



Elementary Students' Metacognition and Epistemological Beliefs Considering Science Achievement, Gender and Socioeconomic Status

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ABSTRACT. There were two focuses in this study. The first one was to investigate the relationship among science achievement, metacognition, and epistemological beliefs for both 4th and 5th grade and 6th through 8th grade students. The second focus was to explore the relationships among gender, socioeconomic status (SES), metacognition, and epistemological beliefs. Altogether 941 elementary students participated in this study. For 4th and 5th grade students, knowledge of cognition, regulation of cognition, and quick learning contributed to science achievement. For 6th through 8th grade students, knowledge of cognition, regulation of cognition, innate ability, and quick learning contributed to science achievement. For both group of students, while metacognition was related both to gender and SES, epistemological beliefs were mostly related to gender.

Key Words: science achievement, epistemological beliefs, metacognition, SES, gender

INTRODUCTION

As components of self-regulated learning, metacognition and epistemological beliefs currently have gained researchers' attention in an effort to understand better students' achievement all around the world (Braten & Stromso, 2005; Schommer, 1993; Sperling, Howard, Miller, & Murphy, 2002). Generally researchers have two research traditions separately to understand development and change in students' epistemological beliefs (e.g. Conley, Pintrich, Vekiri, & Harrison, 2004) and metacognition (e.g. Zimmerman, 2000) as well as their influence on students' academic achievement. More recently, researchers have argued the importance of investigating the relationship between these two psychological constructs to better understand the nature of students' learning (Schommer-Aikins, 2004). The present researchers were interested in investigating the relationships among student's science achievement, metacognition, and epistemological beliefs. Furthermore, to contribute to the literature, researchers investigated the effect of gender and SES on metacognition and epistemological beliefs in a culture where east and west traditions have an influence on students' learning.

Research into Metacognition and Achievement

One of the goals of education is to support the development of students' self-regulatory skills. Zimmerman (1986) defined the self-regulated learners as metacognitively, motivationally, and behaviorally active participants in their own learning. Researchers have been interested in studying self-regularity skills such as metacognition (Amsterlaw, 2006; Sperling et al., 2002; Veenman & Elshout, 1999). "Metacognition refers to awareness that learners have about their general academic strengths and weaknesses and of the cognitive resources they can apply to meet the demands of particular tasks, and second, to their knowledge and skill about how to regulate engagement in tasks to optimize learning process and outcomes" (Winne & Perry, cited in Annevirta & Vauras, 2006, p. 198).

Research on children's metacognition generally includes one of two frameworks (Sperling et al., 2002). One of the framework developed by Flavell (1979) presents metacognition as including metacognitive knowledge and metacognitive experiences. Metacognitive knowledge includes task, person, and strategy components. Metacognitive experiences include feelings of understanding and may

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be implementation of appropriate strategy. Another framework developed by Brown (1978) also claimed two components: knowledge of cognition and regulation of cognition. While knowledge of cognition refers to what individuals know about their own cognition, regulation of cognition refers to metacognitive activities that help control one's own thinking and learning (Schraw & Moshman, 1995).

The knowledge of cognition includes declarative, procedural, and conditional knowledge. Declarative knowledge includes knowledge about factors that may influence individual's performance. Procedural knowledge includes knowledge about the way skills are applied. Conditional knowledge includes knowledge about when and why to apply different cognitive actions. The regulation of cognition includes planning, monitoring, and evaluation constructs. Planning includes selection of necessary strategies to attain intended goals. Monitoring includes regulations or periodic self-testing of individuals' actions during task performance. Evaluation includes analysis of the end products and personal abilities on the task (Paris, Lipson, & Wixson, 1983; Schraw & Moshman, 1995). The current study selected the Brown framework of metacognition as the theoretical framework because the instrument used in the current work was developed by Sperling et al.'s (2002) study while considering the Brown framework.

Effects of metacognition on students' general achievement have been studied by several researchers. Peklaj and Pecjak (2002) found that metacognitive knowledge increased from low to high achieving students. According to van Kraayenoord and Schneider (1999), metacognition affected reading comprehension scores of the participants. Taraban, Rynearson, and Kerr (2000) found that college students' comprehension strategy use was significantly related to higher levels of academic performance. Hwang and Vrongistinos (2002) found that high achieving inservice teachers were more likely to use various self-regulated learning strategies than the low achievers. Sperling et al. (2002) investigated the relationship between achievement and metacognition. The significant correlations between the achievement and metacognition were found for grades 3 through 5. No relationship was observed for 6th through 8th grades students' scores. In order to determine the relationships between achievement and metacognition Sperling et al. (2002) made a literature review and based on their search they realized that the relationship between achievement or aptitude and metacognitive constructs is not clear.

Research into Epistemological Beliefs and Achievement

Research on the nature of knowledge, or epistemology, began with Perry (1968). Since then personal epistemologies have been defined in two different ways. In one definition, researchers define epistemologies as developmental stages (King & Kitchener, 2004; Kegan, 1982; Perry, 1970). In this definition, personal epistemologies develop in parallel with individual cognitive development. Researchers who accept this definition also view personal epistemologies as one-dimensional constructs in which an individual passes through these stages based on his/her their cognitive development.

Other researchers view epistemologies as collections of beliefs (Schommer, 1988; Schommer & Walker, 1997; Schraw, Dunkle, & Bendixen, 1995). Schommer (1990) defined epistemological beliefs from a multidimensional perspective, including beliefs about the nature of knowledge, the certainty, the source, the justification, the acquisition, and the structure of knowledge. In this research tradition, it is argued that epistemological beliefs dimensions develop as a more or less independent of each other. Schommer's (1990) studies pioneered the quantitative measurement of epistemological beliefs on multidimensional perspectives. In her studies, Schommer validated the epistemological questionnaire she had developed. Both with college students (Schommer, 1990) and with high school students (Schommer, 1993), the questionnaire was validated and replicated regarding four factor structures in epistemological beliefs. Schommer's questionnaire later on was used by different researchers with different samples in different countries. Lodewyk (2007) used the questionnaire and obtained three factors, which were fixed and quick ability to learn, simple knowledge, and certain knowledge, in a sample of high school students in Canada. Braten and Stromso (2005) utilized the questionnaire and found that speed of knowledge, certainty of knowledge, knowledge construction and modification, and control of knowledge acquisition were common factor structures in a sample of college business and teacher education majors in Norway.

