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Exploration of Preservice Science Teachers' Epistemological Beliefs, World Views, and Self-Efficacy Considering Gender and Achievement

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ABSTRACT. The purpose of this study was to investigate preservice science teachers' epistemological beliefs, epistemological world views, and self-efficacy beliefs with respect to academic achievement and gender. A total of 391 preservice science teachers participated in this study. Schommer's Epistemological Questionnaire was administered to measure their epistemological beliefs. Factor analysis revealed four factor structures: "Innate ability," "Certain knowledge," "Simple knowledge," and "Omniscient authority." Furthermore, contribution of these factors, epistemological world views, and self-efficacy beliefs on students' grade point average were examined. Innate ability, simple knowledge, and epistemological world views significantly contributed to senior students' grade point average. For freshmen students, significant differences were obtained for omniscient authority, innate ability, and epistemological world views with respect to gender. For senior students, significant differences were obtained for innate ability, omniscient authority, self-efficacy, and outcome expectancy with respect to gender. This cross sectional study suggested that PSTs' epistemological beliefs might change over time and have relationship with their academic achievement.

Key Words: Academic achievement; epistemological beliefs; epistemological world views; gender; self-efficacy beliefs.

INTRODUCTION

Epistemological beliefs refer to teachers' beliefs about the nature of knowledge and knowing. It might be claimed that teachers' epistemological beliefs, epistemological world views, and self-efficacy beliefs might be related to each other (Yilmaz-Tuzun & Topcu, 2008). Having a particular epistemological world view (relativist, realist, contextualist) may influence teachers' belief about the nature of knowledge and knowing (Simple Knowledge, Certain Knowledge, Innate Ability, Omniscient Authority, Quick Learning). According to previous research (e.g., Yilmaz-Tuzun & Topcu, 2008; Schommer-Aikins, 2002; Schraw, & Olafson, 2002), realistic world view is found as positively correlated with less sophisticated beliefs about knowledge. However, contextualist and relativist world views are found as positively correlated with more sophisticated epistemological beliefs. Schraw and Olafson (2002) argued that teachers having realistic world view accepted a less sophisticated belief in simple knowledge, certain knowledge, and omniscient authority. On the contrary, teachers who hold relativist world view developed more sophisticated epistemological beliefs in certain knowledge. Since epistemological world views are mostly related to teaching practices, teachers' epistemological world view might be related to his or her self-efficacy beliefs. However, there are few studies (e.g., Yilmaz-Tuzun & Topcu, 2008) exploring relationships between epistemological world views and self-efficacy beliefs. Moreover, there is not much research on exploring relationships among gender, academic achievement, self-efficacy beliefs, epistemological beliefs and world views. However, we believed that self-efficacy beliefs, epistemological beliefs and world views may show different patterns according to gender and academic achievement.

There are several reasons why authors of this study collected and analyzed Turkish preservice science teachers' beliefs regarding to epistemology, self-efficacy, and epistemological world views with respect to GPA and gender. Some of the reasons were directly related to Turkey. First, as it was stated by Schommer (1994) epistemological beliefs are influenced by education and culture. Since in Turkey there are not many studies about development of individual epistemological beliefs and how Turkish

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educational system and culture contributed to this development, it is important to collect, evaluate, and react Turkish preservice teachers' epistemological beliefs. Second, Turkey is currently redesigning aspects of its educational policy with teachers and students. Thus, the findings of this study are of great value in terms of guiding such efforts at the local and national level. Finally, Turkey presents some interesting and unique characteristics. Turkey has traditionally been influenced by the East and the West; thus results of this study may reflect the Turkish context and could provide possible differences between the East and the West. This study aimed to determine the contributions of epistemological beliefs, epistemological world views, and self-efficacy beliefs on PSTs' GPA. Moreover, in this study the differences in gender regarding PSTs' epistemological beliefs, epistemological world views, and self-efficacy beliefs were explored.

Epistemological Beliefs

The epistemological belief refers to specific belief that people hold about nature of knowledge (Schraw & Olafson, 2002). Epistemological beliefs about nature of knowledge have recently gained researchers' attention in education. Many research revealed that those beliefs are important predictors in students' learning (Hofer & Pintrich, 1997; Schommer, 1993). For example, the more students believe in certain knowledge, the more likely they understand that knowledge written in the tentative text is absolute scientific facts (Schommer, 1990). Historically, studies on personal epistemological beliefs have been started with unidimensional approach. In this approach, researchers have viewed personal epistemologies as developmental stages (e.g., Kegan, 1982; King & Kitchener, 2004). In other words individuals develop their epistemological beliefs in accordance with their cognitive developmental stages. Perry (1968) was the pioneering scholar who studied university students' personal epistemological beliefs. The studies of Perry revealed that students were entering the university with less sophisticated epistemological beliefs such as believing that knowledge is simple, certain, and handed down by authority. However, throughout their education they developed sophisticated epistemological beliefs such as, believing that knowledge is complex, tentative, and acquired through reason and empirical evidence. In multidimensional approach, studies on personal epistemologies have been started with Schommer (1990). Schommer (1993) defined the epistemological beliefs as a system of more or less independent beliefs. In this system there is more than one belief that individual may hold and that person may have sophisticated in some beliefs but not necessarily sophisticated in other beliefs. In contrast to unidimensional approach, in multidimensional approach while a person developing a dimension of epistemological beliefs, she may or may not develop other dimension(s). Schommer (1990) hypothesized five epistemological beliefs that people may hold. These hypothesized beliefs are: (a) the stability of knowledge ranging from unchanging knowledge to tentative knowledge (Certain Knowledge), (b) the structure of knowledge ranging from isolated bits and pieces to integrated concepts (Simple Knowledge), (c) the source of knowledge ranging from omniscient authority to reason and empirical evidence (Omniscient Authority), (d) the speed of learning ranging from quick or not-at-all to gradual (Quick Learning), and (e) the ability to learn ranging from fixed at birth to improvable (Innate Ability). For example, in this system a person may have highly sophisticated epistemological beliefs about certain knowledge, in which she believes that scientific knowledge is tentative, but at the same time she may have less sophisticated belief about omniscient authority, in which she believes that scientific knowledge handed down by authority.

