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An Analysis of the Relationship between Pre-Service Secondary Mathematics Teachers' Epistemological Beliefs towards Learning, their Educational Beliefs, and Critical Thinking Dispositions

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Abstract

This study attempts to identify the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs, and critical thinking dispositions as well as the relationship between them. A relational survey model was employed and the study group consisted of 152 pre-service teachers. The study used Epistemological Beliefs Scale towards Learning (EBStL), The Educational Philosophy Tendencies Scale (EPTS), and Marmara Critical Thinking Dispositions Scale (MCTDS) as data collection tools. The results suggested that pre-service secondary mathematics teachers' epistemological beliefs and critical thinking dispositions were above the average value. Moreover, they were found to have progressive and reconstructivist tendencies. The results also revealed that the pre-service secondary mathematics teachers' epistemological beliefs towards learning did not differ across their gender, academic achievement, parents' educational level while significantly differed in terms of their grade level. The pre-service secondary mathematics' teachers' educational beliefs significantly varied across their gender, grade level while that was not the case for their academic achievement and parents' educational level. Besides, the results confirmed positive and significant relationships between the pre-service teachers' epistemological beliefs towards learning and their critical thinking disposition levels and progressivism, further positive and significant relationships were noted between the critical thinking dispositions and progressivism, reconstructionism and perennialism. Progressivism was found to be explained by epistemological beliefs towards learning and critical thinking dispositions; reconstructionism was found to be explained by critical thinking disposition; epistemological beliefs towards learning was determined to be explained by progressivism and critical thinking disposition, and critical thinking dispositions were identified to be explained by reconstructionism and perennialism

Keywords: Epistemological Belief, Educational Beliefs, Critical Thinking Dispositions, Pre-Service Secondary Mathematics Teachers

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Introduction

Since the day of their existence, human beings have wondered about their own existence and that of the universe by constantly questioning, searching, and producing new knowledge. This knowledge was insufficient to satisfy their curiosity and hence, they started to query the source, limits, meaning, and value of the obtained knowledge. These inquiries related to knowledge led to the emergence of the field of "epistemology", one of the fields of philosophy (Dorsah et al., 2020; Hofer & Pintrich, 1997). Epistemology seeks for giving replies to the questions regarding the possibility, the source, the field, scope/limits, and the rationality of knowledge within the framework of nature of knowledge. What is meant by the nature of knowledge here is how the person knows, where the source of knowledge is, whether knowledge is definite/objective or subjective, what the structure of knowledge is, and how knowledge is learned and controlled (Schommer, 1990). This has led to the emergence of individuals' beliefs about the nature of knowledge, namely the concept of "epistemological belief". Epistemological belief refers to the individual's acceptances, namely the beliefs by the nature, accuracy, source, and structure of knowledge, how knowledge is obtained, and what knowledge is or not (Bromme et al., 2010; Gu, 2016; Hofer, 2001). The scope of epistemological belief is not constrained to subject areas such as the nature, source and accuracy of knowledge; therefore, they also try to answer how learning occurs (Deryakulu, 2017). Thus, epistemological beliefs play a significant role in the teaching-learning process (Green & Hood, 2013; Hofer & Pintrich, 1997).

Research on Epistemological Beliefs (EBs) began with the works of Perry (1868, 1970) (Kutluca et al., 2018; Mardiha & Alibakhshi, 2020) who carried out two longitudinal studies on undergraduate Harvard students in the 1950s and 1960s to document what he called “an intellectual Pilgrim’s Progress” (Mardiha & Alibakhshi, 2020). The first researcher to consider epistemological belief as a multidimensional structure, Schommer (1990) (Kutluca et al., 2018; Mardiha & Alibakhshi, 2020) evaluated learners in terms of their epistemological beliefs and categorized them into two groups as sophisticated (more relativistic) and naïve (more dualistic) learners. Naïve learners believe that knowledge consists of simple and separate parts, while sophisticated learners postulate that knowledge has a complex and holistic structure. Naive learners favor that the ability to learn is genetic and fixed, that knowledge is transmitted through authorities, and that the source of knowledge is considered as experts. Sophisticated learners, on the other hand, have the belief that knowledge is gained not only by experts but also thanks to life-long experiences and thoughts through observation (Schommer-Aikins, 2004). Contrary to naïve beliefs, individuals with sophisticated epistemological beliefs believe that learning ability can be improved and an intense effort is required for learning to take place (Tanık Önal & Saylan Kırmızıgül, 2021). In this vein, naïve learners may interpret their mistakes as a result of their permanent inadequacy, become frustrated, and eventually give up trying. Sophists, however, think that their academic goals will increase their capacity (Üztemur et al., 2021).

When acknowledged as a filtering system through which all components in the learning-teaching process pass, epistemological beliefs are likely to affect and structure educational processes and their outcomes (Wong et al., 2009). In this regard, they can provide us with significant knowledge in predicting various behaviors and attitudes. Numerous studies were carried out to reveal the relation of epistemological beliefs with reading comprehension skills (Bråten & Strømsø, 2009), learning/studying strategies (Liang et al., 2010; Paulsen & Feldman, 1999; Schommer, 1998; Üztemur et al., 2020; Üztemur et al., 2021), academic achievement (Arseven et al., 2021; Cano, 2005; Müller et al., 2008; Üztemur et al., 2020; Vecaldo, 2017; Winberg et al., 2019), self-efficacy levels (Kapucu & Bahçivan, 2015; Tsai et al., 2011), critical thinking levels (Kandemir & Eğmir, 2020; Rott, 2021), knowledge literacy levels (Rosman et al., 2018), motivation levels (Ricco et al., 2010), and self-regulation skills (Muis, 2007). The studies reveal the importance of epistemological beliefs in terms of learning outcomes of the educational process. Safrudiannur (2020) drew attention to the fact that epistemological beliefs are still a subject area that opens gates for theoretical and methodological developments despite all the work done. In this case, the importance of the epistemological beliefs of teachers, one of the most remarkable inputs of the learning and teaching process, burst into prominence as epistemological beliefs deeply influence teachers' understanding of learning/teaching and teaching practices in the classroom, including the measurement-evaluation process (Bråten & Ferguson, 2015; Sheehy et al., 2021; Tanık Önal & Saylan Kırmızıgül, 2021; Üztemur et al., 2020). It is of utmost importance to conduct studies related to the epistemological beliefs in the teacher education process in ensuring that teachers have advanced epistemological beliefs.

Upon analyzing the relevant literature, the philosophical paradigms forming the educational beliefs are also built on the epistemological beliefs. Because individuals' educational philosophy tendencies that constitute the educational beliefs outline the learning-teaching strategies/methods, the materials, and the measurement-evaluation process (Can & Çelik, 2020). The philosophy of education, one of the most essential sub-branches of philosophy, has been defined by Gunzenhauser (2003:52) as "a set of ideas and commitments about the purpose and value of education that guides our practice and helps us make choices". Being as old as education, the philosophy of education includes thinking systematically in order to achieve the identified goals (Yargı & Sıvacı, 2021).

Considering the literature on what educational philosophies are, they generally fall into the following four categories. These are; perennialism, essentialism, progressivism and reconstructionism (Demir & Aktı Aslan, 2021; Gutek, 2014; Segall & Wilson, 2004). Perennialism is the oldest and most conservative educational philosophy (Cevizci, 2015; Wiles & Bondi, 2014), one of the proponents of which is Platon and which is rooted in realism and idealism philosophies (Şişman, 2015). Perennialism advocates that the facts are the same everywhere, they do not change, and individuals should be educated according to these facts (Cohen, 1999). Perennials have a subject-centered curriculum understanding (Ornstein & Hunkins, 2014) and are concerned with the

development of individuals' mental abilities, reasoning skills, and information processing (Cohen, 1999; Ellis, 2015). This philosophy requires that education deal with intellectual education, based upon raising gifted individuals with the right character. Education is teacher-centered in perennialism since the teacher is the most knowledgeable and empowered person in the classroom (Gutek, 2014). Çelik (2020) indicated that the development of creativity and self-discovery is arduous in the perennialism-based curriculum and it is improper for democratic societies since individual differences are not taken into consideration. Having emerged after perennialism and being one of the traditional educational philosophies put forward by educators such as W. C. Bagley, İ. L. Kandel, A. E. Bestor (Acar-Erdol, 2018), essentialism is rooted in idealism and realism philosophies (Demirel, 2020). Essentialism, just as perennialism, advocates that knowledge is universal and absolute that must be transmitted from generation to generation (Gutek, 2014). The curriculum of the essentialism is subject-centered (Yılmaz, 2019). This philosophy has a strict understanding of discipline (Ellis, 2015), and the student has to welcome the authority of the teacher (Yaralı, 2020). According to essentialism, an individual does not have an innate knowledge and skills, knowledge is obtained through experimenting, memorization and repetition are essential after knowledge is gained (Asmaz, 2019; Tisdell & Taylor, 2000).

In recent centuries, industrial and scientific advancements have also affected the understanding of education and contemporary educational philosophies have emerged to meet individuals' needs in line with the requirements of the age. One of the contemporary educational philosophies, progressivism is a development over pragmatism philosophical movement, and its main proponent is John Dewey (Winch & Gingell, 2008; Yargı & Sıvacı, 2021). Unlike perennialism and essentialism, progressivism asserts that knowledge does not have an absolute identity as it has a relative structure (Gutek, 2014). Progressivism advocates education that centers on the student's interests, needs, and first-hand experiences (Jarrah et al., 2020; Ornstein & Levine, 2008). According to progressivism, in which democratic environments are essential, the teacher is a guide and the schools must demonstrate the real-life situations to the students (Williams, 2017). In this regard, Ellis (2015) refers to the significance of curricula that will provide learning environments for individuals to build knowledge. Being one of the contemporary educational philosophies and aiming for real democracy through social reforms, reconstructionism is rooted in pragmatism (Segall & Wilson, 2004). Reconstructionism, which emphasizes that education is not only life but also the future, prioritizes society against too much emphasis on individualism (Tuncel, 2017), and the most important representatives of this philosophy are Theodore Brameld and Isaac Bergson (Asmaz, 2019; Dinamitçi, 2021). Schools should be institutions of social innovation movements, social reforms pioneers (Dewey, 2019), and social roles that come to the fore with a real understanding of democracy in order to engender social change (Winch & Gingell, 2008). It has a student-centered understanding that takes into account the experiences of individuals (Hamrah, 2012). In teaching processes based on

reconstructionism, it is essential to create environments where individuals can use scientific research methods, question and think critically.

