



Science Teacher Candidates' Epistemological Beliefs and Critical Thinking Disposition*

Zeynep KOYUNLU UNLU¹ Ilbilge DOKME²

ARTICLE INFO

Article History:

Received: 27 Apr. 2017

Received in revised form: 03 Aug. 2017

Accepted: 19 Nov. 2017

DOI: 10.14689/ejer.2017.72.11

Keywords

science education,
teacher education,
epistemological beliefs,
critical thinking disposition

ABSTRACT

Purpose: The purpose of the study is to determine the effect of gender and class level on science teacher candidates' epistemological beliefs and critical thinking disposition, as well as examine the relationship between these two dependent variables.

Research Methods: This study was designed as a descriptive survey. Participants were 447 students majoring in science education. The data for the epistemological beliefs was collected with the Scale of Epistemological Beliefs (SEB); data for critical thinking disposition was collected with the California Critical Thinking Disposition Inventory (CCTDI). The data was evaluated in SPSS with a Mann Whitney U, Kolmogorov-Smirnov, and two variable correlation.

Findings The study found that female students had more developed epistemological beliefs than their male counterparts. Students' SEB and CCTDI scores also exhibit a moderate positive correlation. The students' epistemological beliefs and critical thinking dispositions did not vary regularly by class level.

Implications for Research and Practice: Applications developing male students' epistemological beliefs and critical thinking skills can be done so as to reduce the negative effects of gender on the learning-teaching process. Additionally, activities should be included in applied courses (such as lab and student presentations) in the science teaching program to develop such skills in students.

© 2017 Ani Publishing Ltd. All rights reserved

* This study was partly presented at the 2nd International Eurasian Educational Research Congress in Ankara, 08-10 June, 2015

¹ Bozok University, TURKEY, zeynepko.unlu@gmail.com, ORCID: <https://orcid.org/0000-0003-3627-1809>

² Gazi University, TURKEY, ilbilgedokme@gazi.edu.tr, ORCID: <https://orcid.org/0000-0003-0227-6193>

Corresponding author: Ilbilge DOKME

Introduction

A “disposition” is a tendency to do something and, by extension, “thinking dispositions” are a person’s general tendencies to think. Critical thinking typically has two components: “critical thinking skills” and “critical thinking dispositions” (Ennis, 1987). An individual’s performance in critical thinking is supported by two sources. The first is the individual’s natural thinking disposition and the second is the cognitive skills learned later in life (Clifford, Boufal, & Kurtz, 2004). These skills, which help develop critical thinking, are in fact a part of scientific thinking. In its broadest sense, scientific thinking starts with the creation of hypotheses to solve a problem and the collection of information or data in light of these hypotheses. The later stages of scientific thinking require critical thinking skills. This means analyzing the information or data collected beforehand, interpreting them objectively using the principles of determinism and reaching reasonable results (Dick, 1991; Ennis, 1991; Facione, 1990; Halpern, 1998). All of these practices require a systematic effort of the mind. Those who have thinking dispositions learn these skills more quickly and easily. Ennis (1991) argued that those who had thinking dispositions have the following qualities: what they say, write, or desire to convey is accurately and easily understood; they are able to concentrate on a specific subject and consider an event as a whole; they are capable of researching and revealing an event’s causes; they endeavor to be an educated and knowledgeable person; they seek alternatives; they look for a certainty just as much as the case requires; they are aware of people’s fundamental beliefs; they are an open-minded person; they discard current judgments if proof and reasoning is insufficient; they act if proof and reason are sufficient; and they are capable of using other people’s critical thinking skills.

Research on the correlation between critical thinking and epistemology has brought a new perspective to the study of critical thinking. Epistemology, which is the theory of knowledge, has been the primary focus of philosophers for centuries with the question “what is the source of knowledge?”. The subject of knowledge is “the knower” and its object is “the known.” Subjective philosophies regard the knower to be close to the resource of knowledge, while objective philosophies regard knowledge to be close to the known. Beliefs about how knowledge is formed, the certainty level and limits of knowledge, and how the act of knowing is performed are included in epistemological beliefs (Brownlee, Purdie, & Boulton-Lewis, 2001; Burr & Hofer, 2002; Hofer & Pintrich, 1997; Ozden, 2003; Ravindran, Grene, & Debacker, 2000). Perry (1970), who did the first classification of epistemological beliefs, described four developmental stages surrounding these beliefs. First, those beliefs are in the dualism stage think their knowledge is either absolutely wrong or right. Second those in the multiplicity stage accept there are different perspectives, without any criterion determining one opinion being superior to the other. Third, those who recognize that some opinions are better than the others are in the relativism stage. And finally, those in the stage of commitment within relativism recognize that, epistemologically, some opinions are more logical than the others and they stick to the more logical. After Perry, many researchers conducted studies of the development and change of epistemological beliefs over time. For instance, Kuhn

and Weinstock (2002) argued that children initially have the belief of realist epistemology (all arguments are correct), then they have the belief of absolutist epistemology (arguments may be correct or incorrect), and then they have the belief of multiplist epistemology (everyone has an opinion which is correct for themselves). Studies conducted until the late 1980s concerned the types of epistemological beliefs that develop and change and, thus, connect to each other. Schommer (1990) brought a new perspective to epistemology and claimed that the types of epistemological beliefs might differ from each other. For the first time, Schommer (1990) conceptualized epistemological beliefs in five dimensions and developed a questionnaire based on studies by Perry (1970) and Schoenfeld (1983). The epistemological beliefs measured by this questionnaire are, respectively, simplicity of knowledge, certainty of knowledge, source of knowledge from omniscient authority, innate ability of knowledge, and speed of knowledge. Any perspective in epistemology will indicate that a naïve personal epistemology restricts students' thinking and reasoning performances, while mature personal epistemology enhances these performances (Chan, Ho, & Ku, 2011). This anticipated influence of epistemology leads to the conclusion that the correlation between epistemology and critical thinking is an interesting subject of study.

