement directly, this variable emerged as a factor predicting students' use of self-regulated learning strategies which in turn influence students' science achievement. One implication drawn from this finding is that teachers, educators, parents, and policy makers should give emphasis to the endorsement of meaningful learning approaches while de-emphasizing the rote approaches in science learning. It is generally accepted that a heavy loaded science curriculum and overemphasizing the grades and examinations may lead students focus on rote memorization just to meet the expectations. To develop meaningful approaches while learning science, the nature of examinations both in the schools and nationwide, should be shifted from a knowledge-based to a more performance-based type. Rather than assessing only knowledge-based

and lower levels of learning in the examinations, higher order thinking skills and performance of the learners should be evaluated. The whole learning period and students' progress should be assessed instead of assessing just knowledge through mostly multiple-choice examinations. In addition to the nature of the examinations and assessment of students, the learning context should be modified accordingly.

5.4 Limitations and Suggestions for Future Research

There are some limitations of the current study that should be recognized. It is important to interpret the findings based on these limitations associated with the study. It is suggested that recognizing the weaknesses of the study will avoid any interpretation beyond the data or scope of this investigation.

The first limitation is related to the measurement of the constructs within the study. Relying on the self-reported questionnaires and trusting in the self-reported levels of the related constructs as indicated by the students is one of the weaknesses in this study. Another limitation of a research like this is the difficulty of measuring complex psychological constructs like epistemological beliefs, learning approaches, and self-regulated learning strategies. Measurement of such affective factors with a high reliability and validity is a difficult process and requires a careful handling. For all these reasons, insuring the reliability and validity of the instruments used in the study is of critical importance. A fruitful next step in this work is to take a qualitative approach in order to examine the epistemological beliefs, learning approaches, and SRL strategies of students. In-depth interview studies may be used to complement the quantitative data; hence a better and reliable understanding of selected student characteristics can be possible.

A second limitation of the study is related to the measurement of the science achievement. In order to assess students' science achievement, only multiple-choice questions were utilized. This type of assessment may be considered as a rather narrow view of science achievement; hence future studies can make use of various types of questions and techniques to assess participants' science achievement. The low reliability of the achievement test can be regarded as another limitation for this study. In future studies, achievement tests with higher reliabilities may be utilized to have a better measurement of science achievement. Future research may utilize different measures of science achievement as well. Concept specific science tests or general science achievement tests can be included in future studies.

The third limitation concerns the specific data analysis technique used to analyze the data. Like the other correlational methods, structural equation modeling technique does not confirm causation in a model. More specifically, the constructs that are shown to be related each other cannot be shown to have a causal relationship. Therefore, further experimental research is needed to determine a causal link between the constructs of interest.

Future studies may employ more diverse samples to reconfirm especially the three-factor model of the epistemological beliefs encountered in the current study. Although not very much different from the alpha coefficient reported by Conley et al. (2004) in their first studies (t1), the reliability of the Development dimension encountered in this study was low. The low reliability may be possibly accounted for by the translation effect. The Turkish version of the questionnaire may not reflect the original meanings of the some of the items. It is also possible that Turkish students captured the meanings of some items in a different way. Future studies using the same instrument with other samples are needed to provide additional data about the reliability of the instrument.

The questionnaires used in this study are an adaptation of prior instruments. Since the use of any instrument designed for a specific culture may be somehow problematic when used in different cultural contexts, these instruments should be considered as a base for future attempts to develop related questionnaires for the Turkish sample. Although the psychometric properties of the adapted questionnaires were satisfactory for the current study, future research may concentrate on developing new instruments reflecting the cultural characteristics of the Turkey.

Considering the impacts of age, education, and maturation on the development of students' epistemological beliefs, it is suggested that future studies replicate the current study by using different samples of varying age groups.

Longitudinal studies can be also conducted to examine the possible variation across students' epistemological beliefs across time.

The current study can be improved by including other contextual and individual variables which may shape the complexity of student learning. The variables which may be influential in the development of epistemological beliefs, learning approaches, and SRL strategies may be included in the model. The future studies can possibly define different subscales of the SRL strategies as distinct latent variables to discover the specific paths among those subscales with the other variables included in the model.

The EBQ and LAQ utilized in this study were not specifically designed for the domain of science, instead they were domain independent. Future research may pay attention to measure constructs like epistemological beliefs and learning approaches by using domain-specific questionnaires.

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APPENDIX A

THE EPISTEMOLOGICAL BELIEFS QUESTONNAIRE

EPİSTEMOLOJİK İNANÇLAR ANKETİ	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Tüm insanlar, bilim insanlarının söylediklerine inanmak zorundadır.	1☐	2☐	3☐	4☐	5☐
2. Bilimde, bütün soruların tek bir doğru yanıtı vardır.	1☐	2☐	3☐	4☐	5☐
3. Bilimsel deneylerdeki fikirler, olayların nasıl meydana geldiğini merak edip düşünerek ortaya çıkar.	1☐	2☐	3☐	4☐	5☐
4. Günümüzde bazı bilimsel düşünceler, bilim insanlarının daha önce düşündüklerinden farklıdır.	1☐	2☐	3☐	4☐	5☐
5. Bir deneye başlamadan önce, deneyle ilgili bir fikrinizin olmasında yarar vardır.	1☐	2☐	3☐	4☐	5☐
6. Bilimsel kitaplarda yazanlara inanmak zorundasınız.	1☐	2☐	3☐	4☐	5☐
7. Bilimsel çalışma yapmanın en önemli kısmı, doğru yanıta ulaşmaktır.	1☐	2☐	3☐	4☐	5☐
8. Bilimsel kitaplardaki bilgiler bazen değişir.	1☐	2☐	3☐	4☐	5☐
9. Bilimsel çalışmalarda düşüncelerin test edilebilmesi için birden fazla yol olabilir.	1☐	2☐	3☐	4☐	5☐
10. Fen Bilgisi dersinde, öğretmenin söylediği herşey doğrudur.	1☐	2☐	3☐	4☐	5☐
11. Bilimdeki düşünceler, konu ile ilgili kendi kendinize sorduğunuz sorulardan ve deneysel çalışmalarınızdan ortaya çıkabilir.	1☐	2☐	3☐	4☐	5☐
12. Bilim insanları bilim hakkında hemen hemen her şeyi bilir, yani bilinecek daha fazla bir şey kalmamıştır.	1☐	2☐	3☐	4☐	5☐
13. Bilim insanlarının bile yanıtlayamayacağı bazı sorular vardır.	1☐	2☐	3☐	4☐	5☐
14. Olayların nasıl meydana geldiği hakkında yeni fikirler bulmak için deneyler yapmak, bilimsel çalışmanın önemli bir parçasıdır.	1☐	2☐	3☐	4☐	5☐
15. Bilimsel kitaplardan okuduklarınızın doğru olduğundan emin olabilirsiniz.	1☐	2☐	3☐	4☐	5☐
16. Bilimsel bilgi her zaman doğrudur.	1☐	2☐	3☐	4☐	5☐
17. Bilimsel düşünceler bazen değişir.	1☐	2☐	3☐	4☐	5☐
18. Sonuçlardan emin olmak için, deneylerin birden fazla tekrarlanmasında fayda vardır.	1☐	2☐	3☐	4☐	5☐
19. Sadece bilim insanları , bilimde neyin doğru olduğunu kesin olarak bilirler.	1☐	2☐	3☐	4☐	5☐
20. Bilim insanının bir deneyden aldığı sonuç, o deneyin tek yanıtıdır.	1☐	2☐	3☐	4☐	5☐
21. Yeni buluşlar, bilim insanlarının doğru olarak düşündüklerini değiştirir.	1☐	2☐	3☐	4☐	5☐
22. Bilimdeki, parlak fikirler sadece bilim insanlarından değil, herhangi birinden de gelebilir.	1☐	2☐	3☐	4☐	5☐
23. Bilim insanları bilimde neyin doğru olduğu konusunda her zaman hemfikirdirler.	1☐	2☐	3☐	4☐	5☐
24. İyi çıkarımlar, birçok farklı deneyin sonucundan elde edilen kanıtlara dayanır.	1☐	2☐	3☐	4☐	5☐
25. Bilim insanları, bilimde neyin doğru olduğu ile ilgili düşüncelerini bazen değiştirirler.	1☐	2☐	3☐	4☐	5☐
26. Bir şeyin doğru olup olmadığını anlamak için deney yapmak iyi bir yoldur.	1☐	2☐	3☐	4☐	5☐