In Turkey, research on epistemological beliefs have been built on two trends. First trend is about the validation and translation of epistemological beliefs instruments in Turkish context (e.g., Acat, Tüken, Karadağ, 2010; Deryakulu & Büyüköztürk, 2002; Deryakulu & Büyüköztürk, 2005). The second trend is related to exploration of the relationships between epistemological beliefs and other demographic/educational variables in Turkish context (e.g., Aksan & Sözer, 2007; Deryakulu, 2002; Deryakulu & Büyüköztürk, 2005; Meral & Çolak, 2009). In the first trend, Deryakulu and Büyüköztürk (2002) translated and validated Schommer's Epistemological Questionnaire (SEQ) with Turkish University students and found three epistemological beliefs factors (learning depends on effort; learning depends on ability; and there is one truth). The researchers also found that the SEQ should consist of 35

items instead of 63 items in Turkish context. As another validation study of the SEQ, the same researchers (Deryakulu & Büyüköztürk, 2005) studied with Turkish University students and found the same three-factors structure to explain epistemological beliefs. However, they determined that 34 items were useful to explore epistemological beliefs. As seen in these studies, approximately half of the SEQ items were deleted by the researchers to explore epistemological beliefs. In addition, they explored three-factor structure that is not consistent with the current literature. Therefore, further research is necessary to test 63-item and four-factor structure of the SEQ with new samples in Turkish context. In the second trend, Aksan and Sözer (2007) reported significant relationships between university students' epistemological beliefs and problem solving skills. Deryakulu (2002) found significant differences on the types of comprehension monitoring with respect to epistemological beliefs of university students. Deryakulu and Büyüköztürk (2005) reported that female university students had more sophisticated epistemological beliefs than male students.

Although there are many studies exploring relationships between epistemological beliefs and other demographic/educational variables in the current literature, the relationships among epistemological beliefs, GPA, and gender were studied by a few researchers. Schommer (1993) examined the influence of epistemological beliefs on overall academic performance of secondary students. She conducted analyses in which students' GPAs were regressed on the four epistemological factor scores. Results of those analyses revealed that the less the students believed in quick learning, simple knowledge, certain knowledge, and fixed ability; the higher their GPAs were. Gender differences were also investigated in the studies of Schommer (1993) and Schommer, Calvert, Gariglietti, and Bajaj (1997). According to those findings, girls were less likely to believe in quick learning and fixed ability than boys. Marzoohgi, Fouladchang, and Shemshiri (2008) found that Iranian males had less sophisticated epistemological beliefs than females. Conley, Pintrich, Vekiri, and Harrison (2004) stated that when epistemological beliefs can change over time from less sophisticated to more sophisticated; some personal factors can facilitate or restrain these beliefs. In the literature about the role of gender in epistemological beliefs, there are several studies. However, aforementioned studies revealed that there is no consensus regarding the role of gender in epistemological thinking. When Schommer (1993) and Schommer et al. (1997) claimed that gender has an important role in epistemological thinking, King and Kitchener (1994) and Kuhn (1991) stated that gender has almost no role in epistemological thinking. Finally, Pintrich (2002) stated that gender may not have role in epistemological thinking when it is thought as separate dimensions of epistemological beliefs.

Epistemological World Views

The term epistemological world view refers to teachers' set of beliefs about nature of knowledge and acquisition of knowledge (Schraw & Olafson, 2002). Epistemological world views include set of epistemological beliefs and other beliefs such as how epistemological beliefs are acquired and developed and how these beliefs are changed over time. In other words, epistemological world views consist of both epistemological beliefs and the way those beliefs are gained and utilized by people (Schraw & Olafson, 2002). According to Schraw and Olafson (2002), teachers may possess three different epistemological world views. These world views are named as realist, contextualist, and relativist epistemological world views. In each view teachers hold different epistemological beliefs about students' learning, scientific knowledge, and teaching. Thus teachers with realist world view see themselves active during teaching because their role is to transmit knowledge to students, who are seen as passive recipients of the knowledge. Teachers with contextualist world view focus on process of constructing knowledge and to extend the application of that knowledge into the context it is learned in. Teachers with relativist world view provide opportunities to students to learn and think independently. These teachers hold more sophisticated epistemological beliefs than teachers who hold contextualist world view and that teachers with realist world view hold the least. For example, when teachers having relativist world view believe that today's knowledge is suspicious tomorrow, teachers having realist world view believe knowledge doesn't change much over time and represents the accumulation of important truths. The former teachers thinks that knowledge is messy, changing, and must be personalized through experience but in contrast

the latter teachers thinks that knowledge is relatively simple, fixed, and teachable in the same way to a wide array of students (Schraw, Crippen, & Hartley, 2006).

Self-efficacy Beliefs

Numerous research have been conducted to investigate teachers' self-efficacy beliefs (Ashton & Webb, 1986; Dembo & Gibson, 1985; Riggs & Enochs, 1990). Teacher efficacy beliefs are defined as "the extend to which the teacher believes he or she has the capacity to affect student performance" (Berman, McLaughlin, Bass, Pauly, & Zellman, 1977, p. 137). Many researchers have utilized Bandura's self-efficacy theory to explain teacher efficacy. Bandura's self-efficacy theory emphasized the relationship between personal self-efficacy beliefs and actions and behaviors of people (Bandura, 1995). His theory suggested that "self-efficacy beliefs influence the course of action people choose to pursue, how much effort they put forth in given endeavors how long they would persevere in the face of obstacles and failures, their resilience to adversity, whether their thought patterns are self-hindering or self-aiding, how much stress and depression they experience in coping with taxing environmental demands, and the level of accomplishment they realize" (Bandura, 1995, p. 3). Self-efficacy theory includes two cognitive dimensions. These dimensions are personal self-efficacy expectancy and outcome expectancy. According to Bandura (1977), "an outcome expectancy is defined as a person's estimate that a given behavior will lead to certain outcomes. An efficacy expectation is the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193). Similar to the epistemological beliefs, the effects of students' understanding of scientific concepts and gender on self-efficacy beliefs have been studied by a few researchers. Schoon and Boone (1998) studied the effect of having alternative conceptions on PSTs' self-efficacy beliefs. They found that as the number of alternative conceptions increase, the PSTs' self-efficacy and outcome expectancy beliefs decrease. According to Bleicher (2004) and Enochs and Riggs (1990), the male students had higher score on self-efficacy dimension of the STEBI than the female students.

