

An Examination of the Epistemological Views and Learning Styles of Pre-Service Teachers

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Abstract:

Epistemology is the branch of philosophy that investigates human knowledge, in particular its source, nature, limitations, system, and accuracy. The most critical issues in epistemology are considered to be belief in the nature of knowledge and belief in the nature of knowing. Since epistemology involves the structuring processes of knowledge, it assumed to be associated with individual differences, which are influential in determining an individual's ability to organize their thoughts and behaviors as well as personal choices. In addition, the most typical reflections of individual differences are observed in learning styles. Therefore, in this research, we aimed to examine the relationship between the epistemological views and learning styles of pre-service teachers. The study was based on a quantitative design and the epistemological views of the pre-service teachers were determined using the Scientific Epistemological Beliefs Scale developed by Elder (2002) and adapted to Turkish by Acat, Tüken and Karadağ (2010). In addition, the index of learning styles developed by Felder and Soloman (1996) and adapted to Turkish by Samanci and Keskin (2007) was used to identify the participants' learning styles. A total of 698 pre-service teachers from two state universities in Turkey constituted the sample of the research. According to the overall results, the pre-service teachers adopted philosophical skepticism and were inclined towards an active/sensing/visual/sequential learning style. Furthermore, a statistically significant relationship was found between the participants' learning styles and their epistemological views.

Keywords: Pre-service teachers, epistemological views, learning styles

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Introduction

Locke is one of the founders of knowledge theory, which investigates the origin, accuracy, and limits of knowledge, and thus, the degrees and basis of beliefs, opinions, and judgments (as cited in Kale, 2009). Knowledge is a general conceptualization and can be explained as the comprehension of something as something (Topdemir, 2011). Epistemology is the branch of philosophy that examines knowledge. Hofer and Pintrich (2002) defined epistemology as the investigation of the source, nature, limitations, system, and accuracy of human knowledge. According to Perry (1999), King and Kitchener (1994), and Hofer and Pintrich (2002), the most critical issues in epistemology are belief in the nature of knowledge and belief in the nature of knowing.

Epistemological views can be regarded as knowing, knowledge, and the answers sought in response to the questions of ‘what is knowledge’, ‘how is knowledge acquired’, ‘what is the degree of the certainty of knowledge’, “what are the limits of and criteria for knowledge”, and “is the knowledge transferred by authorities (experts) of a discipline to the student as a process external to the latter or is it acquired through the interaction of different disciplines” (Brownlee, Purdie and Boulton-Lewis, 2001; Eryaman and Riedler, 2009; Hofer and Pintrich, 1997; Ravindran, Greene and DeBacker, 2005). Schommer (1990) described epistemological belief as an individual’s opinion about what knowledge is and how knowing and learning take place. Epistemology contains fundamental questions and various propositions regarding these questions (Topdemir, 2011; Sönmez, 2010; Kale, 2009; Sözer, 2009; Bochenski, 2009; Hofer and Pintrich, 2002). These propositions can generally be reviewed under the categories of limits, certainty, accuracy, development, and change of knowledge. Table 1 presents the propositions offered by Hofer and Pintrich (1997) concerning the domains, sub-dimensions, and definitions of epistemology.

Table 1. *Domains, Sub-Dimensions, and Definitions of Epistemological Belief (Hofer and Pintrich, 1997, p. 113)*

	Domain	Sub-dimension	Definition
Epistemology	Nature of knowing	Source of knowledge	Knowledge is determined by an external authority (<i>Dogmatic</i>) Knowledge is structured by the person that knows (<i>Skeptical</i>)
		Confirmation of knowledge	Knowledge is accepted as defined by others without the need for confirmation (<i>Dogmatic</i>) Knowledge is based on the evidence and evaluation of experts (<i>Skeptical</i>)
	Nature of knowledge	Development of knowledge	Knowledge is unchanging and is absolute (<i>Dogmatic</i>) Knowledge is changing and is not absolute (<i>Skeptical</i>)
		Certainty of knowledge	There is only a single truth (<i>Dogmatic</i>) There is more than one truth (<i>Skeptical</i>)

As shown in Table 1, Hofer and Pintrich (1997) examined epistemology under two domains; the nature of knowing and the nature of knowledge. According to the sub-dimensions under these domains, the external development of knowledge and act of knowing dependent on authority and free from questioning is considered to reflect dogmatic philosophical thinking whereas the development of authority-free knowledge based on individual structuring and questioning indicates skeptical thinking. Similarly, Perry (1981) stated that epistemological views shifted from absolute/unchanging knowledge to changing/uncertain knowledge.