Contemporary studies on epistemological beliefs have their roots in the early work of Marlene Schommer (Schommer, 1990), who proposed an original model for epistemological beliefs with five dimensions: certainty of knowledge, simplicity of knowledge, innate ability of knowledge acquisition, speed of knowledge acquisition, and omniscient authority. Many studies support that these epistemic beliefs have powerful effects on cognitive aspects of learning and thinking (Hyytinen, Holma, Toom, Shavelson, & Lindblom-Ylänne, 2014; Kuhn, Cheney, & Weinstock, 2000; Many, Howard, & Hoge, 2002; Mohamed & El-Habba, 2013). Correlations between epistemological beliefs and performance on learning and reasoning tasks have been investigated with a great deal of effort in recent years. It can be deduced from the findings of these studies that students with sophisticated epistemic beliefs were found to have a deep level of understanding (Chen & Pajares, 2010; Kuhn, 1999; Lodewyk, 2007; Peng & Fitzgerald, 2006; Schommer-Aikins & Easter, 2006; Schommer-Aikins, Duell, & Hutter, 2005; Stathopoulou & Vosniadou, 2007) and a higher ability to inquire and reason (Benson, 1989; Hofer & Pintrich, 1997). Bailin (1999) argued that a useful way to think about a problem is in terms of epistemological understanding, and that this way of thinking about the issue can provide both pedagogical and conceptual grounding in efforts to foster critical thinking. Kuhn (1999) developed a critical thinking model and classified a person's epistemological understanding level as realist, absolutist, multiplist or evaluativist. A person with a realist epistemological understanding level has insufficient critical thinking. At this level, arguments are the copies that represent an outer reality. The absolutist epistemological understanding level is a foundation for a more advanced form of critical thinking. In the multiplist epistemological understanding level, where critical thinking is yet insufficient, arguments can be selected freely. In the evaluativist epistemological understanding level, arguments, which can be evaluated

and compared by the criteria of discussion and proof, are judged. At this level, critical thinking can be qualified as a tool that develops comprehension.

After the reform of the Turkish National Education system, one of the important challenges for the science teachers is to encourage the development of critical thinking skills in their students (Ministry of National Education-Turkish Education Board [MoNE-TEB], 2005). Science education curriculum, which will be gradually included in Turkey beginning with the 2017-2018 academic year, also highlights the issues of critical thinking and epistemology in order to cope with global competition and to create a prosperous community (MoNE-TEB, 2017). Besides, studies concerning critical thinking and epistemological beliefs are also available in Turkey and have been conducted with prospective science teachers. For example, a study conducted with prospective science and physics teachers, found that prospective teachers' epistemological beliefs did not differ according to department of study, gender, or class levels. Accordingly, no changes were found in participants' epistemological beliefs throughout their education at university (Koc & Memduhoglu, 2017). Conversely, Yilmaz, Tuzun and Topcu (2013) found in their study with prospective science teachers that epistemological beliefs could change over time and that those beliefs were influential in academic achievement. Another study conducted with prospective physical science teachers found there were differences between prospective teachers' critical thinking tendencies according to gender and class level. Besides, participants' critical thinking tendencies increased in parallel to increase in their achievement levels, and the tendencies decreased as their achievement levels decreased (Tumkaya, 2011). Still another study with science teachers found that most of the participants understood science as a pursuit that is concerned with a limited area and tries to reveal the certain and unchanging truth (Ayvaci & Er Nas, 2010).

Epistemological beliefs influence teachers' practice in the classroom (Luft & Roehrig, 2007). Acquiring developed critical thinking skills is very important in developing epistemological beliefs (Kuhn & Dean, 2004). Since teachers are the unchanging component of the teaching profession for years, it is essential that teachers have critical thinking skills in order to instill in students these skills and to strengthen students' epistemological beliefs. Thus, analyzing the critical thinking tendencies and epistemological beliefs of prospective teachers-who contribute to raising the next generation-is important. Because differences according to gender influence prospective teachers' learning-teaching processes, gender is considered an independent variable in this study. In addition, class levels is considered another variable in this study so as to be able to assess the effects of the education received in the development of those skills. It is believed that an analysis of these variables would give an idea to practitioners and researchers. In addition preservice teachers generally tend to employ rote memorization when it comes to solving science problems, without any attempt to use critical thinking skills. Thereby it can be too hard for students to solve non-routine science problems. Critical thinking includes the component skills of analyzing arguments, making inferences using inductive or deductive reasoning, judging or evaluating, and making decisions or solving problems (Lai, 2011).

Our students' lack of critical thinking skills in science problem solving prompted us to explore critical thinking disposition and the relationships between critical thinking disposition and epistemological belief. This raised the following research questions, which are used within the current study:

1. Is there a statically significant difference between female and male students' scores on the Scale of Epistemological Beliefs (SEB)?
2. Is there a statically significant difference among the scores of freshmen, sophomores, juniors and seniors on the SEB?
3. Is there a statically significant difference between the female and male students' scores on the California Critical Thinking Disposition Inventory (CCTDI)?
4. Is there a statically significant difference among the scores of freshmen, sophomores, juniors and seniors on the CCTDI?
5. Is there any correlation between the science teacher candidates' epistemological beliefs and critical thinking disposition?

Method

Research Design

This study was designed as a descriptive survey study to determine the effect of gender and class level on pre-service science teachers' epistemological beliefs and critical thinking disposition, as well as the relationship between these two dependent variables (Frankeal & Wallen, 2003).