The characteristics of both the ideal individual of contemporary educational philosophies and the individuals with advanced epistemological beliefs are the common qualities is the ability to think critically. Today's information society requires individuals who analyze, criticize and know what/why/how to learn, who actively participate in the learning process, synthesize and produce new information, rather than those who accept ready-made information directly and without questioning. In particular, many of the information access and applications have been transferred to the Internet, databases, media, and social networks where the reliability and validity are uncertain. This made it more difficult to prove the accuracy of the information and to make judgments (Fandiño Parra et al., 2021). The importance of teaching critical thinking, which is one of the skills that students need to have in order to cope with the complexities of their future lives, comes to the fore. Because critical thinking is the process of detecting false information through the mind by challenging the information obtained from the individual's environment (Judge et al., 2009).

The definition of critical thinking put forward by Facione (1990) with the consensus of many experts is as following “critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based”. Individuals having critical thinking skills are those who can objectively evaluate information, who make/develop independent decisions, who find ways to cope with difficult and complex situations and who attach importance to democratic values. Namely, critical thinking can also be viewed as the art of seeing the glass half empty or half full together (Yeşilyurt, 2021). Many studies evaluated critical thinking in two different dimensions named as critical thinking skills and dispositions (Lantian et al., 2021). While critical thinking skill is to be able to think critically with mental effort, critical thinking disposition is to have the desire, sense of responsibility, attitude and a consistent internal motivation for critical thinking (Lantian et al., 2021; Stupnisky et al., 2008). Yung-Kuan et al. (2017) emphasized the importance of having a critical thinking disposition by arguing that critical thinking will either never occur or will not be at the desired level in an individual who does not have a positive critical thinking disposition.

For a good future, the development of students’ critical thinking is the basis of their development in society, and the educational process is of great importance in this regard. Curricula implemented in Turkey also aim at raising individuals with critical thinking dispositions and skills. Raising future generations with critical thinking skills is possible with teachers having this disposition and skill. Hence, it is vital to train pre-service teachers who can keep up with the times, who produce innovative ideas, who have the will and attitude to distinguish between right and wrong through using

scientific and analytical thinking skills, in short, who have critical thinking dispositions. Because pre-service teachers' critical thinking disposition and skill levels play a key role in determining to what extent they will have their students gain these skills in the future.

This study attempts to identify the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions and the relationship between them.

In this regard, answers to the following questions were sought:

1. What are the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions?

2. Do the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions significantly differ across their gender, grade level, academic achievement and parents' educational level?

3. Is there a significant relationship between the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions?

4. Do the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions predict each other at a significant level?

Method

Research Design

This study employed a relational survey model, which tries to determine whether there is a relationship between more than one variable and if there is, the degree of the relationship (Karasar, 2022). The relational studies also aim at identifying whether the determined independent variable or variables predict the dependent variable in addition to examining the relationship between two or more variables (Gravetter & Forzano, 2018).

Study Group

The study group consists of 152 out of 166 pre-service teachers studying at Çanakkale Onsekiz Mart University, Faculty of Education, Department of Mathematics Education. The working group was chosen by convenience sampling method and by taking into account the voluntariness criterion. Convenience sampling provides a practical and rapid data collection based upon existing people or situations (Patton, 2015). Among the study group, 111 are female and 41 are male, 28.3% were the first-year undergraduate students, 25% were the second-year, 24.3% were the third-year and 22.4% were the fourth-year undergraduate students. Considering the pre-service teachers' academic

achievement, more than half of them (55.3%) had an academic achievement of over 3.51 based upon a 4-point system, and 95.4% of them had an academic achievement above 3.00. Upon examining parents' educational level, 54% of their mothers were found to be primary school graduates, while 25% were high school graduates; 32.2% of their fathers graduated from primary school and 23.7% of them from high school.

Data Collection Tools

Epistemological Beliefs Scale towards Learning (EBStL)

This tool, the Turkish adaptation of which was done by Kutluca et al. (2018), was developed by Sing-Chai et al. in 2009. Kutluca et al. (2018) added 4 items to the original scale and carried out exploratory, confirmatory factor and reliability analyses in order to obtain a 23-item five-point Likert-type scale ranging across "strongly agree (5)" and "strongly disagree (1)". Considering the developed epistemological beliefs while coding the data, negative items were reverse coded. Accordingly, the highest score that can be obtained from the scale is 115 and the lowest is 23. The scale consists of four dimensions: "attaining to knowledge" (9 items), "nurture vs. nature" (6 items), "absolute and single reality" (4 items) and "epistemic confliction" (4 items). The Cronbach Alpha internal consistency coefficient of the whole scale was noted to be .79, and that of each dimension was found to differ across .72-.84 (Kutluca et al., 2018).

The Educational Philosophy Tendencies Scale (EPTS)

It is a five-point Likert-type scale consisting of 36 items, ranging from "totally agree (5)" to "strongly disagree (1)". Aytaç and Uyangör (2020) performed exploratory and confirmatory factor analyses along with reliability analyzes. The scale encompasses four dimensions: "progressivism" (13 items), "reconstructionism" (9 items), "essentialism" (7 items) and "perennialism" (7 items). The Cronbach Alpha internal consistency coefficient of the entire scale was found to be .83, and that of each dimension varied across .66-.89 (Aytaç & Uyangör, 2020).

Marmara Critical Thinking Dispositions Scale (MCTDS)

Being a five-point Likert-type, the scale is composed of 28 items, ranging from "always (5)" and "never (1)". Exploratory factor analyzes and reliability analyzes were carried out by Özgenel and Çetin (2018). The scale possesses 6 dimensions such as "reasoning" (6 items), "reaching the judiciary" (6 items), "seeking evidence" (4 items), "seeking the truth" (4 items), "open-mindedness" (4 items) and "systematicity" (4 items). The Cronbach Alpha internal consistency coefficient of the entire scale was found to be.91 and that of each dimension varied across .64-.85 (Özgenel & Çetin, 2018).

Data Analysis

For determining the statistical techniques to be used during data analysis, the kurtosis and skewness values were examined to decide on whether data were normally distributed.

Table 1. The Kurtosis and Skewness Values of the EBStL, EPTS, and MCTDS

Scale	Kurtosis	Skewness
EBStL	-.514	.005
EPTS	-.155	.088
MCTDS	1.326	-.074

Upon analyzing Table 1, the data demonstrated a normal distribution, since kurtosis and skewness values obtained from the overall scales were between (+2.0) and (-2.0) (George & Mallery, 2010). Based upon the analyzes performed to determine whether the distribution was parametric, it was found appropriate to use the independent samples t-test in cases whe re the independent group is two, and one-way ANOVA (F test) when the independent group is more than two (Tabachnick & Fidell, 2013). In addition, Pearson product- moments correlation coefficients were used to determine the relationships between variables, and regression analysis to make predictions.

Findings and Interpretation

This part presents findings and interpretations of the study. The order of the findings is the same as the order of the research questions.

Findings and Interpretation regarding the First Research Question

Within the scope of the first research question; arithmetic mean and standard deviations of the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions are presented in Table 2.

Table 2. Analysis Results regarding the Epistemological Beliefs towards Learning, Educational Beliefs and Critical Thinking Dispositions

	Dimension	X	Sd
Epistemological Beliefs towards Learning	Attaining to Knowledge	35.22 (Min:9, Max:45)	2.96
	Nurture vs. Nature	21.53 (Min:6, Max:30)	3.99
	Absolute and Single Reality	14.97 (Min:4, Max:20)	1.62
	Epistemic Confliction	12.68 (Min:4, Max:20)	2.54
	Total	84.39 (Min:23, Max:115)	6.02

Educational Beliefs	Progressivism	4.56	.405
	Reconstructionism	4.30	.461
	Essentialism	2.37	.497
	Perennialism	3.02	.617
Critical Thinking Dispositions	Reasoning	4.04	.446
	Reaching the Judiciary	3.93	.413
	Seeking Evidence	4.01	.524
	Seeking the Truth	3.92	.462
	Open-mindedness	4.20	.480
	Systematicity	4.07	.511
	Total	4.02	.368

As is seen in Table 2, pre-service secondary mathematics teachers' epistemological beliefs towards learning were determined to be X=84.39 out of 115. Besides, pre-service secondary mathematics teachers had an average of X=35.22 out of 45 in terms of "attaining to knowledge" dimension, X=21.53 out of 30 for the dimension of "nurture vs. nature", X=14.97 out of 20 for the "absolute and single reality" dimension and X=12.68 out of 20 for "epistemic confliction" dimension.

Table 2 reveals that pre-service secondary mathematics teachers' educational beliefs were mostly grounded on progressivism with an average of X=4.56 out of 5. In addition, pre-service teachers' lowest level of educational beliefs was identified to be essentialism with X=2.37 out of 5.

Upon analyzing Table 2 in terms of critical thinking dispositions, pre-service secondary mathematics teachers' critical thinking disposition levels were determined as X=4.02 out of 5. Moreover, pre-service secondary mathematics teachers had the highest average with X=4.20 in terms of the "open-mindedness" dimension of the critical thinking disposition level, while the dimension of "seeking the truth" had the lowest average with X=3.92.