Particularly with the development of modern medicine and the advancement of technology, in addition to socio-cultural and environmental dynamics, mental processes such as thinking, understanding, and exploration have become widely investigated topics in brain research. Giedd et al. (1996) reported that the development of brain continued until the last stages of adolescence, as opposed to what was previously known, and that the most critical stage was early childhood. According to the results of their research, the cerebral cortex, which is the center of control for vital capacities (thinking, perception, and language skills) and constitutes two-thirds of the brain, develops

rapidly in early childhood, during which mental processes such as recognition, understanding, and problem solving also actively take place (Giedd et al., 1996). Confirming the results of Giedd et al.'s study, Reiss et al. reported that the human brain underwent an extensive development in the first three years and approached the completion of this development around the ages of 5-7; however, this process continued until adolescence albeit at a lower level (Reiss, Abrams, Singer, Ross, Denckla, 1996).

Experimental studies have shown that all the mental skills such as thinking, understanding, and problem solving are shaped by the functioning of the brain and the developmental process (Giedd et al., 1996; Reiss et al., 1996). Thus, it is considered that an individual's ability to process, acquire, and transform knowledge differs according to their environment, culture, and educational opportunities. Adler, a personality theorist, argued that learning was shaped by thoughts and that personality was formed based on the way of thinking. Adler further explained this by stating that human beings were born with a social interest and their personal interests based on their thoughts were influential factors for the individualization of their areas of interest and interactions (as cited in Passer & Smith, 2008). Another theorist, Jung, referred to personality typologies suggesting that the origin of our actions and learning had a different and complex structure (Wilson, Robeck, & Michael, 1974). Jung (1927) argued that personality types were related to learning styles and were basically divided into the two classes of introverted and extraverted, and that the way of thinking had a similar structure (Passer, Smith, 2008). Based on the studies on learning, it can be stated that learning styles resulting from personality traits are influential in the construction of individual knowledge. This argument is supported by the definition of learning style by Dunn (1960). According to Dunn, a student uses different and distinctive ways to prepare to learn, learn or remember something new or difficult (Dunn, Griggs, Olson, & Beasley, 1995). This indicates that not only the physiological structure of the brain but also learning styles that form and shape learning have an effect on the ability to think.

The ability to organize one's thoughts and behaviors differs from person to person and these individual differences have an impact on personal choices (Miyake & Friedman, 2012). Individual differences play an important role not only in intelligence, cognitive styles, and behaviors, but also in learning and teaching processes (Jonassen & Grabowski, 1993). Considering the influence of individual differences on learning, it is believed that each individual has their own learning strategies and styles (Dunn, 1986; Dunn & Dunn, 1992; Felder & Silverman, 1988; Gregorc, 1979; Kolb, 1976). In the literature, there are various definitions of learning styles and models. Gregorc (1979) suggested that learning styles were distinctive and observable behaviors that provided information about an individual's capabilities, thoughts about the world, and how they learned. According to Grasha (1996), learning styles are personal qualities that influence the student's ability to learn, interact with their friends and teachers, and participate in the learning process. Kolb (1984), on the other hand, suggested that the learning-style model indicated a process of transforming knowledge from production to experience and described learning styles through a cycle of four learning concepts; diverging, assimilating, converging, and accommodating. Keefe (1979) considered learning styles to be cognitive, emotional, and psychological behaviors that reflected learners' perception, interactions, and reactions in learning environments. According to Fleming (2001), learning styles concern the acquisition and organization of information based on individual characteristics as well as thoughts about knowledge. Felder & Brent (2005), on the other hand, suggested that learning styles referred to the process of taking in and processing information.

A review of the literature on learning styles (Dunn & Dunn, 1992, Eryaman and Genc, 2010; Felder & Silverman, 1988; Fleming, 2011; Gregorc, 1979; Kolb, 1976; Leite, Svinicki & Shi, 2010) shows that rather than considering them as standards, researchers have addressed the cognitive (Gregorc, 1979; Kolb & Kolb, 2005), affective, and physiological dimensions of learning styles (Dunn & Dunn, 1992).