Research Sample

The study was conducted with the participation of prospective science teachers because sophisticated critical thinking tendencies and epistemological beliefs are more integral to scientific inquiry compared to the work conducted in other disciplines.

The study used criterion sampling, purposeful sampling method (Patton, 2002). Participants were 447 students majoring in science education (115 freshmen, 119 sophomores, 129 juniors, and 84 seniors) at a university located in Ankara, the capital of Turkey. Of the participant students, 357 were females and 90 were males.

Research Instruments and Procedures

Scale of epistemological beliefs. The first data collection tool in the study was an SEB with a five-point Likert-type scale developed by Schommer (1990) and adapted by Deryakulu and Buyukozturk (2002). The scale had a total of 35 items, 17 negative and 18 positive. This scale had three factors (Factor I: The belief that learning depends on effort; Factor II: The belief that learning depends on ability; and Factor III: The belief that there is only one truth). The measurement reliability of the scale was 0.72.

California critical thinking disposition inventory. The second data collection tool was the CCTDI with a six-point Likert-type scale from The Delphi project (1990) and adapted by Kokdemir (2003). The scale had a total of 51 items, 22 negative and 29 positive. This scale has six sub-scales "Analyticity", "Open mindedness", "Inquisitiveness", "Self Confidence", "Truth Seeking", and "Systematicity". The measurement study of the scale was to be found 0.81.

Data Analysis

The data was evaluated in the SPSS program, and its .05 degree of significance was accepted. The series mean method was used for missing values. After assigning data to missing values, normality analysis was examined by Kolmogorov-Sminow. It was found that the SEB and CCTDI scores were not a normal distribution according to gender and class level. The Mann Whitney U test was used to determine whether there was a significant difference between students' SEB, CCTDI scores, and gender. The Kruskal Wallis test was used to determine if there was a significant difference between students' SEB, CCTDI scores and class level. To determine the relationship between students' SEB and CCT scores, two variable correlations (Spearman Brown rank difference correlation coefficient) were used.

Results

Findings about the First Research Question

The purpose of the first research question is to determine any statistical differences in students' SEB scores by gender. For this purpose, the authors used the Mann Whitney U test. Table 1 illustrates the SEB factors of male and female students and the t-test results of the means of their total SEB scores.

Table 1

Female and Male Students' Scores on the SEB

Factors of SEB	Groups	N	Mean rank	Sum of rank	U	p
The belief that learning depends on effort	Female	357	228.9	81718.5	14314.5	.1
	Male	90	204.55	18409.5		
The belief that learning depends on ability	Female	357	222.77	79529	15626	.68
	Male	90	228.88	20599		
The belief that there is only one truth	Female	357	233.33	83299.5	12733.5	.00
	Male	90	186.98	16828.5		
Total SEB scores	Female	357	231.45	82626	13407	.01
	Male	90	194.47	17502		

As Table 1 shows, there is no significant difference between male and female students' mean scores on the factor that learning depends on effort (U=14314.5,

$p > .05$) and the belief that learning depends on ability ($U=15626$, $p > .05$). However, there is a significant difference between female and male students' mean scores on the factor that there is only one truth in favor of the female students ($U=12733.5$, $p < .05$). There is also a significant difference between female and male students' total SEB scores ($U=13407$, $p < .05$). The mean of female students' SEB scores is higher than that of the male students). Based upon this finding, it could be claimed that there is a significant difference between male and female participants' SEB scores.

Findings about the Second Research Question

The purpose of the second research question is to determine if there is any significant difference between students' SEB scores and class levels. For this purpose, the authors used Kruskal Wallis. Findings about the second question, whether there is a significant difference between students' class level and SEB scores, are shown in Table 2.

Table 2

The Results of the Students' SEB Scores by Class Level

Groups	N	Mean rank	χ^2	p	Post-hoc
Freshmen	115	227.87	38.1	.00	1>4, 2>1, 2>3, 2>4, 3>4
Sophomores	119	267.15			
Juniors	129	226.31			
Seniors	84	154.03			

As seen in Table 2, students' SEB scores vary by class level ($\chi^2=38.1$, $p < .05$). According to the results, this difference is between the seniors and freshmen, sophomores and juniors. The SEB mean score of students can be seen in Table 2, post-hoc column.

Findings about the Third Research Question

The purpose of the third research question is to determine any statistically significant difference between students' CCTDI scores by gender. For this purpose, the authors used the Mann Whitney U test. The results of the Mann Whitney U test, whether there was a significant difference between female and male students' California Critical Thinking Disposition Inventory (CCTDI) scores, are shown in Table 3.

Table 3*Female and Male Students' Scores on the CCTDI*

Factors of CCTDI	Groups	N	Mean rank	Sum of rank	U	p
Analyticity	Female	357	229.95	82092.5	13940.5	.052
	Male	90	200.39	18035.5		
Open-mindedness	Female	357	222.51	79437.5	15534.5	.62
	Male	90	229.89	20690.5		
Inquisitiveness	Female	357	221.53	79086	15183	.42
	Male	90	233.80	21042		
Self-confidence	Female	357	226.39	80821	15212	.43
	Male	90	214.52	19307		
Truth-seeking	Female	357	215.36	76884	12981	.00
	Male	90	258.27	23244		
Systematicity	Female	357	230.34	82232.5	13800.5	.03
	Male	90	198.84	17895.5		
Total CCTDI scores	Female	357	224.11	80005.5	16027.5	.97
	Male	90	223.58	20122.5		

As Table 3 shows, there is no significant difference between male and female students' factors of analyticity ($U=13940.5$, $p>.05$), open-mindedness ($U=15534.5$, $p>.05$), inquisitiveness ($U=15183$, $p>.05$), self-confidence ($U=15212$, $p>.05$) and the mean of their total CCTDI scores ($U=16027.5$, $p>.05$). However, there is a significant difference between male and female students' mean scores on the systematicity ($U=13800.5$, $p<.05$) and truth-seeking factor ($U=12981$, $p<.05$)

Findings about the Fourth Research Question

The purpose of the fourth research question is to determine any significant difference between students' CCTDI scores and class levels. The authors used Kruskal Wallis for this purpose. Findings about the fourth question, whether there was a significant difference between students' class level and CCTDI scores, are shown in Table 4.