METHOD

Sample

Sample of the study consisted of 391 PSTs who were enrolled in the freshman and the senior courses of five research universities. Freshman and senior students were selected since the researchers planned to compare epistemological beliefs of students who just started their teacher education with students who will complete their education nearly. The selected universities were located in three big cities in Turkey, respectively, Ankara, Eskisehir, and Van. Of 391 participants, 227 were female students and 164 were male students. A total of 178 freshmen PSTs 103 were female and 75 were male. A total of 213 senior PSTs 124 were female and 89 were male. Convenient sampling method was used in the present study. Data was collected from the cities of Eskisehir, Ankara, and Van. Since the sampling is convenient the cities where the participants' retrieved were not the representative of the regions they located. Rather with this sampling we try to capture heterogeneous views regarding the variables interested. Another words, this way of selecting participants have potential in increasing the variability. From each city, different number of universities was enrolled in this study because, in our investigation, we also wanted to capture PSTs' profiles in the each participating city. Ankara, the capital of Turkey, has many universities. To represent the students' characteristics at this city, data were collected from three public universities. A total of 298 preservice teachers participated from these three universities. The other two cities have only one public university; therefore, from each of these cities, only one university was enrolled. From Eskisehir, 32 preservice teachers, and from Van, 61 preservice teachers participated. All of the participating universities were public universities. In each city more than %50 of the preservice science teachers voluntarily participated in the study. Thus, having more than 30% return rate was enough to continue to the study.

Instruments

Schommer Epistemological Questionnaire (SEQ)

Schommer (1990) developed the SEQ to measure college students' epistemological beliefs. The questionnaire includes 63 items. For each item, students can select one of the 5 options (strongly disagree, disagree, undecided, agree, and strongly agree). The questionnaire comprises 5 hypothetical dimensions (simple knowledge, certain knowledge, omniscient authority, innate ability, and quick learning). The reliability of the SEQ was measured by inter item reliability for the items composing each factor ranging from 0.51 to 0.78 (Schommer, 1993). Higher scores obtained from the SEQ refer to less sophisticated epistemological beliefs. These factors were namely, innate ability, simple knowledge, quick learning, and certain knowledge. Turkish translation and validation of the SEQ was made in the previous study of the researchers (Yilmaz-Tuzun & Topcu, 2008). According to this study, with orthogonal varimax rotation and an eigenvalue that is greater than one (as a cutoff point for factors), "principal factoring extraction" generated four factors that account for 54.61% of the variance. Factor analysis results revealed four factors: innate ability, simple knowledge, certain knowledge, and omniscient authority. Inter-item reliabilities for items that compose each epistemological beliefs factor ranged from 0.20 to 0.60.

Epistemological World View Scale (EWV)

This scale focuses on three different epistemological world views. Schraw and Olafson (2002) named these views as realist, contextualist, and relativist world views. This instrument includes 3 vignettes (Schraw & Olafson, 2002). For each vignette, a 5-choice, 3-item Likert-type scale was used. Higher scores obtained from the EWV supports more student-centered and constructivist-based teaching approaches in science classrooms. Inter-item reliability for items was 0.60. For the validity of the translation of the epistemological world view scale, a procedure similar to that for the SEQ was followed.

Self-Efficacy Scale (STEBI-B)

The two scales in the STEBI-B, designed for pre-service teachers, were entitled Personal Science Teaching Efficacy Belief Scale (self-efficacy dimension) and Science Teaching Outcome Expectancy Scale (outcome expectancy dimension). The STEBI-B was a 5-choice, Likert-type scale for pre-service teachers. The respondents in the study completed the Science Teaching Efficacy Belief Instrument Form B (STEBI-B) (Pre-service version) developed by Riggs and Enochs (1990). This instrument used a 5-choice, 23-item Likert-type scale for pre-service teachers –self-efficacy dimension has 13 items and outcome expectancy dimension has 10 items. Higher scores obtained from the STEBI-B refer to more sophisticated self-efficacy beliefs. Riggs and Enochs (1990) reported that the items in the self-efficacy scale and outcome expectancy scale had high reliability (0.89 and 0.76). Appropriate changes in the wording of the items in the instrument were made for the Turkish teachers (Tekkaya, Cakiroglu, & Ozkan 2004). Similar to English version of the STEBI-B, Tekkaya et al. (2004) found high reliability values for the dimensions of the self-efficacy (0.84) and outcome expectancy (0.76). This Turkish version of the STEBI-B was used in the present study.

Data Collection and Analysis

Data collection was carried out during the fall of 2009. An assistant at each university administered the scale. In order to assure the consistency of the data collection procedure each assistant were informed about the administration of the scale. In the first part of data analysis factor analysis was run to determine the factor structure of the SEQ in Turkish context. This analysis enabled us to compare our results with the previous research findings. In factor analysis, once the factor structure was determined, factor scores were calculated for each factor. For the later analysis, these factor scores were utilized. In the second part of data analysis, in order to better understand how the predictor variables might be associated with PSTs' GPA, multiple regression analysis was conducted. To determine the best model associated with students GPA, a statistical enter regression strategy was used. In this analysis, all

of the predictor variables were inserted into the equation simultaneously. Then the independent variables (Innate ability, Certain knowledge, Simple knowledge, Omniscient authority, Epistemological World View, Self-Efficacy, and Outcome Expectancy beliefs) were evaluated in terms of its predictive power over dependent variable (PSTs' GPA) (Pallant, 2001). In the third part of data analysis, Multivariate Analysis of Variance (MANOVA) was performed on gender differences in order to find its effect on 7 dependent variables (Innate ability, Certain knowledge, Simple knowledge, Omniscient authority, Epistemological World Views, Self-Efficacy, and Outcome Expectancy beliefs).