Schommer's (1990) hypothesized dimensions received critiques from other researchers as well. For example, Hofer and Pintrich (1997) stated that quick learning and innate ability are not epistemological dimensions due to their relationship with nature of learning rather than nature of knowing. They postulated four epistemological dimensions as certain knowledge, simple knowledge, omniscient authority, and justification for knowing. Existence of these dimensions was validated by several studies in different samples (Elder, 2002; Kuhn, 1991). In the present study, Schommer's hypothesized dimensions were used to determine elementary students' epistemological beliefs.

During the last decade most of the studies of epistemological beliefs studies focused on different aspects of the older students' academic performance. In those studies, it was mainly found that students who had better comprehension scores got more sophisticated epistemological beliefs in simple and certain knowledge (Kardash & Scholes, 1996; Schommer, Crouse, & Rhodes, 1992). Similarly, students who got higher grade point averages developed more sophisticated epistemological beliefs in quick learning and innate ability (Schommer, 1990; Schommer & Walker, 1997). Likewise, Schommer (1993) examined the influence of epistemological beliefs on overall academic performance. She conducted analyses in which students' grand point averages (GPAs) were regressed on the four epistemological factor scores. Results of analyses revealed that the less students believed in quick learning, simple knowledge, certain knowledge, and fixed ability, the better were their GPAs.

Most recently, researchers started to study younger students' epistemological beliefs to test the hypothesis that students develop epistemological beliefs at early ages (Conley et al., 2004; Schommer-Aikins, Duell, & Hutter, 2005). It was argued that there should be a link between children's theory of mind and epistemological thinking (Chandler, Hallett, & Sokol, 2002). Conley et al.'s (2004) study demonstrated that elementary school students' epistemological beliefs about science changed over time. After a nine-week science course about chemical properties of substances taught with an emphasis on science process skills instruction, the students develop more sophisticated beliefs about the both the source and certainty of knowledge. Authors argued that at this age level, development of the students' epistemological beliefs can be fostered by hands-on or inquiry oriented instruction. Related to students' academic achievement, it was found that higher achiever in science developed more sophisticated epistemological beliefs. In another study, Schommer-Aikins et al. (2005) observed that multidimensional model is applicable for middle grade students. They found that even though quick learning and innate ability were observed as distinct factors in older students, in younger students these two factors emerged as a single factor. It was stated that young children have a global theory of mind whereas older students' mind possessed knowledge as processes and components. Again at this age level studying aimlessly was found as another factor in which younger students believed that learning occurs as chance not as a strategic activity. Related to the achievement variable, authors found that both beliefs in quick learning and innate ability are predictors of students' mathematical problem solving ability. Earlier studies in high school (Schommer, 1993) and college levels, (Schommer, 1990) demonstrated that the development of more sophisticated epistemological beliefs resulted in better use of mathematical problem solving skills and comprehension of complex text. Schommer-Aikins et al. (2005) also found that general epistemological beliefs and mathematical beliefs affect students' mathematical performance and overall academic achievement. Conley et al. (2004) found that low achieving children in science had less sophisticated beliefs in comparison to high achieving children.

Approach to Gender and SES Variables

In this study, gender and SES were used together to better understand the effect of these variables on students' metacognition and epistemological beliefs. The literature presented below clearly presents the reasons of including both gender and SES together in this research.

Unger (1979) differentiated "sex" from "gender". According to the author, sex is a biological characteristic and gender is a cultural characteristic of females and males. Similarly, Rennie (1998, p. 959) argued that "if the issue of gender is to be considered effectively in science teacher education, account must be taken of the way gender is constructed in terms of ethnicity, class, religion, race and

often other variables as well.” In Baker’s study (2003), gender and equity in science education have been reviewed since 1971. This review revealed that between the years 1971 and 1978 not much emphasis was given on gender or equity. In 1980s, gender was investigated with respect to socioeconomic status, but this research was lack of sociological and feminist perspective. In late 1980s, gender equity became an important issue in several studies. By 1990s, researchers became interested in creating a school environment in which girl-friendly instructional strategies, topics, and curriculum would be implemented. Researchers started to investigate the relationship among gender, race, ethnicity, economic status, and religion. Finally, after 2001 researchers started to investigate gender and urban issues.

Historical understanding of gender studies indicated a very important issue for researchers. In this understanding, it is clear that gender issue had been investigated in relationship with other variables such as cognitive abilities, attitudinal variables, sociocultural variables, and home-family variables (Kahle & Meece, 1994). It was indicated that females and males develop their understanding about different aspects of science teaching and learning under the influence of those variables. That is to say, gender differences show heterogeneous findings across different variables. Related to the relationship between gender and cognitive abilities, no clear relationship has been established by researchers. For attitudinal variables males showed superior performance level in the physical sciences but females showed superior performance level in biological sciences. In addition, in science classroom while females mostly preferred teacher demonstrations and writing about science, males preferred problem solving, watching TV about science, and learning about famous scientists (Rae, 1999). In terms of confidence, males have more confidence in their academic abilities in science (Dweck, 1986) but females have more positive perceptions than males about achievement motivation (Simpson & Oliver, 1990). However, Kahle and Meece (1994) summarized that based on the research results gender differences were not similar with respect to different age groups and content areas. Thus, it was difficult to make general conclusion about the relationship between gender and attitudinal variables. Regarding to the relationships between sociocultural variables and gender researchers found several results. For example, females’ success in scientific work was underestimated due to sociocultural influences. In addition, Rossiter (1982) stated that since the scientific work was seen as masculine activity, gender stereotypical image was formed favoring males (Kahle & Meece, 1994). Research on home-family variables such as ethnicity, socioeconomic status, and parental education revealed that these variables affected students’ science achievement in direct and indirect ways. Family background variables influenced science achievement in an indirect way through the availability of economic capacity, the quality of home environment, parents’ educational and occupational aspirations, and the quality of the schools attended. Gender role socialization within the home occurs differently for boys and girls. For example, Hoffman (1977) showed that parents gave importance to their sons’ occupational success, ambitions, and intelligence whereas for their girls they valued being kind, well mannered, and having a good marriage. Moreover, at home boys found more opportunity to play scientific games than girls and those experiences enabled boys to have higher science proficiency scores (Kahle & Lakes, 1983). As a conclusion of their study, Kahle and Meece (1994) argued that ability, level, ethnicity, and socioeconomic status may influence gender differences in science. It was suggested that research on these variables should be conducted to better reflect the changing population characteristics of today.