Table 4

The Results of the Students CCTDI Scores by Class Level

Groups	N	Mean rank	χ^2	p	Post-hoc
Freshmen	115	206.21	7.05	.07	-
Sophomores	119	230			
Juniors	129	244.73			
Seniors	84	208			

According to Table 4, students' total CCTDI scores do not vary by class level ($\chi^2=7.05$, $p>.05$). In other words, class level does not affect CCTDI scores of grade level students.

Findings about the Fifth Research Question

The aim of the fifth research question is to determine the correlation between students' SEB and CCT scores. The authors used two-variable correlations in order to determine any correlation between students' SEB and CCTDI scores. The results of this problem are shown in Table 5.

Table 5

Correlations between SEB and CCTDI Scores

CCTDI	SEB			Total SEB scores
	The belief that learning depends on effort	The belief that learning depends on ability	The belief that there is only one truth	
Analyticity	.39	.12	.13	.27
Open-mindedness	.04	.43	.33	.30
Inquisitiveness	.38	.13	.11*	.22
Self-confidence	.36	.06	.19	.28
Truth-seeking	.03	.34	.24	.23
Systematicity	.01	.24	.22	.21
Total CCTDI scores	.27	.19	.34	.42

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

As clearly seen in Table 5, there is a moderate and positive correlation between the first factor of the SEB, the belief that learning depends on effort, and analyticity, inquisitiveness, self-confidence, while there is a low correlation among open-mindedness, truth-seeking, systematicity and total CCTDI scores. There is a low and positive correlation between the second factor of the SEB (which was the belief that learning depends on ability) and analyticity, inquisitiveness, self-confidence, systematicity, and total CCTDI scores while there is a moderate and positive correlation between this factor and open-mindedness, truth seeking. There is a low and positive correlation between the third factor of the SEB (which is the belief that there is only one truth), and analyticity, and truth seeking, inquisitiveness, self-confidence, systematicity, while there is a moderate and positive correlation between this factor and total CCTDI scores. There is a moderate and positive correlation between total SEB scores and open mindedness, total CCTDI scores.

Discussion and Conclusion

This study aimed to investigate the effect of gender and class level on pre-service science teachers' epistemological beliefs and critical thinking disposition, and as well as examine the relationship between these two dependent variables.

Taking the mean SEB scores into consideration, female students' epistemological beliefs were higher than those of the male students. In "the belief that there is only one truth" sub-dimension of SEB, there was a significant difference in favor of the female students. There was no difference by gender in the "belief that learning depends on effort" and "belief that learning depends on ability" sub-dimensions. This research is consistent with some research findings in terms of the fact that female students have more developed epistemological beliefs than male students (Kaya, 2009; Schommer, 1993). Some studies, in contrast, found that female students believed more than male students that learning depends on effort (Deryakulu & Buyukozturk, 2003; Terzi, Sahan, Celik, & Zog, 2015). The above-mentioned study is different from others in terms of this sub-dimension (the belief that learning depends on effort). Some studies, however, revealed that gender did not affect epistemological beliefs. Tumkaya (2012), for instance, in a study performed with university students, found that epistemological beliefs did not differ according to gender. The researcher claimed that the situation stemmed from the fact that students' epistemological beliefs were shaped by difficulties they encountered in their efforts to reach knowledge and by the opportunities they had.

This study found that students' epistemological beliefs did not increase regularly as their class levels rose from freshman to senior. Yet, the fact that the sophomores had more developed epistemological beliefs than the others could be related to their education. The absence of differences between class levels could also have led to this result. As a matter of fact, in another study found that tenth graders had more developed epistemological beliefs than sixth and eighth graders (Kurt, 2009). Another study suggests that a personal epistemological belief that knowledge is constructed is more likely to be found among juniors and seniors in college than among freshman or sophomore college students (Peterson, 1995, p. 31). A study conducted with high school students, in contrast, found that the final year students had more developed epistemological beliefs than the first-year high school students (Schommer, 1993). Tumkaya (2012) attributes the inconsistencies between findings to such environmental factors as teachers' attitudes, how difficult a course is, the perceived classroom atmosphere and study and assessment conditions rather than class levels.

In critical thinking disposition, it is only in the truth seeking sub-dimension there is a significant difference in favor of the male students. In the systematicity sub-dimension where there is a significant difference in favor of the female students. There are no differences between total critical thinking disposition scores according to gender. Also, the students' critical thinking disposition did not vary regularly by their year of study. Like these results, relevant studies also find that students' critical thinking skills may not change during their university education (Bakır, 2015;

Hyytinen, et. al., 2014). According to another study conducted with approximately 2300 students from 24 different institutions, critical thinking skills did not change in 45% of students during the first two years (Arum & Roksa, 2011). Unlike these results, Walsh and Hardy (1999) conducted a study with university students who were trained in applied and unapplied sciences, and found that female students' open-mindedness and maturity mean scores were higher than those of the male students. The difference in epistemological beliefs and critical disposition by gender and class level results from the rich living experiences in the processes of reaching and acquiring knowledge.

