INVESTIGATING STUDENTS’ EPISTEMOLOGICAL BELIEFS THROUGH GENDER, GRADE LEVEL, AND FIELDS OF THE STUDY

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ABSTRACT

INVESTIGATING STUDENTS' EPISTEMOLOGICAL BELIEFS THROUGH GENDER, GRADE LEVEL, AND FIELDS OF THE STUDY

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This research attempted to investigate the epistemological beliefs held by Turkish students through gender, grade level and fields of the study by using Hofer and Pintrich's (1997) framework.

A total of 1557 sixth, eighth, and tenth grade students from Çankaya district of Ankara participated in the study. Epistemological Beliefs Questionnaire and Demographic Questionnaire were administered to the students in order to determine their epistemological beliefs and their background characteristics. Four main conclusions can be drawn from the current study; epistemological beliefs are multidimensional, epistemological beliefs vary as a function of gender, grade level and fields of the study. Specifically, girls were found to have more sophisticated beliefs in justification of knowledge than boys. Results also supported the idea that epistemological beliefs develops over time. Tenth grade students had more sophisticated beliefs in source of knowledge, certainty of knowledge, and development of knowledge compared to sixth and eighth grade students. Besides, findings of the study revealed differences in epistemological beliefs of students across different major fields of the study. The students attending to the mathematics-science fields were found to have more sophisticated beliefs about justification of knowledge than the students attending to literature-social science fields.

Keywords: Epistemological Beliefs, Gender, Grade Level, Fields of the Study

ÖZ

CİNSİYETİN, SINIF SEVİYESİNİN, VE EĞİTİM GÖRDÜKLERİ ALANLARIN, ÖĞRENCİLERİN EPİSTEMOLOJİK İNANÇLARI ÜZERİNDEKİ ETKİSİ

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Bu çalışmada cinsiyetin, sınıf seviyesinin ve eğitim gördükleri alanların öğrencilerin epistemolojik inançları üzerine etkisi araştırılmıştır.

Araştırmaya, Ankara ilinin Çankaya ilçesindeki ilköğretim ve ortaöğretim okullarında eğitim gören toplam 1557 altıncı, sekizinci ve onuncu sınıf öğrencisi katılmıştır. Öğrencilerin kişisel özellikleri ve sahip oldukları epistemolojik inançlar kişisel bilgi formu ve epistemolojik inançlar anketi uygulanarak belirlenmiştir.

Bu araştırmadan dört önemli sonuç elde edilmiştir; epistemolojik inançlar çok boyutludur ve cinsiyet, sınıf seviyesi ve alanlara göre değişir. Bir diğer sonuç kızların erkeklere göre, bilginin doğruluğu ile ilgili daha gelişmiş inançlara sahip olduğunu göstermektedir. Ayrıca sonuçlar, epistemolojik inançların zamanla değiştiğini desteklemektedir. Onuncu sınıf öğrencilerinin, altıncı ve sekizinci sınıf öğrencilerine göre daha gelişmiş epistemik inançlara sahip olduğu belirlenmiştir. Elde edilen sonuçlara göre, eğitim gördükleri alanların, öğrencilerin epistemolojik inançları üzerinde istatistiksel bir farklılığa neden olduğu belirlenmiştir. Sayısal alanda eğitim gören öğrencilerin, sözel alandaki öğrencilere göre daha gelişmiş inançlara sahip olduğu tespit edilmiştir.

Anahtar Kavramlar: Epistemolojik İnançlar, Cinsiyet, Sınıf Seviyesi, Eğitim Gördükleri Alanlar

To my parents

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LIST OF ABBREVIATIONS

EB: Epistemological Beliefs

EBQ: Epistemological Beliefs Questionnaire

GPA: Grade Point Average

SES: Socio Economic Status

M: Mean

SD: Standard Deviation

DV: Dependent Variable

IV: Independent Variable

RMSEA: Root-Mean-Squared Error of Approximation

SRMR: Standardized- Root- Mean- Square Residual

GFI: Goodness-of- Fit Index

CFI: Comparative Fit Index

N: Sample Size

df: Degrees of Freedom

p: Significance Level

SPSS: Statistical Package for Social Sciences

MANOVA: Multivariate Analyses of Variance

CHAPTER 1

INTRODUCTION

Studies on epistemological beliefs in learning began with William Perry (1970) who attempted to understand how students interpreted educational experiences. Perry's attempts had led to the theory of epistemological development (Hofer & Pintrich, 1997). Perry's research began by two longitudinal studies in the early 1950s and was based on interviews with undergraduate college students who were generally male. After interviewing with students, Perry and his colleagues developed a scheme of intellectual and ethical development which consisted of nine positions. These positions have been clustered into four sequential categories: *dualism, multiplicity, relativism, and commitment within relativism* (Hofer & Pintrich, 1997). Dualism represents right or wrong view of the world and the individuals who have dualistic views believe that authorities know the truth and convey it to the learner. Multiplicity represents a modification of dualism and the individuals who are in this position, believe that all views are equally valid and that each person has a right to have his or her own opinion. The individuals at relativistic category believed that knowledge is relative and contingent and they realized the need to choose and affirm one's own commitments. The individuals at commitment within relativism category make and affirm commitments to values, careers, relationships, and personal identity (Hofer & Pintrich, 1997).

In Perry's model, personal epistemology was captured in a single dimension and consisted of developmental stages (Schommer, 1990). According to Schommer, beliefs about the nature of knowledge are too complex to explain in a unidimensional conception. Therefore, Schommer (1990) defined the personal epistemology as "a belief system that is composed of several more or less independent dimensions" (Schommer 1990, p.498). Schommer hypothesized five epistemological dimensions: Simple Knowledge-knowledge is simple (i.e. less sophisticated belief) rather than complex (i.e. sophisticated belief), Omniscient Authority-knowledge is handed down by authority (i.e. less sophisticated belief) rather than derived from reason (i.e.

sophisticated belief), Certain Knowledge-knowledge is certain (i.e. less sophisticated belief) rather than tentative (i.e. sophisticated belief), Innate Ability-the ability to learn is innate (i.e. less sophisticated belief) rather than acquired (i.e. sophisticated belief) and Quick Learning-learning is quick or not at all (i.e. less sophisticated belief) rather than gradual (i.e. sophisticated belief). Then Schommer (1990) developed an Epistemological Beliefs Questionnaire (EBQ) which consisted of 63 items. In one of Schommer's studies, the 12 subsets of items were determined and the factor analysis was conducted. The factor analysis indicated that 12 subsets of items were loaded onto four factors: *Innate Ability, Simple Knowledge, Quick Learning and Certain Knowledge.* In the first part of the study, Schommer (1990), examined the relation between epistemological beliefs and characteristics of the learners. The 117 junior college students who were enrolled in an introductory psychology class and 149 university students who were enrolled in either an introductory educational psychology class or an introductory physics class were administered a vocabulary test, survey of student characteristics, filler task and Epistemological Beliefs Questionnaire (EBQ). In the second part of the study, she examined the relationship between epistemological beliefs and comprehension. She controlled the effects of epistemological beliefs on conclusions, performance on mastery test and comprehension monitoring. The study was consisted of 86 junior college students who participated in the first study. The students read a passage about psychology or nutrition and were asked to write a conclusion for the passage and to rate their confidence in understanding the passage. The results of the study showed that the students who believed in quick learning oversimplified conclusions and performed poorly on the psychology mastery test. The results also indicated that the more the students believed in certain knowledge, the more absolute conclusions they wrote. The study revealed an important finding that epistemological beliefs affect the students' processing of information and monitoring of their comprehension.

The Schommer's dimensions were found to be somewhat problematic by Hofer and Pintrich (1997). According to Hofer and Pintrich (1997), fixed ability and quick learning were not epistemological dimensions and these dimensions do not focus on the nature of knowledge and knowing. They stated that quick learning gives information about whether learning is quick or not, and this can not be considered as an epistemological belief about the nature of knowledge and that fixed ability beliefs concern the nature of intelligence, not nature of knowledge. Hofer and Pintrich (1997) suggested that epistemological theories composed of four dimensions: *Certainty of Knowledge, Simplicity of Knowledge, Source of Knowledge and Justification for Knowing.* In addition, these four dimensions represent two general areas: *Beliefs about the nature of knowledge and beliefs about the nature of knowing.* Certainty of Knowledge and Simplicity of Knowledge reflect beliefs about nature of knowledge and Source of Knowledge and Justification for Knowing reflect beliefs about nature of knowing. The beliefs about Certainty of Knowledge were explained as absolute truth exists with certainty (i.e. less sophisticated) and as knowledge is tentative and evolving (i.e. more sophisticated). At the lower level of beliefs about Simplicity of Knowledge, knowledge is explained as discrete, concrete and knowable facts and at the higher level, knowledge is explained as relative, contingent, and contextual. At level of less sophisticated beliefs about Source of Knowledge, the individuals believe that knowledge originates outside the self and resides in external authority and at level of more sophisticated beliefs about Source of Knowledge, the individuals believe that knowledge is constructed by the knower in interaction with others. Justification for Knowing dimension examines how individuals evaluate knowledge (Hofer & Pintrich, 1997). The researchers (e.g., Perry, 1970; Schommer, 1990; Hofer & Pintrich, 1997) examined the individuals' epistemological beliefs, developed some theories, and classified beliefs in dimensions. Epistemological belief theories will help us to provide information about the students' beliefs and their thinking about knowledge, so educators and teachers will design teaching and learning process in classroom in terms of students' beliefs.

To date, several researchers across different countries investigated students' beliefs about nature of knowledge and knowing and focused on the factors affecting students' beliefs in the learning process. Among them gender, age, grade level, ethnicity, socioeconomic status, fields of the study, academic performance, learning approaches, learning environments, attitudes towards science, self regulated learning strategies, and self-efficacy beliefs have received great attention by the researchers (e.g., Perry, 1970; Baxter Magolda, 1992; Schommer, 1993; Schommer & Dunnell, 1994; Paulsen & Wells, 1998; Elder, 1999; Conley, Pintrich, Vekiri & Harrison, 2004; Neber & Schommer, 2002; Cano; 2005; Tsai, 2000; Lodewyk, 2007). Briefly these studies revealed that epistemological beliefs change as a function of students' gender, grade level, field of study, academic performance, perceptions of constructivist learning environments, and learning approaches.

In the light of these findings, current study is conducted to determine the students' epistemological beliefs with respect to gender, grade level, and fields of the study.

1.1 Significance of the Study

The vision of the Turkish science curriculum which based on constructivist approach is that all of the students must be educated as scientifically and technologically literate (Ministry of National Education, 2005). In the curriculum, the individual who is scientifically and technologically literate is described as "understands fundamental science concepts, law, theories and the nature of science and scientific knowledge and uses them; uses scientific process skills; understands the relationship between science, technology, society and environment" (Ministry of National Education, 2005, p.5). In order to develop students' thinking and to increase students' science achievement, new arrangements were made in Turkish science curriculum. These arrangements focused on students' active learning environment, students' attitude toward science, classroom environment, and learning approaches. For instance, the importance of the constructivist learning environment in which the students construct their own knowledge was emphasized rather than traditional learning environment in which the knowledge is constructed by the teachers and the textbooks. The constructivist classrooms are more student centered. The students obtain knowledge by doing experiments, using data, and being curious, support knowledge with evidence, they accept the teachers and textbooks as guidance, and they observe that knowledge is changing subject and that there is more than one answer in constructivist classrooms. In their study, Smith, Maclin, Houghton, and Hennessey (2000) revealed that the students in the constructivist classrooms think that science consisted of the development and modification of ideas about how the world works.

Despite giving special attention to the science education in Turkey, some international assessments show that the students don't have a satisfactory understanding of science. For instance, The Program for International Student Assessment (PISA) is an international assessment that measures the 15-year-olds' capabilities of science literacy, mathematics literacy, and reading literacy. In 2006, PISA was focused on science literacy and environmental issues (Bybee, 2008). About 57 countries participated in the assessment. In 2006, the Turkish students' average science score (424) was lower than the OECD countries' (Organisation for Economic Cooperation and Development) average science score (500) (Ministry of National Education, 2007). The score is at around 400 points shows that the students can recall simple scientific knowledge like names, facts, simple rules and use common scientific knowledge in evaluating conclusions. At around 690 points, the students can create models, make predictions, analyze scientific researches, compare data and communicate scientific arguments in detail (PISA, 2006). The Turkish students' science score was slightly higher than 400 point; therefore the Turkish students recall simple scientific knowledge and have common scientific knowledge to resolve simple problems. In terms of these results, the researchers focused on students' failure in international assessments and examined the factors which affect the students' knowledge, performance and learning. One of the factors possibly influencing student performance was explained as students' epistemological beliefs by Schommer and Duell (2001) and they stated that epistemological beliefs play important role in education and learning process. Furthermore, Tsai (2000) found a positive correlation between epistemological beliefs and constructivist learning environment. As can be seen, literature emphasized the importance of the students' epistemological beliefs.

In this study, sixth, eighth, and tenth grade Turkish students' epistemological beliefs are examined to provide a contribution to the education and learning process. This study provides opportunity to determine whether there is a difference between the girls' and boys' epistemological beliefs. Furthermore, this study attempts to discover whether the fields of the study have an impact on students' epistemological beliefs or not. The results obtained from the current study may be used to arrange the students' learning process, learning environment, and the teachers and educators' teaching methods. The classroom environment may be arranged in terms of the students' beliefs. By knowing the students’ epistemological beliefs the teachers have an idea and may plan instructional activities to develop students’ epistemological beliefs.

On the other hand, the previous research generally focused on the high school and college school students’ beliefs. Especially, in Turkey, the studies about elementary school students’ epistemological beliefs are rare. To date there were no study investigating effect of fields of the study on epistemological beliefs of the students in Turkey. In conclusion, this study can be considered as one of the initial attempts to provide information about the students’ beliefs about nature of knowledge and knowing to arrange the conditions of the learning and teaching.

1.2 Definition of Important Terms

Epistemological Beliefs

Epistemological beliefs are defined as the beliefs about nature of knowledge and knowing (Conley et al., 2004).

Source of Knowledge

At level of less sophisticated beliefs about Source of Knowledge, the individuals believe that knowledge originates outside the self and resides in external authority and at level of more sophisticated beliefs about source of knowledge, the individuals believe that knowledge is constructed by the knower in interaction with others (Hofer & Pintrich, 1997).

Justification of Knowledge

The beliefs about how individuals justify knowledge. At lower levels, the individuals use the authority or observation rather than experiments, data, and rules of inquiry (at higher level) to justify knowledge (Hofer, 2000).

Certainty of Knowledge

The beliefs about Certainty of Knowledge range from a belief in a right answer to more than one answer to complex problems (Conley et al., 2004).

Development of Knowledge

The beliefs about Development of Knowledge recognize science is as an evolving subject (Conley et al., 2004). The individuals have less sophisticated beliefs about Development of Knowledge believe that science is unchanging subject. On the other hand, the individuals have more sophisticated beliefs believe that science is evolving and changing subject.

Fields of the Study

In Turkish secondary schools, the students have to choose a field such as mathematics-science, literature-mathematics, and social literature-social sciences, after the first year in the secondary school.

CHAPTER 2

REVIEW OF THE LITERATURE

In this part of the study, the previous studies regarding epistemological beliefs in relation to various learner characteristics are examined.

All the existing studies about epistemological beliefs began with William Perry's (1970) two longitudinal studies with college students (Hofer & Pintrich, 1997). In order to determine students' epistemological beliefs, Perry focused on the developmental stages and he suggested that "personal epistemology is unidimensional and develops in a fixed progression of stages" (cited in Schommer, 1990, p.498). According to Schommer, however, epistemological beliefs were too complex to explain in a single dimension and she defined the personal epistemology as "a belief system that is composed of several more or less independent dimensions" (p.498). She proposed five dimensions to determine students' epistemological beliefs: *innate ability, simple knowledge, quick learning, omniscient knowledge and certain knowledge* (Schommer, 1990). On the other hand, Hofer and Pintrich (1997) classified the dimensions of the personal epistemology into two areas: the nature of knowledge (i.e. certainty of knowledge and simplicity of knowledge) and the nature or process of knowing (i.e. source of knowledge and justification of knowledge). As can be seen, the researchers initially tried to explain the epistemological beliefs by using different definitions, dimensions, and theories. Later, they focused on the factors affecting students' epistemological beliefs, such as age, gender, socioeconomic status, parents' educational level, achievement, learning approaches, learning environment, and motivation, In the following sections, research on young students' and adults' epistemological beliefs in relation to learner characteristics will be examined.

2.1 Research on Young Students' Epistemological Beliefs

This part presents the previous studies about the elementary and high school students' epistemological beliefs with respect to various learner characteristics. For example, Schommer (1993) examined the relationship between epistemological beliefs and academic performance, and the differences in epistemological beliefs among students across the high school years and gender. The epistemological beliefs questionnaire was administered to more than one thousand American high school students who composed of 405 freshmen (180 boys and 225 girls), 312 sophomores (145 boys and 167 girls), 274 juniors (127 boys and 147 girls), and 191 seniors (89 boys and 102 girls). Students' grade point averages were used to measure of their academic performance. Factor analysis and MANOVA were conducted. In this study, the factor structure produced four dimensions: *simple knowledge, certain knowledge, quick learning and fixed ability*. The results of the MANOVA showed that gender and grade level had significant main effect on the epistemological beliefs. Girls were less likely to believe in fixed ability and quick learning, and the less the students believed in quick learning, the higher the GPA they earned. The students who advanced from freshmen to seniors in high school were less likely to believe in simple knowledge, quick learning and certain knowledge. The study suggested that gender and grade level had an effect on the students' epistemological beliefs. Moreover, the results indicated that there was no significant interaction between gender and grade level.

In another research, Schommer and Dunnell (1994) compared gifted and non-gifted students' beliefs about nature of knowledge. Epistemological beliefs questionnaire (Schommer, 1990) was administered to 1165 high school students. One sample (31 boys and 41 girls) of gifted students and three samples (sample A: 26 boys and 46 girls; sample B: 31 boys and 41 girls; and sample C: 34 boys and 38 girls) of non-gifted students were randomly selected from the whole students who participated to the study. The sample consisted of Anglo Americans (68.1%), African Americans (21.5%), Asian Americans (5.5%), Hispanic Americans (3.4%), and Native Americans (1.5%). The students were asked to complete demographic information such as gender and ethnicity and epistemological beliefs questionnaire. Factor analysis and ANCOVA were conducted to analyze the data. Factor analysis showed that the items were loaded onto four factors; *fixed ability to learn, simple knowledge, quick learning and certain knowledge*. The results of the ANCOVA showed that gifted and non-gifted students differ in their belief in simple knowledge and quick learning, that gifted students are less likely to believe in simple knowledge and quick learning, compared to non-gifted students and that gifted students change their beliefs in high school, whereas a change was not observed in non-gifted students' beliefs during the high school. Moreover, no differences were found between gifted and non-gifted students in certain knowledge. In terms of gender, a significant difference was found between boys and girls with respect to fixed ability and quick learning, and boys were more likely to believe in these dimensions than girls. The study suggested that gifted and non-gifted differ in terms of their epistemological beliefs.