Findings and Interpretation regarding the Second Research Question

Within the scope of the second research question; the analysis results on whether pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions significantly differed across their gender, grade level, academic achievement and parents' educational level are presented in Table 3, Table 4, Table 5, Table 6 and Table 7.

Table 3. Analysis of the Epistemological Beliefs towards Learning, Educational Beliefs and Critical Thinking Dispositions in terms of "Gender"

	Dimension	Gender	N	$\overline{X}$	Sd	df	t	p
Epistemological Beliefs towards Learning	Attaining to Knowledge	Female	111	34.98	3.12	150	-1.667	.098
		Male	41	35.88	2.37			
	Nurture vs. Nature	Female	111	22.03	3.66	150	2.594	.010*
		Male	41	20.17	4.55			
	Absolute and Single Reality	Female	111	15.04	1.50	150	.864	.389
		Male	41	14.78	1.90			
	Epistemic Confliction	Female	111	12.44	2.58	150	-1.906	.059
		Male	41	13.32	2.34			
	Total	Female	111	84.49	6.13	150	.308	.758
		Male	41	84.15	5.79			
Educational Beliefs	Progressivism	Female	111	4.60	.383	150	2.178	.033*
		Male	41	4.43	.441			
	Reconstructionism	Female	111	4.33	.458	150	1.030	.305
		Male	41	4.24	.470			
	Essentialism	Female	111	2.35	.522	150	-.956	.341
		Male	41	2.44	.418			
	Perennialism	Female	111	2.94	.607	150	-2.604	.010*
		Male	41	3.23	.602			
Critical Thinking Dispositions	Reasoning	Female	111	4.04	.445	150	.012	.991
		Male	41	4.04	.456			
	Reaching the Judiciary	Female	111	3.94	.384	150	.207	.836
		Male	41	3.92	.489			
	Seeking Evidence	Female	111	4.01	.499	150	-.033	.974
		Male	41	4.01	.591			
	Seeking the Truth	Female	111	3.89	.449	150	-1.411	.160
		Male	41	4.01	.489			
	Open-mindedness	Female	111	4.20	.473	150	.035	.972
		Male	41	4.20	.505			
	Systematicity	Female	111	4.11	.499	150	1.450	.149
		Male	41	3.98	.533			
	Total	Female	111	4.02	.355	150	.087	.931
		Male	41	4.02	.405			

*p < .05

According to Table 3, no significant difference was noted across the pre-service secondary mathematics teachers' epistemological beliefs towards learning in terms of gender (t(150)=.308, p>.05). A significant difference was only identified across the dimension "nurture vs. nature" between men and women at the p=.010 level (t(150)=2.594, p<.05).

On examining the pre-service secondary mathematics teachers' educational beliefs in terms of gender in Table 3, significant differences were found in the dimension of progressivism in favor of females at p=.033 level (t(150)=2.178, p<.05), and in the dimension of perennialism in favor of males at the p=.010 level (t(150)=-2.604, p<.05). Table 3 also displays that the pre-service secondary mathematics teachers' critical thinking dispositions did not significantly differ at the p<.05 level in terms of their gender.

Table 4. Analysis of the Epistemological Beliefs towards Learning, Educational Beliefs and Critical Thinking Dispositions in terms of "Grade Level"

	Grade Level	N	$\overline{X}$	Sd		Sum of Squares	df	Mean Square	F	p
Epistemological Beliefs towards Learning	1st grade	43	85.23	4.99	Between Groups	353.814	3	117.938	3.407	.019*
	2nd grade	38	85.34	6.64						
	3rd grade	37	85.05	5.86	Within Groups	5122.501	148	34.611		
	4th grade	34	81.56	6.04						
	Total	152	84.39	6.02	Total	5476.316	151			
Progressivism	1st grade	43	4.54	.457	Between Groups	.604	3	.201	1.235	.299
	2nd grade	38	4.63	.349						
	3rd grade	37	4.47	.436	Within Groups	24.141	148	.163		
	4th grade	34	4.60	.348						
	Total	152	4.56	.405	Total	24.746	151			
Reconstructionism	1st grade	43	4.26	.461	Between Groups	.818	3	.273	1.289	.280
	2nd grade	38	4.42	.428						
	3rd grade	37	4.23	.490	Within Groups	31.315	148	.212		
	4th grade	34	4.29	.460						
	Total	152	4.30	.461	Total	32.134	151			
Essentialism	1st grade	43	2.37	.513	Between Groups	2.434	3	.811	3.451	.018*
	2nd grade	38	2.53	.537						
	3rd grade	37	2.40	.340	Within Groups	34.797	148	.235		
	4th grade	34	2.17	.519						
	Total	152	2.37	.497	Total	37.231	151			
Perennialism	1st grade	43	2.93	.659	Between Groups	1.808	3	.603	1.601	.192
	2nd grade	38	2.19	.598						
	3rd grade	37	3.02	.487	Within Groups	55.725	148	.377		
	4th grade	34	2.92	.691	Total					
	Total	152	3.02	.617		57.533	151			
Critical Thinking Dispositions	1st grade	43	4.01	.426	Between Groups	.147	3	.049	.357	.784
	2nd grade	38	4.07	.367						
	3rd grade	37	4.01	.415	Within Groups	20.294	148	.137		
	4th grade	34	3.99	.213						
	Total	152	4.02	.368	Total	20.441	151			

*p < .05

As can be seen in Table 4, the pre-service secondary mathematics teachers' epistemological beliefs towards learning significantly varied across their grade level at the p=.019 level against the fourth graders [F(3-148)= 3.407; p<.05]. Tukey test results used to determine the differences among the grade levels demonstrated a significant difference between the fourth grade pre-service teachers and the first graders at the level of p=.036, between the second graders at p=.036 level, and between the third graders at p=.064 level. No significant difference was identified across the factors regarding the pre-service secondary mathematics teachers' epistemological beliefs towards learning at the p<.05 level in terms of their grade levels (attaining to knowledge p=.692; nurture vs. nature p=.129; absolute and single reality p=.243; epistemic confliction p=.230).

As for the educational beliefs, the pre-service teachers' educational beliefs varied significantly only in the dimension of essentialism (F(3-148)= 3.451, p=.018) at p<.05 level. Tukey

test results showed a significant difference at the level of p=.009 between the fourth graders and those in the second grade in favor of the second graders at the level of p=.009.

A closer look at pre-service secondary mathematics teachers' critical thinking dispositions in terms of changes based on grade level indicated no statistically significant difference at the p<.05 level. A similar finding was reported concerning all dimensions of the scale in terms of the grades at the p<.05 level (reasoning p=.776; reaching the judiciary p=.584; seeking evidence p=.682; seeking the truth p=.477, open-mindedness p=.923; systematicity p= .676).

Table 5. Analysis of the Epistemological Beliefs towards Learning, Educational Beliefs and Critical Thinking Dispositions in terms of "Academic Achievement"

	Academic Achievement	N	$\overline{X}$	Sd		Sum of Squares	df	Mean Square	F	p
Epistemological Beliefs towards Learning	2.51-3.00	7	83.14	5.27	Between Groups	180.303	2	90.152		
	3.01-3.50	61	85.72	5.25	Within Groups	5296.012	149	35.544	2.536	.083
	3.51-4.00	84	83.54	6.47						
	Total	152	84.39	6.02	Total	5476.316	151			
Progressivism	2.51-3.00	7	4.32	.521	Between Groups	.506	2	.253		
	3.01-3.50	61	4.54	.397	Within Groups	24.240	149	.163	1.555	.215
	3.51-4.00	84	4.59	.398						
	Total	152	4.56	.405	Total	24.746	151			
Reconstructionism	2.51-3.00	7	4.03	.520	Between Groups	.674	2	.337		
	3.01-3.50	61	4.28	.439	Within Groups	31.460	149	.211	1.596	.206
	3.51-4.00	84	4.34	.469						
	Total	152	4.30	.461	Total	32.134	151			
Essentialism	2.51-3.00	7	2.29	.233	Between Groups	.071	2	.036		
	3.01-3.50	61	2.39	.582	Within Groups	37.160	149	.249	.142	.867
	3.51-4.00	84	2.37	.446						
	Total	152	2.37	.497	Total	37.231	151			
Perennialism	2.51-3.00	7	3.14	.670	Between Groups	1.789	2	.895		
	3.01-3.50	61	3.14	.621	Within Groups	55.743	149	.374	2.391	.095
	3.51-4.00	84	2.92	.601						
	Total	152	3.02	.617	Total	57.533	151			
Critical Thinking Dispositions	2.51-3.00	7	3.94	.553	Between Groups	.111	2	.055		
	3.01-3.50	61	4.00	.364	Within Groups	20.330	149	.136	.405	.668
	3.51-4.00	84	4.04	.356						
	Total	152	4.02	.368	Total	20.441	151			

Table 5 depicts that the pre-service secondary mathematics teachers' epistemological beliefs towards learning were free from a significant difference in terms of their academic achievement [F(2-

149)= 2.536; p>.05]. Only the dimension of "nurture vs. nature" significantly differed across pre-service teachers with 3.01-3.50 and those with that of 3.51-4.00 at the p= .032 level (F(2-149)=3.533, p<.05) in favor of those with high academic achievement (attaining to knowledge p=.884; genetic absolute and single reality p=.946; epistemic confliction p=.463).

Table 5 suggests that the educational beliefs scale did not significantly vary in terms of academic achievement at the p<.05 level. Pre-service teachers with high academic achievement were pointed to have more progressive and reconstructive educational beliefs, whereas those with lower academic achievement had perennialism educational beliefs.

Table 5 also shows that the critical thinking dispositions of pre-service secondary mathematics teachers did not differ significantly in terms of their academic achievement [F(2-149)= .405; p>.05]. As for the dimensions of the scale, a similar layout was noted in terms of their academic achievement at the p<.05 level (reasoning p=.216; reaching the judiciary p=.842; seeking evidence p=.383; seeking the truth p=.268, open-mindedness p=.284; systematicity p=.369). As the pre-service teachers' academic achievement increased, their critical thinking dispositions also increased, albeit a little.