The study also found a moderate and positive correlation between pre-service science teachers' epistemological beliefs and critical thinking disposition. It may be stated that these positive and strong correlations are an indicator that epistemological beliefs and critical thinking skills are quite developed (Kuhn, 1999; Kuhn & Dean, 2004). This situation is influential in academic achievement. There are studies in the literature demonstrating that individuals having developed critical thinking skills and epistemological beliefs have high academic achievement (Tumkaya, 2011). In support of this idea, Peterson (1995) found that the participants who comprehended the structuring or relativity of knowledge had a strong disposition of critical thinking. In the same vein, another study performed with the participation of university students found that students' critical thinking disposition affected their epistemological beliefs (Basbay, 2013). Regarding this point, Man (2007) suggested a model that included a two-way correlation between epistemological beliefs and cognitive skills and thinking dispositions, as well as the influence of cognitive skills, thinking dispositions and epistemological beliefs on critical thinking.

Considering that teachers have been an unchanging component of education for many years, they should have critical thinking skills and strong epistemological beliefs to be able to teach these skills to students. Accordingly, it is important that pre-service teachers' critical thinking inclinations and epistemological beliefs be analyzed since they will contribute to raising future generations. The inclination for critical thinking and epistemological beliefs have a direct relationship with science, which uses scientific methods to gain knowledge. Science lessons provide obtaining knowledge by means of comprehension, interpretation and thinking. Accordingly, science courses should be arranged to improve pre-service teachers' epistemological beliefs and critical thinking skills, particularly those received by pre-service science teachers. In this way, science teachers will raise individuals who have critical thinking and who will learn how to learn in the future.

To improve critical thinking skills and epistemological beliefs in students, the improvement of the teachers' critical thinking skills and epistemological beliefs should be considered. Teachers are responsible for contributing to the development of students, and they should allow students have discussions, express themselves, and compare their own opinions with those of others in a democratic environment. It is possible to conduct studies of teaching departments and small groups of teachers and students about their inclination for critical thinking and epistemological beliefs using qualitative data collection methods.

The course of "Thinking Skills" will be taught to 7th and 8th graders in Turkey beginning with the 2017-2018 academic year (MNE-TEB, 2016). It is thought that the course will contribute to the development of students' epistemological beliefs and critical thinking skills.

As mentioned in the "Discussion" section, there are several studies concerning epistemological beliefs and critical thinking skills in the literature that were conducted with the participation of prospective teachers. Despite some common points, there are inconsistencies between the findings of those studies. Thus, qualitative studies to provide in-depth knowledge about the effects of gender on prospective science teachers' learning-teaching processes and the effects of education received/courses taught on their critical thinking and epistemological beliefs are needed.

References

- Allen, J. D., & Razvi, S. (2006). *Students' perspectives, levels of epistemological understanding, and critical thinking dispositions related to the use of case studies in an educational psychology course*. Annual Meeting of the American Educational Research Association, San Francisco.
- Arum, R., & Roksa, J. (2011). *Academically adrift. Limited learning on college campuses*. Chicago: the University of Chicago Press.
- Ayvacı, H. S., & Er Nas, S. (2010). Fen ve teknoloji öğretmenlerinin bilimsel bilginin epistemolojik yapısı hakkındaki temel bilgilerini belirlemeye yönelik bir çalışma [A study to determine science and technology teachers' basic knowledge about epistemological structure of scientific knowledge. *Kastamonu Education Journal*, 18(3), 691-704.
- Bakır, S. (2015). Critical thinking dispositions of pre-service teachers. *Educational Research and Reviews*, 10(2), 225-233. doi: 0.5897/ERR2014.2021.
- Bailin, S. (1999). The problem with Percy: epistemology, understanding and critical thinking. *Informal Logic*, 19(2&3), 161-170.
- Basbay, M. (2013). Analysing the relationship of critical thinking and metacognition with epistemological beliefs through structural equation modeling. *Education and Science*, 38(169), 249-262.
- Benson, G. D. (1989). Epistemology and science curriculum. *Journal of Curriculum Studies*, 21(4), 329-344.
- Burr, J. E., & Hofer B. K. (2002). Personal epistemology and theory of mind: deciphering young children's beliefs about knowledge and knowing. *New Ideas in Psychology*, 20(2-3), 199-224.
- Brownlee, J., Purdie, N., & Boulton-Lewis, G. (2001) Changing epistemological beliefs in pre service teacher education students. *Teaching in Higher Education* 6(2), 247-268.