APPENDIX B

THE LEARNING APPROACH QUESTIONNAIRE

ÖĞRENME YAKLAŞIMLARI ANKETİ	Kesinlikle Katılmıyorum	Katılmıyorum	Katılıyorum	Kesinlikle Katılıyorum
1. İlk bakışta zor gibi görünen konuları anlamak için genellikle çok çaba sarfederim.	1☐	2☐	3☐	4☐
2. Bir konuya çalışırken öğrendiğim yeni bilgileri o konuyla ilgili eski bilgilerimle ilişkilendirmeye çalışırım.	1☐	2☐	3☐	4☐
3. Ders çalışırken, öğrendiğim konuları günlük hayatta nasıl kullanabileceğimi düşünürüm.	1☐	2☐	3☐	4☐
4. Öğretmenin anlattığı sırayı takip ettiğimde konuları en iyi şekilde hatırlarım.	1☐	2☐	3☐	4☐
5. Öğrenmek zorunda olduğum konuların büyük bir kısmını ezberlerim.	1☐	2☐	3☐	4☐
6. Önemli konuları tam olarak anlayana kadar gözden geçiririm.	1☐	2☐	3☐	4☐
7. Öğretmenler, sınavda çıkmayacak konulara öğrencilerin çok fazla zaman harcamalarını beklememelidirler.	1☐	2☐	3☐	4☐
8. Tam anlamıyla çalışmaya başladığımda, her konunun benim için ilgi çekici olacağını düşünürüm.	1☐	2☐	3☐	4☐
9. Derslerde edindiğim veya kitaplardan okuduğum bilgiler hakkında sık sık kendime sorular sorarım.	1☐	2☐	3☐	4☐
10. Yeni konu hakkında genel bir fikir vermesi bakımından, konuları birbirleri ile ilişkilendirmenin faydalı olduğunu düşünürüm.	1☐	2☐	3☐	4☐
11. Anladığımdan iyice emin olana kadar ders ya da laboratuvar notlarımı tekrar tekrar okurum.	1☐	2☐	3☐	4☐
12. Bir konuyu ana hatlarıyla çalışmanın zaman kaybı olduğunu düşündüğümden, sınıfta ya da ders notlarında anlatılanları detaylı bir şekilde çalışırım.	1☐	2☐	3☐	4☐
13. Okunacak materyalleri (kitap, dergi vb.), iyice anlayıncaya kadar okurum.	1☐	2☐	3☐	4☐
14. Gerçek olaylara dayanan konuları, varsayıma dayanan konulardan daha çok severim.	1☐	2☐	3☐	4☐
15. Bir konu hakkındaki bilgimi başka bir konu hakkındaki bilgilerimle ilişkilendirmeye çalışırım.	1☐	2☐	3☐	4☐
16. Benim için teknik terimlerin anlamlarını öğrenmenin en iyi yolu, ders kitabındaki tanımları hatırlamaktır.	1☐	2☐	3☐	4☐
17. Bulmaca ve problemler çözerek mantıksal sonuçlara ulaşmak beni heyecanlandırır.	1☐	2☐	3☐	4☐
18. Okumam gereken materyalin (kitap, dergi vb.) ne işime yarayacağını genellikle düşünmem.	1☐	2☐	3☐	4☐
19. Konuları iyice öğrenene kadar tekrar tekrar gözden geçiririm.	1☐	2☐	3☐	4☐
20. Çoğunlukla, konuları gerçekten anlamadan okurum.	1☐	2☐	3☐	4☐
21. Fazladan okumalar, kafa karıştırıcı olduğundan, derste önerilen okumaların sadece bir kısmına bakarım.	1☐	2☐	3☐	4☐
22. Fazladan ders çalışmanın gereksiz olduğunu düşündüğüm için, çalışmamı genellikle derste verilen bilgiyle sınırlarım.	1☐	2☐	3☐	4☐
23. Yeni bir konuya başlarken kendime yeni edindiğim bilginin cevaplaması gereken sorular sorarım.	1☐	2☐	3☐	4☐
24. Boş zamanlarımda, diğer derslerde gördüğüm ilginç konular hakkında araştırma yaparım.	1☐	2☐	3☐	4☐

APPENDIX C

THE MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE

ÖĞRENMEDE GÜDÜSEL STRATEJİLER ANKETİ

Bu anketteki sorulara cevap verirken aşağıda verilen ölçeği gözönüne alınız. Eğer ifadenin sizi tam olarak yansıttığını düşünüyorsanız, cevap kağıdınızda 7' yi, eğer ifadenin sizi hiç yansıtmadığını düşünüyorsanız 1'i işaretleyiniz. Bu iki durum dışında ise 1 ve 7 arasında sizi en iyi tanımladığını düşündüğünüz numarayı cevap kağıdınıza işaretleyiniz. Unutmayın doğru ya da yanlış cevap yoktur.