RESULTS

Descriptive Results of Some Selected Items in SEQ, STEBI-B, and EWV

To provide better understanding about items from the instruments, mean and standard deviation scores of these items were presented in Table 1. Items were selected randomly from the instruments in order to provide better representation of the instruments.

Table 1. *Mean and Standard Deviation Scores of Some Selected Items in SEQ, STEBI-B, and EWV*

SEQ Dimensions	N	M	SD
Item 1 (SEQ)	391	3.30	1.10
Item 30 (SEQ)	387	1.86	0.81
Item 5 (STEBI-B)	385	3.75	0.82
Item 15 (STEBI-B)	380	3.82	0.80
Item 1 (EWV)	386	3.20	1.15
Item 3 (EWV)	385	4.07	0.88

In the SEQ, when individuals get high scores (above 2.5), this means that individuals have less sophisticated epistemological beliefs. The item 1 of the SEQ was "If you are ever going to be able to understand something, it will make sense to you the first time you hear it". The mean score of the item 1 showed that PSTs had less sophisticated epistemological beliefs in quick learning dimension of epistemological beliefs. The item 30 of the SEQ was "A sentence has little meaning unless you know the situation in which it is spoken". The mean score of the item 30 showed that PSTs had more sophisticated epistemological beliefs in simple knowledge dimension of epistemological beliefs.

In the STEBI-B, when individuals get high scores (above 2.5), this means that individuals show more sophisticated self-efficacy beliefs. The item 5 of the STEBI-B was "I know the steps necessary to teach science concepts effectively." The mean score of the item 5 showed that PSTs had more sophisticated self-efficacy beliefs in teaching science concepts. The item 15 of the STEBI-B was "Students' achievement in science is directly related to their teacher's effectiveness in science teaching." The mean score of the item 15 showed that PSTs had more sophisticated self-efficacy beliefs regarding teacher's effectiveness in science teaching.

In the EWV, when individuals get high scores (above 2.5), this means that individuals support constructivist (student-centered) teaching approaches. Both items of 1 and 3 results suggested a classroom environment in which teachers design their learning environment considering constructivist (student-centered) teaching approaches. The mean scores of the items 1 and 3 showed that PSTs supported student-centered and constructivist-based learning environments in the science classrooms.

For all instrument items, standard deviation scores ranged 0.80 to 1.15. These values showed that PSTs' self-efficacy beliefs, epistemological beliefs, and epistemological world views scores mostly differentiated and scattered instead of gathering together around mean scores.

Factor Structure of the SEQ

Factor structure of the SEQ was determined in our earlier study (Yilmaz-Tuzun & Topcu, 2008). In here we provide summary of our exploratory factor analysis. Factor analysis enabled us to determine the number and the characteristics of factors that could account for students' responses on the questionnaire. With orthogonal varimax rotation and an eigenvalue that is greater than one (as a cutoff point for factors), "principal factoring extraction" generated four factors that account of 54.61 % of the variance. Factor analysis revealed four factor structures in the data. Factors were named with the technique that Schommer used. Schommer gave descriptive titles to each factor on the basis of high loadings subsets of items. While naming the factors she only considered the subsets that have factor loadings higher than .50. We followed the similar procedure in naming our factors. According to our results, Factor 1 was named as "Innate ability"; Factor 2 was named as "Certain knowledge"; Factor 3 was named as "Simple knowledge"; Factor 4 was "Omniscient authority".

Exploring the predictors of GPA with respect to epistemological beliefs, epistemological world views and self-efficacy beliefs

Multiple regression analysis is used to explain PSTs' GPA with each of the four factor scores of epistemological beliefs (Innate ability, Certain knowledge, Simple knowledge, Omniscient authority), two factor scores of self-efficacy beliefs (self-efficacy beliefs, outcome expectancy beliefs) and mean scores of epistemological world views. In order to test the assumptions we checked the normal distribution with the histogram of the standardized residuals, sample size, multicollinearity (none of the correlations among independent variables were found as higher than 0.50), and linearity. All of the assumptions were not violated for each of our regression analysis. Stevens (1996) suggests that 15 subjects per predictor are needed to met sample assumption. Since the number of the sample (391) exceeds critical number of sample (15 X 7 = 105), this assumption was not violated. Multicollinearity assumption was also not violated since the values of correlations among independent variables ranged 0.25 to 0.38. In order to check the assumptions of the normal distribution with the histogram of the standardized residuals and linearity, we controlled the Normal Probability Plot, and observed that our points lied in a reasonably diagonal line from bottom left to top right. This suggested no major deviations from normality, therefore, no violations in terms of this assumption. The multiple regression analysis suggests that for freshman students none of the predictors contributed to PSTs' GPA. For senior students, innate ability, epistemological world view, and simple knowledge contributed significantly to the model (Table 2). These variables explained totally 10 % of the variability in the PSTs' GPA (Adjusted $R^2 = 0.10$, F (3, 210) = 9.19, $p < 0.05$). Beta weight for innate ability -0.28, epistemological world view -0.15, and simple knowledge -0.14 were found. Effect size (f^2) was found as 0.11. Calculated effect sizes revealed small effect size for senior GPA according to conventional values for effect sizes defined by Cohen (1988). This effect size revealed that the model has significant practical values. Small effect size is not trivial effect size, it indicates the practical value of the statistical significance. Since there are not enough earlier research to compare our effect size, this finding was interpreted as that the correlations among the epistemological beliefs and academic achievement should be considered.