Table 6. Analysis of the Epistemological Beliefs towards Learning, Educational Beliefs and Critical Thinking Dispositions in terms of "Mother Educational Level"

	Mother Educational Level	N	$\overline{X}$	Sd		Sum of Squares	df	Mean Square	F	p
Epistemological Beliefs towards Learning	Primary school	82	84.32	5.85	Between Groups	167.215	3	55.738		
	Middle School	12	85.50	5.87						
	High School	38	85.45	6.14	Within Groups	5309.101	148	35.872	1.554	.203
	Bachelor	20	82.05	6.33						
	Total	152	84.39	6.02	Total	5476.316	151			
Progressivism	Primary school	82	4.52	.430	Between Groups	.279	3	.093		
	Middle School	12	4.65	.392						
	High School	38	4.57	.381	Within Groups	24.466	148	.165	.563	.640
	Bachelor	20	4.61	.359						
	Total	152	4.56	.405	Total	24.746	151			
Reconstructionism	Primary school	82	4.27	.439	Between Groups	.612	3	.204		
	Middle School	12	4.49	.463						
	High School	38	4.29	.528	Within Groups	31.522	148	.213		
	Bachelor	20	4.36	.411					.958	.414
	Total	152	4.30	.461	Total	32.134	151			
Essentialism	Primary school	82	2.44	.518	Between Groups	.846	3	.282		
	Middle School	12	2.25	.460						
	High School	38	2.28	.411	Within Groups	36.385	148	.246	1.147	.332
	Bachelor	20	2.35	.565						
	Total	152	2.37	.497	Total	37.231	151			

Perennialism	Primary school	82	3.03	.616	Between Groups	1.233	3	.411		
	Middle School	12	2.75	.625						
	High School	38	3.10	.631	Within Groups	56.299	148	.380	1.081	.359
	Bachelor	20	2.95	.585						
	Total	152	3.02	.617	Total	57.533	151			
Critical Thinking Dispositions	Primary school	82	4.03	.414	Between Groups	.028	3	.009		
	Middle School	12	4.01	.214						
	High School	38	4.03	.342	Within Groups	20.412	148	.138	.068	.977
	Bachelor	20	3.99	.302						
	Total	152	4.02	.368	Total	20.441	151			

Table 6 presents that the pre-service secondary mathematics teachers' epistemological beliefs towards learning did not significantly differ in terms of mother educational level [F(3-148)= 1.554; p>.05]. Concerning the dimensions of epistemological beliefs towards learning, only the dimension of "attaining to knowledge" showed a significant difference between those whose mothers were primary school graduates and those whose mothers were high school graduates at the p=.044 level (F(3-148)=2.767, p<.05) in favor of those whose mothers were high school graduates (nurture vs. nature p =.268; absolute and single reality p=.960; epistemic confliction p=.666). Pre-service teachers whose mothers had a bachelor's degree have fewer developed epistemological beliefs compared to others.

Upon analyzing the pre-service secondary mathematics teachers' educational beliefs in terms of mother educational level, no significant difference was noted at the p<.05 level. The pre-service teachers whose mothers were primary school graduates were determined to mostly adopt perennialism and essentialism.

As in Table 6, no significant difference was pointed across the pre-service secondary mathematics teachers' critical thinking dispositions in terms of mother educational level [F(3-148)= .068; p>.05]. Likewise, the dimensions of pre-service teachers' critical thinking dispositions did not significantly vary in terms of mother educational level at the p<.05 level (reasoning p=.652; reaching the judiciary p=.929; seeking evidence p=.941; seeking the truth p=.426, open-mindedness p=.625; systematicity p=.850).

Table 7. Analysis of the Epistemological Beliefs towards Learning, Educational Beliefs and Critical Thinking Dispositions in terms of "Father Educational Level"

	Father Educational Level	N	$\overline{X}$	Sd		Sum of Squares	df	Mean Square	F	p
Epistemological Beliefs towards Learning	Primary school	49	84.82	5.19						
	Middle School	29	82.76	6.06	Between Groups	106.020	5	21.204		
	High School	36	84.75	6.04						
	PreBachelor	9	85.44	7.80	Within Groups	5370.296	146	36.783	.576	.718
	Bachelor	27	84.44	6.97						
	Master	2	86.00	4.24						
	Total	152	84.39	6.02	Total	5476.316	151			

Progressivism	Primary school	49	4.44	.424	Between Groups	1.328	5	.266	1.656	.149
	Middle School	29	4.57	.446						
	High School	36	4.61	.379						
	PreBachelor	9	4.50	.423	Within Groups	23.418	146	.160		
	Bachelor	27	4.68	.321						
	Master	2	4.81	.272						
	Total	152	4.56	.405	Total	24.746	151			
Reconstructionism	Primary school	49	4.18	.371	Between Groups	1.541	5	.308	1.470	.203
	Middle School	29	4.30	.536						
	High School	36	4.33	.532						
	PreBachelor	9	4.36	.355	Within Groups	30.593	146	.210		
	Bachelor	27	4.46	.422						
	Master	2	4.56	.629						
	Total	152	4.30	.461	Total	32.134	151			
Essentialism	Primary school	49	2.47	.530	Between Groups	1.307	5	.261	1.063	.384
	Middle School	29	2.24	.563						
	High School	36	2.32	.438						
	PreBachelor	9	2.37	.458	Within Groups	35.924	146	.246		
	Bachelor	27	2.39	.444						
	Master	2	2.71	.202						
	Total	152	2.37	.497	Total	37.231	151			
Perennialism	Primary school	49	3.01	.640	Between Groups	3.099	5	.620	1.663	.147
	Middle School	29	2.89	.638						
	High School	36	3.20	.574						
	PreBachelor	9	2.78	.295	Within Groups	54.433	146	.373		
	Bachelor	27	3.04	.639						
	Master	2	2.36	.707						
	Total	152	3.02	.617	Total	57.533	151			
Critical Thinking Dispositions	Primary school	49	3.98	.396	Between Groups	.961	5	.192	1.441	.213
	Middle School	29	3.94	.339						
	High School	36	4.15	.456						
	PreBachelor	9	3.94	.144	Within Groups	19.479	146	.133		
	Bachelor	27	4.05	.224						
	Master	2	3.91	.025						
	Total	152	4.02	.368	Total	20.441	151			

Table 7 displays that the pre-service secondary mathematics teachers' epistemological beliefs towards learning did not significantly differ in terms of father educational level [F(5-146)= .576; p>.05]. Moreover, pre-service teachers' epistemological beliefs towards learning varied significantly across only in the dimension of "attaining to knowledge" at the p=.032 level (F(5-146)=2.515, p<.05) (nurture vs. nature p=.161; absolute and single reality p=.551; epistemic confliction p=.855).

Upon analyzing the pre-service secondary mathematics teachers' educational beliefs in terms of father educational level, no significant difference was determined at the p<.05 level. The pre-service teachers whose fathers had a higher educational level were determined to mostly adopt progressivism and reconstructionism.

As in Table 7, no significant difference was identified across the pre-service secondary mathematics teachers' critical thinking dispositions in terms of father educational level [F(5-146)= 1.441; p>.05]. When the dimensions of the pre-service teachers' critical thinking dispositions were examined in terms of father educational level, only the dimension of "open-mindedness" (F(5-146)=

2.351, p=.044) significantly differed at p<.05 level (reasoning p=.206; reaching the judgment p=.169; seeking evidence p=.801; seeking the truth p=.448, open-mindedness p=.044; systematicity p=.557). Tukey test results revealed a significant difference between the pre-service teachers whose fathers were primary school graduates and high school graduates (p=.013) in favor of those whose fathers were high school graduates.

Findings and Interpretation regarding the Third Research Question

The analysis results on whether there was a significant relationship between the pre-service secondary mathematics teachers' epistemological beliefs towards learning, educational beliefs and critical thinking dispositions are illustrated in Table 8, Table 9 and Table 10.

Table 8. Pearson Correlation Coefficients between the Epistemological Beliefs towards Learning and Critical Thinking Dispositions

Variables		Critical Thinking Disposition (Total)	Reasoning	Reaching the Judiciary	Seeking Evidence	Seeking the Truth	Open-mindedness	Systematicity
Epistemological Beliefs towards Learning (Total)	r	.250**	.313**	.092	.290**	.245**	.054	.169*
	p	.002	.000	.259	.000	.002	.512	.038
Attaining to Knowledge	r	.320**	.300**	.154	.234**	.282**	.217**	.336**
	p	.000	.000	.058	.004	.000	.007	.000
Nurture vs. Nature	r	-.038	.017	-.068	.054	.020	-.158	-.059
	p	.638	.837	.406	.505	.802	.052	.470
Absolute and Single Reality	r	.193*	.210**	.107	.145	.134	.185*	.125
	p	.017	.010	.152	.075	.100	.022	.124
Epistemic Confliction	r	.157	.234**	.078	.238**	.136	.005	.021
	p	.053	.004	.342	.003	.095	.951	.796

**Correlation is significant at the 0.01 level *Correlation is significant at the 0.05 level

Table 8 shows that the correlation coefficient between the pre-service secondary mathematics teachers' epistemological beliefs towards learning and their critical thinking disposition levels was .250 (p=.002, p<.01), having a positive and significant relationship. Positive and significant relationships were determined between the epistemological beliefs towards learning and the dimensions of critical thinking dispositions such as reasoning (r=.313; p=.000, p<.01), seeking evidence (r=.290; p=.000, p<.01), seeking the truth (r=.245; p=.002, p<.01) and systematicity (r=.169; p=.038, p<.05). Moreover, positive and significant relationships were found between the attaining to knowledge, one of the dimensions of epistemological beliefs, and those of critical thinking dispositions such as reasoning (r=.300; p=.000, p<.01), seeking evidence (r=.234; p=.004, p<. .01), seeking the truth (r=.282; p=.000, p<.01), open-mindedness (r=.217; p=.007, p<.01) and systematicity

(r=.336; p =.000, p<.01). There were also positive and significant relationships between the dimension of epistemic confliction and those of reasoning (r=.234; p=.004, p<.01) and seeking evidence (r=.238; p=.003, p<. .01).