Baker’s (2003) summary of the equity issues in science education covered the articles published until 1996. Thus Kahle and Meece’s (1994) and Baker’s (2003) summaries show similarities with respect to time frame. However, in Baker’s (2003) summary, the author tried to examine the gender issues from the aspect of women and minorities in science. He summarized that women and minorities had limited chance to reach school science due to country characteristics, school characteristics (instruction type, teacher expectations, curriculum materials, access to education, policy and program guidelines), parental attitudes and economic conditions of family, cultural factors (cultural norms and values), and nature of science (science is a White European male domain).

This review of the literature suggests that there needs to be more study conducted in nonwestern

cultures to investigate the gender issue in relationship with ethnicity, race, socioeconomic factors, sociocultural issues, rural-urban setting, home and family characteristics and etc. to better establish the relationships among these variables and cognitive and affective aspects of learning. In this study gender was explored in relationships with socioeconomic factors, which include school setting –urban or rural-, parents’ employment –employed father or mother-, and parent education level, to better understand elementary school students’ epistemological beliefs and metacognition in their science courses. Treating socioeconomic factors from a wide perspective enabled us to investigate the elementary school students’ epistemological beliefs and metacognition in their science courses while considering the gender and SES issues, which are stated in above literature review.

Effects of Gender and SES on Students’ metacognitive skills and Epistemological Beliefs

Sperling et al. (2002) investigated the effects of gender on the two dimensions of the metacognitive skills (knowledge of cognition and regulation of cognition) and could not observe any gender differences in either version of the instrument. There is not enough research available for the effects of SES on students’ metacognitive skills.

Effects of gender on personal epistemological beliefs have been studied by a few researchers. Schommer’s (1993) study investigated gender differences. According to her results girls were less likely to believe in quick learning and fixed ability than boys. On the contrary, Belenky, Clinchy, Goldberger, & Tarule (1986) argued that at the early developmental stage of personal epistemology females view knowledge as handed down by authority while males view knowledge as mastering what is handed down by authority. In this argument, it is clear that at the same stage of the epistemological development females’ epistemological development is less complex than those males with respect to authority.

Related to effects of SES on students’ epistemological beliefs one of Schommer’s (1990) study revealed that “the more educated parents have and the more they expect their children to take responsibilities in the home and for their own thinking, the more likely children to develop a sophisticated system of epistemological beliefs” (p. 503). Conley et al (2004) found that with elementary science students, students with low SES had less sophisticated epistemological beliefs in comparison to students with average SES.

Several researchers (Sungur & Senler, 2009; Sungur, 2007; Yumusak, Sungur, & Cakiroglu) in Turkey explored students’ metacognition in the high schools level. However, there are few studies conducted to measure relationships among *elementary* school students’ gender and SES with their metacognition and epistemological beliefs in all education research area. Especially, in nonwestern cultures, very limited research is available in this manner. Thus, this study will fill a gap in the literature while investigating relationships among elementary school students’ gender, SES, and their epistemological beliefs and metacognition.

METHOD

Sample

The instruments of this study were administered to 315 students enrolled in fourth and fifth grades and 626 students enrolled in sixth, seventh, and eighth grades of seven elementary schools located in Ankara, Turkey. While the target population of the present study was all students enrolled in fourth through eighth grades in Turkey, the accessible population of the present study consisted of all students enrolled in fourth through eighth grades in Ankara, Turkey. Of 315 participants 178 were female and 137 were male. Of 626 participants 326 were female and 300 were male. Schools were selected randomly to gather data from the urban and rural regions of Ankara. A total, 941 students participated in this study.

Instruments

As a quantitative research approach, survey method was used to explore the students' metacognition and epistemological beliefs considering their SES, gender, and science achievement. Two instruments were used to explore students' metacognition (Jr MAI) and epistemological beliefs (EB).

Junior metacognitive awareness inventory (Jr. MAI)

Sperling et al., (2002) developed Jr. MAI (two versions) to measure elementary school students' metacognition. The first inventory (Jr. MAI, Version A) consists of 12 items with a three-choice response (never, sometimes, or always) for use with learners in grades 3 through 5. The second inventory (Jr. MAI, Version B) consists of the same 12 items but also included 6 additional items and used a 5-point Likert scale for use with learners in grades 6 through 8. The instrument was translated into Turkish by Yilmaz-Tuzun and Topcu (2007).

In order to determine the factors of the Jr. MAI, exploratory factor analysis with orthogonal varimax rotation and an eigenvalue of 1 criterion "principal factoring extraction" was performed. For 4th and 5th grade and 6th through 8th grades students the results indicated the presence of two factors and these factors explained the 39% and 36% of the sample variances respectively. Two factor structures fitted well with the Sperling et al., (2002) model. For both groups, Factor 1 was named as regulation of cognition and Factor 2 was named as knowledge of cognition. The alpha reliability values were 0.6 and 0.7 for knowledge of cognition and regulation of cognition dimensions respectively for 4th and 5th grade students. Moreover, the alpha reliability values were 0.7 and 0.8 for knowledge of cognition and regulation of cognition dimensions respectively for 6th through 8th grade students.

Schommer epistemological belief questionnaire (EB)

Schommer (1990) developed the Schommer Epistemological Questionnaire (SEQ) to measure college students' epistemological beliefs. Then Schommer developed elementary school students' version of the SEQ, which is called as EB. The EB included 30 items in Likert format. These items were classified under four dimensions namely, Ability to Learn (Innate Ability), Speed of Learning (Quick Learning), Stability of Knowledge (Certain Knowledge), Structure of Knowledge (Simple Knowledge) (Schommer-Aikins, Mau, Brookhart, & Hutter, 2000). Later on, in another study, Schommer-Aikins et al., (2005) classified items in four different dimensions namely Quick/Fixed Learning, Studying Aimlessly, Omniscient Authority, and Certain Knowledge. In this study, Quick and Fixed learning dimensions could not be separated from each other and Studying Aimlessly emerged as a new dimension. In light of our previous research (Topcu & Yilmaz-Tuzun, 2007) we hypothesized our dimensions as Ability to Learn, Speed of Learning, Stability of Knowledge, Structure of Knowledge and Omniscient Authority. Total item numbers of each dimension are 9, 7, 2, 9, and 2 respectively. The instrument was translated and adapted into Turkish by Topcu and Yilmaz-Tuzun (2007). The researchers conducted a pilot study with the a hundred students for each groups. Reliability values of each factor were found as tolerably low for innate ability, quick learning, omniscient authority, and certain knowledge. For example, with respect to omniscient authority dimension, the reliability value was found as .443. Similar reliability values were found by Schommer et al. (2005) who developed this instrument for the same factor structures. Because of these low indices, the items were reconsidered by the researchers, and necessary changes were made with respect to translation of items and understandable of items by the students. Table 1 presents the sample items from each dimension.