In a study with fifth grade students, Elder (1999) investigated students' epistemological beliefs with respect to gender, ethnicity, and socioeconomic status. The sample consisted of 211 fifth grade students (57% boys and 43% girls) who were different ethnicity (42% Latino, 37% African-American, 17% Caucasian or Asian, and 4% unknown or other) from in a large urban school district in Southern California. In this school, science instruction was based on inquiry model of learning, and during the course of each unit, students work in groups to conduct experiments, manipulate equipments, and generate questions for inquiry. In order to measure students' epistemological beliefs, questionnaire which consisted of two parts was administered. In part I, the students were asked to respond to three open-ended questions which examined the students' thinking about purpose of science, the sources of their own, and scientists' ideas for doing science. In part II, the students were asked to respond to 25 Likert-scaled items with five dimensions: the purpose of science, changeability of science, role of experiments in developing scientific theories, coherence of science and source of science knowledge and the relationships between the constructs. The demographic characteristics of the students and Stanford Achievement Test scores in reading and mathematics were obtained from the district records. The students' responses about purpose of science were categorized and compared. The students (23.2%) explained the purpose of science as explaining phenomena or figuring out how things work and promoting a process of learning in which new knowledge is acquired or discoveries are made, which were considered as good definition. Nearly 46.5% of the students defined the purpose of science as performing activities, making or creating drugs, or doing experiments and this definition was classified as fair definition. About 30.3% of the students' responses about purpose of the science were considered as poor definition. Some of students defined the purpose of the science as completing a task and the others defined as sufficiently nondescript and vague. According to these findings and classifications, authors concluded that the most the fifth-grade students did not hold sophisticated beliefs about purposes of scientific work and 75% of the students had fair or poor understanding of the purpose of science. On the other hands, the students' responses about the sources of their and scientists' ideas were grouped in two dimensions: *active/passive agent and independent/dependent endeavors.* Active agent was defined as ideas originate from active ventures (e.g., thinking, wondering, performing activities, exploring places) and passive agent was defined as ideas arise in a passive manner (e.g., teachers, books, television, computers, one's brain). Independent endeavor was described as ideas come from independent ventures (e.g., from one's mind, thinking, wondering) and dependent endeavor was described as ideas come from dependent ventures (e.g., teachers, books, family members, performing activities, studying materials) (Elder, 1999). In terms of their own ideas, 66% of students generated passive types of sources. Regarding scientists' ideas, the largest proportion of students named active endeavors and passive sources were named by 42% of the students. About 10% of the students named both active and passive sources for their own ideas or scientists' ideas. When the girls and boys were compared, the majority of the girls supplied dependent endeavors or both independent and dependent endeavors as sources of their ideas. The students who were Anglo-middle class and Latino-low SES were more likely to report active endeavors as source for their ideas than the students who were African-American. On the other hand, there were no gender, SES and ethnic group differences with respect to scientists' ideas. When the 25 item-likert scale was examined, items were loaded onto three dimensions: *Change, Reason, and Authority*. Elder (1999) explained the change dimension as "knowledge in science changes and develops over time", the reason dimension as “scientific knowledge derives from testing and experimenting and from reasoning and thinking”, and authority dimension as “scientific knowledge comes from authority figures, including teachers and books” (p.65). ANCOVA revealed that gender, SES and ethnicity groups were found to have no significant differences on these three dimensions. The fifth grade students had similar epistemological beliefs in terms of change, reason, and authority dimensions. The study suggested that elementary students’ epistemological beliefs in science were mixture of naive and sophisticated beliefs.

In a separate study, Smith, Maclin, Houghton and Hennessey (2000) investigated the claims that elementary school students have coherent epistemological commitments, and can make significant progress in developing a sophisticated, constructivist epistemology of science when taught science using a constructivist pedagogy. In their study, the participants consisted of 35 American sixth grade students from two different classes. In constructivist classroom, the teacher encouraged the engagement of students’ own ideas. In other classroom which was more traditional, topics in science were presented by the teacher in a lecture format. The results of this study showed that the students in constructivist classroom believed that science contained the modification of ideas about how the world works, that experiments were necessary to clarify and test ideas. The students in constructivist classroom had more constructivist epistemology of science than the students in traditional classroom. Smith et al. (2000) identified that school science experiences can affect the development of epistemological thinking about science during the elementary school years.

In a study with 5^{th} graders, Conley, Pintrich, Vekiri and Harrison (2004) explored that there was evidence that young children’s epistemological beliefs about science changed over time. In their study, they investigated the changes in students’ epistemological beliefs with respect to gender, ethnicity, SES and achievement. The sample was consisted of 187 (57% female) fifth grade students who were ethnically diverse (46% Latino, 27% Anglo and 27% African American) in 12 elementary school classrooms in the Southwest. The self-report questionnaires were administered in classrooms at the beginning (Time 1) and at the end (Time 2) of the hands-on science unit which was about chemical properties of substances. During the science instruction, the students were asked to perform science investigation, collect data, make observations, interpret results and draw conclusions by using evidence. The self report questionnaire contained 26 items with four dimensions: *Source, Certainty, Development and Justification.* The students' achievement scores were obtained using a combination of mathematics and reading achievement test scores from Stanford Achievement Test and the information about students' gender, ethnicity and socio economic status were collected from school records. In order to determine the changes in students' epistemological beliefs, the correlations between Time 1 and Time 2 were examined. The results revealed that students scored significantly higher on certainty and source of knowledge from Time 1 to Time 2, which indicate a change toward more sophisticated beliefs, and that the changes over time for development and justification of knowledge were no significant. The researchers were conducted four repeated analyses of covariance with gender, ethnicity and SES. The results showed that there were main effects of the socio economic status and achievement on the epistemological beliefs, whereas there were no main effects of the gender and ethnicity. Low SES and low achieving students had lower scores on four dimensions than average SES and higher achieving students, which indicated that low SES and low achieving students had less sophisticated beliefs about knowledge and knowing. On the other hand, there were no interaction between gender, ethnicity, SES and achievement with respect to four dimensions.

In another research, Neber and Schommer-Aikins (2002) examined the issue of self-regulated learning, a spectrum of environmental, motivational beliefs, goal orientation, epistemological beliefs among 93 highly gifted elementary school students (32 fourth, 39 fifth and 22 sixth grade students) and 40 highly gifted secondary school students (24 eighth and 16 twelfth grade students) in science. Motivated learning Strategies Questionnaire, Personal Goals Scales, Schommer's Epistemological Beliefs Questionnaire and Classroom Environment Scale were administered to the 133 students (69 boys and 64 girls). For the each dependent variable, MANOVAs were conducted with gender and school level. The results revealed that high school students' epistemological beliefs did not advance from the elementary level. The high school students had the belief that success is unrelated to work and the searching for single answers in science. On the other hand, there was a significant interaction between school level and gender, which showed that the boys on both elementary and secondary school had naive beliefs in quick learning than girls and that the high school girls' belief in quick learning weaker than elementary school girls.

In a study with 10th grade students, Lodewyk (2007) investigated the relations between students' epistemological beliefs and gender, school orientation, academic achievement and performance on two differently structured academic tasks which were well-structured task and ill-structured task. The sample consisted of 447 (219 males and 228 females) tenth grade science students in six secondary schools which were five public and one independent schools in western British Columbia. Of the 447 students in the sample, 358 were enrolled in public school and 89 students were also enrolled at independent (religious) school. Schommer's (1993) modified epistemological questionnaire and demographic questionnaire were used to obtain related information. An exploratory factor analysis was performed and the factor structure of epistemological beliefs was determined. The items were loaded onto three factors: *fixed and quick ability to learn, simple knowledge, and certain knowledge*. Lodewyk performed MANOVA to assess differences in epistemological beliefs. Results indicated that the girls had significantly more sophisticated beliefs in fixed and quick ability to learn and certain knowledge than boys. The boys had naive beliefs that one's ability is predetermined, that learning occurs quickly, and that knowledge is certain. Moreover, the students were enrolled at independent school had higher scores and more sophisticated beliefs than the students were enrolled at public schools with respect to certain knowledge. The researcher reported no statistical differences between public school and independent school with respect to fixed and quick ability to learn and simple knowledge. On the other hand, the levels of the academic achievement differed in fixed and quick ability to learn and simple knowledge. It was also found that there was no statistical difference between achievement on the well-structured task and on the ill-structured task.

In a separate study, Cano (2005) examined 1600 Spanish secondary students' learning approaches and epistemological beliefs about learning. The participants were grouped at three school levels, middle (200 boys and 309 girls), junior high (200 boys and 238 girls), and senior high (241 boys and 332 girls). In order to measure students' learning approaches and epistemological beliefs, the Spanish version of Learning Process Questionnaire which was contained 36 items and the Schommer's Epistemological Questionnaire (1990) were used. The factor structure of epistemological questionnaire was determined through the exploratory factor analysis. The results revealed four factor structure namely, *quick learning, simple knowledge, fixed ability, and certain knowledge*. Students' full name, age, sex, and grades for all subjects were obtained from students. The results of the MANOVA showed that boys were significantly different in quick learning, fixed ability, and certain knowledge at the three school levels; boys' epistemological beliefs become less naive and more realistic as they advance through high school. On the other hand, the girls had significant differences in simple knowledge, fixed ability, and certain knowledge with respect to school level; girls' epistemological beliefs also become more realistic as they through high school. His findings suggested that the students' epistemological beliefs changed from less naive and simplistic to more realistic and complex through school. The results of the analysis which was conducted to determine the interrelationships between epistemological beliefs and academic achievement showed that the students who had poor academic performance had more naive beliefs. He concluded that epistemological beliefs differ in terms of gender, school level, and achievement.

Tsai (1999) explored the relationships between students' science attainment, scientific epistemological beliefs and information processing operations in their cognitive structures. The sample consisted of 48 (18 female and 30 male) eighth grade students who selected from the 202 eighth grade students with respect to some criteria from a Taiwanese junior high school. The Pomeroy's (1993) Scientific Epistemological Belief questionnaire with two dimensions (constructivist-orientated and empiricist-orientated epistemological views of science) was used. In order to obtain students' cognitive structures following their learning of basic atomic physics, a two-period treatment lesson on the atomic structure was taught by science teacher and at the end of the lessons, every student was interviewed to explore what they had learned. These responses were used as evidence of students' cognitive structure. The results suggested that the students holding scientific epistemological beliefs more orientated to constructivist views of science tended to use more conditional inferential reasoning than those having empiricist-aligned views of science.

In another research, Tsai (2000) investigated the relationship between tenth grade students' scientific epistemological beliefs and perceptions of constructivist learning environments. The Chinese version of the Pomeroy's (1993) Scientific Epistemological Beliefs questionnaire and the Constructivist Learning Environment Survey (CLES) with actual and preferred forms were administered to the 1176 (47% female and 53% male) tenth grade students from Northern, Central, and Southern Taiwan. Pomeroy's items represented traditional views of science (empiricist views) and non-traditional views of science (constructivist views). Tsai stated that the individuals who has empiricist view think that "scientific knowledge is a discovery of an objective reality external to themselves and it is discovered by observing, experimenting or application of a universal scientific method" and the individuals who have constructivist views of science think that "scientific knowledge should be viewed as an invented reality, which is constructed through the use of agreed upon paradigms, acceptable forms of evidence and social negotiations in reaching conclusions" (p.197). The Constructivist Learning Environment Survey was consisted of four dimensions: Negotiation, Prior knowledge, Autonomy, and Students centeredness. The results revealed that students' epistemological beliefs were significantly correlated with their constructivist learning environment, that the students who had more orientated to constructivist views of science tended to perceive that actual learning environments did not offer adequate opportunities for them to negotiate their ideas and tended to show significantly stronger preferences to learn in the constructivist environments. Moreover, there was no significant correlation between students' epistemological beliefs about science and the extent of their preferences to experience learning as a process of creating and resolving personally problematic experiences (students-centeredness scale). This study suggested that there were positive relationships between students' scientific epistemological beliefs and their perceptions of constructivist learning environments.

Overall, studies with elementary and high school students generally revealed that the students' epistemological beliefs were affected by gender, grade level, and academic achievement, and that there was a relationship between students' epistemological beliefs, learning environment, and learning approaches.

2.2 Research on Adults' Epistemological Beliefs

In this part of the study, the studies about undergraduate, graduate students' and preservice teachers' epistemological beliefs will be examined.

One of the earlier studies, Jehng, Johnson, and Anderson (1993) examined the university students' epistemological beliefs with respect to their educational level and field of the study. The sample consisted of 386 (146 male, 252 female) undergraduate and graduate students from three universities in central Illinois. The students were classified into five educational levels (i.e., freshmen, sophomores, juniors, seniors, and graduate students) and four academic fields (i.e., engineering and natural sciences, arts and humanities, social sciences, and business). Schommer's (1990) epistemological beliefs questionnaire and demographic questionnaire were used to collect data. The epistemological beliefs were represented with respect to five dimensions: Certainty of Knowledge, Omniscient Authority, Orderly Process, Innate Ability, and Quick Learning. The results of the MANOVA revealed that educational level and field of the study had significant main effects on the students' epistemological beliefs. Graduate students' scores significantly higher than undergraduate students' scores with respect to Certainty of Knowledge, Omniscient Authority, and Orderly Process, which means that graduate students had more sophisticated beliefs than undergraduate students and they believed that knowledge is uncertain, that independent reasoning is crucial for acquiring knowledge, and that learning is not an orderly process. Results regarding the students' major field of the study showed that students in hard fields (i.e., engineering and business) and soft fields (i.e., social science and arts/humanities) differ in terms of Certainty of Knowledge, Omniscient Authority, and Orderly Process. The students who were in soft fields had more sophisticated beliefs and a stronger tendency to believe that knowledge is uncertain and learning is not an orderly process, and they were more reliant on their independent reasoning ability than the students who were in hard fields. The study suggested that individuals' epistemological beliefs evolve when they are exposed to more advanced education, and that the instructional environments, activities, culture, and the context in which students are cultivated affected the students' epistemological beliefs.

In a separate study, Schommer (1998) investigated the contributions of age and education on adults' epistemological beliefs. A total of 418 adults (140 men, 278 women) who came from all walks of life participated to the study. Of 418, 140 had no more than secondary education, 135 had undergraduate education, and 143 had graduate education. Schommer's (1990) epistemological questionnaire and demographic questionnaire were used to obtain related data. In order to determine the epistemological questionnaire's factor structure, factor analysis was conducted. The results showed that the items were loaded on to four dimensions: *fixed ability, simple knowledge, quick learning, and certain knowledge*. The results of the regression analysis revealed that the older adults had less likely beliefs in fixed ability, and that education predicted two epistemological factors, simple knowledge and certain knowledge, which indicated that more educated participants had experienced had less likely beliefs in simple knowledge and certain knowledge.

Paulsen and Wells (1998) examined the college students' epistemological beliefs across major fields of study and the effects of gender, age, year in college and GPA on students' epistemological beliefs. About 290 students (53.4 % females and 46.6 % males) from public university participated to the study. Of 290 students, 59% were traditional age (17-24 years old) and 41% were nontraditional age (25 and above); and 52.1% were freshmen or sophomores and 47.9% were juniors, seniors, or graduate students. By using Biglan's classification, the students' major fields of study were classified as soft, hard, pure and applied. The pure fields were humanities, fine arts, social sciences, and natural sciences, the applied fields were education, business, and engineering, the soft fields were humanities, fine arts, social sciences, education, and business, and the hard fields were natural sciences and engineering. In the study, Schommer's Epistemological Questionnaire (1990) with four dimensions (simple knowledge, certain knowledge, fixed ability, and quick learning) and demographic questionnaire were used in order to gather information.

The results of ANOVAs revealed that the students majoring in pure fields (humanities, fine arts, social sciences, and natural sciences) had more sophisticated beliefs about simple knowledge, quick knowledge, and certain knowledge than the students majoring in applied fields (education, business, and engineering), and that the students majoring in hard fields (natural sciences and engineering) had more naive beliefs about certain knowledge than the students majoring in soft fields (humanities, fine arts, social sciences, education, and business). Moreover, the results indicated that the males had naive beliefs in fixed ability and quick learning than females, while females had naive beliefs in simple knowledge. The results showed that students of nontraditional age (25 and over) were less likely to have naive beliefs in fixed ability than students of traditional age (17-24 years old), that students with higher GPA had more sophisticated beliefs in simple knowledge than students with lower GPA. On the other hand, no statistical significance was found between educational levels. Based on the results of the study, Paulsen and Wells suggested that students' epistemological beliefs are related to the disciplinary contexts in which they select and experience their specialized coursework in college and gender, age, and GPA were also related to students' epistemological beliefs.

Working with undergraduate students, Bendixen, Schraw, and Dunkle (1998) investigated the relationship among age, education, gender, syllogistic reasoning skill, epistemic beliefs, and moral reasoning. One hundred and fifty four undergraduates (100 women, 54 men) who were enrolled in an introductory educational psychology class at Midwestern University participated to the study. The researchers designed Epistemic Beliefs Inventory which had 32 items and measured five epistemic dimensions described by Schommer (1990): *simple knowledge, certain knowledge, omniscient authority, quick learning, and innate ability*. Syllogistic reasoning test which consisted of 12 items, demographic variable information sheet, Epistemic Beliefs Inventory, and the Defining Issues Test were used in the study. The results of the analyses showed that epistemic beliefs made a unique contribution to moral reasoning, and were important for the young adults' moral reasoning and other social and personal variables. The results also revealed that men were more likely to endorse beliefs in certain knowledge than women.

In a separate research, Kahn (2000) examined if there were relationships between college students’ beliefs about the nature of knowledge and learning and their major fields of study and educational levels and characteristics. The participants consisted of 596 college students from public university in the southern region. Students’ epistemological beliefs were assessed on each of the four dimensions (*fixed ability, quick learning, simple knowledge and certain knowledge*) using Schommer’s (1990) Epistemological Questionnaire. The data were obtained about the students’ characteristics through a demographic survey and from students’ records in Office of Records and Registration. The major fields were classified into six domains: humanities/fine arts, social sciences, business, education, engineering, and natural sciences/math sciences. College educational levels were classified as undergraduate and graduate. Data were analyzed by using regression analysis, t-tests, and multicollinearity diagnostics. The results of the analysis revealed that undergraduate level and graduate level students’ epistemological beliefs differ according to their major fields of study. For example, undergraduate students majoring in business were less likely to hold naive beliefs in simple knowledge than undergraduate students majoring in humanities/fine arts and social sciences. Moreover, results showed that graduate students had less naive beliefs in certain knowledge than undergraduate students. On the other hand, age had an effect on undergraduate students’ beliefs about simple knowledge and fixed ability, and older undergraduates hold more naive beliefs in simple knowledge and fixed ability. Gender had an influence on undergraduate and graduate students’ beliefs about quick learning, that female undergraduate and graduate students hold more naive beliefs in quick learning compared to male undergraduate and graduate students, and that undergraduate students with higher GPA were more likely to hold naive beliefs in simple knowledge than undergraduate students with lower GPA. The study suggested that the college students’ epistemological beliefs differ in terms of the major fields of the study, and educational level.

Working with first-year college students, Hofer (2000) investigated dimensionality of personal epistemology. The participants consisted of 326 college students who were attending to an introductory psychology course. The general epistemological beliefs questionnaire which was the revised version of the Schommer developed by

Qian and Alvermann (1995) and discipline-focused epistemological beliefs questionnaire were used and grades were obtained from the registrar's office to measure the academic performance. The results of the factor analysis revealed that the factor structure consisted of four factor: certain/simple knowledge, justification for knowing, source of knowledge, attainability of truth. The results of the *t* tests showed that a significant difference between science and psychology disciplines was found for each dimension, which indicated that the students tended to believe that knowledge in science as more certain than in psychology, and they accepted authority and expertise as the source of knowledge more in science than in psychology, were more likely to use personal knowledge for justification of knowing in psychology than in science, and believed that truth is attainable by experts in science more than psychology. The students majoring in science more likely to view truth as attainable compared to the students majoring in social science. The results of the MANOVA revealed that there was a gender effect for both certainty/simplicity of knowledge and source of knowledge, that the boys were more likely to see knowledge as certain and to view authority as the source of knowledge than girls. A significant correlation was found between the students' beliefs in certainty and simplicity of knowledge in psychology and science and academic performance. The study suggested that the differences can be assessed by using particular disciplines rather than domain general instrumentation.