An example of sensory models is the VARK model, which was developed by Fleming (2001) to measure visual (V), auditory (A), reading-writing (R), and kinesthetic (K) skills. In addition, learning style measurement tools (Gregorc, 1979; Felder & Silverman, 1988; Dunn & Dunn, 1992,

Kolb & Kolb, 2005) are influenced by various factors such as the level of development and cultural differences. Felder and Soloman (1994) developed an index of learning styles to determine the participants' learning styles based on their choice to complete the presented items using one of the two options representing two extreme poles. This index was based on the four dimensions of active-reflective, sensing-intuitive, visual-verbal, and sequential-global. Active learners learn more by doing something active, experimenting, and utilizing their experience whereas reflective learners tend to think and make connections between events. Sensing learning involves the active use of the five senses and concrete learning is based on perception while intuitive learning refers to a more abstract approach to learning in which intuitions, emotions, feelings, and value judgments play a role. In an individual with a visual learning style, learning is facilitated by pictorial materials, tables, and graphs whereas verbal learners prefer plain texts and listening to explanations. Lastly, sequential learning refers to paying attention to detail and using inductive reasoning whereas global learning involves grasping the whole picture and adopting deductive reasoning.

Significance and aim of the research:

Considering the argument presented by Brunzell and Marcks (2005) that teachers' scientific perceptions influence their students' understanding of science, it is considered that the determination of the epistemological views of teacher candidates would provide an insight into their prospective students' views on knowledge and science. Furthermore, a teacher's attitude towards learning would also shed light on their approach to teaching. The relationship between knowledge and information during mental processes can reveal how pre-service teachers define and create knowledge. The examination of the relationship between the epistemological views of pre-service teachers and their learning styles would also help in determining the role of learning styles (learning tendencies/preferences) in the process of defining and conceptualizing knowledge.

For the reasons presented above, this study aimed to examine the epistemological views and learning styles of pre-service teachers, and for this purpose, the following research questions were formulated:

- 1- What are the epistemological views of pre-service teachers?
- 2- What are the learning styles of pre-service teachers?
- 3- Does the variable of the undergraduate program of pre-service teachers have a statistically significant effect on their epistemological views and learning styles?
- 4- Do the learning styles of pre-service teachers significantly affect their epistemological views?
- 5- Is there a significant relationship between the epistemological views and learning styles of pre-service teachers?

Method

The study was based on a descriptive-correlational design (Büyüköztürk, 2007). A quantitative research method was chosen due to its advantages of allowing the collection of data in a short time without interfering with, or changing the research environment, simultaneous comparison of multiple factors, and accessibility to participant groups (Creswell, 2007).

Sample

The study was conducted in the 2016-2017 academic year with the students enrolled in the undergraduate programs of early childhood education (ECE), classroom teaching (CT), engineering and science education (ESE), and elementary mathematics education (EME) at two state universities operating under the Council of Higher Education in Turkey. The convenience sampling technique was

used to determine the sample. In this technique, the participants are chosen based on their availability, voluntariness, ease of accessibility, and willingness to participate in the research (Johnson & Christensen, 2014). Table 2 presents the distribution of participants by undergraduate program and gender.

Table 2: Distribution of the participant students by undergraduate program and gender

	ECE	CT	ESE	EME	Total
Female	183	258	97	43	581
Male	12	76	17	12	117
Total	195	334	114	55	698

The unequal proportions of the female and male participants resulted from the significantly lower number of male students being enrolled in the education undergraduate programs compared to the female students.

Data collection tools

Scientific Epistemological Beliefs Scale (SEBS) This scale was developed by Elder (2002) and adapted to Turkish by Acat, Tüken and Karadağ in 2010. SEBS consists of a total of 25 items under the following five sub-dimensions; authority/accuracy (9 items), knowledge production process (6 items), source of knowledge (4 items), hypothesizing (3 items), and change of knowledge (3 items). In the current study, Cronbach’s alpha for SEBS was found to be 0.888.

Table 3. Distribution of SEBS Items by Sub-Dimension

Sub-Dimensions	Items									
Authority / Accuracy	1*	5*	12*	15*	16*	20*	23*	24*	25*	
Knowledge Production Process	3*	4	7*	8	11	18				
Source of Knowledge	6*	10*	13*	14*						
Hypothesizing	2	21	22							
Change of Knowledge	9	17	19							

*indicates reverse coded items.