The subscales were subjected to confirmatory factor analysis. Confirmatory factor analysis enabled us to determine the number of factors that could account for elementary school students' epistemological beliefs. For the 4th and 5th grades, we did analysis with five-factor model and four factor models. However for five factors model goodness-of-fit indices were not satisfactory to claim adequate model. In our four factors model we removed the items belonging to Omniscient Authority dimensions due to those items smaller factor loadings. Finally, with four factor model we obtained satisfactory goodness-of-fit indices, $\chi^2: df = 2.26$, Goodness-of-Fit Index (GFI) = .96, Adjusted

goodness-of-Fit Index (AGFI) = .93, Root Mean Square Residual (RMR) = 0.05. According to model, Factor 1: Innate Ability; Factor 2: Quick Learning; Factor 3: Simple Knowledge; and Factor 4: Certain Knowledge. For 6th through 8th grade students we again tried five and four factor model. Five factor model did not give satisfactory goodness-of-fit indices. Eventually, Simple Knowledge factor was removed from the model. Four factor model gave acceptable goodness-of-fit indices, $\chi^2: df = 2.26$, GFI = .95, AGFI = .91, RMR = 0.06. According to model, Factor 1: Innate Ability; Factor 2: Quick Learning; Factor 3: Omniscient Authority; and Factor 4: Certain Knowledge. For both students group the findings showed the similarities with the Schommer-Aikins et al. (2000) and Schommer-Aikins et al. (2005) findings.

Table 1. *Sample Items for each Hypothetical Dimension of Epistemological Questionnaire*

Hypothetical Dimension	Item
Innate Ability	Some people are just born smart, others are born dumb. Students who are average in school will remain average for the rest of their lives.
Quick Learning	If I can not understand something right away, I will keep on trying. Learning something really well takes a long time.
Certain Knowledge	I can depend on facts written in my school books for the rest of my life. Today's facts may be tomorrow's fiction.
Omniscient Authority	Scientists can get the truth if they just keep searching for it. If scientists try hard enough, they can find the truth to almost anything.
Simple Knowledge	The best thing about a science course is that most problems have only one right answer. Being a good student generally involves memorizing facts.

Data Collection and Analysis

Data collection was carried out during the fall 2006. An assistant helped us to collect data. The assistant collected data in each school. In order to assure the consistency of the data collection procedure the assistant followed the same procedure in each classroom. Response rate was 90% for each of the data collection site. The assistant explained the study purpose to the students in class and invited them to participate in the study voluntarily. Students, who have agreed to participate, completed the questionnaire in class while the assistant was present in order to answer any of the students' questions. Two separate surveys related to metacognition and epistemological beliefs were implemented into students. Moreover, students' some SES variables, gender, and science grade point referring last semester were collected. Students' science achievement was limited to only their last semester science grade point.

In the second part of data analysis, to better understand the effect of predictor variables (gender and SES) which might be associated with each dimension of the EB and Jr.MAI, multiple regression analysis was conducted. To determine the best model associated with each dimension of the EB and Jr.MAI, a statistical stepwise regression strategy was utilized. In this analysis, predictor variables were inserted into the model based upon the statistical criteria. When a stepwise strategy is used to investigate data set similar to that presented in this paper, a regression analysis is initiated with no variable, and each predictor variable is added to the equation, one at a time, to determine whether the predictor variable significantly contributes to the regression equation (Tabachnick & Fidel, 2001). For all of our analysis The Statistical Package for Social Science (SPSS) version 13.0 for Windows was used.

RESULTS

There were two focuses in this study. First one was to investigate the relationship among science achievement, metacognition, and epistemological beliefs for 4th and 5th grades and 6th through 8th grades. The second focus was to explore the relationships among gender, SES, and metacognition and epistemological beliefs for 4th and 5th grades and 6th through 8th grades.

Relationship among Science Achievement, Metacognition, and Epistemological Beliefs

The analysis for 4th and 5th grade students revealed that knowledge of cognition, quick learning and regulation of cognition dimension of the two instruments significantly contributed to the model (Table 2). Overall predictor variables in this model explained the 20% of the variability in the students' science achievement. This finding revealed that metacognition influenced the students' science achievement more than epistemological beliefs. In other words, developing better metacognition increased the students' science achievement. Among several dimensions of the EB, only quick learning contributed to students' science achievement. That is, when students see that learning is a gradual process rather than quick got better science grades.

Table 2. *Multiple Regression Analysis Results among Science Achievement, Jr. MAI and EB Dimensions for grades 4th and 5th.*

Science Achievement	β Weight	Adjusted R ²	F	p
Knowledge of Cognition	.225	.200	20.773	.000
Quick Learning	-.179			
Regulation of Cognition	.190			

The multiple regression analysis for 6th to 8th grades students revealed that knowledge of cognition, regulation of cognition, innate ability, and quick learning significantly contributed to the model (Table 3). This model explained the 14% of the variability in the students' science achievement. Similar to 4th and 5th grades this finding revealed that metacognition influenced the students' science achievement more than epistemological beliefs. Still for the students in this level improving metacognition increased the students' science achievement. EB dimensions revealed that developing more sophisticated beliefs on innate ability and quick learning resulted in better science achievement. That is to say, high achiever students see that learning is a gradual process and ability to learn is not fixed at birth.

Table 3. Multiple Regression Analysis Results among Science Achievement, Jr. MAI and EB Dimensions for 6th through 8th Grades

Science Achievement	β Weight	Adjusted R ²	F	p
Knowledge of Cognition	.193	.14	23.900	.000
Regulation of Cognition	.162			
Innate Ability	-.104			
Quick Learning	-.099			

The Relationships among Gender, SES, and Metacognition and Epistemological Beliefs for 4th and 5th and 6th through 8th Grade Students

Multiple regression analysis is used to explain how accurately each of the four factor dimensions (Innate ability, Quick Learning, Simple knowledge, and Certain knowledge) of EB and two dimensions of Jr.MAI (knowledge of cognition and regulation of cognition) generated for 4th and 5th can be predicted from a linear combination of SES and gender. Table 3 summarizes the results of the analysis.