1	2	3	4	5	6	7
beni hiç yansıtmıyor						beni tam olarak yansıtıyor

	beni hiç yansıtmıyor					olarak	beni tam yansıtıyor
1. Fen Bilgisi dersi ile ilgili birşeyler okurken, düşüncelerimi organize etmek için konuların ana başlıklarını çıkarırım.	1	2	3	4	5	6	7
2. Fen Bilgisi dersi sırasında başka şeyler düşündüğüm için önemli kısımları sıklıkla kaçırırım.	1	2	3	4	5	6	7
3. Fen Bilgisi dersi ile ilgili birşeyler okurken, okuduklarıma odaklanabilmek için sorular oluştururum.	1	2	3	4	5	6	7
4. Fen Bilgisi dersiyle ilgili duyduklarımı ya da okuduklarımı ne kadar gerçekçi olduklarına karar vermek için sıklıkla sorgularım.	1	2	3	4	5	6	7
5. Fen Bilgisi dersine çalışırken, önemli bilgileri içimden defalarca tekrar ederim.	1	2	3	4	5	6	7
6. Fen Bilgisi dersi ile ilgili birşeyler okurken bir konuda kafam karışırsa, başa döner ve anlamak için çaba gösteririm.	1	2	3	4	5	6	7
7. Fen Bilgisi dersine çalışırken, daha önce okuduklarımı ve aldığım notları gözden geçirir ve en önemli noktaları belirlemeye çalışırım.	1	2	3	4	5	6	7
8. Eğer Fen Bilgisi dersi ile ilgili okumam gereken konuları anlamakta zorlanıyorsam, okuma stratejimi değiştiririm.	1	2	3	4	5	6	7
9. Fen Bilgisi dersine çalışırken, dersle ilgili okumaları ve ders sırasında aldığım notları defalarca okurum.	1	2	3	4	5	6	7
10. Ders sırasında veya ders için okuduğum bir kaynakta bir teori, yorum ya da sonuç ifade edilmiş ise, bunları destekleyen bir bulgunun var olup olmadığını sorgulamaya çalışırım.	1	2	3	4	5	6	7
11. Dersle ilgili konuları organize etmek için basit grafik, şema ya da tablolar hazırlarım.	1	2	3	4	5	6	7
12. Fen Bilgisi dersinde işlenen konuları bir başlangıç noktası olarak görür ve ilgili konular üzerinde kendi fikirlerimi oluşturmaya çalışırım.	1	2	3	4	5	6	7
13. Fen Bilgisi dersine çalışırken, dersten, okuduklarımdan, sınıf içi tartışmalardan ve diğer kaynaklardan edindiğim bilgileri biraraya getiririm.	1	2	3	4	5	6	7
14. Yeni bir konuyu detaylı bir şekilde çalışmaya başlamadan önce çoğu kez konunun nasıl organize edildiğini anlamak için ilk olarak konuyu hızlıca gözden geçiririm.	1	2	3	4	5	6	7
15. Fen Bilgisi dersinde işlenen konuları anladığımdan emin olabilmek için kendi kendime sorular sorarım.	1	2	3	4	5	6	7
16. Çalışma tarzımı, dersin gereklilikleri ve öğretmenin öğretme stiline uygun olacak tarzda değiştirmeye çalışırım.	1	2	3	4	5	6	7
17. Genelde derse gelmeden önce konuyla ilgili birşeyler okurum fakat okuduklarımı çoğunlukla anlamam.	1	2	3	4	5	6	7

18. Fen Bilgisi dersindeki önemli kavramları hatırlamak için anahtar kelimeleri ezberlerim.	1	2	3	4	5	6	7
19. Fen Bilgisi dersine çalışırken, konuları sadece okuyup geçmek yerine ne öğrenmem gerektiği konusunda düşünmeye çalışırım.	1	2	3	4	5	6	7
20. Mümkün olduğunca Fen Bilgisi dersinde öğrendiklerimle diğer derslerde öğrendiklerim arasında bağlantı kurmaya çalışırım.	1	2	3	4	5	6	7
21. Fen Bilgisi dersine çalışırken notlarımı gözden geçirir ve önemli kavramların bir listesini çıkarırım.	1	2	3	4	5	6	7
22. Fen Bilgisi dersi için birşeyler okurken, o anda okuduklarımla daha önceki bilgilerim arasında bağlantı kurmaya çalışırım.	1	2	3	4	5	6	7
23. Fen Bilgisi dersinde öğrendiklerimle ilgili ortaya çıkan fikirlerimi sürekli olarak gözden geçirmeye çalışırım.	1	2	3	4	5	6	7
24. Fen Bilgisi dersine çalışırken, dersle ilgili okuduklarımı ve derste aldığım notları inceleyerek önemli noktaların özetini çıkarırım.	1	2	3	4	5	6	7
25. Fen Bilgisi dersiyle ilgili konuları, ders sırasında öğrendiklerim ve okuduklarım arasında bağlantılar kurarak anlamaya çalışırım.	1	2	3	4	5	6	7
26. Fen Bilgisi dersindeki konularla ilgili bir iddia ya da varılan bir sonucu her okuduğumda veya duyduğumda olası alternatifler üzerinde düşünürüm.	1	2	3	4	5	6	7
27. Fen Bilgisi dersinde önemli kavramların listesini çıkarır ve bu listeyi ezberlerim.	1	2	3	4	5	6	7
28. Fen Bilgisi dersine çalışırken iyi anlamadığım kavramları belirlemeye çalışırım.	1	2	3	4	5	6	7
29. Fen Bilgisi dersine çalışırken, çalışmalarımı yönlendirebilmek için kendime hedefler belirlerim.	1	2	3	4	5	6	7
30. Ders sırasında not alırken kafam karışırsa, notlarımı dersten sonra düzenlerim.	1	2	3	4	5	6	7
31. Fen Bilgisi dersinde, okuduklarımdan edindiğim fikirleri sınıf içi tartışma gibi çeşitli faaliyetlerde kullanmaya çalışırım.	1	2	3	4	5	6	7

APPENDIX D

THE SCIENCE ACHIEVEMENT TEST

FEN BİLGİSİ TESTİ

1.

Bitki kısımları / Bitki türü	Saçak kök	Odunsu gövde	Yaprak	Çiçek
K	+	-	+	+
L	-	-	+	-
M	-	+	+	+
N	+	-	+	+
P	-	-	+	-

+ : Bitki kısmına sahip olma

- : Bitki kısmına sahip olmama

Tabloda özellikleri verilen K, L, M, N, P bitkilerinden L ve P diğerlerinden <u>ayrı</u> grupta yer almaktadır.

Bu gruplandırma bitkilerin hangi özelliğine göre yapılmıştır?

A) Üreme şekillerine

B) Kök yapılarına

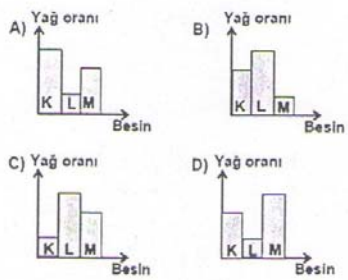
C) Yaşama sürelerine

D) Beslenme şekillerine

2. Yediğimiz besinlerin bir kısmı ağızda, bir kısmı midede kimyasal sindirime uğrar. Yağların kimyasal sindirimi ise tamamen ince bağırsakta gerçekleşir.

Sağlıklı, yetişkin bir insanın yediği besinlerden;

K nın % 15 i, L nin %75 i, M nin %50 si **<u>sadece</u> ince bağırsakta sindirime uğradığına göre, bu besinlerdeki yağ oranı hangi grafikte gösterilmiştir?**



3.

- Enerji kaynağı olarak vücutta önce glikoz sonra sırasıyla diğer karbonhidratlar, yağlar ve proteinler kullanılır.
- Glukagon, karaciğerden kana glikoz verilmesini sağlar.
- İnsülin, kandaki fazla glikozun hücrelere geçişini sağlar.

Bu bilgilere göre; <u>insülin eksikliği</u> ve <u>glukagon fazlalığı</u> olan bir insanda hangisinin olması <u>beklenmez</u>?

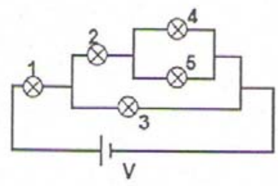
A) Hücrelerden kana hızla yağ geçişinin olması

B) Kandaki glikoz miktarının artması

C) Enerji kaynağı olarak yağların kullanılması

D) Hücrelere glikoz geçişinin azalması

4.