The Index of Learning Styles (ILS) Developed by Felder and Soloman (1994) and adapted to Turkish by Samancı and Keskin (2007), ILS classifies learning styles under the four dimensions of active-reflective, sensing-intuitive, visual-verbal, and sequential-global. The index has a total of 44 items with 11 items in each dimension. To determine their learning style for each item, the participants are presented with two options representing the two extreme poles. In ILS, Cronbach’s alpha is calculated separately for each dimension. According to the results of previous validity and reliability studies, Cronbach’s alpha of the dimensions ranges from 0.50 to 0.75 (Felder, Soloman, 1994; Felkel, Gosky 2012; Samancı, Keskin, 2007; Litzinger, Lee, Wise, Felder, 2005; Zywno, 2003; Livesay, Dee, Nauman, Hites, 2002; Van Zwanberg, Wilkinson, 2000). Similarly, in the current study, Cronbach’s alpha was calculated as 0.653, 0.515, 0.614, and 0.549 for the active-reflective, sensing-intuitive, visual-verbal, and sequential-global dimensions, respectively. . These values indicate that ILS is a reliable scale that can be used in this research.

Administration of the Scales

SEBS and ILS were simultaneously administered to the participants in the fall semester of the 2016-2017 academic year. The participants were given 40 minutes to complete the scales. Participation was voluntary.

Data Analysis

The descriptive analysis of the SEBS scores was performed using Tekin's (1993) formula for scale interval (sequence range / number of groups [4 / 5≈0.80]). According to this formula, the ranges of 1.00-1.80 (I strongly disagree) and 1.81-2.60 (I do not agree) indicate dogmatic approaches whereas the ranges of 2.61-3.40 (I am undecided), 3.41-4.20 (I agree), and 4.21-5.00 (strongly agree) represent skeptical approaches.

Since SEBS contains learning styles representing opposite poles, the symbols of '+' and '-' were used for each preference of the active/sensing/visual/sequential set and the reflective/intuitive/verbal/global set, respectively. The symbolic values were then coded as 1 point '-' and 2 points for '+'. The learning style in the index was determined by descriptively interpreting the frequencies of the symbols used for sub-dimensions.

The point biserial correlation coefficient was used to determine the relationship between epistemological views and learning styles. This coefficient is employed to describe the linear relationship between a continuous-level variable (SEBS in this study) and a binary, non-continuous variable (ILS in this study). (Köklü, Büyüköztürk and Çokluk Bökeoğlu, 2006). Furthermore, to determine whether the variable of undergraduate program resulted in a significant difference, the Bonferroni method was utilized since it allows for multiple (post hoc) comparisons without requiring equal sample sizes considering that in this study, the sample sizes differed between the undergraduate programs (Miller, 1969).

Results and Discussion

Results on the Epistemological Views of Prospective Teachers

Table 4 presents the descriptive statistical values indicating the epistemological views of the pre-service teachers that participated in this study.

Table 4. *Descriptive Statistics and Ranges for the SEBS Scores of the Participants*

Sub-Dimension	Min.	Max.	SD	S	\bar{X}	Range
Authority/Accuracy	11.00	45.00	6.51	42.37	34.68	3.85 = Skeptical Thinking
Knowledge Production Process	11.00	30.00	2.83	7.99	21.29	3.55 = Skeptical Thinking
Source of Knowledge	4.00	20.00	3.07	9.41	14.00	3.50 = Skeptical Thinking
Hypothesizing	3.00	15.00	2.37	5.40	12.12	4.03 = Skeptical Thinking
Change of Knowledge	3.00	15.00	2.30	5.27	12.04	4.01 = Skeptical Thinking
Total SEBS	43.00	125.00	13.46	181.21	94.12	3.77 = Skeptical Thinking

Table 4 shows that the epistemological views of the pre-service teachers were inclined towards skeptical philosophical thinking. In particular, the scores in the sub-dimensions of hypothesizing and change of knowledge were found to be high, indicating skeptical thoughts. However, the participants scored lower in knowledge production process and source of knowledge compared to the remaining sub-dimensions of epistemological beliefs. This indicates that the pre-service teachers were almost undecided about the production process and source of knowledge. In this context, it may be necessary for pre-service teachers to adopt more skeptical approaches in these two sub-dimensions. The general skeptical approach of pre-service teachers is considered to be a positive

result for their students. This result is also in agreement with previous research on pre-service teachers' beliefs reporting that learning is more dependent on effort than ability and that knowledge is changing (Chai, Khine, Teo, 2006; Cheng, Chan, Tang, & Cheng, 2009).