Table 2. *Multiple Regression Results Investigating the Predictors of GPA with respect to Epistemological Beliefs, Epistemological World Views and Self-Efficacy Beliefs*

SEQ Dimensions	B Weight	Adjusted R^2	F	p value
Senior GPA				
Innate Ability	-0.28	0.10	9.18	<.05
Epistemological World View	-0.15			
Simple Knowledge	-0.14			

Exploring the effects of gender on PSTs' epistemological beliefs, epistemological world views, and self-efficacy beliefs

To control errors resulting from multiple comparisons, a multivariate analysis of variance (MANOVA) was performed. MANOVA analysis is used to explain effects of gender on each of the four factor scores of epistemological beliefs (innate ability, certain knowledge, simple knowledge, omniscient authority), two factor scores of self-efficacy beliefs (self-efficacy beliefs, outcome expectancy beliefs) and mean scores of epistemological world views. In order to test the assumptions we checked the normal distribution with the univariate and multivariate normality. Centered Leverage (0.03-0.16), Cook's Distance (0.00-0.04), and Mahalanobis Distance (0.57-27.10) values were found in accepted range (Tabachnick & Fidel, 2001). Box Plots results (Box's M significance value = 0.21) indicated that covariance matrices of the dependent variables were equal across groups (Tabachnick & Fidell, 2001). Error variances of the dependent variables are equal across groups. Multicollinearity and linearity assumptions are also met. Linearity assumption recommends a straight-line relationship between each pair of the dependent variables (Pallant, 2005). For each pair of dependent variables, the scatterplots were checked, and found linear relationships instead of curvilinear or diagonal relationships. Multicollinearity assumption was also not violated since the values of correlations among dependent variables ranged 0.22 to 0.36. A 1 x 7 MANOVA was run to determine possible differences between PSTs' responses of female and male students based on different four factor scores of epistemological beliefs (Innate ability, Certain knowledge, Simple knowledge, Omniscient authority), epistemological world views (mean scores), self-efficacy beliefs (factor score 1), and outcome expectancy beliefs (factor score 2). MANOVA analysis was run separately for freshman and senior students. Freshman and senior students were considered since the researchers planned to compare epistemological beliefs of students who just started their teacher education with students who will complete their education nearly. Since the present study is a kind of cross-sectional study, the researchers just tried to capture PSTs' epistemological beliefs when they first enter to program and when they ready to graduate from the program.

For freshman students the multivariate test was significant for the main effect of gender, Wilks' Lambda = 0.91, F (7, 163) = 2.09, $p < .05$). Univariate follow-up revealed significant differences on innate ability (F (1, 171) = 10.26, $p < .05$), simple knowledge (F (1, 171) = 10.45, $p < .05$), and epistemological world view (F (1, 171) = 3.96, $p < .05$). Follow up analysis revealed very interesting trend among female and male students. For innate ability dimension of the SEQ male students had higher scores than female students. For simple knowledge dimension of the SEQ female students had higher scores than male students. For epistemological world view female students had higher scores than male students. For senior students the multivariate test was significant for the main effect of gender, Wilks' Lambda = 0.80, F (7, 201) = 7.14, $p < .05$). Univariate follow-up revealed significant differences on innate ability (F (1, 209) = 17.23, $p < .05$), simple knowledge (F (1, 209) = 7.46, $p < .05$) omniscient authority (F (1, 209) = 7.16, $p < .05$), self-efficacy (F (1, 209) = 8.66, $p < .05$), and outcome expectancy (F (1, 209) = 7.87, $p < .05$). For innate ability dimension of the SEQ, male PSTs had higher scores than female PSTs. For omniscient authority dimension of the SEQ female PSTs had higher scores than male PSTs. For self-efficacy beliefs female PSTs had higher scores than male PSTs. For outcome expectancy beliefs female PSTs had higher

scores than male PSTs. For all variables small effect sizes were found between .023 and .077 according to conventional values for effect sizes defined by Cohen (1988). These effect sizes revealed that the findings have practical values.

Table 2. *MANOVA Performed on Gender*

	Wilks' Lambda	**F**	**df**	**p**
Freshman	0.91	2.09	7	<.05
Senior	0.80	7.14	7	<.05

Table 3. *Univariate Pairwise Comparison of Gender*

			F	**p**	**f^2**	**Female and Male Mean Scores**
Freshman						
	Innate ability	Female	10.26	< .05	0.05	2.16
		Male				2.36
	Simple Knowledge	Female	10.45	< .05	0.06	3.32
		Male				3.17
	Epistemological World View	Female	3.96	< .05	0.02	3.92
		Male				3.73
Senior						
	Innate Ability	Female	17.23	< .05	0.08	2.07
		Male				2.29
	Simple Knowledge	Female	7.46		0.03	3.24
		Male				3.12
	Authority	Female	7.17	< .05	0.03	3.07
		Male				2.88
	Self-efficacy	Female	8.66	< .05	0.04	3.98
		Male				3.80
	Outcome Expectancy	Female	7.87	< .05	0.04	3.66
		Male				3.49

DISCUSSION

According to multiple regression analysis results, when considering the predictors of PSTs' GPA for seniors, innate ability had significant (negative) relationships. These relationships indicated that less PSTs believe in innate ability the higher GPA scores they gained. As it is expected, high achiever PSTs believed that students' learning ability is not fixed at birth but indeed it is a skill that can be developed. This finding is not similar to Schommer's (1993) studies, where she found only "belief in quick learning" predicts "the academic achievement." In both cross-sectional research (Schommer, 1993) and longitudinal research (Schommer et al., 1997), she found that the less beliefs students had in quick learning, the better GPAs they earned. It is interesting that quick learning dimension was not found in the factor analysis results of our sample. However, in this sample, the innate ability predicts academic performance of senior PSTs. Also, for the senior PSTs' simple knowledge and epistemological world views were significantly contributed to the model. This finding indicated that high achiever believed that PSTs' knowledge about scientific concepts is ever changing scientific understanding and this understanding is complex rather than simple. Moreover, senior PSTs with high GPA started to think about the effectiveness of teacher-centered methods on students' learning. This finding highlights that as in western cultures, PSTs in non-western cultures are also aware of their epistemological beliefs. Moreover, participants of this study were better in expressing their epistemological beliefs in the dimensions of innate ability and simple knowledge when their academic success increased.