Şekilde verilen elektrik devresindeki eşdeğer ampullerden en az ışık veren iki ampul hangileridir?

A) 1 ve 3

B) 2 ve 3

C) 3 ve 4

D) 4 ve 5

5. **Aşağıdakilerden hangisi, atık maddelerin vücuttan uzaklaştırılmasında görevli <u>değildir</u>?**

A) Akciğerler B) Böbrekler

C) İnce bağırsak D) Deri

6.

Gezegen adı	Kendi ekseni etrafında dönme süresi	Güneş etrafında dönme süresi
X	243 gün	225 gün
Y	24 saat	365 gün
Z	59 gün	88 gün

Yukarıda X, Y ve Z gezegenlerine ait bazı bilgiler verilmiştir.

Bu tabloyu inceleyen bir kişi aşağıdaki sonuçlardan hangisine ulaşır?

A) Güneş etrafında en hızlı dönen gezegen Y'dir.

B) X gezegeninin 1 günü 1 yılından daha uzundur.

C) Kendi etrafında en yavaş dönen gezegen Y'dir.

D) Güneş'e en uzak gezegen Z'dir.

7.

I. Göze giren ışık miktarını ayarlar.

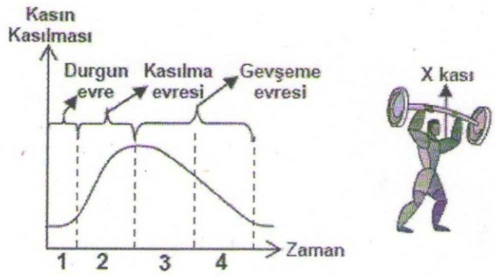
II. Işığın sarı benek üzerine düşmesini sağlar.

III. Işığa duyarlı almaçları bulundurur.

Yukarıda görevleri verilen göze ait bölümlerin isimleri aşağıdaki seçeneklerin hangisinde doğru olarak verilmiştir?

	I	II	III
A)	İris	Retina	Saydam tabaka
B)	Saydam tabaka	Göz merceği	Kornea
C)	Retina	Damar tabaka	Göz bebeği
D)	İris	Göz merceği	Ağ tabaka

8.

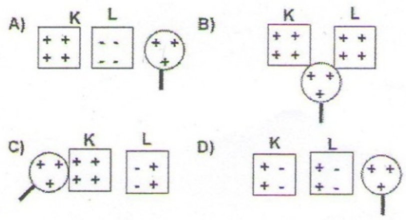


Yukarıdaki grafikte bir kasın durgun, kasılma ve gevşeme evreleri verilmiştir.

Buna göre şekildeki sporcunun X kasının durumu, grafikte hangi zaman aralığındaki gibidir?

A) 1 B) 2 C) 3 D) 4

9. **Başlangıçta (+) yüklü iletken küre ile yüksüz K ve L iletken levhalarının aşağıdaki hangi düzenlenişlerinde yük dağılımları <u>yanlış</u> verilmiştir?**



10. Bir araştırmacı incelediği bir hücrenin hayvana mı yoksa bitkiye mi ait olduğuna karar vermek istiyor.

Aşağıda verilen işlemleri sırası ile yapan araştırmacı, kaçıncı basamakta kesin sonuca ulaşır?

I. Çekirdeğin incelenmesi

II. Hücre zarının incelenmesi

III. Kofulun incelenmesi

IV. Sentriyollerin varlığına bakılması

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

11.

I. Defne, Onur ve Eren'e kan verebiliyor ama alamıyor.

II. Onur, Eren'e kan verebiliyor ama alamıyor.

Üç kişi arasındaki kan alış verişi ile ilgili yukarıda verilen bilgilere göre, kişilerin kan grupları aşağıdakilerden hangisinde doğru olarak verilmiştir?

	Eren	Defne	Onur
A)	B	AB	0
B)	AB	B	0
C)	A	0	AB
D)	AB	0	B

12. Güneş sistemi, Güneş ve etrafındaki gök cisimlerinden oluşur.

Buna göre aşağıdakilerden hangisi Güneş Sistemi'ne ait değildir?

A) Ay

B) Samanyolu

C) Kuyruklu yıldız

D) Asteroit

13.

I. Vücut yüzeyini örter.

II. Hareket etmeyi sağlar.

III. İç organları çarpma ve darbelere karşı korur.

Yukarıda verilen bilgiler içerisinde, aşağıdaki dokulardan hangisinin görevi <u>belirtilmemiştir</u>?

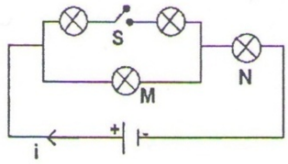
A) Epitel doku

B) Yağ doku

C) Sinir doku

D) Kemik doku

14. Ampullerin parlaklığı, üzerinden geçen akım şiddeti ile doğru orantılıdır.



Ampullerin özdeş olduğu yukarıdaki devrede, S anahtarı kapatılırsa M ve N ampullerinin parlaklığında önceki duruma göre nasıl bir değişme olur?

	M Ampulü	N Ampulü
A)	Artar	Azalır
B)	Değişmez	Artar
C)	Azalır	Değişmez
D)	Azalır	Artar

15. I. Embriyo oluşumu

II. Döllenme

III. Gelişme

IV. Dişi ve erkek üreme hücrelerinin oluşumu

Yukarıda üremeyle ilgili olarak verilen olayların doğru sıralaması aşağıdaki seçeneklerin hangisinde verilmiştir?

A) II-I-III-IV B) IV-II-I-III

C) IV-III-II-I D) III-IV-I-II

16.

Sıcaklığı 25 ^{0}C olan ortamda şekildeki deneyi gözleyen öğrenci, aşağıdaki soruların hangisine cevap <u>veremez</u>?

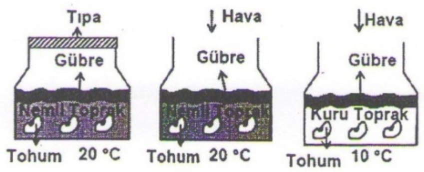
A) Bitki, kökleriyle suyu alır mı?

B) Yapraklarda terleme gerçekleşir mi?

C) Sıcaklık, terleme hızını etkiler mi?

D) Su, bitkiler için önemli midir?

17.



Yukarıdaki düzenekleri inceleyen bir öğrenci aşağıdaki hangi soruya cevap verebilir?

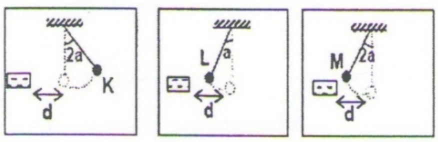
A) Çimlenme, ortamın sıcaklığına bağlı mıdır?

B) Çimlenme için hava gerekli midir?

C) Çimlenme, topraktaki nem miktarına bağlı mıdır?

D) Çimlenme, topraktaki gübre miktarına bağlı mıdır?

18.



Yalıtkan iple bağlı ve eşit kütleli olan K, L ve M cisimlerine (-) yüklü çubuk d kadar yaklaştırıldığında cisimler şekillerdeki gibi denge konumlarına ulaşmaktadır.

Buna göre aşağıdaki ifadelerden hangisi <u>kesinlikle yanlıştır</u>?