Results concerning the learning styles of pre-service teachers

Table 5 shows the descriptive statistics for the results on the learning styles of the pre-service teachers that participated in this study.

Table 5. *The Frequency Values of ILS and Results on Learning Styles*

ILS Sub-Dimensions	f values	% distribution	General preference
Active / Reflective	4072/3606	.53/.47	Active
Sensing / Intuitive	4955/2723	.65/.35	Sensing
Visual / Verbal	5901/1777	.77/.23	Visual
Sequential / Global	3900/3778	.51/.49	Sequential

As shown in Table 5, the pre-service teachers mostly preferred active, sensing, visual or sequential learning styles. This is consistent with the results reported by Slaats, Lodewijks, Van der Sanden (1999) in relation to the students enrolled in the undergraduate programs of the social sciences. It was observed that the learning preferences of the pre-service teachers were concentrated under the sensing and visual sub-dimensions whereas the active/reflective and sequential/global sub-dimensions had a more equal distribution. Although the results of the descriptive analysis provided information on learning preferences through the frequency distributions of the participants' responses, they did not clearly demonstrate which learning style the participants were inclined towards based on the participants' overall responses; therefore, it was necessary to calculate the distribution of the participants' learning styles taking critical value points as references. In other words, for each participant, it was determined whether there was an equal distribution among the active/sensing/visual/sequential or the reflective/intuitive/verbal/global sets or all the sub-dimensions in the scale. The critical threshold values were calculated as 16 points (6 items * 1 point + 5 items * 2 points) for the set of active/sensing/visual/sequential sub-dimensions and 18 points (6 items * 2 points + 5 points * 1 point) for the set of reflective/intuitive/verbal/global sub-dimensions. For the overall scale, 64 and 68 points represented the former and latter sets, respectively, and the participants who scored 65 to 67 in total were found to prefer two sub-dimensions from each of the two sets and were coded in this way. As a result of these analyses, three groups emerged concerning their learning styles (active/sensing/visual/sequential, reflective/intuitive/verbal/global, and a group with a balanced distribution). Table 6 shows the descriptive statistics for the learning styles preferred by the pre-service teachers.

Table 6. *Descriptive Statistics for the Learning Styles Preferred by the Prospective Teachers*

Groups of Learning Styles	f	%
Active/Sensing/Visual/Sequential	455	65.00
Reflective/Intuitive/Verbal/Global	57	8.00
Balanced distribution	186	27.00
Total	698	100.00

An examination of Table 6 reveals that 65% of the participants were located in the active/sensing/visual/sequential group and 27% exhibited a balanced distribution in terms of the sub-dimension of learning styles. Although a balanced distribution of learning styles is considered to be important for an effective process of learning (Healy, 2004; De Bello, 1990; Felder, 1996), there was only a small percentage of the participants (8%) in the reflective/intuitive/verbal/global group. It has been reported that children generally prefer active, sensing, and visual learning styles (Dunn, Griggs, Olson, & Beasley, 1995); therefore, it can be stated that the pre-service teachers' preferences regarding learning styles would be appropriate for their prospective students. Although it has been

reported that the majority of the children are global learners (Dunn, et. al., 1995), some of the recent studies have also shown that children can think analytically (Arnup, Murrphy, Roodenburg, & McLean, 2013; Koyré, 2004). However, considering the argument that for effective learning, both poles of learning styles should be efficiently utilized (Healy, 2004; De Bello, 1990; Felder, 1996), pre-service teachers should adopt a more balanced learning approach rather than concentrating on a single dimension.

A comparison of the results concerning the epistemological views and learning styles of pre-service teachers in relation to the variable of undergraduate program

A one-way variance analysis (ANOVA) was used to determine the differences in the epistemological views of the pre-service teachers based on the undergraduate program in which they were enrolled. The results of the analysis are given in Table 7.