Table 4. Multiple Regression Results for grades 4th and 5th

Jr.MAI Dimensions	β Weight	Adjusted R ²	F	p
Knowledge of Cognition				
Father Education Level	.189	.10	7.815	.000
Girls	.127			
Urban	-.135			
Mother Education Level	.142			
Regulation of Cognition				
Girls	.183	.10	6.922	.000
Working Father	-.163			
Father Education Level	.134			
Urban	-.137			
Mother Education Level	.121			
EB Dimensions				
Quick Learning				
Girls	-.207	0.06	9.888	0.000
Mother Education Level	-.154			
Innate Ability				
Girls	-.130	0.02	5.263	.022

For knowledge of cognition mean scores, four of the predictor variables —father education level, girls, urban, mother education level— contributed significantly to the model. Altogether these variables explained 10% of the variability in the knowledge of cognition mean scores. According to the beta weights given in the table, several dimensions of the SES contributed to the model. Those dimensions were father education level, schools in urban areas, and mother education level. When the father and mother education level increased the students developed better knowledge of cognition skills. However the students in urban areas developed less knowledge of cognition skills during their science courses. Girls developed better metacognition in their science courses.

For regulation of cognition mean scores, five of the predictor variables —girls, working father, father education level, urban, mother education level— contributed significantly to the model. Altogether these variables explained 10% of the variability in the regulation of cognition mean scores. Beta weights revealed that similar to knowledge of cognition, when father education level and mother education level increased, the students developed better regulation of cognition skills. Again the students in urban areas developed less regulation of cognition skills. Interestingly as a dimension of SES the students who have working fathers developed less regulation of cognition skills. Girls developed better regulation of cognition skills.

As a dimension of EB, for quick learning mean scores, two of the predictor variables —girls, mother education level— contributed significantly to the model. Of the 6% variance in the quick learning mean scores were explained by predictor variables. Beta weights indicated that when mother education level increased the students believed that learning is a gradual process not quick process (more sophisticated epistemological beliefs). Results also revealed that being girls was an indication of having more sophisticated epistemological beliefs in quick learning dimension.

Table 5. Multiple Regression Results for Grades 6th through 8th

Jr.MAI Dimensions	β Weight	Adjusted R²	F	p
Knowledge of Cognition				
Father Education Level	.147	.05	10.816	.000
Urban	.111			
Girls	.093			
Regulation of Cognition				
Girls	.177	.04	12.331	.000
Urban	.095			
EB Dimensions				
Innate Ability				
Girls	-.119	.02	8.452	.004
Omniscient Authority				
Girls	.121	.02	8.683	.003
Quick Learning				
Girls	-.105	.01	6.530	.011

For innate ability mean scores, one of the predictor variables —girls— significantly contributed to the model. This finding revealed that girls developed more sophisticated beliefs in innate ability in that girls believed that ability to learn is not fixed at birth rather it can be developed with formal and informal experiences. For 6th to 8th grades, the multiple regression analysis procedure utilized for 4th and 5th grades was conducted. Table 5 summarizes the results of the analysis.

For knowledge of cognition mean scores, three of the predictor variables —father education level, urban, girls— contributed significantly to the model. Altogether these variables explained 5% of the variability in the knowledge of cognition mean scores. Findings revealed that when the father education level increased the students developed better knowledge of cognition skills. Again students in urban areas developed better knowledge of cognition skills. Girls developed better metacognition in their science courses.

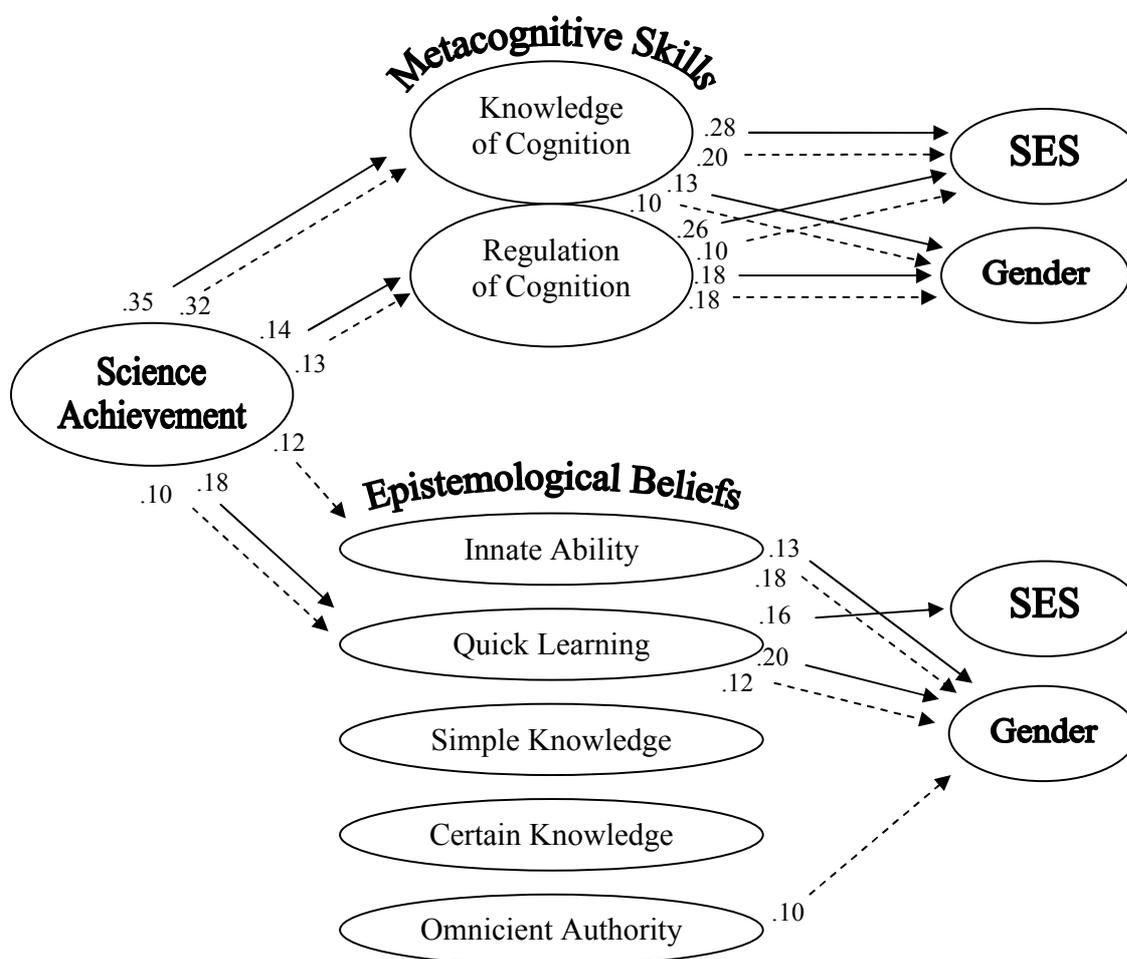


Figure 1. Pattern of relationships among science achievement, metacognition, epistemological beliefs, SES and gender. Straight arrows refers to correlational values for 4th and 5th grade students, dashed arrows refers to correlations values for 6th through 8th grades.