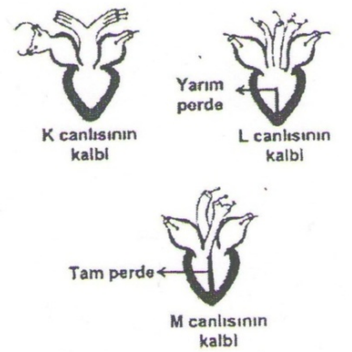
A) L ile M aynı miktarda yükle yüklüdür.

B) Çubuk ile L zıt yükle yüklüdür.

C) M cismi (+) yüklüdür.

D) K cismi (-) yüklüdür.

19.



Yukarıdaki şekillerde üç ayrı hayvan türüne ait kalpler şematik olarak gösterilmiştir.

Bu hayvanlara ait kalpleri incelediğimizde aşağıdaki yorumlardan hangisini <u>yapamayız</u>?

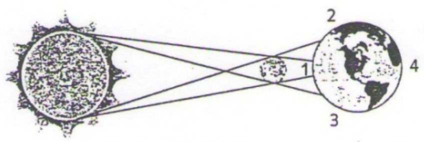
A) K ve L türlerine ait hayvanların kalbinde temiz ve kirli kan birbirine karışmaktadır.

B) K ve L türlerine ait hayvanlar, soğukkanlıdır.

C) M türüne ait hayvan birim zamanda daha fazla oksijen tüketmektedir.

D) M türüne ait hayvan daha iri vücutludur.

20.



Yukarıdaki şekilde Güneş tutulması gösterilmektedir.

Buna göre hangi bölge veya bölgelerde kararma oluşur?

A) Yalnız 1

B) 2 ve 3

C) 2, 3 ve 4

D) 1 ve 4

21.

	A	B	C
Enerji üretimi	-	+	-
Protein sentezi	-	-	+
Salgı maddelerinin oluşturulması	+	-	-

+ : Organelde gerçekleşen olaylar

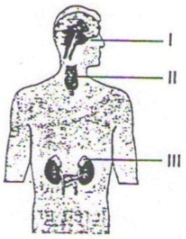
- : Organelde gerçekleşmeyen olaylar

Yukarıdaki tabloda bir hücerede bulunan A, B ve C organellerinde gerçekleşen olaylar verilmiştir.

Buna göre A, B ve C harfleri ile gösterilen organeller, aşağıdaki seçeneklerin hangisinde doğru olarak verilmiştir?

	A	B	C
A)	Sentrozom	Mitokondri	Golgi cisimciği
B)	Ribozom	Kloroplast	Mitokondri
C)	Golgi cisimciği	Mitokondri	Ribozom
D)	Golgi cisimciği	Sentrozom	Kloroplast

22.



Yukarıdaki şekil üzerinde numaralandırılarak gösterilen iç salgı bezleri aşağıdaki seçeneklerin hangisinde doğru olarak verilmiştir?

	I	II	III
A)	Hipofiz B.	Tiroit B.	Böbrek Üstü B.
B)	Tiroit B.	Hipofiz B.	Testis
C)	Hipofiz B.	Tiroit B.	Yumurtalık
D)	Tiroit B.	Hipofiz B.	Böbrek Üstü B.

23. **Aşağıda deri ile ilgili verilen bilgilerden hangisi <u>yanlıştır</u>?**

A) Yağ doku tabakası alt derinin altında bulunur.

B) Duyu almaçları üst deride yer alır.

C) Ter bezleri boşaltıma yardımcı olur.

D) Deriye renk veren maddeler üst deride bulunur.

24. I. Güneş sisteminde yer alan en büyük gezegendir.

II. Güneş'e en uzak gezegendir.

III. Güneş sisteminde halkalı gezegen olarak bilinen gezegendir.

Yukarıda bazı özellikleri verilen gök cisimlerinin isimleri aşağıdaki seçeneklerin hangisinde doğru olarak verilmiştir?

	I	II	III
A)	Jüpiter	Plüton	Satürn
B)	Dünya	Uranüs	Jüpiter
C)	Jüpiter	Neptün	Uranüs
D)	Satürn	Uranüs	Jüpiter

25.

Burun → Gırtlak → I → Bronş → II → Akciğer kılcalları

Yukarıda soluk alma sırasında dışarıdan alınan havanın geçtiği solunum sistemi yapı ve organları verilmiştir.

Bu sıralamada I ve II numaralı yerlere aşağıdakilerden hangisi gelmelidir?

	I	II
A)	Soluk borusu	Alveol
B)	Yutak	Bronşçuk
C)	Bronşçuk	Hava kesesi
D)	Soluk borusu	Diyafram

APPENDIX E

THE LETTER OF PERMISSION

T.C.
ÇANKAYA KAYMAKAMLIĞI
İlçe Milli Eğitim Müdürlüğü

Kültür : Kültür
Sayı : B.08.4.MEM.4.06.02.01.11.070/
Konu : Araştırma

10.05.2006 27508

.... MÜDÜRLÜĞÜNE

Orta Doğu Teknik Üniversitesi Fen ve Matematik Alanları Eğitimi Anabilim Dalı doktora öğrencisi Şule ÖZKAN KAŞKER'in, 12 sayfa, 154 sorudan oluşan anketi ek listede isimleri belirtilen okullarda uygulamasına izin verildiğine ilişkin Bakanlığımız Eğitimi Araştırma ve Geliştirme Dairesi Başkanlığı'nın 03.05.2006 tarih ve 580/1845 sayılı yazısı ekte gönderilmiştir.

Bakanlık emri gereğince işlem yapılmasını rica ederim.

Züleyha TEKÇE AKÇA
Müdür a.
Şube Müdürü

24.05.2006
Teslim aldım.
ŞULE ÖZKAN KAŞKER

EKLER:
1- Bakanlık Emri.
2-Anket (12 sayfa, 154 soru)
3- Liste (1 Sayfa)