Table 7. The Results of ANOVA Analysis on the Epistemological Views of the Prospective Teachers Based on Their Undergraduate program

	<i>Source of Variance</i>	<i>Sum of Squares</i>	<i>df</i>	<i>Mean Squares</i>	<i>F</i>	<i>p</i>
<i>Authority Accuracy</i>	Inter-group	259.314	3	86.438	2.049	.106
	Intra-group	29275.512	694	42.184		
	Total	29534.825	697			
<i>Knowledge Production Process</i>	Inter-group	143.726	3	47.909	6.126	.000
	Intra-group	5427.393	694	7.820		
	Total	5571.119	697			
<i>Source of Knowledge</i>	Inter-group	46.034	3	15.345	1.636	.180
	Intra-group	6510.953	694	9.382		
	Total	6556.987	697			
<i>Hypothesizing</i>	Inter-group	35.505	3	11.835	2.202	.087
	Intra-group	3729.625	694	5.374		
	Total	3765.130	697			
<i>Change of Knowledge</i>	Inter-group	29.058	3	9.686	1.846	.137
	Intra-group	3640.737	694	5.246		
	Total	3669.795	697			
<i>Total SEBS</i>	Inter-group	1900.350	3	633.450	3.534	.015
	Intra-group	124405.54	694	179.259		
	Total	126305.89	697			

As shown in Table 7, there was a significant difference between the pre-service teachers in terms of their epistemological views; however, an examination of the sub-dimensions of the epistemological views shows that the only significant difference was observed in the sub-dimension of knowledge production process but the remaining sub-dimensions did not significantly differ. A Bonferroni post hoc analysis was performed to identify the undergraduate programs that caused the significant difference. The results of this analysis are given in Table 8.

Table 8. Results of the Bonferroni (Post Hoc) Analysis on the Epistemological Views of the Pre-Service Teachers Based on Their Undergraduate programs

BEİÖ	Undergraduate program (I)	Undergraduate program (J)	Mean Difference (I-J)	Standard Error
<i>Knowledge Production Process</i>	ESE	ECE	1.11619*	.32970
		CT	1.08966*	.30334
		EME	.13158	.45912
<i>Overall SEBS</i>	ESE	ECE	3,52753	1.57852
		CT	3.92877*	1.45229
		EME	-,15359	2.19811

*p ≤ .05

According to the post hoc analysis, there was no significant difference between the ESE and EME students in terms of the sub-dimension of the knowledge production process; however, for the same sub-dimension, the score of the remaining participants from the other undergraduate programs differed. This may be due to the ESE and EME programs including courses on the nature of science, which aim to provide students with an understanding of the changing nature of scientific knowledge.

A second one-way ANOVA was performed to determine whether the learning styles of the pre-service teachers differed according to their undergraduate program. The results of this analysis are given in Table 9.

Table 9. The Results of ANOVA Analysis on the Learning Styles of the Pre-Service Teachers Based on Their Undergraduate program

ILS Sub-Dimensions	Source of Variance	of Sum Squares	of df	Mean Squares	F	p
Active / Reflective	Inter-group	9.871	3	3.290	.806	.491
	Intra-group	2832.851	694	4.082		
	Total	2842.722	697			
Sensing / Intuitive	Inter-group	9.282	3	3.094	.772	.510
	Intra-group	2780.897	694	4.007		
	Total	2790.179	697			
Visual / Verbal	Inter-group	10.008	3	3.336	.806	.491
	Intra-group	2871.025	694	4.137		
	Total	2881.033	697			
Sequential / Global	Inter-group	12.666	3	4.222	1.198	.310
	Intra-group	2446.503	694	3.525		
	Total	2459.169	697			

Table 9 shows that there was no significant difference between the learning styles of the pre-service teachers based on the undergraduate program variable. It is noteworthy that the results concerning learning styles were similar to those obtained in relation to the epistemological views (Table 8). The similar learning styles of the pre-service teachers attending different undergraduate programs may be explained by the similarity of their scores in the university entrance test in Turkey that affected their choice of undergraduate program. In addition, this result is meaningful when interpreted together with the descriptive statistics presented in Table 6. Furthermore, 65% of the pre-service teachers were found to prefer an active/sensing/visual/sequential learning style whereas for 27%, the distribution of the learning style preferences was balanced. These percentages reveal that the vast majority (92%) of the pre-service teachers participating in this research were open to adopting an active/sensing/visual/sequential learning style and that the undergraduate program variable did not affect this distribution.

A third ANOVA was conducted to determine the variances in the epistemological views of the pre-service teachers based on their learning styles. Table 10 presents the results of this analysis.