Another interesting result of the multiple regression analysis suggests that for freshman PSTs none of the predictors contributed to PSTs' GPA. However, for senior PSTs significant contributions of predictor variables were found as stated in above paragraph. These two results revealed that development of epistemological beliefs can influence PSTs' GPA throughout their teacher education programs. This finding is consistent with Schommer's (1993) first hypothesis about multidimensional theory, which is epistemological beliefs change over time. Furthermore, this finding also support Schommer's (1993) second hypothesis about multidimensional theory, which is epistemological beliefs are a system of less or more independent beliefs. For instance, among four factors found in this study only innate ability and simple knowledge contributed to PSTs' GPA in different magnitudes.

Multiple regression analysis also revealed that epistemological world views were negatively contributed to the model. Higher achiever students believed the effectiveness of the teacher-centered methods. In the Turkish educational system, many teachers might have applied traditional teaching strategies, for example, expository. Thus, PSTs mainly experienced expository based teaching approach. This experience shaped their beliefs about teaching. When they enter teacher education programs, PSTs may still hold these beliefs about teaching due to the prolonged exposure to this teaching practice throughout their previous education (Gunstone, Slattery, Bair, & Northfield, 1993; Hollingsworth, 1989; McDiarmid, Ball, & Anderson, 1990). Therefore, their previous learning experiences influence the PSTs professional development during teacher education programs. Our study suggests that PSTs had difficulties in developing their epistemological world views during teacher education programs.

According to multivariate analysis of variance (MANOVA), differences were found between females and males with respect to beliefs in innate ability and simple knowledge dimensions for freshman and senior PSTs. In each class level, females were less likely to believe in innate ability. Findings revealed that for innate ability female students believed one's ability to learn can be enhanced throughout their life. As opposed to this males believed that learning ability is fixed at birth. These results indicated that females have more sophisticated beliefs in terms of the innate ability. Similarly, Schommer (1993) also found that the less beliefs female students have in innate ability, the higher GPAs they have. Schommer (1992) and Schommer et al. (1997) also found that female students developed more sophisticated beliefs in quick learning. However, related to simple knowledge female PSTs were more likely to see scientific knowledge as isolated bits and pieces rather than integrated concepts. Similarly, for omniscient authority the senior male PSTs had more sophisticated beliefs than the female PSTs. Thus the female PSTs believed that scientific knowledge handed by authority while the male PSTs believed that scientific knowledge can be best acquired by active participation to the knowledge construction. Belenky, Clinchy, Goldberger, and Tarule (1986) provided similar evidences for the gender differences. According to them, at the early stages of personal epistemology development, the female students view knowledge as handed down by authority; while the male students view knowledge as mastering what is handed down by authority. At this point, we wanted to argue that believing omniscient authority may also lead these female PSTs believed that knowledge is simple rather than integrated, because they have tendency to memorize what scientists say. It is evident that female PSTs' epistemological development is less sophisticated than those males with respect to authority. These findings highlighted that both males and females developed more or less epistemological beliefs in western cultures. In other words, while males were better in some of the epistemological beliefs, they were worse in other epistemological beliefs than females. Similar more or less epistemological beliefs development was also observed for our participants. Even though King and Kitchener (1994) and Kuhn (1991) stated that gender has almost no role in epistemological thinking, our results and some of the earlier studies indicated that in different cultures gender play a role in developing epistemological beliefs.

According to MANOVA results, for senior students' self-efficacy and outcome expectancy dimensions of the STEBI indicated significant main effect with respect to gender. Findings revealed that for both dimensions female PSTs had more positive beliefs than male PSTs. For self-efficacy beliefs Bleicher (2004) and Enochs and Riggs (1990) found an opposite direction in beliefs for females and

males. Their findings showed that male students had higher score on self-efficacy dimension of the STEBI. Our results suggest that female PSTs had more benefit from their teacher education program regarding science teaching than male PSTs.

For freshman students, we also found a difference between male and female PSTs' epistemological world views. MANOVA results revealed that in both freshman and senior classes, the female PSTs have more positive beliefs about the teaching related issues. This result suggests that in early years of their teacher education programs, girls believe in effectiveness of student-centered teaching methods. However, when they progressed from freshman to senior, they became more concerned about their own teaching skills and effectiveness of their teaching on students achievement.

CONCLUSION AND IMPLICATIONS

Results of the present study revealed some issues of critical importance related to the implementation of effective science teaching practices for PSTs during teacher education programs. This cross sectional study suggested that PSTs' epistemological beliefs might change over time and have relationship with their academic achievement. For freshman students, GPAs were not predicted with any dimension of the SEQ but for senior students, GPAs were predicted with innate ability and simple knowledge dimensions. However, we found that the change in the PSTs' epistemological beliefs in the innate ability and simple knowledge dimensions of the SEQ were effective in explaining their GPA scores. Effect of students' epistemological beliefs on their understanding was also supported by Schommer's (1990) study. Thus, teacher educators need to provide environment for PSTs to develop their epistemological beliefs in order to increase those students' academic success throughout teacher education programs.

It was found that epistemological world views of the PSTs were hardly improved during their teacher education programs. During teacher education programs, PSTs learn variety of student-centered methods. But, most of the time PSTs gain the theoretical knowledge about those methods. PSTs are hardly having experience with practical knowledge. Thus, they are having difficulty developing positive beliefs in implementing student-centered methods. Finally, when these PSTs become teachers they have a tendency to use lecturing methods to teach science. In other words, since these students might have had little opportunity to see how student-centered methods practiced by their instructors, they might have developed beliefs about inapplicability of these methods. Thus, they might begin to think about the effectiveness of using traditional teaching methods such as lecturing for their future career. This claim is already supported in the science education literature. Czerniak and Lumpe (1996) argued that teachers are likely to teach science the way they were taught such as lecturing. Teacher education programs play very critical role in helping PSTs transfer their theoretical knowledge to practical knowledge. Czerniak and Lumpe (1996) argued that in order to make teachers believe the effectiveness of student-centered teaching methods such as constructivist theories on student learning "Teachers need to see constructivist practices modeled. And they need time to practice the teaching strategies, and reflect upon their efforts, engage in dialogue with others" (p. 259). During field experience courses university instructors and mentor teachers can work cooperatively to provide PSTs more opportunity to practice their theoretical knowledge.