In a separate study, Trautwein and Lüdtke (2006) examined the relationship of beliefs in the certainty of knowledge with school achievement and college majors in Germany. In this study, the data were collected in two times. At Time 1, 2854 students (45% male) who were in final year of upper secondary school participated to the study and at Time 2, the data of 1495 participants were accessed two years later by mail. The results revealed that certainty beliefs correlated significantly and negatively with SES, cultural capital, cognitive abilities, and final school grades, that no significant correlation was found between certainty beliefs and gender and age. In terms of the future field of study, at Time 1 and Time 2, the social science students had the lowest certainty scores and business, engineering, and math/natural sciences students had the highest certainty scores. The decrease was observed among the certainty beliefs of the humanities/arts and social science students, while an increase in certainty beliefs was observed for the engineering students. The study suggested that there was an important role of the certainty beliefs in the academic context and supported the self selection and socialization hypotheses.

More recently, Liu and Tsai (2008) investigated whether science and non-science major students have different scientific epistemological views (SEV). In this study, 220 first-year undergraduate students (41% males and 59% females) participated from two public universities in southern Taiwan. The students were from science majors (i.e., physics, chemistry, mathematics, biology, and science education) and non-science majors (i.e., language, art, and education). The Views on Science-Technology-Society survey and Scientific Epistemological Views questionnaire were used to collect data. The scientific epistemological views were measured with five dimensions: role of social negotiation (SN), invented and creative nature of science (IC), theory-laden exploration (TL), cultural impacts (CU), and changing and tentative feature of science knowledge (CT). The results of the analysis showed that there was no difference in students' views between two universities, that the students from the college of sciences had less sophisticated views about science than non-science majors on the theory-laden and cultural impacts. Science education majors had naïve views on the TL and CU dimensions than the other majors. The students in fine arts, education, and humanity had naïve views on the SN and IC dimensions than the students in pure science. On the other hand, there was no difference between the students' views with respect to gender. The results of the open-ended questions showed that the students often described the science as rational and objective and there were four differences between high and low SEV groups. The students having higher SEV tended to believe that scientific knowledge is justified through objective observations and experiments. Science was considered as a study about the natural world by about one-quarter of samples. The study suggested that the academic experiences may play a role in influencing students' beliefs.

Recently, Schommer-Aikins and Easter (2006) examined two epistemic paradigms; ways of knowing (*connected knowing and separate knowing*) and epistemological beliefs (*beliefs about knowledge structure, knowledge stability, learning speed, and learning ability*). The sample consisted of 107 (57 women, 48 men) college juniors and seniors enrolled in Business Communication 100W. In order to measure ways of knowing, Attitude towards Thinking and Learning instrument was used. Kardash Epistemological Beliefs Scale (2000) was used to measure epistemological beliefs with structure of knowledge (structure), knowledge construction and modification (construction), the speed of knowledge acquisition (speed), characteristics of successful students (success), and attainability of truth (truth). In addition, the Reading Comprehension Test was administered and final grade scores were obtained to measure academic achievement. The results of MANOVA revealed that there was no gender difference with respect to epistemological beliefs. On the other hand, the results showed that gender differences were found only in belief about separate knowing, that men had a significantly higher score in separate knowledge, that both men and women had significantly higher connected knowing scores than simple knowing scores, and that there were no significant differences between separate knowledge and connected knowing with respect to age and year in school. On the other hand, the results showed that both connected knowing and separate knowing were significantly correlated with speed, construction (which suggested that the more students believed in separate knowing or connected knowing, the more they believed that learning takes time and is constructive process) and final grades, that the modest significant correlations were found between separate knowing and structure as well as success, and that only speed correlated with reading comprehension.

To sum up, the studies about adults' epistemological beliefs showed that similar to young people, adults' epistemological beliefs also vary with respect to gender, educational level, and academic achievement.

2.3 Studies in Turkey

Recently in Turkey, there have been some research efforts about students' epistemological beliefs (e.g. Kızılgüneş, 2007; Özkan, 2008; Özkal, 2007). For example, in her study, Özkal (2007) investigated the relationships among scientific epistemological beliefs, perceptions of constructivist learning environment, attitude towards science, prior knowledge, gender, and approaches to learning. Epistemological Beliefs Questionnaire, Constructivist Learning Environment Scale, Learning Approaches Questionnaire, Demographic Questionnaire and Attitude towards Science Scale were administered to the 1152 (46% girls and 53.9% boys) 8th grade students from public schools in Çankaya, one of the large district of Ankara. The Epistemological Beliefs Questionnaire, developed by Saunders (1998), was used to assess the students' epistemological beliefs with two dimensions: *Fixed views* (8 items) *and tentative views* (8 items). Fixed views are related with traditional views and describe scientific knowledge as unchanging truth, on the other hand, tentative views are related with constructivist views and describe scientific knowledge as subject to review and change in the light of solid new observations (Özkal, 2007). The results of the analysis showed that the mean scores of the tentative views were higher than the mean scores of the fixed views, which indicated that the students had slightly more tentative views of scientific epistemological beliefs, and that the students were aware of the fact that scientific knowledge can change by time and it is not certain. Moreover, the girls had slightly more tentative views than boys. In addition, the students who had meaningful learning orientations tended to have tentative views of epistemological beliefs and higher attitude towards science, on the other hand, the students who had rote learning orientations had fixed views of epistemological beliefs. Meaningful learning approaches scores were significantly correlated with scientific epistemological beliefs, attitudes towards science and prior knowledge. In conclusion, she reported that the students were aware of the nature of knowledge including the purpose of science, sources of scientific knowledge, role of evidence and experiments, changeability of knowledge in science and coherence of scientific knowledge.

In a study with 6th grade students, Kızılgüneş (2007) investigated the predictive influences of students' achievement motivation, meaningful learning approach and epistemological beliefs on classification concept achievement. The Learning Approach Questionnaire (Cavallo, 1996), Epistemological Beliefs Questionnaire (Conley et al., 2004), Achievement Motivation Questionnaire and Classification Concept test were used the participants included 1041 sixth grade students (507 girls, 534 boys) from elementary schools in Çankaya, Ankara. The results of the study showed that 6th grade students mostly believe in tentative nature of science, which indicated that students believed that science is an evolving and contextual process and is constructed by the knower. In addition, a significant positive correlation was found between students' epistemological beliefs, performance goal orientations, learning goal orientations and self efficacy. This correlation showed that the higher the students' performance goal orientations, learning goal orientations and self efficacy, the more tentative beliefs they had.

In her study, Özkan (2008) proposed a model to explore the relationships between elementary students' epistemological beliefs, learning approaches, self regulated learning strategies, and their science achievement. The sample consisted of 1240 seventh grade students (51.4% boys, 47.8% girls) from 21 public elementary schools in Çankaya, Ankara. The demographical Questionnaire, Epistemological Beliefs Questionnaire, Learning Approach Questionnaire, Motivated Strategies for Learning Questionnaire, and Science Achievement Test were used in the study. In order to determine the factor structure of the epistemological beliefs questionnaire, exploratory factor analysis was conducted. The results of the factor analysis showed three factors structure (*source/certainty, development, and justification*), instead of four factor structure (*source of knowledge, certainty of knowledge, development of knowledge, and justification of knowledge*) found by Conley et al. (2004). The results of the descriptive statistics showed that there was a clear difference in the mean scores of Justification dimension among boys and girls, that girls' mean score was higher than boys, which implied that girls tended to have more sophisticated beliefs in Justification of knowledge than boys and they believed the importance of evidence and evaluating claims for justifying knowledge. Furthermore, the results revealed that there was a difference among low and high socioeconomic status (SES) groups in each dimension of epistemological beliefs, and that students' epistemological beliefs predicted science achievement directly. Source/certainty dimension predicted science achievement, while there were no relationships between the beliefs about justification and development and science achievement. There was a positively relationship between source/certainty dimension and science achievement, which means that the more students had higher science scores tended to believe that there is more than one answer and knowledge is constructed by the knower. In addition, the results revealed that source/certainty dimension was negatively related with the rote learning, and these dimensions negatively predicted meaningful learning approach, which means that the more the students believe in 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 learning mode, and the less they adopt a meaningful learning approach to learning. Furthermore, the results showed that there was a negatively relationship between the beliefs in the development of knowledge and meaningful learning approach, which means the more the students believe in the evolving and changing nature of science, the less they adopt a meaningful learning approach. On the other hand, the belief in the development of knowledge was found to be positively related with the rote learning, which means the students have more sophisticated beliefs in development of knowledge rely on memorization and recall simple facts. Justification was found to be positively related to meaningful learning approach, but negatively to the rote approach to learning, which means that the more the students believe that knowledge is constructed examination of evidence and the opinions of experts, the more they adopt meaningful learning approach, and tend to avoid rote learning approach. In addition, the results showed that students' epistemological beliefs do not predict their use of self-regulated learning strategies.

More recently, Topçu and Yılmaz-Tüzün (2009) investigated the relationship among elementary students' science achievement, metacognition, and epistemological beliefs, and also focused on the relationships among gender, socioeconomic status, metacognition, and epistemological beliefs. The sample consisted of 315 fourth and fifth grade students (178 girls and 137 boys) and 626 sixth, seventh and eighth grade students (326 girls and 300 boys). The data were collected using metacognitive awareness inventory and Schommer's epistemological questionnaire. The epistemological beliefs were measured with four dimensions (for 4^{th} and 5^{th} grade students, *innate ability, quick learning, simple knowledge, and certain knowledge dimensions,* and for 6^{th} and 8^{th} grade students, *innate ability, quick learning, omniscient authority, and certain knowledge dimensions*). For 4^{th} and 5^{th} grade students, the results revealed that metacognition influenced the students' achievement than students' epistemological beliefs. Only the quick learning contributed to students' science achievement, the students had higher science grades had more sophisticated beliefs in quick learning, which suggested that they believed that learning is a gradual process rather than quick. For 6^{th} and 8^{th} grade students, the results showed that the students had better science grades had more sophisticated beliefs in quick learning and innate ability, so they thought that learning is a gradual process and ability to learn is not fixed at birth. On the other hand, the results showed that the epistemological beliefs were mostly related to gender. The girls were attending to 4th and 5th grade had more sophisticated beliefs in quick learning and innate ability, and the girls attending to 6th and 8th grade had less sophisticated beliefs in omniscient authority than boys. The students with more educated mothers had more sophisticated beliefs in quick learning compared to others.

In addition, some researchers were interested in determining university students' epistemological beliefs. For example, working with university students, Erdem (2007) examined the relationship between test anxieties and the epistemological beliefs and problem-solving beliefs of students on general chemistry course. The sample consisted of the 142 students in the Chemistry Education Department and Computer Education and Instructional Technologies Department of Hacettepe University and 31 students in Chemistry Education Department of the Faculty of Science of Middle East Technical University. The Epistemological Questionnaire was used to measure students' epistemological beliefs with four dimensions: *quick/fixed learning, study aimlessly, omniscient authority, and certain knowledge*. In addition, Test Anxiety Inventory and Problem-solving Questionnaire were used. The results of the analysis showed that the students' epistemological beliefs differ in terms of the departments which the students attended, while there was no statistically difference between the boys and girls with respect to epistemological beliefs. In addition, the results of the Pearson correlation analysis showed that there was a negatively relationship between epistemological beliefs and problem-solving beliefs, while there was no statistically relationship between test anxiety and epistemological beliefs.

In a recent study, Yılmaz-Tüzün and Topçu (2008) examined the preservice elementary science teachers' epistemological beliefs and the relationships among epistemological beliefs, epistemological world views, and self-efficacy beliefs. The Schommer (1990) Epistemological Questionnaire, the epistemological World Views Scale, and the Science Teaching Efficacy Belief Instrument were administered to 425 preservice elementary science teachers (246 female and 183 male) who were enrolled in large universities in Eskişehir, Van, and Ankara. The results of the factor analysis revealed that in order to measure epistemological beliefs, four factors were used: *Innate Ability, Simple Knowledge, Certain Knowledge, and Omniscient Authority*. The epistemological world views were classified as realist, contextualist, and relativist. The results of the multiple regression analysis showed that the Innate Ability was found to have a significant negative relationship with self-efficacy, outcome expectancy, and world view, which means that the less preservice teachers believe in Innate ability the more they feel confident about their science teaching and influencing their students' achievement and they are relativist in their epistemological world views. In terms of another result, the certain knowledge was found to have a significant negative relationship with only outcome expectancy, which means that the preservice teachers feel confident about influencing students' achievement only when the scientific knowledge they teach is accepted as unchanging scientific findings. In addition, the results showed that simple knowledge was found to have a significant positive relationship with only world view, which means that the teachers believe the relativist world view which was about the effectiveness of student-centered teaching approaches and they accept that science may be taught when students memorize the isolated facts. The results suggested that preservice teachers had more sophisticated beliefs in the Innate Ability dimension but their beliefs about Certain Knowledge and Simple Knowledge did not change and stayed at a simple level.

Another recent study explored the different dimensions of epistemological beliefs held by pre-service teachers (Oksal, Şenşekerci & Bilgin, 2007). The sample consisted of 350 pre-service primary school teachers (262 females and 88 males) participated in the study. The information about the students' gender, citizenship, religion, ethnicity and the parents' socioeconomic status and educational level were determined through demographic questionnaire. In order to determine the students' epistemological beliefs, data were obtained by using the epistemological beliefs questionnaire which consisted of 23 items. The results of the factor analysis revealed that the items were loaded onto four factors: *Belief in Science as Source of Knowledge* (e.g., We can reach the truth only through science), *Belief in a Rational Society* (e.g., Scientific developments require a secular legal system), *Belief in*

Superstitious Rituals (e.g., I believe that our dreams reveal what would happen in the future) *and Belief in Supernatural Powers* (e.g., I believe in power of the Evil Eye). Data analysis showed that there was a significant difference between females and males with respect to Belief in Rational Society. The beliefs of the male students in rational society were higher than the female students. Furthermore, the significant differences were found on the students' epistemological beliefs with respect to parents' educational level. The beliefs of students whose parents were primary school graduates in science and rational society were greater than the students whose parents were secondary and high school graduates. The students whose mothers were primary school graduates had greater scores than the students whose mothers were secondary school graduates with respect to belief in supernatural powers. On the other hand, no significant difference was found between the students' epistemological beliefs with respect to socioeconomic status.

Studying with preservice science teachers, Sünger (2007) investigated the relationship among self efficacy beliefs, epistemological beliefs, and attitudes towards science teaching. The participants consisted of 21 junior students from chemistry education department, 15 students from physics education department, and 32 students form elementary science education department from Middle East Technical University, Ankara. The Science Teaching Efficacy Beliefs Instrument, the Epistemological Beliefs Survey developed by Kardash (2002), and Science Attitude Scale were administered to the participants. The epistemological beliefs survey measured the students' beliefs with five factors: *Speed of Knowledge Acquisiton, Structure of Knowledge, Knowledge Construction and Modification, Characteristics of Successful Students, and Attainability of Objective Truth.* The results revealed that there was no significant relationship between preservice elementary science teachers' self efficacy beliefs and epistemological beliefs, that there was significant relationship between preservice elementary science teachers' epistemological beliefs and attitudes towards science teaching, that there was no significant relationship between preservice secondary science teachers self efficacy and epistemological beliefs, that there was no significant relationship between preservice secondary science teachers' attitudes toward science teaching and epistemological beliefs. Most of the participants which were both preservice elementary science teachers and preservice secondary science teachers have positive epistemological beliefs toward science teaching and they claimed that knowledge was important to get achievement. In conclusion, the results suggested that preservice science teachers search knowledge, and try to understand nature of knowledge with their high attitudes towards science teaching.

More recently, Can and Arabacıoğlu (2009) examined the science (n=38) and mathematics (n=35) teacher candidates' epistemological beliefs with respect to gender and disciplines. The data were collected using the Personal Information Form and Epistemological Belief Scale which was developed by Schommer (1990) to measure epistemological beliefs with four factors. However, in this study, when the questionnaire was adapted into Turkish, the questionnaire measured the epistemological beliefs with three factors and the researchers were classified these factors as *the belief in learning depends on effort (BLDE), the belief of learning depends on ability (BLDA), and the belief of there is only one true truth (BOTT)*. The results about gender showed that there was a significant difference between male and female with respect to BLDA, while there were no significant differences between girls and boys with respect to BLDE and BOTT. The male students had more beliefs in learning depends on ability than female students. In addition, statistically significant differences were found between science teacher candidates and mathematics teacher candidates with respect to the belief in learning depends on effort, and the belief of learning depends on ability. The belief of there is only one true truth, and the science teacher candidates found to had higher mean scores than mathematics teacher candidates.

Kaplan and Akgül's (2009) study examined 49 prospective elementary science teachers' epistemological beliefs by using Pomeroy's (1993) Epistemological Beliefs questionnaire. The high scores from the scale were considered as traditional views about science and the low scores represented more contemporary views about science. The questionnaire was consisted of open-ended questions and choice items. The results of the analysis showed that majority of the prospective elementary science teachers had high scores from the scale, so they had traditional epistemological beliefs. On the other hand, data represent that the prospective elementary science teachers defined the knowledge as scientific knowledge. The results also revealed that the participants mostly perceive the experiment and rationale as the source of knowledge.

To be brief, the some studies show that students’ epistemological beliefs differ in terms of some factors, such as gender, age, grade level, fields of study, socioeconomic status, achievement, and learning approaches. The studies, however, produced mixed results. While some studies reported statistically significant difference, others reported no difference between epistemological beliefs and various variables.

CHAPTER 3

PROBLEMS AND HYPHOTHESES

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

3.1 Main Problems

1. What are the nature and the number of factors that comprise the epistemological beliefs of Turkish students?
2. What are the epistemological belief profiles of 6^{th}, 8^{th}, and 10^{th} grade students?
3. What is the epistemological belief profile of 10^{th} grade students with respect to fields of the study?
4. Are there any statistically significant differences in epistemological beliefs held 6^{th}, 8^{th}, and 10^{th} grade students with respect to gender and grade level?
5. Is there a statistically significant difference in epistemological beliefs held by 10^{th} grade students with respect to fields of study (mathematics-science, literature-mathematics, and literature-social science)?

3.2 Sub-Problems

1. Is there a statistically significant difference between girls' and boys' epistemological beliefs?
2. Is there a statistically significant difference between the epistemological beliefs of the 6th, 8th, and 10th grade students?

3.3 Hypotheses

1. There are no statistically significant differences in epistemological beliefs held 6th, 8th, and 10th grade students with respect to gender and grade level.

2. There is no statistically significant difference between girls' and boys' epistemological beliefs.

3. There is no a statistically significant difference between the epistemological beliefs of the 6th, 8th, and 10th grade students.

4. There is no statistically significant difference in epistemological beliefs held by 10th grade students with respect to fields of study (mathematics-science, literature-mathematics, and literature-social science).

CHAPTER 4

METHOD

In the previous chapters, purpose of the study, significance of the study, the related literature, problems and hypothesis of the study were presented. In the following chapters, population and sampling, instruments of the study, description of variables, procedure, method used to analyze data, assumptions and limitations of the study will be explained.

4.1. Population and Sample

All sixth, eighth and tenth grade students in Ankara were identified as the target population of the study. However, it was hard to reach the identified target population. Therefore, the accessible population was determined as all sixth, eighth, and tenth grade students in public schools in the Çankaya district of Ankara. The desired sample size was determined and cluster random sampling was used to obtain sample. The 15 elementary schools and 15 secondary schools were randomly selected from the Çankaya district. A total of 1557 students who were volunteers and had permission from their parents were participated in the study. Of 1557 students, 491 (31.5%) were in sixth grade, 570 (36.6%) were in eighth grade and 454 (29.2%) students were in tenth grade. The sample consisted of 720 boys (46.2%), and 792 (50.9%) girls, aged between 12 and 18 years. The characteristics of the sample were presented in Table 4.1. For example, about 78.9 % of the elementary school students indicated that their science GPA scores belonging to previous semester are four or five. About 31% of the 10th grade students indicated that their physics GPA scores are 3 and 29% of the students have 4 and above. Most of the 10th grade students (31%) reported their chemistry scores as 3 and 32% of the students indicated their biology scores as 3 for the previous semester.