Table 10. The Results of ANOVA on the Epistemological Views of the Pre-Service Teachers Based on Their Learning Styles

	<i>Source of Variance</i>	<i>Sum of Squares</i>	<i>df</i>	<i>Mean Squares</i>	<i>F</i>	<i>p</i>
Authority / Accuracy	Inter-group	334.025	2	167.012	3.975	.019
	Intra-group	29200.801	695	42.016		
	Total	29534.825	697			
Knowledge Production Process	Inter-group	10.180	2	5.090	.636	.530
	Intra-group	5560.939	695	8.001		
	Total	5571.119	697			
Source of Knowledge	Inter-group	53.174	2	26.587	2.841	.059
	Intra-group	6503.813	695	9.358		
	Total	6556.987	697			
Hypothesizing	Inter-group	4.431	2	2.215	.409	.664
	Intra-group	3760.700	695	5.411		
	Total	3765.130	697			
Change of Knowledge	Inter-group	27.310	2	13.655	2.605	.075
	Intra-group	3642.486	695	5.241		
	Total	3669.795	697			
Total SEBS	Inter-group	1187.712	2	593.856	3.299	.038
	Intra-group	125118.179	695	180.026		
	Total	126305.891	697			

An examination of the variations in the epistemological views of the pre-service teachers based on their learning styles showed a significant difference only in the authority/accuracy sub-dimension and the remaining sub-dimensions did not significantly differ. This is in agreement with the results reported by previous studies. The results given in Table 10 were expected since earlier in the research, it was observed that the undergraduate program of the pre-service teachers did not cause a significant difference in terms of their epistemological views and learning styles. However, a Bonferroni (post hoc) test was necessary to determine which sub-dimension(s) of ILS resulted in the significant variation in the authority/accuracy sub-dimension of SEBS. The results of this analysis are given in Table 11.

Table 11. The Results of the Bonferroni (Post Hoc) Analysis on the Epistemological Views of the Pre-Service Teachers Based on Their Learning Styles

SEBS	(I) ILS	(J) SEBS	Mean Difference	Std. Error
Authority / Accuracy	Active/Sensing/ Visual/Sequential	Reflective/Intuitive/ Verbal/Global	-2.56715*	.91075
		Balanced Distribution	-.32408	.56412
Overall SEBS	Active/Sensing/ Visual/Sequential	Reflective/Intuitive/ Verbal/Global	-4.84087*	1.88521
		Balanced Distribution	-.60941	1.16771

*p ≤ .05

Table 9 reveals the significant difference between the active/sensing/visual/sequential and reflective/intuitive/verbal/global groups in terms of the scores in the authority/accuracy sub-dimension of SEBS. Based on this result, it can be stated that the pre-service teachers with a preference for an active/sensing/visual/sequential learning style considered knowledge as an authority and believed that

it was absolute/unchanging. In contrast, according to the participants preferring a reflective/intuitive/verbal/global learning style, knowledge represented authority. When interpreted together with the results presented above, it can be concluded that 65% of the pre-service teachers accepted knowledge as an authority.

Relationship between the epistemological views and learning styles of the pre-service teachers

The relationship between the SEBS and ILS scores of the participants was analyzed using the point biserial correlation coefficient formulated as follows:

$$r_{nc} = \frac{\bar{x}_p - \bar{x}_q}{SD} * \sqrt{p \cdot q}$$

- r_{nc} The point biserial correlation coefficient
- \bar{x}_p The mean ILS score for the sub-dimension set of active/sensing/visual/sequential
- \bar{x}_q The mean ILS score for the sub-dimension set of reflective/intuitive/verbal/global
- SD Standard deviation of the total ILS score (13.29)
- p The frequency of active/sensing/visual/sequential within ILS
- q The frequency of reflective/intuitive/verbal/global within ILS

SEBS X (score)	ILS
$\bar{x}_{p1}=70.00$	Active/Sensing/Visual/Sequential
$\bar{x}_{p2}=88.00$	Active/Sensing/Visual/Sequential
$\bar{x}_{q1}=101.00$	Reflective/Intuitive/Verbal/Global
$\bar{x}_{p3}=118.00$	Active/Sensing/Visual/Sequential
$\bar{x}_{q2}=43.00$	Reflective/Intuitive/Verbal/Global
$\bar{x}_{p455}=94.00$	Active/Sensing/Visual/Sequential (1)
$\bar{x}_{q57}=61.00$	Reflective/Intuitive/Verbal/Global (2)

$$\bar{x}_p = \frac{70 + 88 + 118 + \dots + 94}{455} = 93.562$$

$$\bar{x}_q = \frac{101 + 43 + \dots + 61}{57} = 98.403$$

$$p = \frac{455}{512} * 100 = 0.89$$

$$q = \frac{57}{512} * 100 = 0.11$$

$$r_{n\zeta} = \frac{\bar{x}_p - \bar{x}_q}{SS} * \sqrt{p \cdot q}$$

$$r_{n\zeta} = \frac{93.562 - 98.403}{13.29} * \sqrt{0.89 * 0.11} = -0.113$$

The negative value does not indicate a direction.