According to Schommer-Aikins (2004), if teachers know their students' epistemological beliefs, they will be able to apply appropriate instructional strategies to help lower achieving students into higher level thinking and higher achiever students to do appropriate development during their courses. In order to accomplish this, first teachers need to develop their own beliefs then it would be easier for them to apply appropriate strategies for their student. For innate ability male PSTs stayed at the early stage of their epistemological development from freshman to senior classes. For omniscient authority female students stayed at the early stage of their epistemological development from freshman to senior classes. Teacher educators need to consider the development of female and

male PSTs' epistemological beliefs in different dimensions. These beliefs need to be addressed during their courses to help teachers develop themselves in these dimensions of the SEQ. Our study revealed that in different cultures males and females developed dissimilar epistemological beliefs. Thus, while developing epistemological beliefs of females and males culture based studies should be considered.

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Fen Öğretmen Adaylarının Epistemolojik İnançlarının, Dünya Görüşlerinin ve Öz-Yeterlik İnançlarının Cinsiyet ve Başarıya Göre İncelenmesi

ÖZ. Bu çalışmada fen öğretmen adaylarının epistemolojik inançları, epistemolojik dünya görüşleri ve öz-yeterlik inançları akademik başarıya ve cinsiyete göre incelenmiştir. Çalışmaya 391 öğretmen adayı katılmıştır. Katılımcıların epistemolojik inançlarını belirlemek için Schommer`in (1990) epistemolojik inanç ölçeği kullanılmıştır. Faktör analizi sonucu 4 faktör bulunmuştur. Bunlar, doğuştan gelen yetenek, bilginin değişmezliği, bilginin karmaşık olmayışı ve bilginin otorite tarafından belirlendiğidir. Epistemolojik inanç faktörlerinin yanı sıra, epistemolojik dünya görüşünün ve öz-yeterlik inancının akademik başarıyı ne ölçüde açıkladığı araştırılmıştır. Doğuştan gelen yetenek, bilginin karmaşık olmayışı ve epistemolojik dünya görüşü istatistiksel olarak anlamlı bir şekilde katılımcıların akademik başarısını açıklayabilmiştir. Birinci sınıf öğrencileri için, cinsiyet bakımından bilginin otorite tarafından belirlendiği, doğuştan gelen yetenek ve epistemolojik dünya görüşlerinin farklılık gösterdiği tespit edilmiştir. Son sınıf öğrencileri içinse yine cinsiyet bakımından doğuştan gelen yetenek, bilginin otorite tarafından belirlenmesi ve öz-yeterlik inançlarının her iki boyutunda da farklılıklar bulunmuştur. Bu çalışma epistemolojik inançların zamanla değişebildiğini ve akademik başarı üzerinde etkili olduğunu göstermiştir.

Anahtar Sözcükler: Akademik başarı, epistemolojik inançlar, epistemolojik dünya görüşü, cinsiyet, öz-yeterlik inançları.

Amaç ve Önem: Epistemolojik inançlar insanların bilginin doğası hakkında sahip oldukları inançlarını kapsar (Schraw & Olafson, 2002). Bilginin doğası hakkında insanların sahip oldukları inançlarını belirlemek günümüzde araştırmacıların büyük ilgisini çekmektedir. Çoğu araştırmacılar bu inançların öğrencilerin öğrenmesinde önemli bir rolü olduğunu savunmaktadırlar (Hofer & Pintrich, 1997; Schommer, 1993). Schommer'e (1990) göre insanların sahip oldukları epistemolojik inançlar beş boyutta incelenebilir. Bunlar: (a) Bilginin kesinliği (bu boyut bilginin değişmez yapıda olduğu inançlardan bilginin sürekli değiştiğini içeren inançları kapsar), (b) Bilginin basit oluşu (bu boyut bilgilerin birbirinden ayrı değişmez yapıda olduğu inançlardan bilginlerin birbiri ile ilişkili olduğuna dair insanların sahip oldukları bütün inançları içerir), (c) Bilim otoritesi (bu boyut bilginin kaynağının bilim adamları olduğunu belirten inançları ve bilginin çalışmalar sonucunda elde edilen bulgulardan ortaya çıktığını belirten inançları içerir), (d) Öğrenme hızı (bu boyut bilginin hızlıca öğrenilmesinden yavaş yavaş öğrenilmesine dair inançları içermektedir), ve (e) Bilgiyi öğrenme yeteneğinin doğuştan oluşu (bu boyut bilginin öğrenilmesinin doğuştan gelen bir yetenek olduğundan bu yeteneğin zamanla geliştirilebilineceğine yönelik inançları içermektedir). Epistemolojik dünya görüşü ise bilginin doğası ve bilginin nasıl elde edileceğine yönelik öğretmenlerin sahip olduğu epistemolojik inançları içerir (Schraw & Olafson, 2002). Öğretmenin kendine güven yönündeki inançları da öğretmenlerin konuları öğretmeye yönelik ve öğrenci başarısını ve öğrenmesini etkilemeye yönelik sahip oldukları inançlarını içerir (Berman, McLaughlin, Bass, Pauly, & Zellman, 1977). İlköğretim fen ve teknoloji dersi öğretmen adaylarının epistemolojik inançlarının, epistemolojik dünya görüşlerinin ve fen ve teknoloji dersini öğretmeye yönelik kendine güvenlerinin öğretmen adaylarının belirli karakterlerini (cinsiyet ve akademik başarı) göz önünde tutarak incelemek aşağıda belirtilen açılardan önemlidir. Öncelikle, Schommer'inde (1994) belirttiği gibi epistemolojik inançlar eğitim ve kültürden etkilenmektedir. Dolayısıyla Türk eğitim sistemi ve kültürü içerisinde öğretmen adaylarının epistemolojik inançlarının incelenmesi bu alanda az sayıda olan çalışmaları zenginleştirecektir. Bu tür çalışmalar dünyada ki yeni yaklaşımların Türk kültürü açısından incelenmesini sağlayarak Türkiye'deki eğitim konusunda yapılan çalışmaları da (müfredat geliştirme, öğretmen yeterliliklerini belirleme ve yükseltme) destekleyecektir. Bu çalışmanın amacı fen öğretmen adaylarının epistemolojik inançlarını, epistemolojik dünya görüşlerini ve öz-yeterlik inançlarını akademik başarı ve cinsiyete göre incelenmesidir.