Table 9. Pearson Correlation Coefficients between the Epistemological Beliefs towards Learning and Educational Beliefs

Variables		Progressivism	Reconstructionism	Essentialism	Perennialism
Epistemological Beliefs towards Learning (Total)	r	.186*	.121	-.102	-.018
	p	.022	.139	.211	.828
Attaining to Knowledge	r	.257**	.292**	.070	.277**
	p	.001	.000	.388	.001
Nurture vs. Nature	r	.062	-.037	-.044	-.179*
	p	.446	.652	.593	.027
Absolute and Single Reality	r	.130	.134	-.131	.045
	p	.110	.100	.108	.581
Epistemic Confliction	r	-.039	-.082	-.172	-.112
	p	.631	.313	.034	.169

**Correlation is significant at the 0.01 level *Correlation is significant at the 0.05 level

Table 9 figures positive and significant relationships between epistemological beliefs towards learning and progressivism (r=.186; p=.022, p<.05). Besides, a negative but insignificant relationship was identified between epistemological beliefs towards learning and essentialism and perennialism educational beliefs. Positive and significant relationships were determined between the dimension of "attaining to knowledge" and progressivism (r=.257; p=.001, p<.01), reconstructionism (r=.292; p=.000, p<.01) and perennialism (r=.277; p=.001, p<.01) educational beliefs.

Table 10. Pearson Correlation Coefficients between the Critical Thinking Dispositions and Educational Beliefs

Variables		Critical Thinking Dispositions (Total)	Reasoning	Reaching the Judiciary	Seeking Evidence	Seeking the Truth	Open-mindedness	Systematicity
Progressivism	r	.388**	.289**	.258**	.255**	.309**	.347**	.399**
	p	.000	.000	.001	.002	.000	.000	.000
Reconstructionism	r	.347**	.283**	.219**	.235**	.417**	.285**	.226**
	p	.000	.000	.007	.004	.000	.000	.005
Essentialism	r	-.105	-.134	-.049	-.065	-.069	-.084	-.086
	p	.198	.099	.549	.426	.395	.304	.292
Perennialism	r	.187*	.066	.198*	.060	.205*	.225**	.159
	p	.021	.420	.014	.461	.011	.005	.050

**Correlation is significant at the 0.01 level *Correlation is significant at the 0.05 level

As can be seen in Table 10, positive and significant relationships were found between critical thinking dispositions and progressivism (r=.388; p=.000, p<.01), reconstructionism (r=.347; p=.000, p<.01) and perennialism (r=.187; p=.021, p<.05) educational beliefs. And negative relationship was

determined between critical thinking dispositions and essentialism (r=.105; p=.198) despite not at a significant level. Positive and significant relationships were found between each dimension of the critical thinking dispositions and progressivism and reconstructionism educational beliefs.

Findings and Interpretation regarding the Fourth Research Question

Linear regression analysis was used to determine whether the relationship between the pre-service secondary mathematics teachers' epistemological beliefs towards learning, educational beliefs and critical thinking dispositions was predictive. Analysis results are shown in Table 11, Table 12, Table 13, Table 14, Table 15 and Table 16.

Table 11. Regression Analysis of the Epistemological Beliefs towards Learning on their Critical Thinking Dispositions

Independent Variable	Dependent Variable	B	Std. Error	β	t	R	R2	F	p
Epistemological Beliefs towards Learning	Critical Thinking Dispositions (Total)	2.733	.409	.250	6.688	.250	.063	10.010	.002*
		.015	.005		3.164				
	Reasoning	2.079	.486	.313	4.276	.313	.098	16.317	.000*
		.023	.006		4.039				
	Reaching the Judiciary	3.401	.472	.092	7.205	.092	.008	1.284	.259
		.006	.006		1.133				
	Seeking Evidence	1.877	.575	.290	3.262	.290	.084	13.813	.000*
		.025	.007		3.717				
	Seeking the Truth	2.331	.514	.245	4.539	.245	.060	9.619	.002*
		.019	.006		3.101				
	Open-mindedness	3.837	.550	.054	6.974	.054	.003	.432	.512
		.004	.007		.657				
	Systematicity	2.867	.577	.169	4.967	.169	.028	4.393	.038*
		.014	.007		2.096				

*p < .05

Table 11 suggests that the pre-service secondary mathematics teachers' epistemological beliefs towards learning had a positive but weak effect on their critical thinking dispositions. The R2 value (R=.250; R2 = .063; p<0.05), which is expressed as the explanatory power of the model, illustrates that 6.3% of the critical thinking disposition variance is explained by the epistemological beliefs towards learning. Upon analyzing the values with regard to the dimensions of critical thinking disposition, 9.8% of the reasoning (R=.313; R2 = .098; p<0.05) dimension, 8.4% of seeking evidence (R=.290; R2 = .084; p<0.05) were explained by the epistemological beliefs towards learning.

Table 12. Regression Analysis of the Epistemological Beliefs towards Learning on their Educational Beliefs

Independent Variable	Dependent Variable	B	Std. Error	β	t	R	R2	F	p
Epistemological Beliefs towards Learning	Progressivism	3.505	.456	.186	7.677	.186	.035	5.366	.022*
		.012	.012		2.317				
	Reconstructionism	3.523	.525	.121	6.706	.121	.015	2.210	.139
		.009	.006		1.487				
	Essentialism	3.082	.567	-.102	5.439	.102	.010	1.576	.211
		-.008	.007		-1.255				
	Perennialism	3.169	.708	-.018	4.477	.018	.000	.047	.828
		-.002	.008		-.217				

*p < .05

According to Table 12, the pre-service secondary mathematics teachers' epistemological beliefs towards learning had a positive but weak effect only on their progressivism educational belief. The R2 value (R=.186; R2 =.035; p<0.05), the explanatory power of the model, shows that 3.5% of the progressivism education belief variance is explained by the epistemological belief towards learning.

Table 13. Regression Analysis of the Critical Thinking Dispositions on their Epistemological Beliefs towards Learning

Independent Variable	Dependent Variable	B	Std. Error	β	t	R	R2	F	p
Critical Thinking Dispositions	Epistemological Beliefs towards Learning (Total)	67.9227	5.227	.250	12.996	.250	.063	10.010	.002*
		4.094	1.294		3.164				
	Attaining to Knowledge	24.860	2.513	.320	9.893	.320	.103	17.149	.000*
		2.576	.622		4.141				
	Nurture vs. Nature	23.203	3.574	-.038	6.492	.038	.001	.222	.638
		-.417	.885		-.471				
	Absolute and Single Reality	11.550	1.422	.193	8.122	.193	.037	5.820	.017*
		.849	.352		2.413				
	Epistemic Confliction	8.313	2.245	.157	3.703	.157	.025	3.810	.053
		1.085	.556		1.952				

*p < .05

Table 13 suggests that the pre-service secondary mathematics teachers' critical thinking dispositions had a positive but weak effect on their epistemological beliefs towards learning. Expressed as the explanatory power of the model, R2 value (R=.250; R2 = .063; p<0.05) points out that 6.3% of the epistemological belief towards learning variance is explained by the critical thinking dispositions. Considering the values related to the dimensions of epistemological beliefs on learning, the dependent variable, 10.3% of the dimension of attaining to knowledge (R=.320; R2 = .103; p<0.05) and 3.7% of the absolute and single reality dimension (R=.193; R2 = .037; p<0.05) were explained by the critical thinking dispositions.

Table 14. Regression Analysis on the Predictive Power of the Critical Thinking Dispositions on their Educational Beliefs

Independent Variable	Dependent Variable	B	Std. Error	β	t	R	R2	F	p
Critical Thinking Dispositions	Progressivism	2.839	.334	.388	8.489	.388	.151	26.629	.000*
		.427	.083		5.160				
	Reconstructionism	2.553	.388	.347	6.583	.347	.120	20.494	.000*
		.435	.096		4.527				
	Essentialism	2.943	.443	-.105	6.648	.105	.011	1.674	.198
		-.142	.110		-1.294				
	Perennialism	1.753	.544	.187	3.225	.187	.035	5.448	.021*
		.314	.135		2.334				

*p < .05

As is figured in Table 14, the pre-service secondary mathematics teachers' critical thinking dispositions were determined to have a positive effect on their educational beliefs- progressivism (β= .388), reconstructionism (β=.347) and perennialism (β=.187). The explanatory power of the model, R2 value signifies that 15.1% of the progressivism (R=.388; R2 =.151; p<0.05) and 12% of the reconstructionism (R=.347; R2 =.120; p<0.05) were explained by the critical thinking disposition.