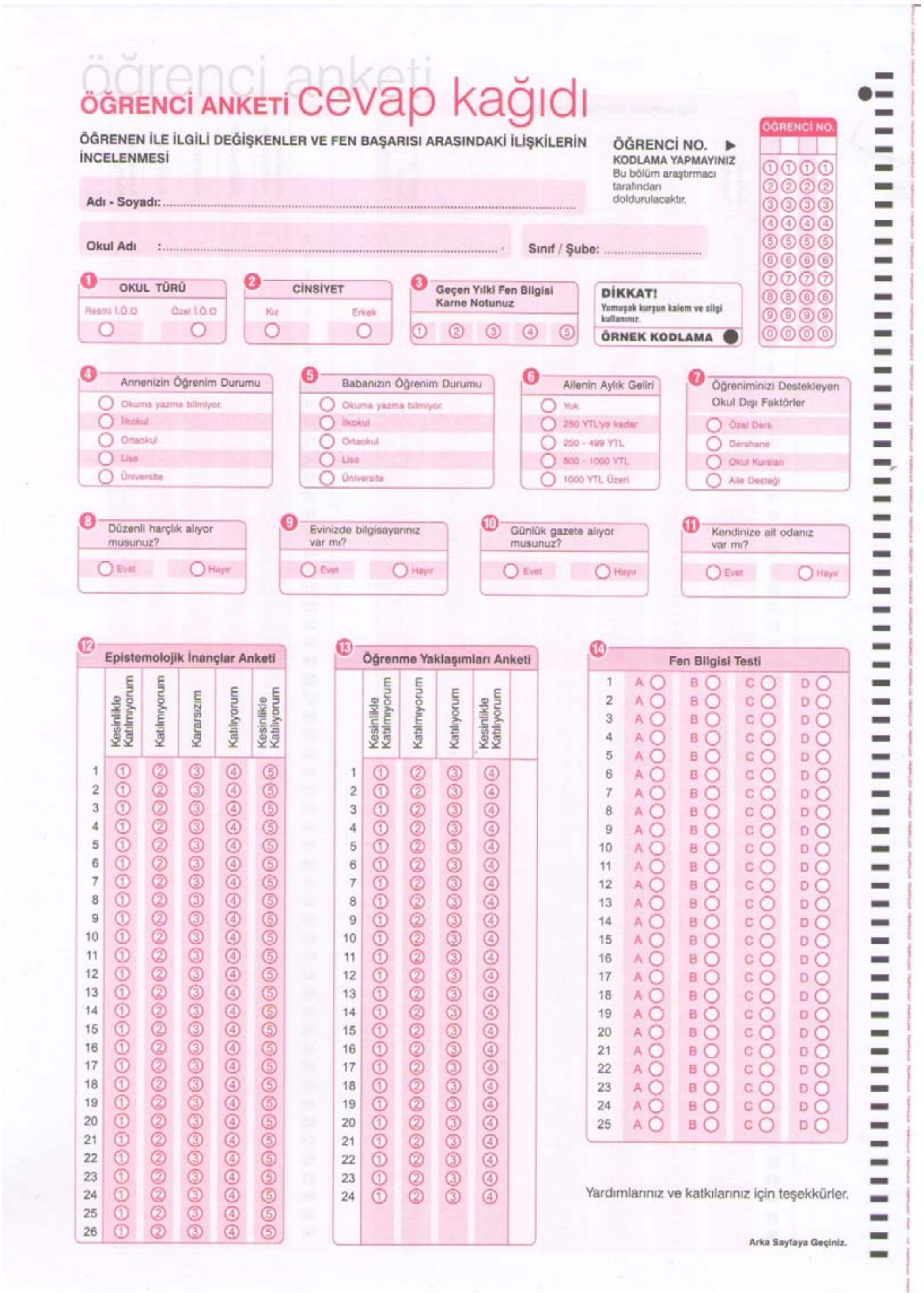
Adres :
Kumrular Caddesi 3. Sokak
Kızılay / ANKARA

Tel : 418 68 75 – 418 84 58
Fax : 419 27 84 – 85

Web : http://.cankaya-meb.gov.tr
e-posta : cankaya@cankaya-meb.gov.tr

APPENDIX F

SAMPLE OPTICAL FORM



öğrenci anketi

ÖĞRENCİ ANKETİ cevap kağıdı

ÖĞRENEN İLE İLGİLİ DEĞİŞKENLER VE FEN BAŞARISI ARASINDAKİ İLİŞKİLERİN İNCELENMESİ

Adı - Soyadı: ....

Okul Adı : ....

Sınıf / Şube: ....

ÖĞRENCİ NO. ▶ KODLAMA YAPMAYINIZ Bu bölüm araştırmacı tarafından doldurulacaktır.

ÖĞRENCİ NO.

1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
0	0	0	0

1 OKUL TÜRÜ: Resmi İ.Ö.O ○ Özel İ.Ö.O ○

2 CİNSİYET: Kız ○ Erkek ○

3 Geçen Yılki Fen Bilgisi Karne Notunuz: ① ② ③ ④ ⑤

DİKKAT! Yumuşak kurşun kalem ve silgi kullanınız.

ÖRNEK KODLAMA ●

4 Annenizin Öğrenim Durumu
- ○ Okuma yazma bilmiyor.
- ○ İlkokul
- ○ Ortaokul
- ○ Lise
- ○ Üniversite

5 Babanızın Öğrenim Durumu
- ○ Okuma yazma bilmiyor.
- ○ İlkokul
- ○ Ortaokul
- ○ Lise
- ○ Üniversite

6 Ailenin Aylık Geliri
- ○ Yok
- ○ 250 YTL'ye kadar
- ○ 250 - 499 YTL
- ○ 500 - 1000 YTL
- ○ 1000 YTL Üzeri

7 Öğreniminizi Destekleyen Okul Dışı Faktörler
- ○ Özel Ders
- ○ Dershane
- ○ Okul Kursları
- ○ Aile Desteği

8 Düzenli harçlık alıyor musunuz? ○ Evet ○ Hayır

9 Evinizde bilgisayarınız var mı? ○ Evet ○ Hayır

10 Günlük gazete alıyor musunuz? ○ Evet ○ Hayır

11 Kendinize ait odanız var mı? ○ Evet ○ Hayır

12 Epistemolojik İnançlar Anketi

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1	①	②	③	④	⑤
2	①	②	③	④	⑤
3	①	②	③	④	⑤
4	①	②	③	④	⑤
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17	①	②	③	④	⑤
18	①	②	③	④	⑤
19	①	②	③	④	⑤
20	①	②	③	④	⑤
21	①	②	③	④	⑤
22	①	②	③	④	⑤
23	①	②	③	④	⑤
24	①	②	③	④	⑤
25	①	②	③	④	⑤
26	①	②	③	④	⑤

13 Öğrenme Yaklaşımları Anketi

	Kesinlikle Katılmıyorum	Katılmıyorum	Katılıyorum	Kesinlikle Katılıyorum
1	①	②	③	④
2	①	②	③	④
3	①	②	③	④
4	①	②	③	④
5	①	②	③	④
6	①	②	③	④
7	①	②	③	④
8	①	②	③	④
9	①	②	③	④
10	①	②	③	④
11	①	②	③	④
12	①	②	③	④
13	①	②	③	④
14	①	②	③	④
15	①	②	③	④
16	①	②	③	④
17	①	②	③	④
18	①	②	③	④
19	①	②	③	④
20	①	②	③	④
21	①	②	③	④
22	①	②	③	④
23	①	②	③	④
24	①	②	③	④

14 Fen Bilgisi Testi

1	A ○	B ○	C ○	D ○
2	A ○	B ○	C ○	D ○
3	A ○	B ○	C ○	D ○
4	A ○	B ○	C ○	D ○
5	A ○	B ○	C ○	D ○
6	A ○	B ○	C ○	D ○
7	A ○	B ○	C ○	D ○
8	A ○	B ○	C ○	D ○
9	A ○	B ○	C ○	D ○
10	A ○	B ○	C ○	D ○
11	A ○	B ○	C ○	D ○
12	A ○	B ○	C ○	D ○
13	A ○	B ○	C ○	D ○
14	A ○	B ○	C ○	D ○
15	A ○	B ○	C ○	D ○
16	A ○	B ○	C ○	D ○
17	A ○	B ○	C ○	D ○
18	A ○	B ○	C ○	D ○
19	A ○	B ○	C ○	D ○
20	A ○	B ○	C ○	D ○
21	A ○	B ○	C ○	D ○
22	A ○	B ○	C ○	D ○
23	A ○	B ○	C ○	D ○
24	A ○	B ○	C ○	D ○
25	A ○	B ○	C ○	D ○

Yardımlarınız ve katkılarınız için teşekkürler.