Table 4.1 Characteristics of the Sample

		Frequency (*f*)	Percentage (%)
Gender			
	Girl	792	50.9
	Boy	720	46.2
	Missing	45	2.9
	Total	1557	100
Grade Level			
	6th	491	31.5
	8th	570	36.6
	10th	454	29.2
	Missing	42	2.7
	Total	1557	100
Fields of the Study			
	Math-Sci	214	47.3
	Lit-Math	195	43.1
	Lit-Soc	43	9.5
	Total	452	100
Science GPA			
	1	16	1.5
	2	48	4.6
	3	156	15
	4	305	29.3
	5	516	49.6
	Total	1041	100
Physics GPA			
	1	62	13.9
	2	116	26
	3	138	30.9
	4	69	15.5
	5	61	13.7
	Total	446	100
Chemistry GPA			
	1	23	5.3
	2	85	19.6
	3	133	30.6
	4	123	28.3
	5	70	16.1
	Total	434	100

Table 4.1 (Continued)	Frequency (*f*)	Percentage (%)
Biology GPA		
1	22	5
2	83	18.9
3	141	32
4	122	27.7
5	72	16.4
Total	440	100

Information regarding socio-economic status of sample (SES) was presented in Table 4.2. Table shows that while about 25% of the students had mothers graduated from high school and from primary school, 2.2% of the students' mother was illiterate. Nearly equal numbers of the students had fathers graduated from high school and graduated from university. Regarding employment status, the majority of the fathers were employed (88%) whereas most of the mothers were unemployed (61%). Most of the students indicated that they have one sibling (46%), have a separate study room (78%), and have a computer at their home (76%). About 31% of the students reported that they have between 26-100 books in their home. Also, most of the students (48%) indentified that they sometimes have daily newspaper at their home.

Table 4.2 Socio-Economic Status of the Sample (SES)

Educational Level		Mother		Father	
		f	%	*f*	%
	Illiterate	34	2.2	7	0.4
	Primary School	373	24	199	12.8
	Secondary School	229	14.7	195	12.5
	High School	387	24.9	342	22
	University	273	17.5	323	20.7
	Master	42	2.7	81	5.2
	Doctorate	5	0.3	16	1
	Missing	214	13.7	394	25.3
	Total	1557	100	1557	100
Work Status					
	Employed	519	33.3	1372	88.1
	Unemployed	951	61.1	89	5.7
	Missing	87	5.6	96	6.2
	Total	1557	100	1557	100
Number of Sibling					
	0	186	11.9		
	1	717	46.1		
	2	382	24.5		
	3 and above	201	12.9		
	Missing	71	4.6		
	Total	1557	100		
Separate Study Room					
	Have a room	1220	78.4		
	No room	175	11.2		
	Missing	162	10.4		
	Total	1557	100		
Amount of reading materials in the home					
	0-10 books	50	3.2		
	11-25 books	250	16.1		
	26-100 books	476	30.6		
	More than 200 books	308	19.8		
Presence of Computer					
	Have a computer	1183	76		
	No computer	202	13		
	Missing	172	11		
	Total	1557	100		

Table 4.2 (Continued)		*f*	%
Daily newspaper at home			
	Never	66	4.2
	Sometimes	740	47.5
	Always	544	34.9
	Missing	207	13.3
	Total	1557	100

4.2 Data Collection Instruments

The data collection instrument had two different parts. The first part of the instrument consisted of Demographical Questionnaire and the second part of the instrument consisted of Epistemological Beliefs Questionnaire (EBQ).

4.2.1 Demographical Questionnaire

The Demographical Questionnaire was designed to obtain information about the characteristics of the sample. The instrument consisted of 13 items investigating gender, grade level, report card science grades belonging to the previous school term, the number of sibling, parents' occupation and education level, number of books at home, presence of a separate study room at home, presence of computer at home, and frequency of buying daily newspapers. Besides, information about the fields of the study for 10^{th} graders (i.e. Mathematics-Science, Literature-Mathematics and Literature-Social Science) were collected. Information about the number of siblings, parents' educational level and occupation, number of books at home, presence of study room and computer, and frequency of buying newspapers can be used as indicators of socio-economic status, while the report card science grades can be used to determine science achievement.

4.2.2 Epistemological Beliefs Questionnaire (EBQ)

Epistemological Belief Questionnaire was used to determine students' epistemological beliefs through four dimensions: *Source, Certainty, Development, and Justification*. The questionnaire originally consists of 26-items was developed by

Conley et al. (2004). Items were rated on a 5-point Likert scale (1= strongly disagree; 5= strongly agree). The items were prepared in respect to four dimensions to the determine beliefs about the nature of knowledge (i.e. certainty of knowledge and simplicity of knowledge) and the nature of knowing (i.e. source of knowledge and justification for knowing) (Hofer & Pintrich, 1997). The Source dimension consists of five items (item 1, item 6, item 10, item 15, and item 19) concerning beliefs about knowledge residing in external authorities (e.g., "Everybody has to believe what scientists say"). The Certainty dimension consists of six items (item 2, item 7, item 12, item16, item20, and item 23) referring to a belief in a right answer (e.g., "Once scientists have a result from an experiment that is the only answer"). The Development dimension has six items (item 4, item 8, item 13, item 17, item 21, and item 25) and measures beliefs about science as an evolving and changing subject (e.g., "Some ideas in science today are different than what scientists used to think"). The Justification dimension consists of nine items (item 3, item 5, item 9, item 11, item 14, item 18, item 22, item 24, item 26) concerning with role of experiments and how individuals justify knowledge (e.g., "A good way to know if something is true is to do an experiment"). In order to measure the students' epistemological beliefs, the items of the Source and Certainty dimensions were reversed so that for each of the dimensions, higher scores reflected more sophisticated beliefs. Epistemological Belief Questionnaire was translated and adapted into Turkish by Özkan (2008). Özkan reported the total reliability of the questionnaire as .78.

For the present study, the data examined in terms of the factor structure through exploratory factor analysis (EFA). As presented in Table 4.3, factor analysis produced four factors. Factor 1 consisted of the items of the Justification dimension with three additional items which were item2 and item7 which originally belong to the Certainty dimension and item13 which belongs to Development dimension. Factor 2 consisted of the items of the Certainty dimension and one additional item (item19) that originally belongs to the Source dimension. However, item2, item7, and item16 which belong to the Certainty dimension in original scale were not loaded in Certainty dimension in our data. Factor 3 consisted of the items of the Development dimension. Factor 4 consisted of the items of the Source dimension. As a result, item2, item7, item13, item16, and item19 were removed from the analyses.

In Figure 4.1, the items' distribution and basic model were showed in terms of the four dimensions.

Table 4.3 Varimax Rotation of Four Factor Solution for EBQ Items

Items	Factor 1	Factor 2	Factor 3	Factor 4
14	**.719**	.064	.176	.015
5	**.680**	-.075	.152	.200
26	**.670**	.064	.144	-.106
18	**.654**	.142	.228	-.099
9	**.620**	.069	.256	.091
11	**.615**	.119	.160	-.087
3	**.611**	.057	.113	.055
7	**-.594**	.312	-.050	-.048
24	**.577**	.137	.161	-.083
22	**.526**	.308	.250	-.058
13	**.499**	-.016	.313	.062
2	**-.322**	.170	.125	.297
20	.042	**.679**	.066	.126
23	-.044	**.674**	.099	.119
19	.127	**.615**	-.043	.256
12	.305	**.563**	-.026	.236
8	.111	-.066	**.705**	.117
25	.211	.118	**.669**	.006
17	.288	.101	**.655**	.099
21	.253	.029	**.491**	-.093
4	.274	.031	**.335**	.089
1	.093	.093	-.027	**.729**
6	.216	.107	.032	**.716**
16	-.202	.303	.138	**.574**
15	-.278	.251	.007	**.504**
10	.052	.383	.095	**.421**

The total reliability of the 26 items was found to be .81 as measured by the Cronbach alpha coefficient. After removing these five items, the total reliability of the 21 item questionnaire was found to be .83 as measured by the Cronbach alpha coefficient. In Table 4.4, the items of the dimensions, the numbers of the items and internal consistencies were indicated. One of the indicators of internal consistency is Cronbach’s alpha coefficient. Pallant (2001) stated that the Cronbach alpha coefficient of a scale should be above .70, but for the short scales (e.g., scales with less than ten items), Cronbach values can be found quite low (e.g., .5). If the scale’s overall Cronbach alpha is less than .70, the researcher needs to remove the items. As can be seen in table 4.4, for this study, the reliability analysis yielded sufficient Cronbach Alpha coefficients for the four dimensions of epistemological beliefs.

Table 4.4 The Dimensions of EBQ, Items, the Internal Consistencies, and the Number of Items

Items	Dimensions	Cronbach alphas	N
3, 5, 9, 11, 14, 18, 22, 24, 26	Justification	.83	9
12, 20, 23	Certainty	.59	3
4, 8, 17, 21, 25	Development	.61	5
1, 6, 10, 15	Source	.59	4

The four-factor structure was examined with the confirmatory factor analysis (CFA) approach by using the structural equation modeling (SEM) technique. The fix indexes to be used for evaluating the proposed model were goodness-of-fit index (GFI = 0.937), adjusted goodness-of-fit index (AGFI = 0.921), root mean square error of approximation (RMSEA = 0.0564), and standardized root mean square residuals (S-RMR = 0.0595). Jöreskog and Sörbom (1993) stated that GFI and AGFI should be greater than .90 for a good model fit (as cited in Özkan, 2008). The values of 0.08 or less in S-RMR and RMSEA identify a good model data fit (Schreiber, Stage, King, Nora, & Barlow, 2006). The values obtained for the study proved that the fit of this model was good. In this study, four-factor model was replicated with the Turkish sample.

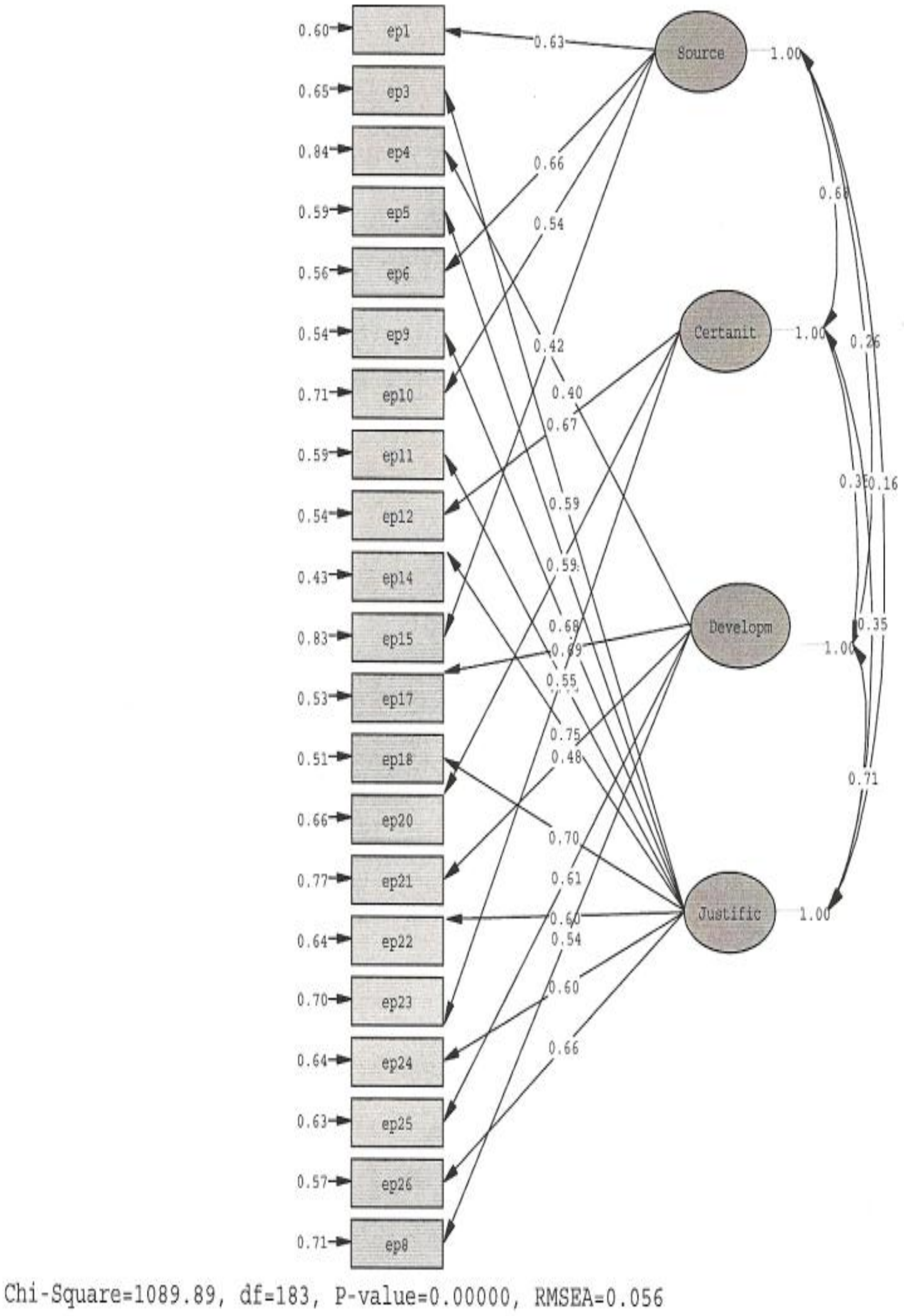

Figure 4.1 The basic model of four-factor structure

4.3 Variables

In this study, the differences of the students' epistemological beliefs in terms of the gender and grade level were examined. Also the difference between epistemological beliefs of tenth graders in different field of the study was examined. The variables were categorized as dependent and independent variables.

4.3.1 Dependent Variables

The dependent variable is the scores obtained from four dimensions of epistemological beliefs: *Source, Certainty, Development, and Justification.* This variable is continuous and measured on interval scales. The students' scores on scientific epistemological beliefs were examined in terms of the dimensions.

4.3.2 Independent Variables

The independent variables of the study are gender, grade level, and the fields of the study. Gender, grade level, and fields of tenth graders are categorical variables and measured on nominal scale.

4.4 Procedure

Before the study, the researcher defined the research problem and formulated the search terms about the study. Epistemology, personal epistemology, epistemological beliefs, science education, gender, grade level, and fields of the study were identified as the keywords. The previous studies were searched from Educational Resources Information Center (ERIC), EBSCOHOST, Social Science Citation Index (SSCI), International Dissertations Abstracts, Science Direct, Springer databases, YÖK, MEB Dergisi, and Hacettepe Eğitim Dergisi. The documents were provided from METU online library, METU library, TUBITAK-ULAKBIM, and internet (Google-Google scholar), put in order, and read carefully by the researcher. The related literature was reviewed in detail. After completing the literature review, the instruments of the study were selected and prepared. The schools and the participants were determined randomly. The parental approval form and volunteer participation form were prepared for the students. The permission was granted for the administration of the instruments from the METU Ethics Committee and the Ministry of Education (see Appendix C).

After the purpose of the study, significance of the study, procedure, and the directions of the study were explained to participants, the researcher administered the instruments to the participants. Also, the researcher explained the importance of completing all instrument without leaving any item empty. All students were assured that any data will be held in confidence and the names of the schools and students will not be used in any kind of publication. Also, the students were given the grantee that the results of the study would not affect any of their grades in the school and the study will not give any physical and psychological harm to them.

Before administration, parental approval forms were distributed to get permission of the parents for including their children in the study. Next day, the students who had permission from their parents were given volunteer participation form. All measuring instruments were administered to a total of 1557 sixth, eighth, and tenth grade students who were volunteers and had permission from their parents from selected schools in fall semester of 2008-2009. The participants completed the instruments in one class hour.

The optical forms were designed and read by a private firm were used in the study. The data were analyzed by the researcher by using specific statistical packages.

4.5 Analysis of Data

SPSS version 15 (Statistical Package for Social Sciences) and LISREL were used to analyze the data. The data analysis consisted of some parts. In the first part of the data analysis, the data was checked for outliers, normality, and missing cases. Secondly, factor analysis was performed. Then, in order to determine the general characteristics of sample, descriptive statistics, means, standard deviations, percentages, and histograms were used in the second part of the data analysis. Next, Confirmatory Factor Analysis (CFA) was conducted to verify the factor structure of Epistemological Beliefs Questionnaire by using LISREL.

In order to test the hypotheses of the study, Multivariate Analysis of variance (MANOVA) was performed. If there is more than one dependent variable in the same analysis, MANOVA is an appropriate statistical technique. MANOVA tells if there is statistically significant difference between groups on the dependent variable and provides the univariate results for each of the dependent variable separately (Pallant, 2001). To determine the effects of the grade level and gender on students' epistemological beliefs, two-way MANOVA was conducted with all students' data. A one-way MANOVA was conducted to determine the effect of the fields of the study on 10^{th} graders' epistemological beliefs. The significance level was set to .05 (probability of making Type I error).

4.6 Assumptions and Limitations of the Study

4.6.1 Assumptions of the Study

1. The administration of the instruments was under standard conditions.

2. The participant students responded to the items of the questionnaires sincerely and correctly.

3. Many teachers in the schools provided a peaceful and sincere atmosphere and supported to the research.

4.6.2 Limitations of the Study

1. This research was limited to 1557 sixth, eighth, and tenth grade students attending to public schools in Çankaya district of Ankara.

2. This research was limited to the information obtained from the questionnaires.

3. The questionnaire is a self-reported questionnaire and the results entirely depended on students' answers.

4.7 Ethical Issues in the Study

First part of the ethical issues was to protect participants from the harm. The students in this study were protected from physical and psychological harm and discomfort. There were no items which affect the students and expose to any harm. Two consent forms were prepared to inform the students and their parents about the purpose and significance of the study. If the students and parents were volunteers to the study, they would be participated. The consent forms consisted of the researcher' phone number and e-mail address if students and parents had questions about the study. The second part of the ethical issues was confidentiality. The students did not write their names on the instruments and they were informed about their answers kept secret. Deception was not an issue in this study. The students and their parents were informed about the purpose of the study and directions.

4.8 Threats to Internal Validity of the Study

Franenkel and Wallen (2006) defined the internal validity as the differences on the dependent variable are directly related to the independent variable and not due to some other unintended variable. In this part of the study, the possible threats to internal validity were discussed.

Subject Characteristics

Subject characteristics (e.g., age, gender, ethnicity, maturity, intelligence, attitude, socioeconomic status) may affect on the study (Franenkel & Wallen, 2006). For the present study, subject characteristics were not a problem, all the students were sixth, eighth, and tenth grade level from the public schools and their age and socioeconomic status were nearly equal.

Mortality

Another threat to internal validity was mortality. The individuals may drop out of the study, which may affect to the study (Franenkel & Wallen, 2006). Moreover, mortality was not a threat to internal validity for the current study, because this study was not a longitudinal study.

Location

According to Franenkel and Wallen (2006), the location may affect the results of the study. For example, the classrooms which have better lighting and are larger may affect the students' performance and responses. The data collection instruments were administered to the students in different conditions, so the location could be a threat for the current study. For example, some classrooms were small and poorly lighted rooms, the others were larger and had better lighting.

Instrumentation

The instrumentation, such as instrument decay, data collector characteristics, and data collector bias could not be threats for the current study. The nature of the instrument was not changed in some way or another and all questionnaires were applied to the participants by the researcher, so the instrumentation threat was controlled.

Testing

In some studies, where the data are collected over a period of time, the participants are tested at the beginning of the study by using pretest and at the end of the study by using posttest. This may affect the results of the study (Franenkel & Wallen, 2006). In current study, the instruments were used only one time, so the testing threats to internal validity could not be a threat.

History

The unexpected and unplanned events may occur during the study and these events may affect the responses of the participants (Franenkel & Wallen, 2006). In current study, the unexpected events did not happen, so the threat of the history could not affect the results.