For regulation of cognition mean scores, two of the predictor variables —girls, urban— contributed significantly to the model. Girls and the students in urban areas developed better regulation of cognition skills.

As dimensions of the EB, for omniscient authority mean scores, innate ability mean scores, and quick learning mean scores only one of the predictor variables —girls— contributed significantly to the models. Beta weights indicated that the girl students developed more sophisticated epistemological beliefs in innate ability and quick learning dimensions of the EB but less sophisticated epistemological beliefs omniscient authority dimension of the EB.

Based on the multiple regression analysis we summarized the relationships among science achievement, metacognition, epistemological beliefs, gender, and SES in below figure (Figure 1). According to values in figure 1 it was clearly found that science achievement was related to metacognition more than epistemological beliefs. While metacognition related to both SES and gender, epistemological beliefs mostly related to gender.

DISCUSSION

This study revealed that elementary school students' science achievement was related to their (Figure 1) metacognition and epistemological beliefs. Based on the number and magnitude of correlations found in this study it can be suggested that students' metacognition seem to play more important role in improving students' achievement than their epistemological beliefs. This finding suggested that science achievement was mostly influenced by metacognition. Schraw, Crippen, & Hartley (2006) supported the idea that as a form of motivation, self-efficacy and personal epistemological beliefs are "necessary, but not sufficient, for skilled learning" (p.116). They argued that "the role of metacognition is especially important because it enables individuals to monitor their current knowledge and skill levels, plan and allocate limited learning resources with optimal efficiency, and evaluate their current learning state" (p.116). This way of approach to learning may improve science achievement. As Sperling et al., (2002) stated the relationship between metacognition and achievement is inconsistent and not well addressed in earlier research. For example, some researchers claimed that metacognitive processes are separate from achievement whereas some others argued that increase in metacognition should lead to increase in academic achievement (Sperling, et al., 2002). This study supported that metacognition was related to students' science achievement.

In another hypothesis it was stated that the relationship exists between metacognition and achievement should be less strong in the younger academic years than in more advance years (Sperling, et al., 2002). However, with their study Sperling et al.'s (2002) could not support this hypothesis. Similar to Sperling et al.'s (2002) study this study fails to support this hypothesis because in this study we found that in younger years knowledge of cognition and regulation of cognition explained the science achievement as proportion of 14% and in advanced years knowledge of cognition and regulation of cognition explained achievement as proportion of 12%. Sperling et al.'s (2002) stated that "it is more likely that learners age and gain in more content specific knowledge, strategic processes also become more domain specific. Hence, a more domain-general measure of metacognitive processes loses its predictive power" (p. 74). Similar to this quotation, in this study, older students may have developed more domain specific metacognition in their science courses.

For both 4th and 5th grades and 6th through 8th grades while metacognition were related to both gender (being female) and SES (father education level, mother education level, urban), epistemological beliefs were mostly related to gender (being female). Being girl was positively correlated with knowledge of cognition and regulation of cognition in both 4th and 5th grades and 6th through 8th grades. For epistemological beliefs females developed more sophisticated beliefs in quick learning and innate ability dimensions in 4th and 5th grade students. In 6th through 8th grades in addition to these epistemological beliefs girls developed less sophisticated beliefs in omniscient authority. In Turkey, in science courses most of the time the instructional delivery method includes teacher demonstrations, explanations, and writing about science and learning by memorization was seen as the common learning strategy among the students (Berberoglu & Hei, 2003). Since these characteristics of the science courses are more suitable for female students (Rae, 1999) these students might find a more suitable classroom environment to develop their metacognition and epistemological beliefs. Similarly Zimmerman and Martinez-Pons (1990) also

found that among self-regulation skills girls mostly used record keeping and monitoring, environmental structuring, and goal setting and planning than boys. Related to epistemological beliefs, similar to our findings Schommer (1993) also found that females may have a slight epistemological advantage with respect to quick learning and innate ability. However, Belenky et al.'s (1986) finding was contrary to our findings. Less sophisticated beliefs in omniscient authority might also again result in the females' preferences in learning science. Being passive during the science courses and accepting what their teachers say were expected as types of epistemological beliefs that are present in omniscient authority dimension of the EB.

Furthermore, Muis, Bendixen, & Haerle (2006) argued that students' epistemological beliefs may show differences across different subject matters. They defined domain-specific epistemic beliefs "as beliefs about knowledge and knowing that can be articulated in reference to any domain to which students have been exposed" (p. 36). It was emphasized that domain specific epistemic beliefs are shaped by teachers' teaching approaches, grading, school policies and practices. The findings of this study supported the idea that the way the science courses implemented in our classrooms influence students' epistemological beliefs. We assume that some of the general epistemological beliefs we measure in this study may form the students' domain specific epistemological beliefs. Muis et al. (2006) also point that a student's general epistemic beliefs interfere with more domain-specific beliefs.

Results revealed that in 4th and 5th grades father and mother education level positively correlated with students' metacognition. Earlier studies in different age levels revealed that parents' education level positively related to students' science achievement (Schibeci & Riley, 1986; Simpson & Oliver, 1990). As we stated earlier we found positive relationships between science achievement and metacognition. Thus, parents' education level might influence students' science achievement in indirect way. For 6th through 8th grades only father education level contributed significantly to the knowledge of cognition. Thus this finding suggests that parent education level influence younger students' metacognition more than older students. In other words, when the age level increases children become less depend on their parents to develop their metacognition.