Arka Sayfaya Geçiniz.

15 **Öğrenmede Güdüsel Stratejiler Anketi**

	Beni Hiç Yansıtmıyor	2	3	4	5	6	Beni Tam Olarak Yansıtıyor
1	①	②	③	④	⑤	⑥	⑦
2	①	②	③	④	⑤	⑥	⑦
3	①	②	③	④	⑤	⑥	⑦
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56	①	②	③	④	⑤	⑥	⑦

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
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56	①	②	③	④	⑤

APPENDIX G

THE FINAL SIMPLIS SYNTAX FOR THE STRUCTURAL MODEL

```
Science achievement and learner related variables  - A path analysis
Observed Variables
BELBOOK NOMORE SCTKNOW AGTRUE IDEBOOK IDESCIENCE
CHAMIND BEFSTART DOEXPER MOREXPER RELATENEW GOOVER
QUESTION REREAD NEWANS NOTUNDERS LOOKSOME RESTSTUDY
SELFTOT SCIENTOT
Correlation Matrix From File EX1.COR
Sample Size: 1240
Latent Variables: SOU/CER DEV JUST MLEARN RLEARN SELFRL SCIACH
Relationships:
BELBOOK NOMORE SCTKNOW AGTRUE = SOU/CER
IDEBOOK IDESCIENCE CHAMIND = DEV
BEFSTART DOEXPER MOREXPER = JUST
RELATENEW GOOVER QUESTION REREAD NEWANS = MLEARN
NOTUNDERS LOOKSOME RESTSTUDY = RLEARN
SELFTOT = SELFRL
SCIENTOT = SCIACH
MLEARN = SOU/CER DEV JUST
RLEARN = SOU/CER DEV JUST
SELFRL = MLEARN RLEARN
SCIACH = SOU/CER SELFRL
Set the Error Variance of Srl to 0
Set the Error Variance of Science to 0
Admissibility Check = OFF
Path Diagram
Number of Decimals = 3
Wide Print
Print Residuals
End of Problem
```