- Chan, N-M., Ho, I. T., & Ku, K. Y. L. (2011). Epistemic beliefs and critical thinking of Chinese students. *Learning and Individual Differences* 21, 67-77.
- Chen, J., & Pajares, F. (2010). Implicit theories of ability of grade 6 science students: relation to epistemological beliefs and academic motivation and achievement in science. *Contemporary Educational Psychology*, 35, 75-87.
- Clifford, J. S., Boufal, M. M., & Kurtz, J. E. (2004). Personality traits and critical thinking skills in college students: Empirical tests of a two-factor theory. *Assessment*, 11, 169-176.
- Deryakulu, D., & Buyukozturk, S. (2002). Epistemolojik inanç olceginin gecerlik ve güvenirlilik çalışması [The reliability and validity study of epistemological beliefs scale]. *Egitim Araştırmaları Dergisi*, 8, 111-125.
- Dick, R. D. (1991). An empirical taxonomy of critical thinking. *Journal of Instructional Psychology*, 18(2), 79-92.
- Ennis, R. H. Ennis (1987). A Taxonomy of Critical Thinking Dispositions and Abilities. In J.B. Baron and R.J. Sternberg (Eds.), *Teaching for thinking*. New York: W.H. Freeman.
- Ennis, R. H. (1991). An elaboration of a cardinal goal of science instruction: scientific thinking. *Educational Philosophy and Theory*, 23 (1), 31-44.
- Facione, P. A. (1990). *Critical thinking: a statement of expert consensus for purposes of educational assessment and instruction*. Millbrae, CA: The California Academic Press.
- Frankel, J. R., & Wallen, N. E. (2003). *How to design and evaluate in education*. New York: McGraw-Hill Higher Education.
- Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Dispositions, skills, structure training, and metacognitive monitoring. *American Psychologist*, 53(4), 449-455.
- Hofer, B., & Pintrich, P. (1997). The development of epistemological theories: beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, 67, 88-140.
- Hyytinen, H., Holma, K., Toom, A., Shavelson, R. J., & Lindblom-Ylänne, S. (2014). The complex relationship between students' critical thinking and epistemological beliefs in the context of problem solving. *Frontline Learning Research*, 6, 1-25. doi: <http://dx.doi.org/10.14786/flr.v2i4.124>
- Koc, S., & Memduhoglu, H. B. (2017). Öğretmen adaylarının epistemolojik inançlar: bir karma yöntem çalışma [Epistemological beliefs of preservice teachers: a mixed method study]. *Electronic Journal of Social Sciences*, 16(60), 119-134.

- Kokdemir, D. (2003). *Belirsizlik durumlarında karar verme ve problem çözme [Uncertainty in decision making and problem solving]*. Yayınlanmamış doktora tezi, Ankara Üniversitesi, Ankara.
- Kuhn, D. (1999). The developmental model of critical thinking. *Educational Researcher*, 28(2), 16-26, 46.
- Kuhn, D., Cheney, R., & Weinstock, M. (2000). The development of epistemological understanding. *Cognitive Development*, 15(3), 309-328.
- Kuhn, D., & Dean, D., Jr. (2004). Metacognition: A bridge between cognitive psychology and educational practice. *Theory into Practice*, 43(4), 268-273.
- Kuhn, D., & Weinstock, M. P. (2002). What is epistemological thinking and why does it matter? In Hofer, B. K. & Pintrich, P. R. (Eds.), *Personal epistemology: the psychology of beliefs about knowledge and knowing* (pp. 121-144). Mahwah, NJ: Erlbaum.
- Lai, E. R. (2011). *Critical thinking: A literature review*. Pearson's Research Reports.
- Lodewyk, K. (2007). Relations among epistemological beliefs, academic achievement, and task performance in secondary school students. *Educational Psychology*, 27, 307-327.
- Luft, J., & Roehrig, G. H. (2007). Capturing science teachers' epistemological beliefs: the development of the teacher beliefs interview. *Electronic Journal of Science Education*, 11(2), 38-63.
- Man, C. N. (2007). *Epistemological beliefs and critical thinking among Chinese students*. Master thesis, The University of Hong Kong, China.
- Many, J., Howard, F., & Hoge, P. (2002). Epistemology and preservice teacher education: How do beliefs about knowledge affect our students' experiences? *English Education*, 34, 302-322.
- Mohamed, M. T., & El-Habba, M. (2013). The relationship between epistemic beliefs and academic performance: are better students always more mature? *Journal of Educational and Developmental Psychology*, 3(1). doi: <http://dx.doi.org/10.5539/jedp.v3n1p158>
- MoNE-TEB. (2005). *Fen bilimleri dersi öğretim programı (ilkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar) [Science curriculum (primary and secondary schools 3, 4, 5, 6, 7 and 8 classes)]*. Ankara.
- MoNE-TEB. (2017). *Fen bilimleri dersi öğretim programı (ilkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar) [Science curriculum (primary and secondary schools 3, 4, 5, 6, 7 and 8 classes)]*. Ankara.
- MoNE-TEB. (2016). *Düşünme eğitimi dersi (7. ve 8. sınıflar öğretim programı) [Course of thinking education teaching program (7 and 8 classes)]*. Ankara.
- Ozden, Y. (2003). *Öğrenme ve öğretme [Learning and teaching]*. Ank: PegemA Yayınları.

- Patton, M. Q. (2002). *Qualitative research & evaluation methods*. Thousand Oaks, CA: Sage.
- Peng, H., & Fitzgerald, G. (2006). Relationships between teacher education students' epistemological beliefs and their learning outcomes in a case-based hypermedia learning environment. *Journal of Technology and Teacher Education*, 14, 255-285.
- Perry, W. G. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. New York: Holt, Rinehart and Winston.
- Peterson, A. K. (1995). *The relationship between personal epistemology and accountability on critical thinking disposition*. Doctoral dissertation, Iowa State University, Iowa.
- Ravindran, B., Grene, B.A. & Debacker, T.K. (2000). Predicting preservice teachers' cognitive engagement with goals and epistemological beliefs. *Department of Educational Psychology*, 222-232.
- Schoenfeld, A. H. (1983). Beyond the purely cognitive: Beliefs systems, social cognitions, and metacognitions as driving forces in intellectual performance. *Cognitive Science*, 7, 329-363.
- Schommer, M. A. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82(3), 498-504.
- Schommer, M. (1993). Epistemological development and academic performance among secondary students. *Journal of Educational Psychology*, 85, 406-411.
- Schommer-Aikins, M., Duell, O., & Hutter, R. (2005). Epistemological beliefs, mathematical problem-solving beliefs, and academic performance of middle school students. *Elementary School Journal*, 105, 289-304.
- Schommer-Aikins, M., & Easter, M. (2006). Ways of knowing and epistemological beliefs: combined effect on academic performance. *Educational Psychology*, 26, 411-423.
- Strathopoulou, C., & Vosniadou, S. (2007). Exploring the relationship between physical related epistemological beliefs and physical understanding. *Contemporary Educational Psychology*, 32, 255-281.
- The Delphi Report (1990). Retrieved from:
https://assessment.trinity.duke.edu/documents/Delphi_Report.pdf
- Tumkaya, S. (2011). Fen bilimleri öğrencilerinin eleştirel düşünme eğilimleri ve öğrenme stillerinin incelenmesi [Comparison of college science major students' learning styles and critical thinking disposition]. *Journal of Kirsehir Education Faculty*, 12(3), 215-234.