The equation used to calculate the significance of the correlation is given below:

$$t = \frac{r_{n\zeta} \sqrt{N - 2}}{\sqrt{1 - (r_{n\zeta})^2}}$$

For $N = 512 - 2$ (after subtracting the degree of freedom), the t value ($p_{.05;510}$) would be 1.96.

$$t = \frac{r_{n\zeta} \sqrt{N - 2}}{\sqrt{1 - (r_{n\zeta})^2}} = \frac{0.113 \sqrt{512 - 2}}{\sqrt{1 - (0.113)^2}} = 2.58$$

$$p_{.05;510} = 1.96;$$

$$2.58 > 1.96 \rightarrow p < .05$$

Based on the calculated value, it was concluded that the correlation between the epistemological views and learning styles was significant. In other words, there was a significant relationship between the epistemological views of the pre-service teachers that preferred a reflective/intuitive/verbal/global learning style. However, as mentioned above, the percentage of participants in the active/sensing/visual/sequential group was found to be very low (8%); therefore, this learning style affected the epistemological views of only 8% of this sample.

Conclusion and Recommendations

This study investigated the epistemological views and learning styles of pre-service teachers enrolled in four different undergraduate programs of the faculty of education at two state universities in Turkey. For this purpose, the epistemological views and learning styles of the pre-service teachers were examined in terms of the sub-dimensions under which they emerged and it was determined whether there was a significant relationship between their learning styles and epistemological views. Each of the four undergraduate programs have different student profiles, represent different student groups in terms of their achievement in the Turkish university entrance test, and offer different undergraduate courses. Therefore, the interpretation of the data in the light of this information would be more meaningful.

One of the most noteworthy findings of this research was that the majority of the participant pre-service teachers tended to have a skeptical approach regardless of their undergraduate program. Considering the role of teachers in the development and shaping of the epistemological beliefs of children the skeptical approach of the pre-service teachers can be viewed as a positive outcome.

The second important finding in the research was that a considerable percentage of pre-service teachers had an active/sensing/visual/sequential learning style. Here, the first notable point is that they

had similar learning styles despite having being placed in different undergraduate programs based on their achievement in different areas. The analyses showed that learning styles did not differ according to the undergraduate programs. Secondly, only 27% of the pre-service teachers were found to have a balanced distribution in terms of their preference of learning styles despite the anticipation that this percentage would be higher. This anticipation also resulted from the previous researchers' suggestions that for effective learning, a balanced distribution of learning styles is necessary. Considering that the pre-service teachers were placed in their respective undergraduate programs after achieving a certain score in the central examination, we expected that a higher percentage of the participants would have a more balanced distribution concerning their preferred learning styles. From one perspective, this can be interpreted positively in that as stated above, most children have an active/sensing/visual/sequential learning style. Therefore, the pre-service teachers have chosen a learning style that is appropriate for the profile of students with whom they will interact during their teaching.

One of the hypotheses of the study concerning the possible effect of learning styles on epistemological views was partially confirmed through analyses. The results of the analyses revealed a relationship between learning styles and epistemological views in the sub-dimension of authority/accuracy. To clarify, a significant relationship was found between the reflective/intuitive/verbal/global learning style and the epistemological views of the participants. However, there was a limitation concerning the very low percentage of pre-service teachers (8%) that preferred a reflective/intuitive/verbal/global learning style. In other words, the relationship that was observed had a low practical benefit.

In conclusion, the learning style preferences of the pre-service teachers were mostly concentrated at one end of the spectrum. It was also found that the learning styles had an effect on the epistemological views of the participants. Considering that the epistemological views of the teachers have an impact on those of their students, we believe that through undergraduate courses that support abstract thinking, the pre-service teachers should be encouraged to adopt a variety of learning styles, which will in turn increase their ability to construct effective learning environments for their students.

Since this research was conducted with pre-service teachers enrolled in four different teaching programs in the education faculties of two different state universities in Turkey, this may be considered as a limitation. Therefore, future studies can be undertaken with larger samples including different teaching programs to determine the scientific epistemological views of pre-service teachers.

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