Table 15. Regression Analysis of the Educational Beliefs on their Epistemological Beliefs towards Learning

Independent Variable	Dependent Variable	B	Std. Error	β	t	R	R2	F	p
Progressivism	Epistemological Beliefs towards Learning (Total)	71.795	5.460	.186	13.149	.186	.035	5.366	.022*
		2.765	1.193		2.317				
	Attaining to Knowledge	26.671	2.639	.257	10.106	.257	.066	10.584	.001*
		1.877	.577		3.253				
	Nurture vs. Nature	18.728	3.675	.062	5.097	.062	.004	.584	.446
		.614	.803		.764				
	Absolute and Single Reality	12.598	1.479	.130	8.516	.130	.017	2.584	.110
		.520	.323		1.607				
	Epistemic Confliction	13.798	2.338	-.309	5.901	.039	.002	.231	.631
		-.246	.511		-.481				
Reconstructionism	Epistemological Beliefs towards Learning (Total)	77.627	4.578	.121	16.957	.121	.015	2.210	.139
		1.573	1.058		1.487				
	Attaining to Knowledge	27.152	2.167	.292	12.530	.292	.086	14.032	.000*
		1.876	.501		3.746				
	Nurture vs. Nature	22.900	3.053	-.037	7.500	.037	.001	.205	.652
		-.319	.706		-.453				
	Absolute and Single Reality	12.950	1.227	.134	10.553	.134	.018	2.732	.100
		.469	.284		1.653				
	Epistemic Confliction	14.624	1.935	-.082	7.556	.082	.007	1.023	.313
		-.452	.447		-1.011				
Essentialism	Epistemological Beliefs towards Learning (Total)	87.329	2.387	-.102	36.583	.102	.010	1.576	.211
		-1.237	.985		-1.255				
	Attaining to Knowledge	34.228	1.176	.070	29.099	.070	.005	.748	.388
		.420	.485		.865				
	Nurture vs. Nature	22.358	1.588	-.044	14.077	.044	.002	.286	.593
		-.351	.655		-.535				
	Absolute and Single Reality	15.977	.639	-.131	25.011	.131	.017	2.609	.108
		-.426	.264		-1.615				
	Epistemic Confliction	14.765	.995	-.172	14.833	.172	.030	4.589	.034*
		-.880	.411		-2.142				

Perennialism	Epistemological Beliefs towards Learning (Total)	84.917 -.173	2.452 .796	-.018	34.637 -.217	.018	.000	.047	.828
	Attaining to Knowledge	31.216 1.329	1.158 .376	.277	26.963 3.533	.277	.077	12.484	.001*
	Nurture vs. Nature	25.023 -1.159	1.598 .519	-.179	15.657 -2.233	.179	.032	4.987	.027*
	Absolute and Single Reality	14.611 .118	.658 .214	.045	22.214 .553	.045	.002	.305	.581
	Epistemic Confliction	14.067 -.461	1.026 .333	-.112	13.709 -1.382	.112	.013	1.910	.169

*p < .05

Table 15 reveals that only the progressivism educational belief of the pre-service secondary mathematics teachers had a positive but weak effect on their epistemological beliefs towards learning. Expressed as the explanatory power of the model, R2 value (R=.186; R2 = .035; p<0.05) proves that 3.5% of the epistemological belief towards learning variable (variance) was explained by the independent variable in the model, namely, progressivism. Moreover, the pre-service secondary mathematics teachers' educational beliefs of progressivism, reconstructionism and perennialism were determined to have a positive but weak effect on the dimension of attaining to knowledge epistemological belief. Regarded as the explanatory power of the model related to the dimension of attaining to knowledge, R2 values exhibit that 6.6% (R=.257; R2 =.066; p<0.05) of the dimension of attaining to knowledge was explained by progressivism, 8.6% (R=.292; R2=.086; p<0.05) by reconstructionism and 7.7% (R=.277; R2 =.077; p<0.05) by perennialism.

Table 16. Regression Analysis of the Educational Beliefs on their Critical Thinking Dispositions

Independent Variable	Dependent Variable	B	Std. Error	β	t	R	R2	F	p
Progressivism	Critical Thinking Dispositions (Total)	2.414 .353	.313 .068	.388	7.717 5.160	.388	.151	26.629	.000*
	Reasoning	2.586 .318	.394 .086	.289	6.560 3.696	.289	.083	13.663	.000*
	Reaching the Judiciary	2.733 .264	.368 .081	.258	7.420 3.272	.258	.067	10.708	.001*
	Seeking Evidence	2.506 .330	.468 .102	.255	5.359 3.227	.255	.065	10.416	.002*
	Seeking the Truth	2.315 .352	.405 .089	.309	5.712 3.973	.309	.095	15.785	.000*
	Open-mindedness	2.321 .412	.416 .091	.347	5.585 4.532	.347	.120	20.539	.000*
	Systematicity	1.779 .504	.432 .094	.399	4.119 5.335	.399	.159	28.461	.000*
Reconstructionism	Critical Thinking Dispositions (Total)	2.833 .277	.264 .061	.347	10.720 4.527	.347	.120	20.494	.000*
	Reasoning	2.861 .274	.328 .076	.283	8.728 3.611	.283	.080	13.036	.000*
	Reaching the Judiciary	3.089 .197	.309 .071	.219	10.005 2.754	.219	.048	7.585	.007*
	Seeking Evidence	2.862 .267	.390 .090	.235	7.335 2.959	.235	.055	8.757	.004*
	Seeking the Truth	2.123 .418	.321 .074	.417	6.605 5.623	.417	.174	31.613	.000*
	Open-mindedness	2.922 .296	.353 .081	.285	8.289 3.638	.285	.081	13.236	.000*
	Systematicity	3.000 .250	.381 .088	.226	7.878 2.835	.226	.051	8.039	.005*

Essentialism	Critical Thinking Dispositions (Total)	4.207	.146	-.105	28.858	.105	.011	1.674	.198
		-.078	.060		-1.294				
	Reasoning	4.323	.176	-.134	24.537	.134	.018	2.751	.099
		-.121	.073		-1.659				
	Reaching the Judiciary	4.031	.164	-.049	24.508	.049	.002	.360	.549
		-.041	.068		-.600				
	Seeking Evidence	4.173	.208	-.065	20.022	.065	.004	.638	.426
		-.069	.086		-.799				
	Seeking the Truth	4.073	.184	-.069	22.187	.069	.005	.727	.395
		-.065	.076		-.853				
	Open-mindedness	4.390	.191	-.084	23.021	.084	.007	1.064	.304
		-.081	.079		-1.032				
	Systematicity	4.284	.203	-.086	21.137	.086	.007	1.119	.292
		-.088	.084		-1.058				
Perennialism	Critical Thinking Dispositions (Total)	3.686	.147	.187	25.048	.187	.035	5.448	.021*
		.112	.048		2.334				
	Reasoning	3.893	.181	.066	21.477	.066	.004	.655	.420
		.048	.059		.809				
	Reaching the Judiciary	3.534	.165	.198	21.428	.198	.039	6.137	.014*
		.133	.054		2.477				
	Seeking Evidence	3.856	.213	.060	18.100	.060	.004	.545	.000*
		.051	.069		.738				
	Seeking the Truth	3.458	.184	.205	18.788	.205	.042	6.548	.011*
		.153	.060		2.559				
	Open-mindedness	3.670	.191	.225	19.261	.225	.050	7.973	.005*
		.175	.062		2.824				
	Systematicity	3.677	.205	.159	17.919	.159	.025	3.895	.051
		.132	.067		1.974				

*p < .05

As depicted in Table 16, the pre-service secondary mathematics teachers' progressivism, reconstructionism and perennialism educational beliefs were determined to have a positive effect on their critical thinking dispositions. R2 values, known as the explanatory power of the models, outline that 15.1% of the critical thinking disposition variance was explained by progressivism, 12% by reconstructionism and 3.5% by perennialism. Besides, the pre-service secondary mathematics teachers' progressivism and reconstructionism educational beliefs had a positive and significant impact upon all dimensions of critical thinking dispositions. Essentialism educational belief was noted to have a negative and insignificant effect on all dimensions of critical thinking dispositions. Considered as the explanatory power of the model, R2 values show that 15.9% of the systematicity dimension (R=.399; R2 =.159; p<0.05) and 12% of the open-mindedness dimension (R=.347; R2 =.120; p<0.05) were explained by progressivism. Likewise, the R2 value, which is expressed as the explanatory power of the model related to the reconstructionism indicates that 17.4% (R=.417; R2 = .174; p<0.05) of the seeking the truth dimension was explained by reconstructionism in the model.

Result, Discussion and Recommendations

This study attempts to identify the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions and the relationship between them. Within the scope of the first research question, an answer to the following question was sought: "What are the pre-service secondary mathematics teachers' epistemological beliefs towards learning, educational beliefs and critical thinking dispositions?".

Based upon the findings, the pre-service secondary mathematics teachers' epistemological beliefs towards learning were determined to be above the average. Similar layouts emerged in various studies. In the study conducted with 987 pre-service teachers, Wu et al. (2021) concluded that the average of epistemological beliefs was above the normative value. Dorsah et al. (2020) carried out a study with 115 pre-service teachers and reported that their epistemological beliefs were above average. Moreover, in the study conducted with 472 pre-service teachers, Yalçın and Yıldız (2020) highlighted those pre-service teachers had sophisticated epistemological beliefs. In their study on pre-service teachers' epistemological beliefs, Langcay et al. (2019) noted that they have a complex structure along the source of knowledge, and they tend to be sophisticated. Tanık Önal and Saylan Kırmızıgül (2021) conducted their study with 182 pre-service teachers and pointed that they have sophisticated epistemological beliefs. In another study performed with 213 pre-service teachers, Altay (2021) outlined that teachers have medium level epistemological beliefs and their epistemological beliefs on learning are close to advanced level. The results regarding the dimensions of epistemological beliefs revealed that pre-service teachers' epistemological beliefs in the "epistemic confliction" dimension, which includes the information-cognitive conflict created by the phenomena of nature or society that seem to be chaotic, that have more than one solution, that cannot be resolved with a single algorithm, and that seem to be devoid of order, have a lower level of development than the other dimensions. The result regarding the dimension of "attaining to knowledge", referring to knowledge that is structured in degrees, the limits of knowledge and knowing, the methods of accessing knowledge and the effort to reach knowledge, indicated that pre-service teachers have more advanced epistemological beliefs compared to other dimensions. In addition, the pre-service teachers were determined to have developed beliefs in terms of the "absolute and single reality" dimension. The results of the study conducted by Vecaldo (2017) implied that 464 pre-service teachers and teachers hold mature epistemological beliefs about "effort and process in learning". Güler (2020) reported that the pre-service teachers have mature beliefs in the dimensions that "learning depends on effort and ability", but an underdeveloped belief as for the dimension of "there is only one truth". In the study conducted by Wong et al. (2009) with 604 pre-service teachers, the most adopted epistemological belief was identified to be the dimension of "effort and process in learning", while the least adopted one was the dimension of "belief in expert knowledge". In a similar vein, Chai et al. (2006) carried out a study with 537 pre-service teachers and reported that the beliefs about the significance of effort and process in learning were predominant. The results obtained from both this study and other studies indicate that the pre-service teachers have awareness of the significance of effort in the learning process, yet their beliefs related to the variability of the truths and multiple solutions do not have a sufficient level of development. Considering that epistemological beliefs are a feature that holds a significant impact on educational activities and affects the teacher's understanding of education and in-class practices, it is quite pleasing that pre-service teachers have epistemological beliefs that are higher than medium. However, the fact that each dimension of epistemological beliefs

does not have the desired level of development cannot be underestimated. Given that epistemological beliefs do not have an innate and unchanging structure and they have a structure that changes and develops over time (Özeren, 2020), we can shape our future generations by attaching more importance to the training of educators with advanced epistemological beliefs both within the scope of pre-service training and in-service training. As a result of the study conducted with 110 university students aged between "16-65", Bath and Smith (2009) emphasized that epistemological beliefs can be a key predictor of lifelong learning.