- Tumkaya, S. (2012). The investigation of the epistemological beliefs of university students according to gender, grade, fields of study, academic success and their learning styles. *Educational Sciences: Theory & Practice*, 12(1), 88-95.
- Walsh, C.M., & Hardy, R.C. (1999). Dispositional differences in critical thinking related to gender and academic major. *Journal of Nursing Education*, 38(4), 149-155.
- Yılmaz Tuzun, O., & Topcu, M. S. (2013). Exploration of preservice science teachers' epistemological beliefs, world views, and self-efficacy considering gender and achievement. *Elementary Education Online*, 12(3), 659-673.

Fen Bilgisi Öğretmen Adaylarının Epistemolojik İnançları ve Eleştirel Düşünme Eğilimleri

Atıf:

- Koyunlu Unlu, Z., & Dokme, I. (2017). Science teacher candidates' epistemological beliefs and critical thinking disposition. *Eurasian Journal of Educational Research*, 72, 203-220, DOI: 10.14689/ejer.2017.72.11

Özet

Problem Durumu: Eleştirel düşünme ile epistemoloji arasındaki ilişkinin araştırılması eleştirel düşünme ile ilgili araştırmalara yeni bir bakış açısı getirmiştir. Bilgi felsefesi olarak adlandırılan epistemoloji filozofların yüzyıllardır "bilginin kaynağı nedir?" sorusuna verdiği yanıtların adresi olmuştur. Bilginin öznesi "bilen" nesnesi "bilinen" dir. Öznel felsefeler bilginin kaynağını bilene yakın görürken nesnel felsefeler bilgiyi bilinene yakın görmüşlerdir. Bilginin ne olduğu nasıl oluştuğu, bilginin kesinlik derecesi ve sınırları, bilme eyleminin nasıl gerçekleştiği üzerine inançlar ise epistemolojik inançlar kapsamında yer almaktadır. Epistemolojik inançlarla ilgili dört gelişim evresi tanımlanmıştır: Bilginin doğası ile ilgili inançları düalizm evresinde olanlar bilgilerin ya mutlak doğru veya yanlış olduğunu düşünürler, çoğulcu evresinde olanlar da bir fikrin diğerinden daha üstün olduğunu ayırt edecek bir ölçüt olmaksızın farklı bakış açılarının varlığını kabul ederler. Bazı fikirlerin diğerlerinden daha iyi olduğunu fark edenlerin epistemolojik inançları görecelidir. Bağlılık evresinde olanlar epistemolojik olarak bazı fikirlerin diğerlerinden daha iyi olduğunu fark edip iyi olana bağlı kalırlar. Hangi perspektiften bakarsak bakalım zayıf epistemolojik inançların öğrencilerin düşünme ve mantık yürütme performanslarını sınırlayacağı, olgunlaşmış epistemolojik inançların ise öğrencilerin bu performanslarını genişleteceği düşünülebilir. Epistemolojinin bu şekilde öngörülen etkisi epistemoloji ve eleştirel düşünme arasındaki ilişkinin araştırılmasını ilgi çekici bir araştırma konusu kılmaktadır.

Öğretmenin, yıllar boyunca öğretimin değişmeyen bileşeni olduğu göz önünde bulundurulduğunda öğrencilere eleştirel düşünme becerisinin kazandırılması ve öğrencilerin epistemolojik inançlarının güçlendirilmesi için öncelikle öğretmenlerin bu beceriye hakim olmaları gerekmektedir. Bu doğrultuda gelecek nesillerin yetişmesine katkı sağlayacak olan öğretmen adaylarının eleştirel düşünme eğilimlerinin ve epistemolojik inançlarının incelenmesi önem teşkil etmektedir. Eleştirel düşünme eğilimi ve epistemolojik inançlar, bilgiye ulaşmada bilimsel yöntemin kullanıldığı fen ile doğrudan ilişkili olduğundan bu araştırma fen bilgisi öğretmen adayları üzerinde gerçekleştirilmiştir.

Araştırmanın Amacı: Bu araştırmanın amacı cinsiyet ve sınıf seviyesinin fen bilgisi öğretmen adaylarının epistemolojik inançları ile eleştirel düşünme eğilimlerine etkisini ve bu iki bağımsız değişken arasındaki ilişkiyi belirlemektir.