Maturation

The participants' behaviors may change, due to time passing. This cause maturation threat and the maturation is a serious problem for the studies which use the pre-post data (Franenkel & Wallen, 2006). There could not be maturation threat in the present study, because the data were collected only one time.

Attitude of Subjects

Another threat to internal validity is the attitudes of the subjects. The participants' attitude and thoughts may affect their responses and the results of the study

(Franenkel & Wallen, 2006). We assumed that this threat was controlled by explaining the purpose and significance of the study.

Regression

According to Franenkel and Wallen (2006), regression threat may be present whenever change is studied in a group which has extreme preintervention performance. In current study, there was no intervention, so the regression was not a threat for the study.

CHAPTER 5

RESULTS

This chapter consists of the results obtained from descriptive statistics and inferential statistics. While descriptive statistics were used to provide information about the students' epistemological beliefs, inferential statistics were used to determine the effects of gender, grade level and fields of tenth graders on students' scientific epistemological beliefs. For the descriptive statistics, frequency analyses, the mean scores, and standard deviation were used. For inferential statistic, multivariate analysis of variance (MANOVA) was conducted.

5.1. Descriptive Statistics

The first research question was about determining sixth, eighth, and tenth grade students' epistemological beliefs with respect to the four variables; Source, Certainty, Development, and Justification.

Main Problem 2: What is the epistemological belief profile of sixth, eighth, and tenth grade students?

The mean scores and standard deviations were used to explain the students' epistemological beliefs profile. As can be seen in Table 5.1, the results of the descriptive statistics indicated that students generally had sophisticated epistemological beliefs as indicated by the mean scores ranging from 3.45 to 3.94 on a five point scale. Justification dimension had the highest mean value (M=3.94, SD=.662), followed by Development (M=3.54, SD=.610), and then by Certainty (M=3.47, SD=.860). The lowest mean score appeared for the Source dimension (M=3.45, SD=.716). These results imply that the participants of this study generally agreed with the idea that the experiments and using data are necessary to construct knowledge, that science is an evolving and changing subject, that knowledge is not certain and there may be more than one right answer and that knowledge is not constructed only by the teachers and other experts. When descriptive statistics results examined with respect to gender and grade level, it was seen that in general, mean scores of all variables were above the middle point of five-point scale. For example, concerning gender differences, the results showed that the girls tended to have more sophisticated views in Certainty and Justification dimension when compared with boys. For the Certainty dimension, girls' mean score (*M* = 3.53, *SD* = .863) was higher than boys' (*M* = 3.42, *SD*= .867). For the Justification dimension, girls' mean score (*M* = 4.00, *SD* = .632) was slightly higher than that of boys (*M* =3.87, *SD* = .704). However, the boys' mean scores and girls' mean scores were nearly equal for the Source dimension (boys *M* = 3.46, *SD*= .743; girls *M* = 3.44, *SD*= .699) and Development dimension (boys *M* =3 .55, *SD* = .642; girls *M* =3.53, *SD*= .589). A clear picture displaying gender difference in Source, Development, Certainty, and Justification dimensions can be seen in Figure 5.1.

Table 5.1 Descriptive Statistics for EB Dimensions by Gender and Grade level

		Dimensions							
		Source		**Certainty**		**Development**		**Justification**	
Gender	**Grade Level**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Girls	6th	3.25	0.74	3.28	0.88	3.35	0.60	3.96	0.67
	8th	3.55	0.66	3.64	0.88	3.57	0.59	3.99	0.65
	10th	3.48	0.66	3.60	0.78	3.62	0.54	4.03	0.57
Total		3.44	0.69	3.53	0.86	3.53	0.58	4.00	0.63
Boys	6th	3.28	0.73	3.15	0.81	3.51	0.65	3.84	0.74
	8th	3.56	0.74	3.49	0.88	3.48	0.64	3.82	0.76
	10th	3.58	0.70	3.68	0.82	3.71	0.59	3.99	0.53
Total		3.46	0.74	3.42	0.86	3.55	0.64	3.87	0.70
Total	6th	3.27	0.74	3.20	0.84	3.44	0.63	3.90	0.71
	8th	3.55	0.70	3.57	0.88	3.53	0.61	3.91	0.70
	10th	3.52	0.68	3.63	0.80	3.66	0.56	4.02	0.56

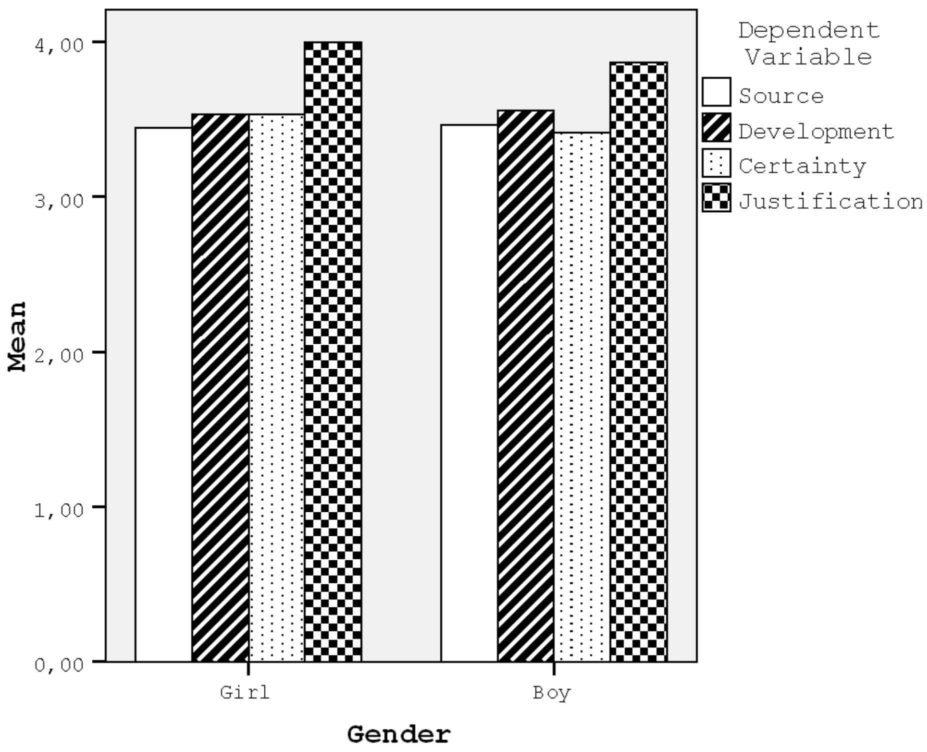

Figure 5.1 Distribution of Mean Scores of Source, Development, Certainty and Justification Dimensions with respect to Gender

Table 5.1 also showed that the mean scores of Source, Certainty, and Development dimensions also vary with respect to grade level. While the 10th grade students got the highest mean scores for Development, Certainty, and Justification dimensions, the 6th grade students earned the lowest mean scores for Source, Certainty, and Development dimensions. For the Justification dimension, however, same mean scores were found for 6th and 8th grade students. These findings imply that 10th grade students tended to have more sophisticated views in Development, Certainty, and Justification dimensions compared to 6th and 8th grade students. For the Source dimension, 8th and 10th grade students had nearly equal mean scores (Figure 5.2).

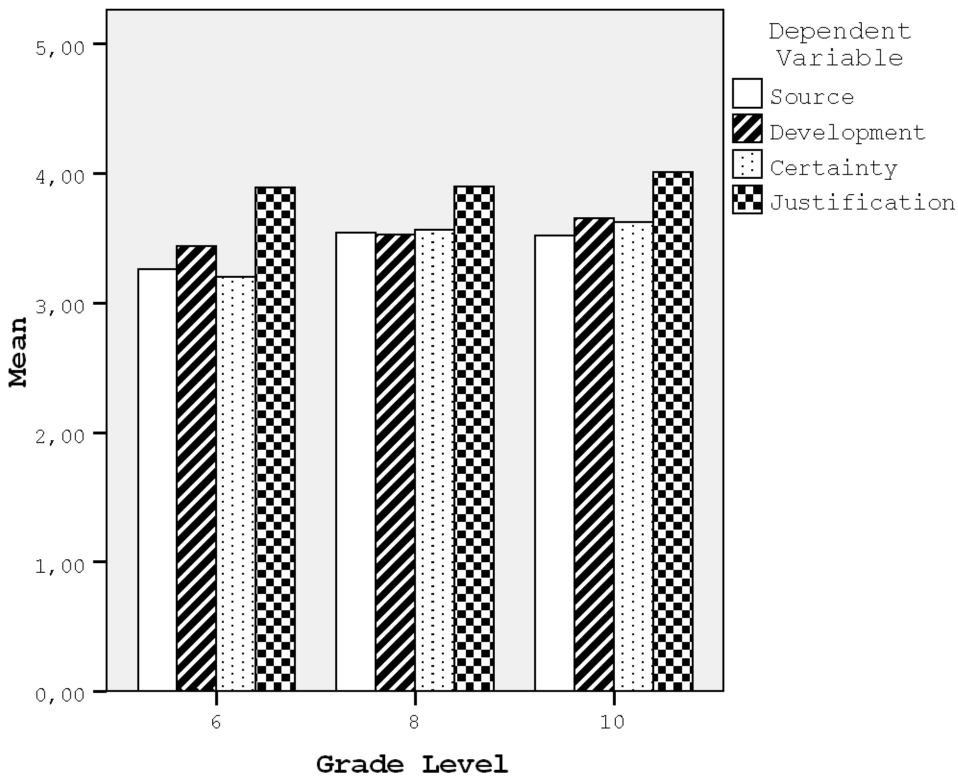

Figure 5.2 Distribution of mean scores of Source, Development, Certainty, and Justification Dimensions with respect to Grade Level

Main Problem 3: What is the epistemological belief profile of 10th grade students with respect to fields of the study?

Table 5.2 presented the 10th grade students' epistemological beliefs with respect to the fields of study. Table showed that while mathematics-science field students had the highest mean scores on the Source, Certainty, and Justification dimensions, the literature-social science students had the highest mean scores on Development dimension. These results revealed that students attending to mathematics-science field tended to believe that there may be more than one right answer, that knowledge is not constructed by only teachers, and that the experiments are necessary to construct knowledge. The literature-social science students, on the other hand, tended to believe that science is an evolving and changing subject. The literature-mathematics students' mean scores were above the middle point of five-point scale and higher than the literature-social science students' scores for the Source, Certainty and Justification dimensions and lower than the mathematics-science students' for each dimension.

Table 5.2 Descriptive Statistics for the EB Dimensions by Fields of the Study

	Dimensions							
	Source		Certainty		Development		Justification	
Fields of the Study	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Mathematics-Science	3.54	0.72	3.73	0.83	3.70	0.56	4.09	0.54
Literature-Mathematics	3.52	0.64	3.60	0.79	3.62	0.54	3.99	0.57
Literature-Social Science	3.43	0.71	3.34	0.64	3.72	0.66	3.80	0.63
Total	3.52	0.69	3.64	0.81	3.67	0.56	4.02	0.57

In Table 5.3, the frequency distributions of the responses to the 21 items in the EBQ were listed for the Source, Certainty, Development, and Justification dimensions separately. For example, concerning source of knowledge, when disagree and strongly disagree options were evaluated together, the majority of the students (66%) disagreed that "Everybody has to believe what scientists say", and that "In science, you have to believe what the science books say about stuff". Another Source item which is "If you read something in a science book, you can be sure it's true" received the highest undecided response (41%), and one-third of the students were agreed to this item. Regarding to certainty dimension, approximately 66% of the students reported that they disagreed or strongly disagreed that "Scientists pretty much know everything about science; there is not much more to know". For another certainty item (Once scientists have a result from an experiment, which is the only answer), More than half of the students (55%) reported their disagreement. Concerning

Justification dimension, when agree and strongly agree options were assessed together, majority of the students (86%) reported that they were agreed or strongly agreed that “It is good to have an idea before you start an experiment” and the most students (75%) were agreed that “In science, there can be more than one way for scientists to test their ideas”, and that “Ideas about science experiments come from being curious and thinking about how things work” which belongs to Justification dimension. Regarding Development dimension, the majority of the students (70%) agreed or strongly agreed the item “Ideas in science sometimes change”, higher than half of the students (57%) agreed that “Some ideas in science today are different than what scientists used to think”, and 55% of the students indicated that they agreed or strongly agreed the item “The ideas in science books sometimes change”.

Table 5.3 Frequency Distributions of the Items in EBQ

Dimensions	Items	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Source	Everybody has to believe what scientists say	23.8	42.2	19.7	11.0	3.2
	In science, you have to believe what the science books say about stuff.	28.7	37.6	18.4	11.7	3.7
	Whatever the teacher says in science class is true.	19.6	32.2	24.5	16.9	6.8
	If you read something in a science book, you can be sure it's true.	5.5	20.2	41.1	27.1	6.1
Certainty	Scientists pretty much know everything about science; there is not much more to know.	33.6	32.6	16.3	12.2	5.3
	Once scientists have a result from an experiment, which is the only answer.	18.5	32.1	26.2	15.9	7.3
	Scientists always agree about what is true in science.	16.0	25.5	32.4	19.5	6.6

Table 5.3 (Continued)

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Development	Some ideas in science today are different than what scientists used to think.	3.2	9.9	29.8	41.9	15.1
	The ideas in science books sometimes change.	5.3	10.1	29.6	41.4	13.6
	Ideas in science sometimes change	4.2	9	17.2	49.5	20.0
	New discoveries can change what scientists think is true.	3.8	11.7	37.1	34.6	12.8
	Sometimes scientists change their minds about what is true in science.	4.3	9.7	28.5	44.7	12.8
Justification	Ideas about science experiments come from being curious and thinking about how things work.	3.8	5.8	15.1	45.1	30.3
	It is good to have an idea before you start an experiment.	5.1	4	5.1	33.5	52.3

Table 5.3 (Continued)		**Strongly Disagree**	**Disagree**	**Undecided**	**Agree**	**Disagree**
	Ideas in science can come from your own questions and experiments.	2.8	8.2	27.2	45.1	16.7
	One important part of science is doing experiments to come up with new ideas about how things work.	4.0	7.2	10.2	39.5	39.2
Justification	It is good to try experiments more than once to make sure of your findings.	4.7	7	9.0	35.1	44.2
	Good ideas in science can come from anybody, not just from scientists.	5.5	8.4	14.5	38.3	33.2
	In science, there can be more than one way for scientists to test their ideas.	3.6	6.5	15.2	48.5	26.1
	Good answers are based on evidence from many different experiments.	4.1	7.6	22.2	43.9	22.2
	A good way to know if something is true is to do an experiment.	5.6	5.7	9.0	33.6	46.1

5.2 Inferential Statistics

Multivariate analysis of variance is conducted in order to compare groups, if there is more than one dependent variable which should be related in some way (Pallant, 2001). This analysis tells us whether the differences between the groups on the dependent variables. In this study, there are four dependent variables: Source, Development, Certainty and Justification dimensions and there are three independent variables: Gender, Grade Level and Fields of the Study.

5.2.1 Assumptions of Multivariate Analysis of Variance

Assumptions were checked before conducting MANOVA. MANOVA has seven assumptions: sample size, independence of observations, normality, outliers, linearity, multicollinearity and singularity, and homogeneity of variance-covariance matrices (Pallant, 2001).

Sample size

In order to conduct MANOVA, the cases in each cell should be more than the number of the dependent variables (Pallant, 2001). The minimum required number of cases in each cell in this study was four (the number of dependent variables). We have enough cells (independent variables are gender, grade level which consists of three levels, and fields of the study which consists of three levels). Therefore the sample size (N=1519) assumption was met in this study.

Independence of Observations

During the implementation of the questionnaire, it was assumed that the students were independent, each student completed the questionnaire individually, and there was no interaction among the students in the classroom. According to Stevens (2002), the violation of this assumption is serious and if there is a suspect about the violation of this assumption, the researcher should set a more stringent alpha value.

Normality

In order to provide normality assumption, univariate and multivariate normality were checked. Histograms, skewness and kurtosis values and Kolmogorov-Smirnow statistic were examined in order to check univariate normality. As presented in Table 5.4, the skewness and kurtosis values for all dimensions were between -2 and +2 range which is acceptable for a normal distribution (Pallant, 2001). Histograms for Source, Development, and Certainty dimensions indicated that the scores were reasonably normally distributed and the histogram for the Justification dimension indicated that there was a non-normal distribution (Figure 5.3). Morever, the skewness and kurtosis values for the Justification dimension were acceptable for the normal distribution.

Furthermore, in order to check univariate normality, Kolmogorov-Smirnov statistic was examined. A non-significant result indicates normality (Pallant, 2001). In this case the significance value was .00 for each variable, which suggested violation of the normality. According to Pallant (2001), in large samples violation of the assumption of normality is quite met.

In order to check multivariate normality, Mahalanobis distance was calculated as 24.75 and this value was found higher than the critical value given in the Chi-square table. In this study, there are four dependent variables, so the critical value is 18.47 in the Chi-square table. If Mahalanobis distance is greater than the critical value, there are multivariate outliers (Pallant, 2001). In this study, the twenty-one cases which had higher values than the critical value were detected and removed from further analysis.