As for the pre-service teachers' educational beliefs within the framework of the first research question, they were found to have mostly progressivism and reconstructionism, while the lowest education belief was determined to be essentialism. Akagündüz Yinilmez and Soylu (2021) concluded that pre-service teachers mostly adopt contemporary educational beliefs (existentialism and reconstructionism) and that the least adopted educational belief is essentialism. In another study conducted by Gökbulut (2020), 233 pre-service teachers mostly adopt progressivism, while the least preferred one is essentialism. Likewise, Yaralı (2020) conducted a study with 657 pre-service teachers and reported that the least adopted educational belief is essentialism; moreover, Abalı Öztürk and Bilgen (2018) concluded that essentialism is the least adopted educational belief by 769 pre-service teachers. Fries (2012) signified that most of the education faculties have progressive education beliefs. Similar findings emerged in the study conducted by Minor et al. (2001). The findings of all the studies are congruent with those of the present study. This paves the way for the fact that the pre-service teachers' educational beliefs are in line with contemporary educational philosophies. Considering that the curricula in Turkey are built on the philosophy of progressivism, pre-service teachers may be said to have educational beliefs at a satisfactory level in order to achieve the objectives of curricula. It is likely that pre-service teachers are trained according to the targeted educational philosophy during their pre-service education, meaning that teacher-training programs also include educational beliefs concerning the educational philosophies of progressivism and reconstructionism. Hordvik et al. (2020) defined teacher education pedagogy as a process that is influenced by the beliefs, knowledge and experiences of teacher educators, the expectations of teacher educators and pre-service teachers as well as the traditions of the university, curricula and courses.

Within the scope of the first research question, the pre-service secondary mathematics teachers' critical thinking disposition levels were found to be higher than the medium value, furthermore, they had the highest score in terms of the "open-mindedness" dimension, and the lowest score in terms of the "Seeking the Truth" dimension. Upon analyzing the relevant literature regarding the pre-service teachers' critical thinking dispositions, similar results emerged in the studies conducted by Koçer (2021) with 165 pre-service teachers, Sevgi and Şahin (2021) with 424 pre-service teachers; Öztürk (2020) with 273 pre-service science teachers, Alkoç (2020) with 442 pre-service teachers, Yüzgeç (2020) with 135 pre-service teachers, Uysal et al. (2020) with 275 pre-

service teachers, Ocak et al. (2016) with 278 pre-service teachers; Piji Küçük and Uzun (2013) with 274 pre-service teachers and Durukan and Maden (2010) with 240 pre-service teachers. Accordingly, the majority of studies examining teachers' critical thinking dispositions have similar results (Arslan & Kutluca, 2021; Aslan, 2019; İzci & Özden, 2021). However, some research results in the related literature also suggested that pre-service teachers and teachers have lower level critical thinking dispositions (Burks, 2019; Çiçek Sağlam & Büyükuysal, 2013; Nickname & Royafar, 2019; Polat & Kontaş, 2018). In his study titled "Pre-service teachers critical thinking and developing and using models in science", Burks (2019) investigated the dispositions of pre-service teachers to develop models related to critical thinking skills, prejudices and active use in their lessons. The study results suggested that the pre-service teachers' knowledge level about critical thinking skills was low, their active use was low, and they were insufficient in defining and explaining the multiple dimensions of critical thinking. The results obtained from the studies may vary due to the differences of the working groups. Various recommendations could be provided by taking the studies conducted with teachers and pre-service teachers into consideration. Activities/elective courses may be included in teacher education to improve their dispositions and skills, online databases may be created so that pre-service teachers can benefit from them asynchronously, course definitions may be revised by associating the learning objectives of the courses in the undergraduate program with critical thinking skills, academic staff's critical thinking skills may be reviewed in order to make critical thinking dispositions more positive. The inclusion of the "critical and analytical thinking" course in the vocational knowledge elective course pool in education faculties in Turkey since 2018 is a favorable development in terms of developing critical thinking skills.

Based upon the second research question, an answer to the following question was sought: "Do the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions differ significantly across gender, grade level, academic achievement and parents' educational level?". In this regard, the pre-service secondary mathematics teachers' epistemological beliefs towards learning did not significantly vary across their gender, and that female and male pre-service teachers had beliefs at approximately the same level of development. The relevant literature includes various studies indicating that teachers' and pre-service teachers' epistemological beliefs are free from a significant difference in terms of gender (Arseven et al., 2021; Chan, 2003; Chan, 2008; Chan & Elliott, 2000; Conley et al., 2004; Elmalı & Yıldız, 2017; Kaya & Ekici, 2017; Koç & Memduhoğlu, 2017; Olgun, 2018; Tanık Önal & Saylan Kırmızıgül, 2021). However, many studies also revealed that epistemological beliefs differed significantly in terms of gender (Avcı et al., 2020; Chai et al., 2006; Hofer, 2000; İçli, 2021; Kanadlı & Akay, 2019; Kutluca et al., 2018; Lodewyk, 2007; Özeren & Akpınar, 2020; Schommer & Dunnell, 1994; Soysal et al., 2018; Üztemur & Dinç, 2018; Vecaldo, 2017). Some of these studies suggested that males have more sophisticated epistemological beliefs, while a large number of them argued that females have

more sophisticated epistemological beliefs. Considering the different results from both this study and the related studies, it is unlikely to clarify the fact about whether gender is an effective factor in the epistemological beliefs of teachers and pre-service teachers. This study also determined that the pre-service secondary mathematics teachers' epistemological belief towards learning significantly differed against the 4th graders, and those of the 1st, 2nd, and 3rd graders were at approximately the same level of development and were higher than the 4th graders. The results of some studies are in parallel to that of the present study, yet most of these studies are in contrast to the result obtained from this study by showing that epistemological beliefs become more sophisticated the class promotes. Having taken the leading role in conducting the first study on people's epistemological beliefs, William Perry (1970) investigated the university students' views in order to examine the role of students and teachers during the learning process starting from the first to the last year. The results demonstrated that most of the first grade university students thought that knowledge is an unchangeable concept, whereas the fourth graders believed that the nature of knowledge is science and that it could be changed (İçli, 2021). In addition, there are also studies suggesting that epistemological belief levels do not significantly differ in terms of grade level (İçli, 2021; Kutluca et al., 2018). The difference in study results on whether university education develops individuals' epistemological belief does not present us clear information. Based upon the assumption that epistemological beliefs can be developed, university education is expected to have positive effects in this sense. The epistemological beliefs of the academic staff also play a significant role in this process. It is recommended to carry out studies on the development of the academic staff's epistemological beliefs. The findings of this current study also unveiled that the pre-service secondary mathematics teachers' epistemological beliefs towards learning are free from a significant difference in terms of their academic achievement. The results of some studies are in line with that of this study (Harteis et al., 2010; Mohamed & El-Habbal, 2013). Mohamed and El-Habbal (2013) concluded that students with sophisticated epistemological beliefs did not achieve high success in exams and those with naive epistemological beliefs showed higher academic performance. They cited the reasons as the inadequacy of teaching practices and the inclusion of cognitive-level questions based on recall and memorization in the exams. Unlike the result of this study, most of the related studies refer to significant and positive relationships between epistemological beliefs and academic achievement (Bozpolat & Durdu, 2020; Cano, 2005; Chen & Pajares, 2010; Conley et al., 2004; Hofer & Pintrich, 1997; Holschuh, 1998; Kanadlı & Akbaş, 2015; Schommer et al., 1992; Schommer-Aikins et al., 2005; Qian & Alvermann, 2000; Üztemur et al., 2020; Winberg et al., 2019; Zhou et al., 2019). The results of these studies can be explained by factors such as the fact that learners with sophisticated epistemological beliefs adopt deep rather than superficial learning approaches, they spend more effort on learning, they are persistent and responsible, and they tend to use learning strategies more effectively in challenging academic tasks. It is of great importance to develop the perceptions of learners with advanced epistemological beliefs towards academic achievement, which can be

achieved by the quality of the tools used in measurement and evaluation. Studies may be conducted on the preparation of the tools measuring academic performance and having the quality of measuring high-level skills for advanced epistemological beliefs. The results showed that the pre-service secondary mathematics teachers' epistemological beliefs towards learning differed significantly in terms of parents' educational level only in the dimension of "attaining to knowledge" between those whose parents' were primary school graduates and high school graduates in favor of those whose parents were high school graduates. The study carried out by İçli (2021) revealed that epistemological beliefs did not differ in terms of the father's educational level; however, a significant difference was identified in terms of the mother's educational level. Accordingly, primary school graduates were found to have more learner-centered pedagogical beliefs compared to the literate ones. Bozpolat and Durdu (2020) reported that the variables of father's educational level and mother's educational level have different results.