As a dimension of SES, urban contributed students' metacognition negatively for 4th and 5th grades but positively in 6th through 8th grades. This finding reflects effects of Turkish Educational Testing system. All elementary students have to take high school entrance exam after their elementary school education. When students have high grades from this exam, they will have an opportunity to enter prestigious schools such as Anatolian or Science High Schools. For this purpose, parents of 6th through 8th grade students, mostly in urban areas, use their economical advantages to provide private courses and teachers for their children. As a result, these children need to follow both their regular schools and those private courses requirements. Thus, these children learn better use of their metacognition in order to achieve in those requirements. Unfortunately, for 4th and 5th grades students in urban areas could not take the advantageous of living in urban areas to develop their metacognition. On the contrary having comfortable living conditions let these students to be inattentive in their learning.

Annevirta and Vauras (2006) stated that children's ability to regulate their performance is influenced by environmental variables, social interaction, child's own regulatory skills and adult's role in problem solving processes. They emphasized that in order to accurately measure young children's metacognition researchers need to consider the effects of those variables. Findings of this study supported that environmental variable such as going to schools in urban setting, social interaction with parents, and parents' educational level were significantly influenced the young students' metacognition.

In addition to above major findings, one of our multiple regression analysis findings for 4th and 5th grade students indicated that for quick learning, mother education level contributed to model. As it was expected, when mother education level increased students' epistemological beliefs became more sophisticated in which students believed that learning is gradual rather than quick process. Since being more patient than fathers and knowing that learning takes time as a result of their education, mothers may help their children to have this belief.

CONCLUSION AND IMPLICATIONS

Based on the distinctive correlations found between metacognition and science achievement, it seems important to enhance students' metacognition to increase their science achievement in elementary school.

For epistemological beliefs, we found correlations between innate ability and quick learning and students' science achievement. Related to other three dimensions of the EB we could not observe any relationships between them and science achievement. However, earlier studies' findings supported the idea that students with higher achievement developed more sophisticated epistemological beliefs in different dimensions (Schommer, 1990; Schommer & Walker, 1997). Thus, we believe that the students' epistemological beliefs need to be developed in different dimensions for having better science achievement. Teachers, principals, and policy makers should give enough importance to developing students' epistemological beliefs throughout their formal education.

As it was indicated in the discussion, the way the science courses implemented in Turkey is more suitable for females' preferences. This approach might be one of the reasons for females to develop better metacognition and epistemological beliefs than that of male students. Moreover, in university entrance exam and high school entrance exams female students had higher scores in science sections than male students (Ministry of Education, 2006; Bilisim Teknolojileri Toplulugu, 2005). This may also an indication of effects of metacognition and epistemological beliefs on the science achievement. But one needs to keep in mind that result of the high stake exams in Turkey revealed contradictory information with the common belief revealed by earlier studies in other countries, in which it was reported that due to effects of different variables (home-family variables, educational variables) males had a superior success in and attitudes toward science over girls (Kahle & Lakes, 1983; Kahle & Meece, 1994).

In this study, not only gender but also SES contributed significantly to the students' metacognition and epistemological beliefs. This study revealed that students with educated parents have advantageous over others in terms of developing their metacognition and epistemological beliefs. Since those variables indirectly influence students' science achievement, students with different SES need to be considered by teachers in order to increase those students' learning in science.

Teachers' role in developing young children metacognition (Annevirta & Vauras, 2006) and epistemological beliefs (Schommer- Aikins, 2004) are important. Thus, as a future research it is necessary to investigate the effects of teachers' behaviors and teaching styles on development of children's metacognition and epistemological beliefs. Teachers play critical role in making students become aware of what makes a skillful learner, how s/he can take the responsibility of his/her learning, and learn the knowledge with well developed epistemological understanding.

Most of the current research revealed the importance of studying domain specific metacognition and epistemological beliefs. The results of this study and such the future studies may be very helpful for domain specific teachers to organize their learning environment and activities. Moreover, teacher educators may help preservice teachers to learn such information throughout their teacher education programs.

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İlköğretim Öğrencilerinin Biliş Ötesi ve Epistemolojik İnançlarıyla Fen Başarıları, Cinsiyetleri ve Sosyoekonomik Durumları

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ÖZ. Bu çalışmanın iki ana amacı vardır. Birincisi, 4. ve 5. sınıf ve 6, 7 ve 8. sınıf öğrencilerinin fen başarısı, biliş ötesi bilgi-düzenlemeleri ve epistemolojik inançları arasındaki ilişkiyi belirlemektir. İkincisi ise cinsiyet ve sosyoekonomik statü (SES) ile biliş ötesi bilgi-düzenlemeleri ve epistemolojik inançlar arasındaki ilişkileri incelemektir. 4 ve 5. sınıflar için yapılan çoklu regresyon analizinde, biliş ötesinin her iki boyutu ve öğrenmenin anında ve çabucak gerçekleşmesini temsil eden epistemolojik inanç boyutu anlamlı bir şekilde öğrencilerin fen başarısını açıklamıştır. 6, 7 ve 8. sınıflar içinse yine biliş ötesinin her iki boyutu ve epistemolojik inançların bilginin doğuştan kazanıldığı ve öğrenmenin anında ve çabucak olduğu boyutları anlamlı bir şekilde öğrencilerin akademik fen başarısını açıklamıştır. Bunun yanı sıra tüm öğrenci grupları için biliş ötesinin her iki boyutu cinsiyetle ve sosyoekonomik statü ile ilişkili iken epistemolojik inançlar daha çok cinsiyetle ilişkili bulunmuştur.

Anahtar Sözcükler: fen başarısı, epistemolojik inançlar, biliş ötesi bilgi ve düzenleme, SES, cinsiyet

Amaç ve Önem: Bu çalışmanın iki ana amacı vardır. Birincisi, 4. ve 5. sınıf ve 6, 7 ve 8. sınıf öğrencilerinin fen başarısı, biliş ötesi bilgi-düzenlemeleri ve epistemolojik inançları arasındaki ilişkiyi belirlemektir. İkincisi ise cinsiyet ve sosyoekonomik statü (SES) ile biliş ötesi bilgi düzenlemeler ve epistemolojik inançlar arasındaki ilişkileri incelemektir. Şu ana kadar literatürde çoğunlukla üniversite seviyesinde öğrencilerin biliş ötesi bilgi-düzenlemeleri ve epistemolojik inançları incelenmiştir. Bu çalışmada ise, bu değişkenlerin ilköğretim seviyesinde incelenmesinin yanı sıra, bu değişkenlerin fen başarısı, cinsiyet ve sosyoekonomik statü gibi demografik değişkenlerle olan ilişkisine bakılmıştır. Yine Amerika başta olmak üzere, birçok batı ülkesinde öğrencilerin biliş ötesi bilgi-düzenlemeleri ve epistemolojik inançlarına bakılmışken bu konuda doğu ve orta doğu ülkelerinde böyle bir çalışmaya çok nadiren rastlanmaktadır. Türkiye doğuyla batı arasında yer alan bir ülke olarak, Türkiye'de yapılan bu çalışma literatüre sosyokültürel anlamda değerli katkılar sağlayacaktır.