Table 5.4 Skewness and Kurtosis Values for Each Dependent Variable

	Source		Development		Certainty		Justification	
	Skewness	**Kurtosis**	**Skewness**	**Kurtosis**	**Skewness**	**Kurtosis**	**Skewness**	**Kurtosis**
Gender								
Girls	-0.29	-0.04	-0.41	-0.23	-0.42	-0.26	-1.15	1.55
Boys	-0.30	-0.22	-0.40	-0.03	-0.22	-0.29	-1.01	0.91
Grade level								
6^{th}	-0.08	-0.32	-0.37	-0.15	-0.16	-0.15	-1.02	0.74
8^{th}	-0.42	0.35	-0.30	0.19	-0.36	-0.42	-1.03	1.00
10^{th}	-0.31	-0.23	-0.47	0.32	-0.45	-0.10	-1.06	1.59
Fields of the study								
Math-Sci	-0.48	-0.20	-0.30	0.00	-0.72	0.42	-1.03	1.79
Lit-Math	-0.30	-0.20	-0.55	0.44	-0.34	-0.40	-1.16	1.47
Lit-Soc	0.52	-0.47	-0.72	0.97	-0.29	-0.86	-1.05	1.62

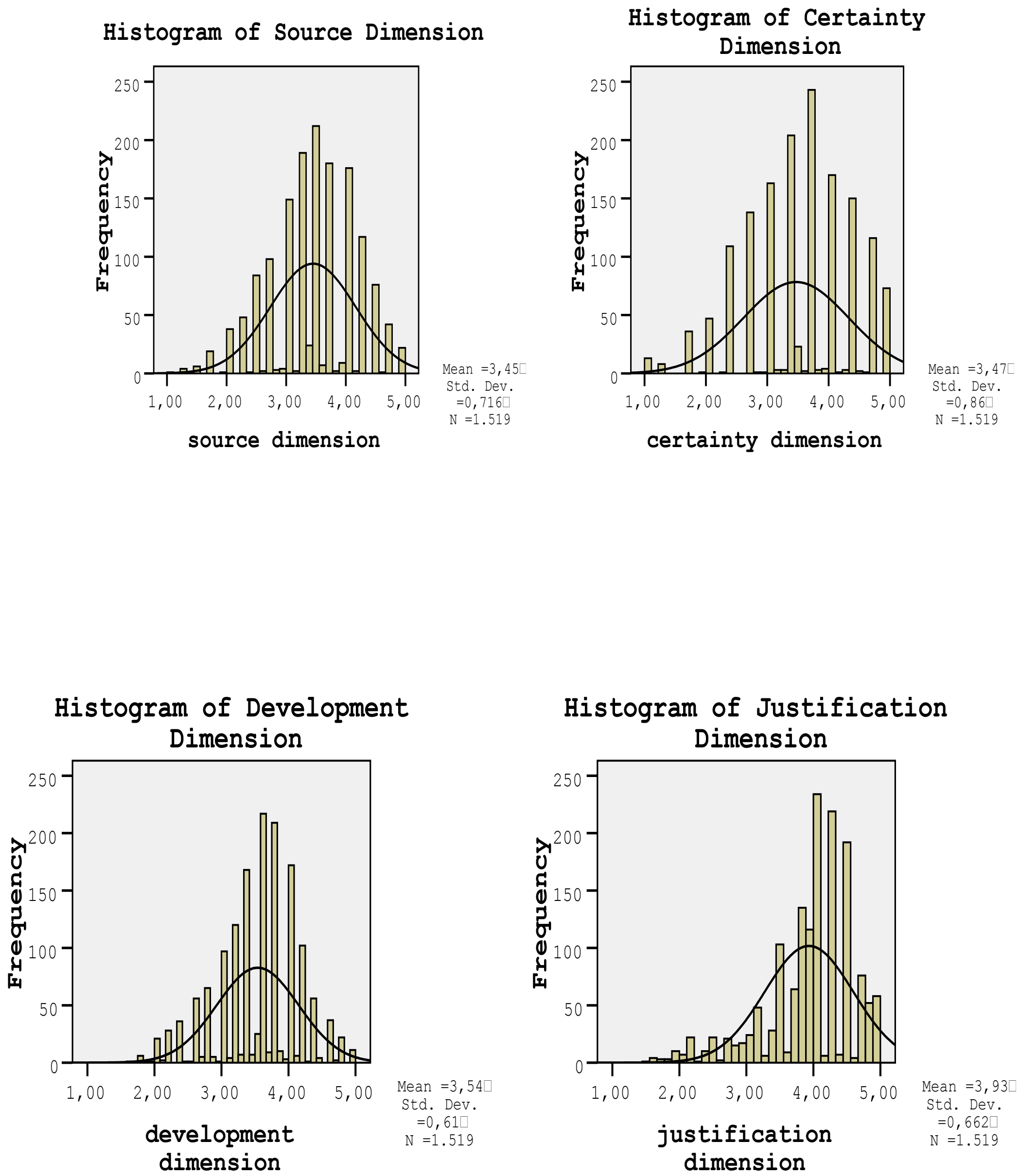

Figure 5.3 Histograms for the Source, Certainty, Development and Justification Dimensions

Outliers

According to Field (2005), cases with standardized scores which exceed 3.29 are inspected as outliers. In this study, 17 cases were detected as outliers and deleted from the data file. Moreover, 21 cases having Mahalanobis distance greater than the critical value (18.47) were removed from the data set previously. So, there was no threat of outliers any more. Therefore, the sample size of the study decreased from 1557 to 1519 which was still suitable for the MANOVA.

Linearity

In order to check assumption of linearity, scatter plots were generated separately for each pair of dependent variables and the straight-line relationship between each group was controlled. The scatter plots showed that there was no violation of the linearity assumption.

Multicollinearity and Singularity

In order to check multicollinearity and singularity assumption, the correlation coefficients were calculated and the strength of the correlations among dependent variables was examined. According to Pallant (2001), correlations up around .8 or .9 were not appropriate for the statistic. As indicated in table 5.5, Pearson correlation coefficients between dependent variables ranged from -.165 to .558 and did not exceed the value of .8. So, there was no violation of the multicollinearity assumption.

Table 5.5 Pearson Correlations Between Dependent Variables

Gender	Grade Level		Source	Development	Certainty
		Source	-	-	-
Girls	6th	Development	.480	-	-
		Certainty	.145	.345	-
		Justification	-.050	.443	-.157
		Source	-	-	-
Boys	6th	Development	-.010	-	-
		Certainty	.377**	.059	-
		Justification	-.012	.503**	.108
		Source	-	-	-
Girls	8th	Development	.139**	-	-
		Certainty	.397**	.182**	-
		Justification	.032	.408**	.128*
		Source	-	-	-
Boys	8th	Development	.236**	-	-
		Certainty	.558**	.254**	-
		Justification	.303**	.641**	.379**
		Source	-	-	-
Girls	10th	Development	.032	-	-
		Certainty	.324**	.151*	-
		Justification	-.044	.511**	.187**
		Source	-	-	-
Boys	10th	Development	.228**	-	-
		Certainty	.238**	.299**	-
		Justification	.005	.524**	.281**
Fields of the study					
Math- Sci		Source	-	-	-
		Development	0.081	-	-
		Certainty	.244**	.279**	-
		Justification	-.165*	.498**	.186**
Lit-Math		Source	-	-	-
		Development	.155*		
		Certainty	.385**	.175*	-
		Justification	.083	.500**	.285**
Lit-Soc		Source	-	-	-
		Development	.063		
		Certainty	.125	-.130	-
		Justification	.054	.532**	-.180

Homogeneity of Variance-Covariance Matrices

In order to check homogeneity of variance assumption, a separate MANOVA was conducted for the each independent variable. The results of the Box Test of Equality of Covariance Matrices showed that the assumption of homogeneity of variance-covariance matrices was violated. According to Pallant (2001), if the significance value is greater than .001, the assumption is not violated. In this study, for the field of the study variable, significance value was .018 and higher than .001 which indicated that there was not violation of the assumption. For gender and grade level variable, the sinificance value was .000 and smaller than .001 which indicated that there was a violation of the assumption.

Furthermore, in the Levene's Test of Equality of Error Variances table, if the significance value is less than .05, this indicates that there is a violation of the assumption (Pallant, 2001). As indicated in table 5.6, which presents the values for gender and grade level, significance values were higher than .05 for Source and Certainty dimensions, but for Development and Justification dimensions, significance values were less than .05 which indicates a violation of assumption. According to Stevens (2002), if the sizes of the groups are equal (e.g., largest/smallest<1.5), analysis of variance is robust to violation of this assumption and the violation of the assumption has the minimal effect. In this study, when the largest group size divided to smallest group size, the ratio obtained was smaller than 1.5. So MANOVA can be conducted.

Table 5.6 Levene's Test of Equality of Error Variances for Gender and Grade Level

	F	**df1**	**df2**	**Sig. (*p*)**
Source	1.95	5	1451	.084
Development	2.53	5	1451	.027
Certainty	2.04	5	1451	.070
Justification	6.43	5	1451	.000

5.2.2 Results Regarding Gender and Grade Level

Main Problem 4: Are there any statistically significant differences in epistemological beliefs held 6^{th}, 8^{th}, and 10^{th} grade students with respect to gender and grade level?

A two-way multivariate analysis was conducted to investigate the effects of gender and grade level on students' epistemological beliefs (i.e. Source, Development, Certainty and Justification). In order to evaluate multivariate significance, Pillai's Trace statistic was used. According to Tabachnick and Fidell (1996), if there is violation of some assumptions, Pillai's Trace is more robust. MANOVA results regarding the gender and grade level are presented in Table 5.7. The results indicated a statistically significant gender effect on the combined dependent variables (Pillai's Trace=0.019, F (4, 1448)=6.928, p=0.00, η^2=0.019). The partial eta squared value of .019 represented that the 1.9 % of the variance in dependent variables could be explained by gender. Moreover, a statistically significant grade level effect on the combined dependent variables were found (Pillai's Trace=0.071, F (8, 2898)= 13.392, p=0.00, η^2=0.036). The partial eta squared value of .036 showed that the 3.6 % of the variance in dependent variables could be explained by grade level. In order to evaluate effect size in gender and grade level, Partial Eta Squared results should be considered. The values were .019 and .036 for gender and grade level respectively. These result suggested a small effect for the gender and a medium effect for the grade level (Cohen, 1988).

The results also revealed a statistically significant interaction between gender and grade level (Pillai's Trace=0.012, F(8,2896)=2.249, p=0.022, η^2=0.006). In other words, the grade level effect depended on gender (and vice versa) with respect to dependent variables. The partial η^2 value of .006 indicated that the 0.6% of the variance in collective dependent variables was explained by grade level and gender together and was considered as small effect size.

Table 5.7 MANOVA Results for Gender and Grade Level

Effect	Pillai's Trace	F	Hypothesis df	Error df	*P*	Partial η^2	Observed Power
Gender	.019	6.928	4.000	1448	.000	.019	.995
Grade Level	.071	13.392	8.000	2898	.000	.036	1.000
GenderXGrade Level	.012	2.249	8.000	2896	.022	.006	.877

In order to investigate on which dependent variables students with different gender (girls and boys) and grade level (6^{th}, 8^{th} and 10^{th}) students differed, follow-up univariate analyses of variance was conducted and significance was tested using the Bonferroni method which reduces the chance of a type 1 error. According to Pallant (2001), the alpha level is found by dividing the original alpha level by the number of dependent variables. In this study, the alpha level of 0.0125 was found by dividing the original alpha level (i.e., 0.05) by the number of dependent variables (i.e., 0.05/4=0.0125). Interpretation of effects on the dependent variables, therefore, was made based on Bonferroni adjusted alpha level of 0.0125. The follow-up analyses for pairwise comparisons are displayed in Table 5.8. According to the table while the mean scores on Source, Development and Certainty dimensions of the epistemological beliefs were significantly different with respect to grade level, the mean difference between boys and girls was significant only with respect to Justification dimension. In addition, a statistically significant interaction was found between gender and grade level with respect to development dimension. However, the partial eta squared value was 0.008 which represented that only 0.8% variance of development dimension explained by this interaction and was considered small effect size.

Table 5.8 Follow-Up Pairwise Comparisons

Source	Dependent Variable	df	F	*p*	Partial η^2	Observed Power
Gender	Source	1	1.464	.226	.001	.227
	Development	1	2.631	.105	.002	.368
	Certainty	1	2.089	.149	.001	.303
	Justification	1	10.336	.001*	.007	.895
Grade Level	Source	2	23.685	.000*	.032	1.000
	Development	2	16.944	.000*	.023	1.000
	Certainty	2	33.164	.000*	.044	1.000
	Justification	2	4.037	.018	.006	.721
Gender X Grade Level	Source	2	.511	.600	.001	.135
	Development	2	5.822	.003*	.008	.872
	Certainty	2	2.312	.099	.003	.471
	Justification	2	1.097	.334	.002	.244
Error	Source	1451				
	Development	1451				
	Certainty	1451				
	Justification	1451				

Scheffe test was carried out to determine which pairs cause the significant grade level difference with respect to dimensions of Epistemological Beliefs. According to Pallant (2001), in order to reduce the risk of a Type 1 error, the Scheffe test is most cautious method.

Table 5.9 Post-Hoc Comparisons of the Mean Differences

Dependent Variable	**Grade Level**	**Grade Level**	**Mean Difference**	**Significance(*p*)**
Source	6	8	-0.283	.000*
		10	-0.252	.000*
	8	6	0.283	.000*
		10	0.031	.792
	10	6	0.252	.000*
		8	-0.031	.792
Development	6	8	-0.092	.054
		10	-0.221	.000*
	8	6	0.092	.054
		10	-0.128	.004*
	10	6	0.221	.000*
		8	0.128	.001*
Certainty	6	8	-0.362	.000*
		10	-0.424	.000*
	8	6	0.362	.000*
		10	-0.062	.571
	10	6	0.424	.000*
		8	0.062	.571
Justification	6	8	-0.013	.953
		10	-0.121	.024
	8	6	0.013	.953
		10	-0.108	.040
	10	6	0.121	.024
		8	0.108	.040

*The mean difference is significant at the .0125 level.

Regarding Source dimension, statistically significant mean difference was found with respect to grade level by using a Bonferroni alpha level of 0.0125, ($F(2,1451)=23.685$, $p=.000$, $\eta^2=.032$). The partial eta squared value indicated that 3.2% of the variance in source dimension was explained by grade level and was considered as medium effect. The results of Scheffe test shows that there was a significant mean difference between 6^{th} and 8^{th} grade, in favor of 8^{th} graders, and between 6^{th} and 10^{th} grade, in favor of 10^{th} graders, while there was no significant mean difference between 8th and 10th grade with respect to Source of knowledge. These results revealed that 6th grade students' mean score was the lowest, so the 6th grade students tended to hold less sophisticated beliefs about source of knowledge compared to 8th and 10th grade students, which indicates that 6th grade students were more likely to rely on authority, such as teachers, textbooks, and other experts. On the other hand, there was no statistically significant mean difference between girls and boys with respect to source of knowledge, *F* (1, 1451) =1.464, *p*=.226 (Table 5.8). Regarding development of knowledge, there was a significant mean difference between 6th and 10th graders, in favor of 10th graders and between 8th and 10th graders, in favor of 10th graders, while there was no significant mean difference between 6th and 8th graders. The mean score for the 10th graders (*M*=3.66, *SD*=.57) was higher than the 6th graders' (*M*=3.44, *SD*=.64) and 8th graders' (*M*=3.53, *SD*=.62). These findings implied that 10th grade students appeared to be more sophisticated belief about development of knowledge compared to 6th and 8th graders and they believe that science is an evolving and changing subject. However, there was no statistically mean difference between girls and boys with respect to development of knowledge, *F* (1, 1451) =2.631, *p* =.105. Regarding the certainty of knowledge, there was a significant mean difference between 6th and 8th grade students, in favor of 8th graders and between 6th and 10th grade students, in favor of 10th graders while there was no significant mean difference between 8th and 10th grade students. So the 8th and 10th graders had more sophisticated beliefs about certainty of knowledge compared to 6th graders and believed that there may be more than one answer to solve complex problems. There was no statistically mean difference between girls and boys with respect to certainty of knowledge *F* (1, 1451) =2089, *p*=.149. Regarding the Justification of knowledge, there was no statistically significant mean difference between 6^{th,} 8th and 10th grade students. On the other hand, there was a statistically mean difference between girls and boys with respect to justification of knowledge *F* (1, 1451) =10.336, *p*=.001. The mean scores showed that the girls (*M*=4.00, *SD*=.62) had more sophisticated beliefs about justification of knowledge than boys (*M*=3.87, *SD*=.70), which indicated that the girls had more beliefs about experiments and using data are necessary to construct knowledge than boys.

As can be also seen in Table 5.8, there was an interaction effect between grade level and gender with respect to development of knowledge (*p*= 0.003). When the grade level increases, the girls' mean scores on development dimension increase (see figure 5.4). Specifically, there is an increase from grade 6th to 8th and from grade 8th to 10th. This finding imply that the girls at about tended to hold more sophisticated views about development of knowledge, compared to those at 6th and 8th graders. For the boys, while there is an increase from 8th to 10th grades, there was a decrease from 6th to 8th grades. Tenth grade boys tended to hold more sophisticated beliefs compared to boys at 6th and 8th grades, on the other hand, 8th grade boys seemed to have less sophisticated beliefs about development of knowledge compared to 6th grade and 10th grade boys.

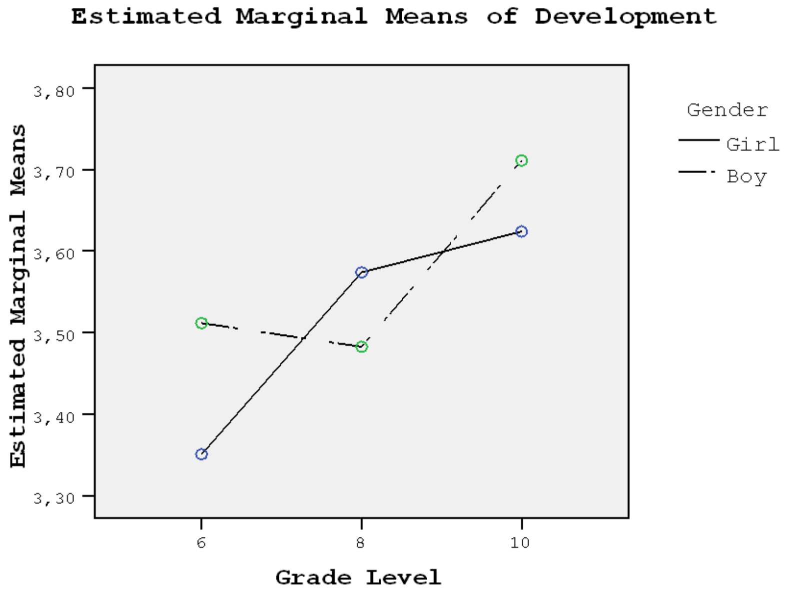

Figure 5.4 Plot for Estimated Marginal Means for Development Dimension with respect to Grade Level and Gender

Concerning Source dimension, Figure 5.5 reveals that there was an increase from 6th to 8th grades for both girls and boys. The girls' beliefs increased from 6th to 8th grade, however, decreased from 8th to 10th grades. On the other hand, the boys attending to the 6th grade had less sophisticated beliefs about source of knowledge compared to boys attending 8th and 10th grade. There was an increase from 6th to 8th and from 8th to 10th grades for the boys. Therefore, the boys attending 10th grade had more sophisticated beliefs about source of knowledge compared to 6th and 8th grade boys. On the other hand, 10th grade girls had less sophisticated beliefs about source of knowledge, compared to 8th grade girls.

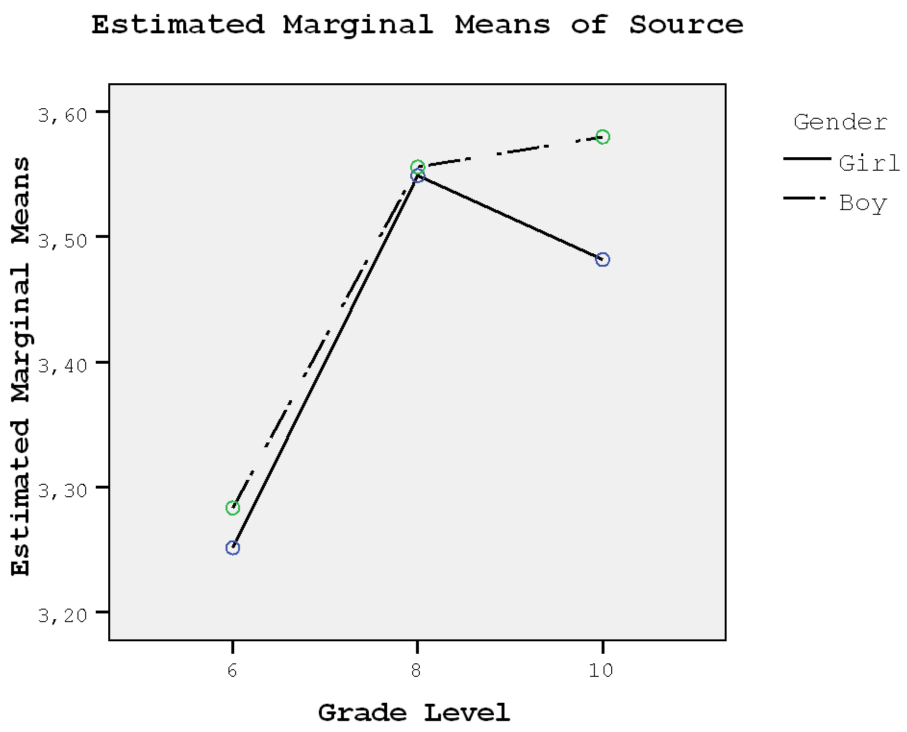

Figure 5.5 Plot for Estimated Marginal Means for Source Dimension with respect to Grade level and Gender

Regarding Certainty dimension, there is an increase from 6th to 8th grades and a decrease from 8th to 10th grades for the girls. There is an increase from 6th to 8th grades and from 8th to 10th grade for the boys (Figure 5.6). These findings indicated that 6th grade girls had less sophisticated beliefs about certainty of knowledge compared to 8th and 10th grade girls, on the other hand, 8th grade girls had more sophisticated beliefs compared to 6th and 10th grade girls. The boys attending 10th grade had more sophisticated beliefs about certainty of knowledge compared to 6th and 8th grade boys, whereas 6th grade boys had less sophisticated beliefs about certainty of knowledge compared to 8th and 10th grade boys.