This study also concluded that the pre-service secondary mathematics' teachers' educational beliefs significantly differed in terms of gender in favor of females in the dimension of progressivism and in favor of males in the dimension of perennialism. This result is consistent with previous studies (Abalı Öztürk & Bilgen, 2018; Aydemir & Kaya, 2021; Dinamitçi, 2021; Gökbulut, 2020; Kumral, 2015; Yaralı, 2020; Yazıcı, 2017). All these studies showed that contemporary educational beliefs are more adopted by females, while traditional education beliefs by males. In addition, the literature also includes many studies indicating that educational beliefs do not significantly differ in terms of gender (Altınkurt et al., 2012; Demir et al., 2021; Fritz, 2008). The results of this study on whether the pre-service secondary mathematics teachers' educational beliefs differed significantly in terms of grade level, academic achievement and parents' educational level outlined that only the dimension of essentialism varied across grade level (between the fourth and second graders), but not in terms of academic achievement and parents' educational level. The results also showed that the second grade students mostly adopt essentialism educational belief. The results of some studies are line with that of this study indicating that the educational beliefs of teachers and pre-service teachers are affected by their grade levels (Demirtaş & Batdal Karaduman, 2016; Yaralı, 2020). Considering the average of each educational belief of the fourth grade level, it is unlikely to mention that the tendency towards contemporary education beliefs increases or decreases as grade levels increase.

This study analyzed whether the pre-service teachers' critical thinking dispositions significantly differed in terms of gender, grade level, academic achievement and parents' educational level. As a result, their critical thinking dispositions did not vary in terms of gender; moreover, the average of the female and male pre-service teachers were exactly the same. The related studies concluded that the teachers' and pre-service teachers' critical thinking dispositions are free from a significant difference in terms of gender (Akbulut, 2019; Alkoç, 2020; Demirbilek & Kırbaç, 2021; Erdem et al., 2013; Facione et al., 1995; Fitriani et al., 2019; Khandaghi et al., 2011; Mahmoud &

Mohamed, 2017; Öztürk, 2020; Polat & Kontaş, 2018; Soğukpınar, 2017; Tous & Haghighi, 2016; Uslu, 2020; Yüzgeç, 2020). Unlike the result of this present study, some studies found that critical thinking dispositions differed significantly in terms of gender (Ateş, 2018; Bulut, 2020; Kim et al., 2014; Koçer, 2021; Ocak et al., 2016; Shubina & Kulakli, 2019; Uysal et al., 2020). Most of these studies suggested that women have a higher level of critical thinking dispositions. Based on the results of both this study and related studies, it is impossible to put across whether gender is an effective factor in the teachers' and pre-service teachers' critical thinking dispositions. Another result of current study suggested that the pre-service secondary mathematics teachers' critical thinking dispositions did not vary in terms of grade level and the averages were quite close to each other. Similar layouts were identified within the relevant studies (Altuntaş et al., 2018; Ip, Lee et al., 2000; Khandaghi et al., 2011; Ocak et al., 2016; Uslu, 2020). Contrary to these studies, some studies conducted with pre-service teachers affirmed that the grade level had an effect on their critical thinking dispositions (Alkoç, 2020; Ateş, 2018; Kermansaravi et al., 2013; Noone & Seery, 2018; Öztürk, 2020; Sevgi & Şahin, 2021; Uysal et al., 2020; Yüzgeç, 2020). Pre-service teacher education is expected to positively affect critical thinking dispositions with regard to the quality of teacher education. In this case, a difference is foreseen in favor of the upper grade levels in terms of critical thinking disposition. Based on the results implying that grade level is not an effective factor, it may be wise to emphasize that pre-service teacher education is insufficient in terms of positively affecting critical thinking dispositions. In this context, it is paramount in conducting longitudinal studies with a view to revealing the current situation and educating teachers who have critical thinking dispositions. The results of this study on whether the pre-service secondary mathematics teachers' critical thinking dispositions differed significantly in terms of academic achievement and parents' educational level announced that as the academic achievement increased, critical thinking dispositions also increased, but no significant difference was found between them and critical thinking dispositions did not vary in terms of parents' educational level. Similar results emerged in previous studies (Akbulut, 2019; Polat & Kontaş, 2018; Şahin, 2018). Some studies (Altuntaş et al., 2018; Yakar et al., 2010;) examining the critical thinking dispositions in terms of academic achievement reached the conclusion that critical thinking disposition does not significantly vary in terms of academic achievement, while others (Abbasi & Izadpanah, 2018; D'Alessio et al., 2019; Ip et al., 2000; Wettstein et al., 2011) showed that critical thinking dispositions changes positively in terms of academic achievement. This may be due to the fact that the sample groups are pre-service teachers from different branches as their openness to critical thinking is not the same in each branch. In fact, some studies suggested that the critical thinking dispositions of pre-service science and social science teachers also vary (Rodzalan & Saat, 2015). Concentrated on the results obtained from the studies indicating that critical thinking disposition varies positively in terms of academic achievement; it can be said that one of the criteria of being successful in teacher training programs is critical thinking skills or that teacher education programs develop critical thinking. Making course definitions by associating the criteria for being

successful in the courses in teacher training programs with critical thinking skills will be positive in terms of educating teachers having critical thinking dispositions.

Besides, an answer to third research question was sought “Is there a significant relationship between the pre-service secondary mathematics teachers’ epistemological beliefs towards learning, educational beliefs and critical thinking dispositions?”. The results confirmed a positive and significant relationship between the pre-service teachers’ epistemological belief towards learning and their critical thinking disposition levels. In addition, positive and significant relationships were noted between the epistemological beliefs towards learning and the dimensions of “reasoning”, “seeking evidence”, “seeking the truth” and “systematicity” in critical thinking dispositions; between "attaining to knowledge", which is one of the dimensions of epistemological beliefs towards learning, and "reasoning", "seeking evidence", "seeking the truth", "open-mindedness" and "systematicity", the dimensions of critical thinking dispositions; between the dimension of "epistemic confliction" and those of "reasoning" and "seeking evidence". In parallel to the result of the present study, Koyunlu Ünlü & Dökme (2017) and Oğuz & Sarıçam (2015) found a positive significant relationship between the pre-service teachers’ epistemological beliefs and their critical thinking dispositions. Akbay et al. (2018) and Wyre (2007) concluded that epistemological beliefs have positive effects on university students’ critical thinking dispositions. In another study conducted by Kandemir and Eğmir (2020) with 678 secondary school students, a positive, medium level and significant relationship was determined between all dimensions of epistemological beliefs and critical thinking dispositions. Within the scope of the third research question, positive and significant relationships were found between the levels of epistemological belief towards learning and progressivism; between the dimension of "attaining to knowledge" and educational beliefs of progressivism, reconstructionism and perennialism. Besides, a negative but insignificant relationship was found between epistemological beliefs towards learning and essentialism and perennialism educational beliefs. Wong et al. (2009) carried out a study with 604 pre-service teachers and found that the "talent is innate" epistemological belief dimension negatively affected the constructivist understanding based on progressivism education belief, and the "effort in learning" epistemological belief dimension negatively affected the traditional understanding based on essentialism educational belief. Usta (2019) reported that there is a positive relationship between primary school teachers' naïve epistemological beliefs and their traditional educational beliefs. In another study conducted by Chai et al. (2011) with Singaporean pre-service teachers, pre-service teachers with sophisticated epistemological beliefs were identified to have a tendency towards adopting deep and contemporary educational beliefs in learning. Likewise, Saeed et al. (2014) noted that pre-service teachers with sophisticated epistemological beliefs have a constructivist understanding based mainly upon progressivism.

The research results also revealed positive and significant relationships between the pre-service secondary mathematics teachers’ critical thinking dispositions and their educational beliefs of

progressivism, reconstructionism and perennialism. A negative but insignificant relationship was observed between critical thinking dispositions and essentialism. The study conducted by Ağdacı (2018) with teachers showed that educational beliefs support the teachers' critical thinking skills no matter which educational belief they adopt. In their study with 908 pre-service teachers, Alkın-Şahin et al. (2014) supported the results of this study through revealing a significant relationship between educational beliefs and critical thinking dispositions.

Within the scope of the fourth research question, an answer to the following question was sought: "Do the pre-service secondary mathematics teachers' epistemological beliefs towards learning, their educational beliefs and critical thinking dispositions significantly predict each other?". In this regard, progressivism was found to be explained by epistemological belief towards learning, epistemological belief towards learning was explained by progressivism, epistemological belief towards learning was explained by critical thinking dispositions, the dimensions of "attaining to knowledge" and "absolute and single reality" were explained by critical thinking dispositions, progressivism and reconstructionism were explained at a high level by critical thinking disposition, and critical thinking dispositions were explained by reconstructionism and perennialism at a high level. Similarly, the study conducted by Kozikoğlu and Erden (2018) with 341 pre-service teachers found that progressivism, existentialism and reconstructionism are significant predictors of views on critical pedagogy principles. Üztemur et al. (2020) pointed out that secondary school students' epistemological beliefs significantly predicted their learning approaches. The results indicating positive relationships between epistemological beliefs on learning, critical thinking disposition and educational beliefs and their predictive roles suggest that none of them can be underestimated in teacher education. Given that the only way to implement the curricula that meet the needs of our age is to train teachers of this quality, it is possible to train contemporary educators with contemporary educational beliefs through curricula that enable the formation of sophisticated epistemological beliefs based on critical thinking in teacher education. In this regard, it is essential that teacher-training programs focus on thinking skills training and equip them with practices that aim at educating pre-service teachers who learn to learn. It is of great importance to create and test teacher-training programs, and to carry out academic studies that focus on the development of solution proposals in terms of creating future programs and raising future generations.

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