Yöntem: Çalışmaya 391 birinci ve dördüncü sınıflarda eğitimini sürdüren fen öğretmen adayları katılmıştır. Çalışmaya beş devlet üniversitesinde okuyan öğretmen adayları katılmıştır. Ankara`da ki üç

devlet üniversitesi, Eskişehir`deki bir devlet üniversitesi ve Van`da ki bir devlet üniversitesi çalışmanın uygulandığı üniversitelerdir. Çalışmaya 227 bayan öğretmen adayı katılırken, 164 erkek öğretmen adayı katılmıştır. Yine çalışmaya 178 birinci sınıf ve 213 dördüncü sınıf öğretmen adayı katılmıştır. Bu örneklem ile çalışmanın genellenebilirliğinin artırılması amaçlanmıştır. Katılımcıların epistemolojik inançlarını belirlemek için epistemolojik inanç ölçeği (Schommer, 1990) araştırmacılar tarafından daha önceki çalışmalarında (Yilmaz-Tuzun & Topcu, 2008) Türkçeye çevrilmiş olup geçerlik ve güvenirlik çalışmaları yapılmıştır. Epistemolojik inanç ölçeğinin güvenirlik değeri, diğer epistemolojik inanç anket çalışmalarında bulunan güvenirlik değerlerine yakın değerde bulunup, çok yüksek olmasa da epistemolojik inanç çalışmaları için yeterli düzeydedir. Yine ölçeğin alt boyutları faktör analizi sonucunda büyük ölçüde istenen kategoriler altında çıkmıştır. Faktör analizi sonucu literatürle uyumlu bir şekilde dört kategori elde edilmiştir. Katılımcıların epistemolojik dünya görüşlerini (Schommer & Olafson, 2002) belirlemek için epistemolojik dünya görüşü ölçeği bu çalışmanın yazarları tarafından Türkçeye çevrilerek geçerlik ve güvenirlik çalışmaları yapılmıştır (Yilmaz-Tuzun & Topcu, 2008). Son olarak katılımcıların öz-yeterlik inançlarının tespiti için daha önce Tekkaya ve arkadaşları (2004) tarafından Türkçeye çevrilmiş, geçerlik ve güvenirlik çalışmaları yapılmış öz-yeterlik ölçeği bu çalışmada kullanılmıştır. Ölçeğin öz-yeterlik boyutu için güvenirlik değeri 0.84 olarak bulunurken, diğer boyutu için güvenirlik değeri 0.76 olarak bulunmuştur.

Bulgular: Çalışmada katılımcılar iki grup (birinci sınıf ve dördüncü sınıf) öğrencilerden oluştuğu için her grup için ayrı analizler yapılmıştır. Örneğin epistemolojik inançların, epistemolojik dünya görüşlerinin ve öz-yeterlik inançlarının akademik başarıyı ne kadar açıkladığını belirlemek için hem birinci sınıflar hem de dördüncü sınıflar için çoklu regresyon analizi yapılmıştır. Analiz sonuçlarında birinci sınıflarda bu değişkenlerin akademik başarı üzerinde etkili olmadığı tespit edilmiştir, dördüncü sınıflarda bir kısım değişkenin akademik başarıyı açıklamada etkili olduğu görülmüştür. Doğuştan gelen yetenek, bilginin kompleks olmayışı, ve epistemolojik dünya görüşü değişkenlerinin istatistiksel olarak anlamlı bir şekilde fen ve teknoloji öğretmen adaylarının akademik başarısını açıkladığı tespit edilmiştir. Cinsiyetin bu değişkenler açısından birinci sınıflar ve dördüncü sınıflarda bir farklılık oluşturup oluşturmadığını tespit etmek için çoklu varyans analizi (MANOVA) kullanılmıştır. Birinci sınıf öğrencileri için cinsiyet bakımından bilginin otorite tarafından belirlendiği, doğuştan gelen yetenek ve epistemolojik dünya görüşleri farklılık gösteren değişkenler olarak tespit edilmiştir. Son sınıf öğrencileri içinse yine cinsiyet bakımından doğuştan gelen yetenek, bilginin otorite tarafından belirlenmesi değişkenleri ile öz-yeterlik inançlarının her iki boyutunda farklılıklar tespit edilmiştir.

Tartışma, Sonuç ve Öneriler: Bu çalışma epistemolojik inançların zamanla değişebildiğini ve akademik başarı üzerinde etkili olduğunu göstermiştir. Bu sonuç literatürdeki birçok çalışma tarafından da desteklenmektedir. Böylece fen eğitimcileri fen ve teknoloji dersi öğretmen adaylarına sağlayacakları ortamlar ile onların hem epistemolojik inançlarını, epistemolojik dünya görüşlerini ve dersi öğretime yönelik öz-yeterliklerini akademik başarıları ve cinsiyete bağlı olarak geliştirilmesinde katkıda bulunabilirler. Bu çalışma özelikle cinsiyet ve akademik başarı göz önünde tutularak epistemolojik inançlardan bazı boyutların ve genel olarak epistemolojik dünya görüşlerinin bilimdeki gelişimlere paralel olarak fen ve teknoloji dersi öğretmen adaylarına üniversitedeki eğitimleri boyunca daha özenli bir şekilde verilmesinin gerekliliğini ortaya koymuştur. Özellikle özel öğrenme yöntemleri dersi ve okul uygulamaları dersi gibi uygulama olanağı bulunan derslerde öğretmen adaylarına teorik olarak öğrendikleri konuları uygulama şansı verilmesi çok faydalı olacaktır.