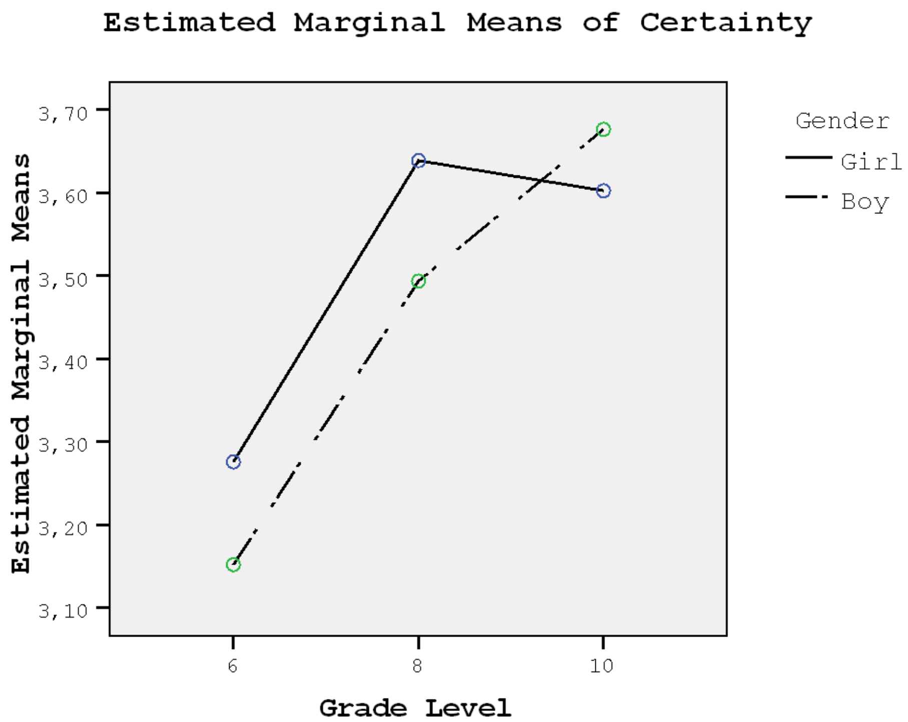

Figure 5.6 Plot for Estimated Marginal Means for Certainty Dimension with respect to Grade Level and Gender

Regarding Justification dimension, (see Figure 5.7), the boys' mean score decreases from 6th to 8th grade and increases from 8th to 10th grades. There was a gradual increase from 6th to 8th and from 8th to 10th grades for the girls. These findings showed that 10th grade girls had more sophisticated beliefs compared to 6th and 8th grade girls, whereas 6th grade girls had less sophisticated beliefs compared to 10th and 8th grade girls. The boys who are at 10th grade had more sophisticated beliefs about justification of knowledge, compared to 6th and 8th grade boys, whereas 8th grade boys had less sophisticated beliefs about justification knowledge compared to those who at 6th grade.

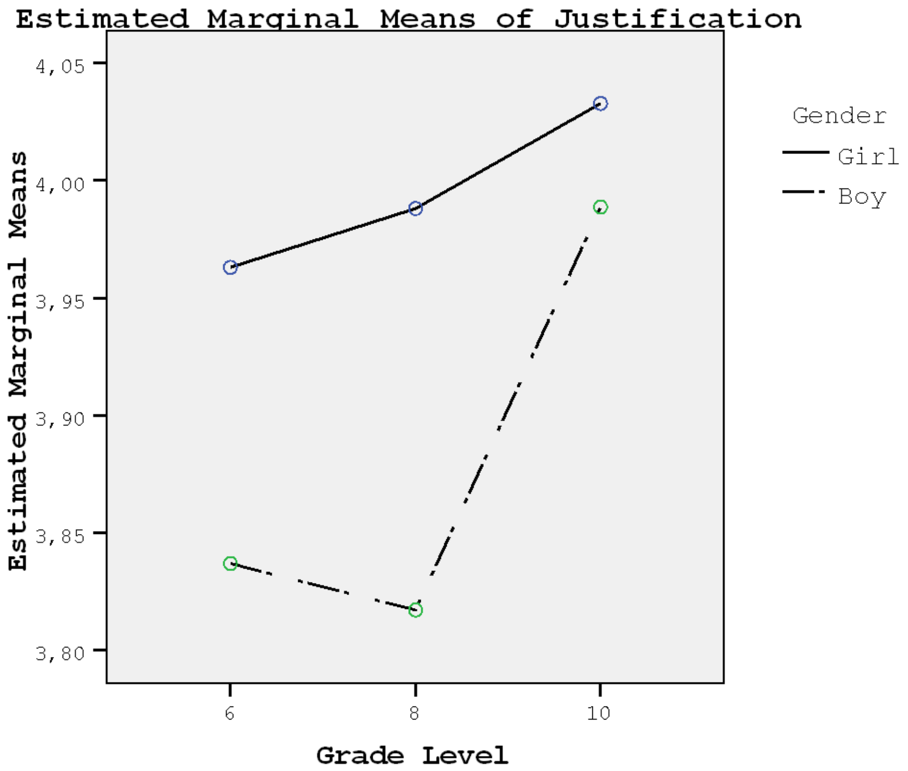

Figure 5.7 Plot for Estimated Marginal Means for Justification Dimension with respect to Grade Level and Gender

5.2.3 Results Regarding Fields of the Study

Main Problem 5: Is there a statistically significant difference in epistemological beliefs held by 10th grade students with respect to fields of study (mathematics-science, literature-mathematics, and literature-social science)?

One-way multivariate analysis was conducted to investigate the effects of the fields of the study on the students' epistemological beliefs (i.e. Source, Development, Certainty and Justification).

In order to evaluate multivariate significance, Pillai's Trace statistic was used. MANOVA results regarding the fields of the study are presented in Table 5.10. The results of MANOVA indicated a statistically significant effects of fields of the study on the dependent variables (Pillai's Trace=0.049, F (8, 882)=2.787, p=0.005, η^2=0.025). The partial eta squared value of .025 represented that the 2.5 % of the variance in dependent variables could be explained by gender and was considered as a small effect.

Table 5.10 MANOVA Results for Fields of the Study

Effect	Pillai's Trace	F	Hypothesis df	Error df	*P*	Partial η^2	Observed Power
Fields of the Study	.049	2.787	8.000	882	.005	.025	.943

Follow-up analyses of variances on each dependent variable are presented in Table 5.11. By using the Bonferroni method, the significance of the each dependent was tested again. Each relation was tested at the alpha level of 0.0125 which was calculated by dividing the original alpha level of 0.05 by the number of dependent variables (0.05/4=0.0125). Table 5.11 showed that a statistically significant difference between fields of the study was found with respect to justification dimension, while no significant difference between fields of the study was found with respect to Source, Development, and Certainty dimensions.

Table 5.11 Follow-Up Pairwise Comparisons

Source	**Dependent Variable**	**df**	**F**	***p***	**Partial**	**Observed Power**
Fields of the Study	Source	2	.421	.657	.002	.118
	Development	2	1.078	.341	.005	.239
	Certainty	2	4.489	.012	.020	.767
	Justification	2	4.998	.007	.022	.813

In order to determine which pairs cause the significant difference with respect to dimensions of Epistemological Beliefs, Scheffe test was carried out. As can be seen in Table 5.12, a statistically significant mean difference was found between the students attending to Mathematics-Science field and Literature-Social Science field with respect to justification dimension. The mean score of the students attending to Mathematics-Science (*M*=4.09, *SD*=.54) was higher than the mean score of the students attending to the Literature-Social Science (*M*=3.80, *SD*=.57). The students attending to Mathematics-Science field had more sophisticated beliefs about justification of knowledge and they believed that the experiments and using data are necessary to construct knowledge. No significant mean difference was found between the students attending to Mathematics-Science and Literature-Mathematics and the students attending to Literature-Mathematics and Literature-Social Science with respect to Justification dimension. As can be seen in table 5.11, there was no significant mean difference between fields of the study with respect to Source, Development, and Certainty dimensions.

Table 5.12 Post-Hoc Comparisons of the Mean Differences

Dependent Variable	Field	Field	Mean Difference	Significance(*p*)
Source	1	2	0.018	0.965
		3	0.106	0.657
	2	1	-0.018	0.965
		3	0.087	0.754
	3	1	-0.106	0.657
		2	-0.087	0.754
Development	1	2	0.074	0.414
		3	-0.021	0.976
	2	1	-0.074	0.414
		3	-0.095	0.605
	3	1	0.021	0.976
		2	0.095	0.605
Certainty	1	2	0.126	0.289
		3	0.387	0.016
	2	1	-0.126	0.289
		3	0.261	0.154
	3	1	-0.387	0.016
		2	-0.261	0.154
Justification	1	2	0.098	0.217
		3	0.284	0.011*
	2	1	-0.098	0.217
		3	0.186	0.146
	3	1	-0.284	0.011*
		2	-0.186	0.146

* The mean difference is significant at the .0125 level.

Note: 1=Mathematics-Science Field, 2= Literature-Mathematics Field, 3=Literature-Social Science

5.3 Summary of the Results

- The descriptive results of the study showed that most of the students tended to hold more sophisticated beliefs about nature of the knowledge and knowing.
- Majority of the students believe that knowledge is not constructed by authority (i.e. teachers, textbook), that scientific knowledge can change by time, that knowledge is not certain and that using data and experiments are necessary to construct knowledge.
- The results of the MANOVA showed that gender had a statistically significant effect on students' epistemological beliefs. Girls had more sophisticated beliefs and tended to believe that the experiments and using data are necessary to construct knowledge compared to boys.
- The results of the MANOVA revealed that grade level had a statistically significant effect on students' epistemological beliefs. Moreover, the results showed that there was a statistically significant difference between sixth grade and eighth grade students, that eighth grade students had more sophisticated beliefs than sixth grade students and they tended to believe that knowledge is not constructed by only teachers and other experts, and that there may be more than one right answer. On the other hand, no statistically significant difference was found between eighth grade and sixth grade students with respect to beliefs on experiments and using data are necessary to construct knowledge and scientific knowledge can change in time.
- Furthermore, the findings showed that there was a statistically significant mean difference between sixth grade and tenth grade students. Tenth grade students had more sophisticated beliefs than sixth grade students and they tended to believe that knowledge is not constructed by authority, that scientific knowledge can change in time, that knowledge is not certain. On the other hand, there was no statistically significant difference between sixth and tenth grade students with respect to beliefs on using data and experiments are necessary to justify knowledge.

- Moreover, the results showed that there was a statistically significant mean difference between tenth grade and eighth grade students, that tenth grade student had more sophisticated beliefs than eighth grade students and they believed that knowledge can change in time. On the other hand, there was no statistically significance mean differences between eighth grade and tenth grade students with respect to beliefs on knowledge is not constructed by authority, knowledge is not certain, and the experiments and using data are necessary to construct knowledge.
- The results of the MANOVA also showed that there was an interaction between grade level and gender with respect to beliefs about knowledge can change in time.
- In addition, the results of the MANOVA revealed that fields of the study had made an effect on the students' epistemological beliefs. The results showed that there was a statistically significant mean difference between the students attending to mathematics-science field and literature-social sciences field, that the students attending to mathematics-science field had more sophisticated beliefs than the students attending to literature-social science field and they tended to believe that the experiments and using data are necessary to construct knowledge. On the other hand, there was no statistically significant mean difference between the students attending to mathematic-science field and literature-mathematics field and between the students attending to literature-social science field and literature-mathematics field.

CHAPTER 6

DISCUSSIONS AND IMPLICATIONS

This chapter consisted of discussion of the results, implications of the study and recommendations for further research.

6.1 Discussion of the Results

In this investigation, a cross-age study was conducted to investigate the effects of the gender and grade level on students' epistemological beliefs. The current research also interested in determining the effects of fields of the study on tenth grade students' epistemological beliefs.

In order to determine the dimensionality of the epistemological belief questionnaire, factor analysis was conducted. The results of the factor analysis showed that the Turkish students' epistemological beliefs were explained with Conley et al.'s (2004) four factor model which consisted of Source, Certainty, Development, and Justification of Knowledge. The results of the current study, thus, supported the Schommer's multidimensional theory and suggested that multidimensional theory is more suitable than unidimensional theory to explain Turkish students' epistemological beliefs. On the other hand, using the same questionnaire, Özkan (2008) identified three-factor model which comprised Development, Justification, and Source/Certainty dimensions. She attributed the difference of the number and nature of epistemological beliefs between Turkish sample and other related samples to the different socio cultural contexts, age, education, and maturation issues. Özkan claimed that Turkish culture gives importance to respect to teachers, parents, and other authority, so the students associated certain knowledge with source of knowing and they might think that source of knowing determines whether the knowledge is external to the self or not and also whether there is more than one right answer. Finding difference about factor structure between the present study and Özkan's study can be related to the age, grade level, development level of students and nature of the 2003 science and technology curriculum. In her study, Özkan studied with only seventh grade students, while current study was conducted with sixth, eighth, and tenth grade students. In addition, her participants were taught with old science curriculum (year 2000) while participants of present study were taught with the new science curriculum which is more constructivist-oriented. Therefore, the differences between old and new curriculum may cause the factor structure difference between the present study and Özkan's study. Researchers claimed that the beliefs about Certainty and Source dimensions may be united into one factor at earlier ages and developed with age and education at later ages (Cano, 2005; Kahn, 2000; Özkan, 2008; Paulsen & Wells, 1998). The results of the current study supported these claims and provided evidence that students' epistemological beliefs changed and developed with age and grade level. In studying with undergraduate students, Schommer (1990) reported four factor structures which consisted of Innate Ability, Simple Knowledge, Quick Learning, and Certain Knowledge. However studying with high school students, Schommer (1993) found three factor structure (i.e. Simple Knowledge, Quick Learning, and Certain Learning); Innate Ability changed with Fixed Ability. On the other hand, in a study with undergraduate students, Topçu and Yılmaz-Tüzün (2008) found four factor structures namely, Innate Ability, Simple Knowledge, Certain Knowledge, and Omniscient Authority. They attributed the apparent discrepancy to the nature of the Turkish educational system. According to Topçu and Yılmaz-Tüzün, many teachers use traditional teaching approaches, which leads students believe that "science is a body of knowledge discovered by scientists" and that "the teachers deliver this knowledge to students" (p.77).

Overall, the factor analysis can produced different structure depending on age/grade level, development of students' level, socio cultural structure, and education system. To be brief, the results of the factor analysis obtained from the current study supported to the multidimensional theory which proposed by Schommer (1990) and showed that the Turkish students' epistemological beliefs are explained with four distinct factors.

Descriptive statistics revealed that the participants of the current study generally had fairly sophisticated beliefs about nature of knowledge and knowing. For the each dimension (i.e. Justification, Development, Certainty, Source) students obtained a mean value that was higher than the mid-point of the five-point scale, implying that participants generally tended to believe that (a) using data and experiments are necessary to construct knowledge, (b) knowledge can change in time and science is evolving and changing subject, (c) knowledge is not certain and (d) knowledge is not constructed by only authority (e.g., teachers, books). These results were consistent with those reported in the literature (e.g., Conley et al., 2004; Kızılgüneş, 2007; Özkan, 2008; Özkal, 2007). For instance, studies conducted by Turkish researchers, showed that the students generally had sophisticated beliefs and tended to believe that evidence and evaluating claims to justify knowledge are important (*M*= 3.99), that science is an evolving subject (*M*= 3.60) and that the knowledge is constructed by the knower and there may be more than one answer (*M*=3.28) (Özkan, 2008). In her study, Kızılgüneş (2007) stated that the sixth grade students' epistemological beliefs differ from a view of science as fixed and authoritative to a view of science as tentative and dynamic and reported that the students generally have tentative epistemological beliefs. By using different instrument, Özkal (2007) found that the mean score of tentative views (*M*= 23.46) of scientific epistemological beliefs is higher than fixed views (*M*= 21.25), of scientific epistemological beliefs, which indicated that the 8^{th} grade students have slightly more tentative views of scientific epistemological beliefs and the students tended to believe scientific knowledge can change by time and it is not certain. Conley et al. (2004) reported that students began their study with fairly sophisticated beliefs about Source of Knowledge and Certainty of Knowledge and over time more strongly endorsed the beliefs that knowledge is not constructed by only teachers and other experts and knowledge is not certain and there may not be just one right answer in science. On the other hand, they stated that the increases in more sophisticated beliefs about Development and Justification of Knowledge were not reliable. Consequently, they reported that students had sophisticated epistemological beliefs, as evidenced by the distance of the observed means from the midpoint of the scale.

To determine the effects of the gender and grade level on students' epistemological beliefs, the two-way multivariate analyses of variance (MANOVA) was conducted. The results showed that there was a statistically significant effect of gender on the students' epistemological beliefs (*p*=0.00) and that the 1.9% of the variance in students' epistemological beliefs could be explained by gender. In other word, small effect size for gender effect was observed. Follow-up analyses revealed that there was a statistically significant difference between girls and boys with respect to Justification dimension of epistemological beliefs, in favor of girls. In line with expectations, the girls had more sophisticated beliefs about Justification of Knowledge than boys. This means that girls tended to believe that using data and experiments are necessary to construct knowledge. The reason of the significant difference between girls' and boys' epistemological beliefs can be explained with Cano's (2005) claim that girls had more realistic beliefs about knowledge compared to boys. Therefore, the girls need to strengthen their knowledge with evidence, experiments, and data. In his study, Cano (2005) found that girls' epistemological beliefs about knowledge and learning were more realistic than boys'. Cano's stated that girls need to realistic knowledge, which was provided by making experiments, collecting data, and using evidence. The findings of the current study are consistent with Özkan's (2008) study who reported that girls tended to have more sophisticated beliefs in Justification dimension compared to boys. Similarly, some of the previous studies also demonstrated that compared to boys, girls had more sophisticated epistemological beliefs (e.g., Bendixen et al., 1998; Lodewyk, 2007; Neber & Schommer-Aikins, 2002; Özkal, 2007; Paulsen & Wells, 1998; Schommer, 1993; Schommer & Dunnell, 1994; Topçu & Yılmaz-Tüzün, 2009). For example, Topçu and Yılmaz-Tüzün (2009) identified that the girls attending to fourth and fifth grade had more sophisticated beliefs in Quick Learning and Innate Ability, and the girls attending to sixth and eighth grade had less sophisticated beliefs in Omniscient Authority. They stated that the science courses in Turkey which consisted of teacher demonstrations, explanations, and writing about science and learning by memorization are suitable for girls, so the girls develop their epistemological beliefs in suitable classroom environment. In another study, Schommer (1993) stated that girls were less likely to believe in fixed ability and quick learning. According to Schommer, girls were more likely to show less confidence in their understanding and were more accurate in their comprehension monitoring. She also stated that the girls' beliefs in gradual learning may prevent them to explain conclusions which they understand. Neber and Schommer (2002), however, reported that boys had naive beliefs in only quick learning. Furthermore, Lodewky (2007) stated that the girls had significantly more sophisticated beliefs in Fixed and Quick Ability to learn and certain knowledge than boys. Lodewyk argued that boys tended to believe that learning occurs quickly and knowledge is certain, and he identified that "Epistemological beliefs such as these could handicap boys' engagement in learning and performance, and may partially account for their low performance relative to girls on both tasks and their lower overall academic achievement" (p.324).