Araştırmanın Yöntemi: Betimsel tarama yönteminin kullanıldığı bu araştırmaya bir üniversitenin fen bilgisi öğretmenliği bölümünde öğrenim gören 447 öğrenci (357 kız, 90 erkek) katılmıştır. Bu öğrencilerden 115'i birinci, 119'u ikinci, 129'u üçüncü ve 84'ü dördüncü sınıf öğrencisidir. Veri toplama aracı olarak Epistemolojik İnançlar Ölçeği (EİÖ) ve California Eleştirel Düşünme Eğilimi Ölçeği (CEDEÖ) kullanılmıştır. Ölçüm güvenirliği (Cronbach Alpha) 0.72 olan EİÖ, toplam 3 boyut (öğrenmenin çabaya bağlı olduğuna inanç, öğrenmenin yeteneğe bağlı olduğuna inanç, tek bir doğrunun var olduğuna inanç) ve 35 maddeden oluşmaktadır. CEDEÖ ise 6 boyut (analitiklik, açık fikirlilik, meraklılık, kendine güven, doğruyu arama, sistematiklik) ve 51 maddeden oluşmaktadır. CEDEÖ'nün ölçüm güvenirliği (Cronbach Alpha) 0.81'dir. Veriler SPSS programında analiz edilmiştir. Kayıp değerler için SPSS'de seriler ortalaması yöntemine başvurulmuştur. Daha sonra verilerin normallik varsayımları Kolmogorov-Smirnov testi ile değerlendirilmiştir. SEB ve CCTDI puanlarının cinsiyet ve sınıf seviyesine göre normal dağılım göstermediği tespit edilmiştir. Bu nedenle veri analizinde Mann Whitney U, Kruskal Wallis H- Testleri ile Sperman Brown Sıra Farkları korelasyon katsayısı kullanılmıştır.

Araştırmanın Bulguları: Kız ve erkek öğrencilerin öğrenmenin çabaya bağlı olduğuna ve öğrenmenin yeteneğe bağlı olduğuna dair faktör ortalama puanları arasında anlamlı bir farklılık bulunmamıştır. Fakat kız ve erkek öğrencilerin tek bir doğrunun var olduğuna dair inanç faktörü ortalama puanları arasında kız öğrencilerin lehine anlamlı bir farklılık bulunmuştur. Ayrıca kız ve erkek öğrencilerin EİÖ puanları arasında kız öğrencilerin lehine anlamlı bir farklılık vardır. Öğrencilerin EİÖ puanları sınıf seviyesine göre farklılaşmaktadır.

Kız ve erkek öğrencilerin analitiklik, açık fikirlilik, meraklılık, kendine güven ve toplam CEDEÖ puanları arasında anlamlı olarak bir farklılık bulunmamıştır. Fakat kız ve erkek öğrencilerin doğruyu arama ve sistematiklik faktörü ortalama puanları arasında anlamlı olarak bir farklılık bulunmuştur. Öğrencilerin CEDEÖ sonuçları sınıf seviyesine göre farklılaşmamaktadır.

SEB birinci faktörü olan öğrenmenin çabaya bağlı olduğuna inanç ile analitiklik, meraklılık ve kendine güven arasında orta düzeyde ve pozitif yönde; açık fikirlilik, doğruyu arama, sistematiklik ve toplam CEDEÖ puanları arasında düşük düzeyde

bir korelasyon vardır. EİÖ ikinci faktörü olan öğrenmenin yeteneğe bağlı olduğuna inanç ve analitiklik, meraklılık, sistematiklik ve toplam CEDEÖ ortalama puanları arasında düşük düzeyde; kendine güven, açık fikirlilik ile orta düzeyde ve pozitif yönde bir ilişki vardır. EİÖ üçüncü faktörü olan tek bir doğrunun var olduğuna inanç ile açık fikirlilik ve toplam CEDEÖ puanları arasında pozitif yönde ve orta düzeyde; analitiklik, meraklılık, kendine güven, doğruyu arama, sistematiklik arasında pozitif yönde ve düşük düzeyde bir ilişki vardır. Toplam EİÖ puanları ve toplam CEDEÖ puanları arasında ise pozitif yönde ve orta düzeyde bir ilişki vardır.

Araştırmanın Sonuçları ve Önerileri: Sonuç olarak fen bilgisi öğretmenliği bölümünde öğrenim gören kız öğrencilerin epistemolojik inançlarının erkek öğrencilere göre daha gelişmiş olduğu, öğrencilerin epistemolojik inançları ve eleştirel düşünme eğilimlerinin sınıf seviyesine göre düzenli olarak değişmediği, genel olarak epistemolojik inançlar ve eleştirel düşünme eğilimleri arasında orta düzeyde bir ilişki olduğu söylenebilir. Tartışma kısmında değinildiği gibi literatürde öğretmen adayları üzerinde gerçekleştirilen epistemolojik inanç ve eleştirel düşünme konulu pek çok nicel araştırma mevcuttur. Bu araştırma sonuçlarında ortak noktalar olsa bile tutarsızlıklar mevcuttur. Cinsiyet faktörünün fen bilgisi öğretmen adaylarının öğrenme-öğretme süreçlerine ve alınan eğitimin/derslerin eleştirel düşünme ile epistemolojik inançlara etkisi konularında derinlemesine bilgi sağlayacak nitel çalışmalara ihtiyaç vardır.

Eleştirel düşünme becerisinin ve epistemolojik inançların gelişimi için öncelikle öğretmen eğitimine önem verilmelidir. Bu konuda öğrencinin gelişimine katkı sağlamakla görevli olan öğretmenlere büyük görevler düşmektedir. Demokratik bir ortamda öğrencilerin tartışmalarına, kendilerini ifade etmelerine ve düşüncelerini diğerleri ile karşılaştırmalarına izin verilmelidir.

Cinsiyet faktörünün öğrenme-öğretme sürecine olumsuz etkilerinin azaltılması için erkek öğrencilerin epistemolojik inanç ve eleştirel düşünme becerilerini geliştiren uygulamalar yapılabilir. Ayrıca fen bilgisi öğretmenliği programında verilen uygulamalı derslerde (laboratuvar ve sunumların öğrenciler tarafından yapıldığı dersler gibi) öğretmen adaylarının bu becerilerini geliştiren etkinliklere yer verilmelidir.

Anahtar Kelimeler: fen eğitimi, öğretmen eğitimi, epistemolojik inançlar, eleştirel düşünme eğilimi