APPENDIX H

THE BASIC MODEL WITH ESTIMATES AND t-VALUES

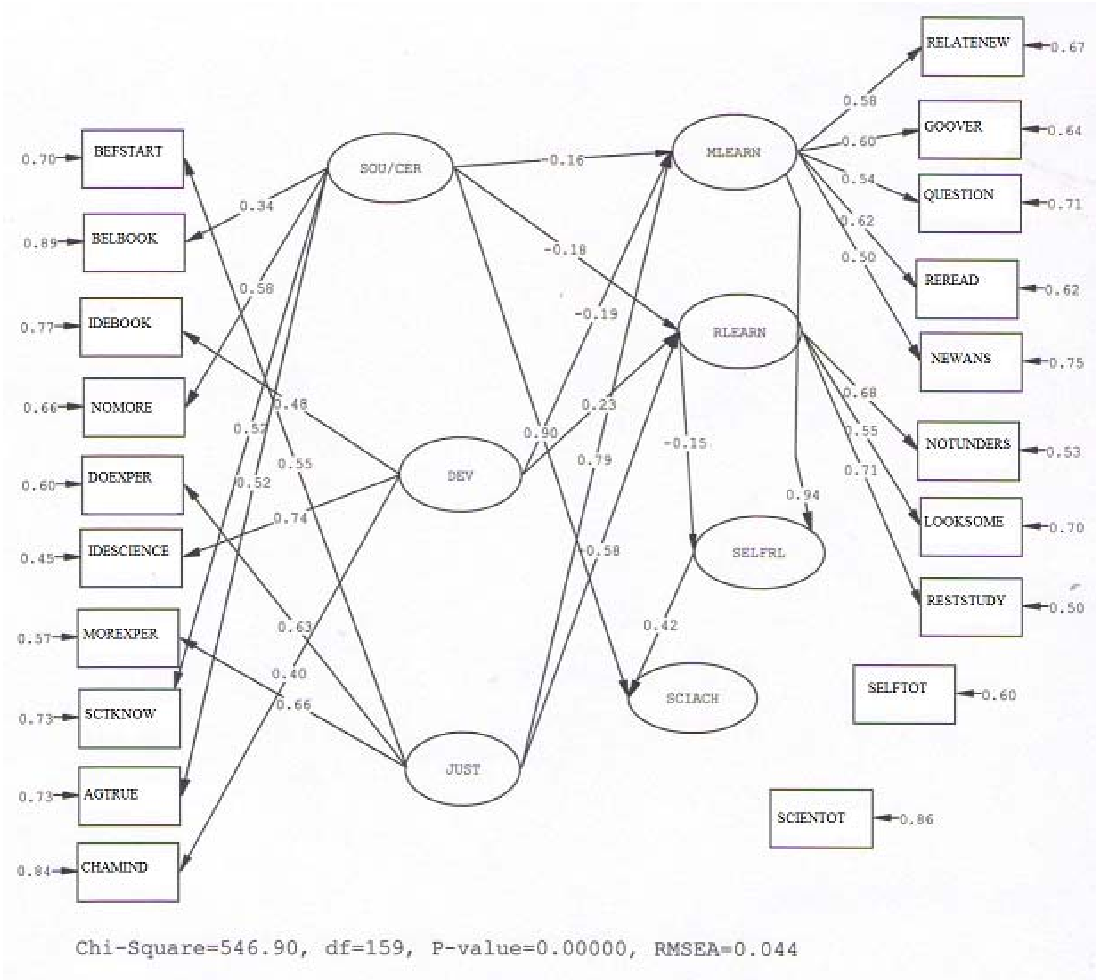

Figure K1. The basic model

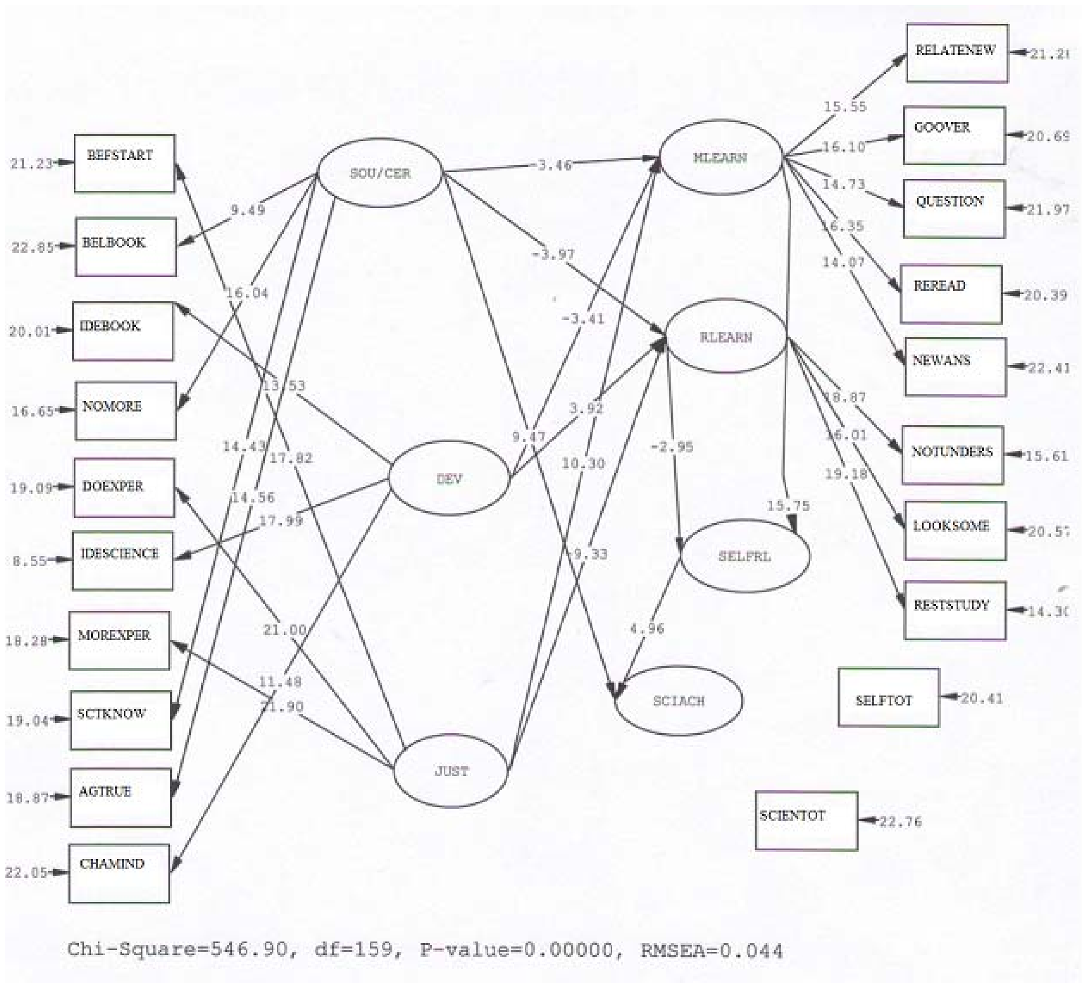

Figure K1.(Continued)

APPENDIX I

GOODNESS-OF-FIT STATISTICS

Degrees of Freedom = 159
Minimum Fit Function Chi-Square = 548.445 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 546.901 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 387.901
90 Percent Confidence Interval for NCP = (320.536 ; 462.858)
Minimum Fit Function Value = 0.443
Population Discrepancy Function Value (F0) = 0.313
90 Percent Confidence Interval for F0 = (0.259 ; 0.374)
Root Mean Square Error of Approximation (RMSEA) = 0.0444
90 Percent Confidence Interval for RMSEA = (0.0403 ; 0.0485)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.988
Expected Cross-Validation Index (ECVI) = 0.524
90 Percent Confidence Interval for ECVI = (0.469 ; 0.584)
ECVI for Saturated Model = 0.339
ECVI for Independence Model = 3.602
Chi-Square for Independence Model with 190 Degrees of Freedom = 4423.009
Independence AIC = 4463.009
Model AIC = 648.901
Saturated AIC = 420.000
Independence CAIC = 4585.466
Model CAIC = 961.167
Saturated CAIC = 1705.802
Root Mean Square Residual (RMR) = 0.0476
Standardized RMR = 0.0476
Goodness of Fit Index (GFI) = 0.958
Adjusted Goodness of Fit Index (AGFI) = 0.944
Parsimony Goodness of Fit Index (PGFI) = 0.725
Normed Fit Index (NFI) = 0.876
Non-Normed Fit Index (NNFI) = 0.890
Parsimony Normed Fit Index (PNFI) = 0.733
Comparative Fit Index (CFI) = 0.908
Incremental Fit Index (IFI) = 0.909
Relative Fit Index (RFI) = 0.852
Critical N (CN) = 460.511

.

VITA

PERSONAL INFORMATION

Surname, Name: Özkan Kaşker, Şule
Nationality: Turkish
Date and Place of Birth: 30.11.1975, Ankara
Marital Status: Married
Phone: +90 312 479 86 18
Email: ozkan_sule@hotmail.com

EDUCATION

Degree	**Institution**	**Year of Graduation**
MS	METU SSME.	2003
BS	METU SSME	2000
High School	Yükseliş College, Ankara	1995

WORK EXPERIENCE

Year	**Place**	**Enrollment**
2007-Present	Ahi Evran University, Kırşehir	EU Expert
2000-2007	METU Department of Elementary Education	Research Assistant

PUBLICATIONS

1. Aşcı, Z., **Özkan, Ş** and Tekkaya, C. (2001). Students' Misconceptions About Respiration: A Cross-Age Study. *Eğitim ve Bilim*, 120 (26), 29-36.

2. **Özkan, Ş**., Sungur, S., & Tekkaya, C. (2004). The effect of tenth graders learning style preferences on their biology achievement. *Eğitim ve Bilim*, 29 (134), 75-79.

3. **Özkan, Ş**., Çakıroğlu J., and Tekkaya, C. (2008). Students' perceptions of the science laboratory learning environment. In D.W Sunal, E.L. Wright, & C. Sundberg (Eds.), *Research in Science Education: The Impact of the Laboratory and Technology on K-16 Science Learning and Teaching* (pp.111-134). Greenwich: Information Age Publishing.

4. Keskin, Ö. M., Uysal, E., **Özkan, Ş**., (2005). 4. Sınıf Fen ve Teknoloji Ders Kitabı, Çalışma Kitabı, Öğretmen Kılavuzu, Düzgün Yayıncılık, Ankara.

5. Keskin, Ö. M., **Özkan, Ş**., Uysal, E., Adıgüzel, S., Yenilmez, A., Özdemir, E. Aydın, E. E., (2005). 5. Sınıf Fen ve Teknoloji Ders Kitabı, Çalışma Kitabı, Öğretmen Kılavuzu, Düzgün Yayıncılık, Ankara.

6. Keskin, Ö. M., Uysal, E., **Özkan, Ş**., (2006). 6. Sınıf Fen ve Teknoloji Ders Kitabı, Çalışma Kitabı, Öğretmen Kılavuzu, Doku Yayıncılık, Ankara

7. Aksu, M., Ertepınar, H., Bulut, S., Olkun, S., Çakıroğlu, E., Çakıroğlu, J., Kılıç, G.B., Sungur, S., Toluk, Z., Buldu, N., Doğan, O., **Özkan, Ş**., Yıldırım, H.H. (2005). Matematik Fen ve Ben 1, 2 ve 3. Öğrenci ve Eğitici Kitapları, Eğitim Gönüllüleri Vakfı, İstanbul.

8. Ertepınar, H., Çakıroğlu, J., Kılıç, G.B., Sungur, S., Buldu, N., **Özkan, Ş**. (2006). Matematik Fen ve Ben 4 ve 5. Öğrenci ve Eğitici Kitapları, Eğitim Gönüllüleri Vakfı, İstanbul.

9. Ertepınar, H., Çakıroğlu, J., Kılıç, G.B., Sungur, S., Buldu, N., **Özkan, Ş**. (2007). Matematik Fen ve Ben 6, 7 ve 8. Öğrenci ve Eğitici Kitapları, Eğitim Gönüllüleri Vakfı, İstanbul.

10. Olgun Kamay, P., **Özkan, Ş** (2006). İlk Fen Deneyimlerim. SMG Yayıncılık, Ankara.