However, findings of the current study were inconsistent with those who found statistically significant gender difference in favor of boys (e.g., Kahn, 2000; Paulsen & Wells, 1998). Kahn (2000), for instance, found that gender had an impact on undergraduate and graduate students' beliefs about Quick Learning, and that female students hold more naive beliefs in Quick Learning compared to male students. Kahn (2000) explained these inconsistencies as the ways in which gender is distributed between domains in which students hold more versus less naive beliefs. Kahn reported that undergraduate students majoring in natural and math sciences more likely to hold naïve beliefs about Fixed Ability and Quick Learning than the undergraduate students majoring in business or the graduate students majoring in humanities/fine arts were likely to hold less naïve beliefs in Fixed Ability and Certain Knowledge than the graduate students majoring in the social sciences, education, business, administration, engineering, and natural and math sciences. On the other hand, Paulsen and Wells (1998) reported that the girls were likely than boys to have naive beliefs in Fixed Ability and Quick Learning. Moreover, they found that boys were less likely than girls to have naive beliefs in Simple Knowledge, and stated that this finding has not been observed in any studies.

The present study failed to indicate a statistically significant difference between girls and boys with respect to Source of Knowledge, Development of Knowledge, and Certainty of Knowledge which means that girls and boys tended to have very similar beliefs about these epistemological beliefs. This result is encouraging in terms of reducing gender gap at least in Source of Knowledge, Development of Knowledge, and Certainty of Knowledge. The results partly consisted with those that revealed no statistically difference between girls and boys with respect to epistemological beliefs (e.g., Conley et al., 2004; Elder, 1999; Schommer-Aikins and Easter, 2006). For instance, Conley et al. (2004) found that boys and girls were not different with respect to Source of Knowledge, Certainty of Knowledge, Development of Knowledge and Justification of Knowledge. They observed that boys and girls had similar beliefs about nature of knowledge and knowing, and they stated that teachers and classrooms can influence the development of epistemological beliefs. On the other hand, Elder (1999) reported that there was no differences between girls and boys with respect to authority, certainty, developing, and reasoning, however, the percentage of students reporting sources of their own ideas as dependent endeavors differed by gender. A greater percentage of girls than boys supplied dependent endeavors or both independent and dependent endeavors as sources for their ideas in science. Elder suggested that hands-on science education is more equitable to girls than traditional science education and text based instruction. The findings of current study explained in light of Elder's and Conley et al.'s suggestions.

The current study also revealed a statistically significant effect of grade level on students' epistemological beliefs, explaining 3.6% of the variance. The magnitude of the grade level effect on students' epistemological beliefs was medium (Pallant, 2001). The results of the post-hoc comparisons showed a statistically significant difference between sixth and eighth grade students with respect to Source of Knowledge and Certainty of Knowledge. In other words, eighth grade students had more sophisticated beliefs about Source of Knowledge and Certain of Knowledge and they tended to believe that knowledge is not constructed by authority (e.g., teachers, books) and that there may be more than one right answer. On the other hand, no statistically significant difference was found between sixth and eighth grade students with respect to Development of Knowledge and Justification of Knowledge. Post-hoc analyses also showed that there was a statistically significant difference between sixth and tenth grade students with respect to Source of Knowledge, Certainty of Knowledge, and Development of Knowledge. This means that tenth grade students had more sophisticated beliefs about these dimensions. Moreover, a statistically significant difference was found between eighth and tenth grade students with respect to Development of Knowledge. Tenth grade students had more sophisticated beliefs about Development of Knowledge compared to eighth grade students. On the other hand, no significant difference was found between tenth and eighth grade students with respect to Source of Knowledge, Certain of Knowledge, and Justification of Knowledge. In conclusion, the students' epistemological beliefs change with respect to grade level. In general, tenth grade students had more sophisticated beliefs compared to sixth and eighth grade students, and sixth grade students had less sophisticated beliefs compared to tenth and eighth grade students. These findings were not surprising, because in line with the previous studies, the students' epistemological beliefs changed during elementary and secondary school. The students who are tenth grade level are at academically advance level when compared to sixth and eighth grade level. As suggested Jehng et al. (1993) students' epistemological beliefs develop when they are administered to more advanced education. Moreover, learners' epistemological beliefs can be affected by the instructional environment, activities, culture, and the context they exposed. The study suggested that age and maturation may play important roles in shaping students' epistemological beliefs. These findings are consistent with the prior studies (e.g., Cano 2005; Jehng et al., 1993; Kahn, 2000; Schommer, 1993). For instance, Schommer (1993) found a significant grade level effect on the students' epistemological beliefs and stated that there was epistemological development during high school, and that the students' beliefs in Simple Knowledge, Certain Knowledge, and Quick Learning changed significantly from freshman to senior year. Also, Cano (2005) reported significant differences at each school level (middle, junior high, and senior high) and claimed that as grade level increases, epistemological beliefs change, becoming less naive and simplistic, and more realistic and complex. On the other hand, Kahn's (2000) study concluded that graduate students and undergraduate students differed on their epistemological beliefs, and that graduate students who were at advanced academic level had less naive beliefs in Certain Knowledge than undergraduate students and they tended to believe that knowledge is tentative rather than absolute. The graduate students viewed knowledge as isolated pieces rather than as highly interrelated concepts. He explained the reason of this finding as the examination of learning outcomes with multiple choice exams which causes memorization rather than the study of concepts and theories. Also, Jehng et al. (1993) found that graduate students had more sophisticated beliefs than undergraduate students in terms of Certainty of Knowledge, Omniscient Authority, and Orderly Process.

However, contrary to the findings of the current study, some researchers reported no significant grade level effect on students' epistemological beliefs (e.g., Paulsen & Wells, 1998). Paulsen and Wells, reporting no statistically significant relationship between grade levels and epistemological beliefs, observed a negative relationship between students' advanced level and beliefs in fixed ability, simple knowledge, and quick learning. They suggested that only 2.8% of the sample was graduate students, which causes the lack of significance.

The results of the MANOVA revealed that there was an interaction between grade level and gender with respect to development of knowledge. When the grade level increases, the girls' mean score on Development dimension increases. The girls who were at 10^{th} grade tended to hold more sophisticated views about Development of Knowledge than the girls who were at 6^{th} and 8^{th} grades. On the other hand, the boys who were at 10^{th} grade tended to hold more sophisticated beliefs than the boys at 6^{th} and 8^{th} grades, moreover, 8^{th} grade boys had less sophisticated beliefs about Development of Knowledge compared to 6^{th} grade boys. For Development dimension, the girls at 6^{th} and 10^{th} grade had less sophisticated beliefs compared to the boys at 6^{th} and 10^{th} grade, while, the girls at 8^{th} grade had more sophisticated beliefs than the boys at 8^{th} grade. In their studies, Neber and Schommer (2002) also found an interaction between grade level and gender, this interaction indicated that the boys attending to both elementary and secondary school had naive beliefs in Quick Learning than girls, and that the high school girls' belief in Quick Learning weaker than elementary school girls.

The current study also found statistically significant but small effect of the fields of the study on students' epistemological beliefs. The 2.5% variance in students' epistemological beliefs could be explained by fields of the study. Statistically significant difference between the students attending to mathematics-science field and literature-social science fields was observed only with respect to Justification of Knowledge. The students attending to mathematics-science field had more sophisticated beliefs than the students attending to literature-social sciences and they tended to believe that the experiments and using data are necessary to construct knowledge. These results are expected because the students attending to mathematics-science field have a total of six hours science courses in a week (Table 6.1). They experience with the concepts of scientific laws and theories and they construct experiments, collect data, and interpret the results, so they observe that experiments and data are necessary to obtain knowledge in science courses. Such learning environments shape students' beliefs away from naïve beliefs in Justification toward more sophisticated beliefs. On the other hand, the students attending to literature-social science had no science courses in tenth grade level (Table 6.1). Rather, they have courses favoring literacy, history, geology, psychology, and sociology rather than positive sciences. They generally learn certain knowledge like the history, causes, and results of the wars and the experiments are not used in their lesson. The students select their fields in terms of their characteristics, the field which is selected affects their epistemological beliefs, and the students' beliefs differ in terms of fields of the study. These results, therefore, could be attributed to the characteristics of curriculum and the nature of the discipline. We concluded that disciplinary culture and instructional environment that characterizes study in these fields are important determinants of students' epistemological beliefs.

Table 6.1 Distribution of courses per week according to fields of the study

	Fields of the Study		
	Math-Sci	**Lit-Math**	**Lit-Soc**

Courses			
Mathematics	4 hours	4 hours	No Math course
Physics	2 hours	No Physics course	No Physics course
Chemistry	2 hours	No Chemistry course	No Chemistry course
Biology	2 hours	No Biology course	No Biology course

The findings of the present study are consistent with the some prior studies (e.g., Hofer, 2000; Jehng et al., 1993; Kahn, 2000; Liu & Tsai, 2008; Paulsen & Wells, 1998; Trautwein & Lüdtke, 2006). For example, Paulsen and Wells (1998) stated that students' epistemological beliefs differ in terms of their major fields of study and major fields of study may provide an explanation of the differences in students' epistemological beliefs. The results of their study showed that the students' majoring in pure fields had sophisticated beliefs about Simple Knowledge, Quick Knowledge, and Certain Knowledge than the students majoring in applied fields, and that the students majoring in hard fields had more sophisticated beliefs about Certain knowledge than the students majoring in soft fields. The reason of the differences between fields of the study was explained by Paulsen and Wells (1998) as "the distinctive characteristics of instructional environments that differentiate one disciplinary context from another might play some role in shaping or reinforcing students' epistemological beliefs either before or after students begin their college studies and select their major fields" (p.378). On the other hand, Kahn (2000) found a significant difference in college students' epistemological beliefs across fields of the study. The epistemological beliefs of students majoring in humanities/fine arts and social sciences became less naïve relative to students in other fields. Kahn explained the reason of the students' less naïve beliefs about certain majors (humanities/fine arts and social sciences) as "the way in which teaching and learning is addressed in those specific disciplines and the characteristics of the disciplinary context of the humanities/fine arts and social sciences disciplines" (p.155). In conclusion, the results of the studies revealed that the students attending to fields which are interested in science generally have more sophisticated epistemological beliefs. In Liu and Tsai (2008) indicated that science majors have less sophisticated beliefs than non-science majors and suspected that the students majoring in science were involved in an epistemic environment that knowledge in science is presented as objective and universal longer than majoring in humanities and social sciences. According to Hofer (2000), some beliefs showed the students' personal characteristics, these characteristics provide to select science as major field of study, moreover, the school science affected the students' views about the culture of science. Trautwein and Lüdtke (2006) found the statistically significant differences between fields of the study. They suggested that self selection process and socialization effects may be the reason of the differences. For example, the students who have more strongly beliefs in the certainty of scientific knowledge choose to hard science. In another study, Jehng et al (1993) stated that students who were in soft fields (i.e., social science and arts/humanities) had a stronger tendency and tended to believe that knowledge is uncertain, that learning is not an orderly process than students were in hard fields (i.e., engineering and business). According to them, instructional environments affected the students' beliefs. For example, the researchers stated that the exercises in hard fields' courses are well defined and solutions can be verified by a set of rules and principles, while most problems in soft fields are ill-structured and solutions are not immediately available. The structure of knowledge in hard fields is systemic and sequential, moreover, in soft field, the climate is full of uncertainty and contradictory. In conclusion, Jehng et al. suggested that students' beliefs are the context in which they are cultivated, product of the activity, and culture.

To sum up, the results of the study suggested that factor structure of epistemological beliefs questionnaire which consisted of Source of Knowledge, Certainty of Knowledge, Development of Knowledge, and Justification of Knowledge is supported the multidimensional theory. The results also suggested that gender, grade level and fields of the study had an effect on the students' epistemological beliefs. Girls tended to believe that evidence, experiments and data are necessary to justify knowledge compared to boys. Furthermore, the students' epistemological beliefs develop over time, so tenth grade students had more sophisticated beliefs compared to eighth and sixth grade; sixth grade students had less sophisticated beliefs. In addition, the students' epistemological beliefs differ as a function of field of the study; students' attending to mathematics-science fields had more sophisticated beliefs about Justification of Knowledge.

6. 2 Implications of the Study

In terms of the findings of this study and prior studies, following suggestions can be offered:

1. The teachers and educators should be informed about the importance of epistemological beliefs and should be explained how they can develop students' epistemological beliefs.

2. The results of the study showed that boys and girls differ in terms of Justification dimension of epistemological beliefs. The teachers and educators should encourage boys to believe more sophisticated epistemological beliefs. The teachers can provide this by using appropriate hands-on science instruction. In this instruction, the boys are able to obtain correct answers by using experiments, and evidence.

3. The results of the study showed that the students' epistemological beliefs on Source of Knowledge, Development of Knowledge, and Justification of Knowledge differ in terms of grade level. In general, tenth grade students had more sophisticated beliefs compared to sixth and eighth grade students. To develop students' epistemological beliefs with respect to grade level, the instructional methods, classroom activities, and constructivist learning environment may be arranged for science lessons.

4. In current study, the students' epistemological beliefs on Justification dimension differ in terms of the fields of the study. The students attending to math-science had more sophisticated beliefs than the students attending to literature-social sciences. The curriculum should be arranged to develop the epistemological beliefs of the students attending to literature-mathematics and literature-social science.

5. Teachers should encourage students to explicate that whether knowledge is certain or uncertain, and also whether knowledge is fixed or changing subject. For example,

teachers can demonstrate that the model of atom was changed by the scientists in terms of findings

6. 3 Recommendations for Further Research

There are some suggestions of present study for further studies:

1. In further study, longitudinal studies can be conducted. It can be beneficial to examine the change of students’ epistemological beliefs and whether the girls’ and boys’ epistemological beliefs develop throughout school time.

2. The sample of the study was selected from the public schools. The further study can be conducted to compare the students’ beliefs in different types of schools (e.g., Anatolian high schools, science high schools, social science high schools).

3. The sample consisted of sixth, eighth, and tenth grade students. It would be beneficial to conduct this study with other grade level and undergraduate school students to compare their epistemological beliefs with respect to age, gender difference, grade level, and fields of the study.

4. In this study, the effects of the gender, grade level, and fields of the study on students’ epistemological beliefs were examined; the further study can be conducted to determine the effects of the socio economic status and academic achievement on students’ epistemological beliefs.

5. The data was collected from one district of Ankara. The further study can be conducted in different regions of Turkey.

6. In this study, data were obtained by using self-reported instrument. In further study, qualitative data can be gathered using interviews and observation.

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APPENDICES

APPENDIX A

DEMOGRAPHICAL QUESTIONNAIRE

Sevgili Öğrenciler,

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

Yardımlarınız için teşekkür ederim.

ODTÜ Yüksek lisans öğrencisi

Fatma KURT

Kişisel Bilgiler

1. Cinsiyetiniz: ❑ Kız ❑Erkek
2. Doğum tarihiniz (yıl): …………….
3. Sınıfınız: ❑ 6 ❑ 8 ❑ 10
   10. sınıflar için: alanınız ❑ MF ❑ TM ❑ TS ❑ Yabancı Dil

4. **6.** ve **8.** sınıflar için: Geçen dönemki Fen Bilgisi dersi karne notunuz: ………
   10. sınıflar için: Geçen dönemki biyoloji karne notunuz:……………………

   Geçen dönemki fizik karne notunuz:………………............

   Geçen dönemki kimya karne notunuz:……………………..

5. Kardeş sayısı: …………
6. Anneniz çalışıyor mu?

❑ Çalışıyor ❑Çalışmıyor

7. Babanız çalışıyor mu?

❑ Çalışıyor ❑Çalışmıyor

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

11. Evinizde kaç tane kitap bulunuyor? (Magazin dergileri, gazete ve okul kitapları **dışında**)

❑ Hiç yok ya da çok az (0 – 10)

❑ 11 – 25 tane

❑ 26 – 100 tane

❑ 101- 200 tane

❑ 200 taneden fazla

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

13. Evinizde bilgisayarınız var mı?
❑ Evet ❑Hayır

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

APPENDIX B

TURKISH VERSION OF EPISTEMOLOGICAL BELIEFS QUESTIONNAIRE

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 C

PERMISSION TAKEN FROM THE MINISTRY OF EDUCATION

11.03.2008
İlköğretim Fen ve Matematik Bölümü
SBE/2008-265

1956

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B.30.2.ODT.0.70.72.00/400 1673-313 6.3.2008

SOSYAL BİLİMLER ENSTİTÜSÜ MÜDÜRLÜĞÜ'NE

İLGİ: 15.1.2008 tarih ve B.30.2.ODT.0.E1.00.00/2008/400/143-733 sayılı yazınız.

İlgi yazınız T.C. Ankara Valiliği Milli Eğitim Müdürlüğü'ne iletilmiş olup, alınan yazı ve ekleri ilgisi nedeni ile ilişikte sunulmuştur.

Gereğini bilgilerinize arz ederim.

Saygılarımla.

Nesrin ÜNSAL
Öğrenci İşleri
Dairesi Başkanı

ÖĞRENCİ İŞLERİ DAİRESİ BAŞKANLIĞI
Ev. Arş. ... Saat :

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

Bölüm : Strateji Geliştirme
Sayı : B B.08.4.MEM.4.06.00.04-312/ 1720
Konu : Araştırma İzni (Fatma KURT)

22.02/2008

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
Öğrenci İşleri Dairesi Başkanlığına

İlgi : a) 23.01.2008 tarih ve 956 sayılı yazınız.
b) 30.01.2008 tarih ve 312/16608 sayılı Valilik Oluru.

Üniversiteniz İlköğretim Fen ve Matematik Alanları Eğitimi Anabilim Dalı Yüksek Lisans Programı öğrencisi Fatma KURT'un, **"Öğrencilerin Epistomolojik İnançlarının Saptanması"** konulu tez çalışması kapsamında; ekli listede belirlenen okullarda uygulama yapma isteği ilgi (b) Valilik Oluru ile uygun görülmüş olup, konu hakkında çalışmanın yapılacağı İlçe Milli Eğitim Müdürlüğüne bilgi verilmiştir.

Mühürlü anket örneği (2 sayfa 26 maddeden oluşan) yazımız ekinde gönderilmiş olup, uygulama yapılacak sayıda çoğaltılması ve çalışmanın bitiminde iki örneğinin (CD/disket) Müdürlüğümüz Strateji Geliştirme Bölümüne gönderilmesi hususunda bilgilerinizi ve gereğini rica ederim.

Murat Bey BALTA
Vali a.
Milli Eğitim Müdürü

EKLER :
1. Epistomolojik İnançlar Anketi (1 sayfa, 26 madde)
2. Kişisel Bilgi Formu (1 sayfa)
3. Okul Listesi (1 sayfa)
4. Valilik Onayı (1 Sayfa)

- 03.03.08 003868

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

BÖLÜM : Strateji Geliştirme
SAYI : B B.08.4.MEM.4.06.00.04-312/ 16609
KONU : Araştırma İzni (Fatma KURT)

20.02.2007

VALİLİK MAKAMINA
ANKARA

İLGİ : a) M.E.B. Bağlı Okul ve Kurumlarda Yapılacak Araştırma ve Araştırma Desteğine Yönelik İzin ve Uygulama Yönergesi.
b) ODTÜ Öğrenci İşleri Dairesi Başkanlığının 23.01.2008 tarih ve 956 sayılı yazısı.

Orta Doğu Teknik Üniversitesi İlköğretim Fen ve Matematik Eğitimi Anabilim Dalı, Yüksek Lisans Programı Öğrencisi Fatma KURT'un **"Öğrencilerin Epistomolojik İnançlarının Saptanması"** konulu tez çalışması ilgi (a) yönerge doğrultusunda Müdürlüğümüz Değerlendirme Komisyonu tarafından incelenmiş olup, uygulanacak ölçeklerin (22 Sayfadan oluşan), ekli listede belirlenen okullarda, gönüllülük esasına dayalı olarak uygulanması Müdürlüğümüzce uygun görülmüştür.

Makamlarınızca da uygun görüldüğü takdirde Olurlarınıza arz ederim.

Murat Bey BALTA
Milli Eğitim Müdürü

OLUR
18/02/2007

Mehmet KURDOĞLU
Vali
Vali Yardımcısı

EKLER :
1. Epistomolojik İnançlar Anketi (1 sayfa 26 madde)
2. Kişisel bilgi Formu (1 sayfa)