Yöntem: Çalışmada nicel bir araştırma yöntemi kullanılmıştır. Tarama yöntemiyle (survey) toplam 941 ilköğretim öğrencisinden bilgi toplanmıştır. Araştırma ölçekleri 315 dördüncü ve beşinci sınıfta bulunan öğrenciye uygulanırken; 626 altı, yedi ve sekizinci sınıf öğrencisine uygulanmıştır. Ankara'da bulunan okullar rastgele seçim yöntemiyle belirlenmiştir. Ayrıca, Ankara ilinin hem merkezi hem de kırsal kesimlerinden tamamen rastgele bir şekilde bilgi toplanmıştır. Çalışmada iki ölçek kullanılmıştır. Bunlardan birincisi Sperling ve arkadaşları (2002) tarafından geliştirilen Junior Metacognition Awareness Inventory (Jr. MAI) ölçeğidir. Ölçeğin Türkçeye çevrilmesi, geçerlik ve güvenilirlik çalışmaları Yılmaz-Tuzun ve Topcu (2007) tarafından yapılmıştır. Geçerlik ve güvenilirlik çalışmaları yapılan bu ölçek, yine bu çalışmada ilköğretim öğrencilerinin biliş üstü bilgi ve düzenlemelerini tespit etmek için kullanılmıştır. İkinci ölçek ise, Schommer-Aikins ve arkadaşları (2000) tarafından geliştirilen ilköğretim öğrencileri için epistemolojik inanç ölçeğidir. Bu ölçeğin de Türkçeye çevrilmesi, geçerlik ve güvenilirlik çalışması Topcu ve Yılmaz-Tuzun (2007) tarafından yapılmıştır.

Bulgular: 4. ve 5. sınıflar için yapılan çoklu regresyon analizinde biliş ötesinin her iki boyutunun ve öğrenmenin hızlı olduğunu temsil eden epistemolojik inanç boyutlarının anlamlı bir şekilde öğrencilerin fen başarısını açıkladığı tespit edilmiştir. 6, 7 ve 8. sınıflar içinse yine biliş ötesinin her iki boyutu ve epistemolojik inançların bilginin doğuştan kazanıldığı ve öğrenmenin hızlı olduğu boyutları anlamlı bir şekilde öğrencilerin fendeki akademik başarısını açıklamıştır. Bunun yanı sıra, tüm öğrenci grupları için biliş ötesinin her iki boyutu cinsiyetle ve sosyoekonomik statü ile ilişkili iken, epistemolojik inançlar daha çok cinsiyetle ilişkili bulunmuştur.

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Tartışma, Sonuç ve Öneriler: İlköğretim öğrencileri için biliş ötesi bilgi ve düzenlemeyle fen başarıları arasındaki pozitif bir ilişkinin bulunması araştırmacıları şöyle bir çıkarım yapmaya itmiştir. Eğer ilköğretim öğrencilerinin biliş ötesi bilgi ve düzenlemeleri geliştirilirse bu durum öğrencilerin fen başarısında bir artışa yol açabilir. Yine epistemolojik inançların bazı boyutlarıyla fen başarısı arasında anlamlı ilişkiler bulunmuştur. Bu konudaki literatürün de bu sonucu desteklemektedir (Schommer, 1990; Schommer & Walker, 1997). Eğer öğrencilerin epistemolojik inançları istenen ve ileri yönde gelişmişse bu öğrencilerin fen başarısının da bu yönde gelişmesi gerektiği bu çalışmada olduğu gibi birçok çalışmada da belirtilmiştir. Bu durumda öğretmenler öğrencilerin formal eğitimi boyunca onların epistemolojik inanç yönünden gelişmelerine önem vermelidirler.

Yapılan bu çalışmada her iki öğrenci grubu için cinsiyet bakımından kızların erkeklere göre daha gelişmiş düzeyde biliş üstü bilgi ve becerilere sahip oldukları tespit edilmiştir. Aynı zamanda, iki öğrenci grubu içinde, öğrenmenin anında ve çabucak gerçekleşmesini temsil eden epistemolojik inanç boyutu ve bilginin doğuştan kazanıldığı boyutlarında kızların erkeklere göre daha gelişmiş düzeyde epistemolojik inançlara sahip oldukları tespit edilmiştir. Yine ülkemizde üniversite ve liselere giriş sınavlarında kızların erkeklere göre daha başarılı oldukları tespit edilmiştir (Ministry of Education, 2006; Bilişim Teknolojileri Topluluğu, 2005). Yapılan bu çalışmayla, her ne kadar kızların başarılarında başka eğitsel ve sosyal değişkenler etkili olabilse de, biliş üstü boyutların ve epistemolojik inançların kızlarda daha gelişmiş olmasının başarılarını da olumlu yönde etkilediğini söyleyebiliriz.

Bu çalışmada cinsiyetin yanı sıra sosyoekonomik statünün de anlamlı bir şekilde ilköğretim öğrencilerinin epistemolojik inançlarını ve biliş üstü boyutları açıkladığı tespit edilmiştir. Örneğin, anne ve babası eğitilmiş aile çocuklarının epistemolojik inançlar ve biliş üstü boyutları bakımından daha gelişmiş düzeyde buldukları tespit edilmiştir.

İlköğretim öğrencilerinin biliş üstü bilgi ve düzenlemelerini (Annevirta & Vauras, 2006) ve epistemolojik inançlarını (Schommer-Aikins, 2004) geliştirmede öğretmenlerin rolü önemlidir. Bu nedenle, öğretmenlerin davranışlarının ve öğretim stillerinin öğrencilerin biliş üstü bilgi ve düzenlemelerinin ve epistemolojik inançlarının gelişiminde önemli etkisinin olduğu düşünülmektedir. Bu konuda gelecekte yapılacak olan araştırmalar bu konuya ışık tutacaktır.