An Examination of the Relationships Between Pre-Service Teachers' Epistemological Beliefs and Types of Multiple Intelligence*

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Abstract

In the literature, there are studies that separately tackled with how the epistemological beliefs and multiple domains of intelligence of the individuals have developed through their experiences. However, no study has investigated the relationship between them. Consequently, this study aims to investigate the pre-service science, elementary mathematics and classroom teachers' epistemological beliefs, their Multiple Intelligence (MI) domains, and the relationship between these. The sample of this descriptive survey study consists of 457 pre-service teachers (PSTs) in total. The data is collected through the 'Multiple Intelligence Inventory' and 'Epistemological Beliefs Questionnaire'. One-way ANOVA and Pearson correlation coefficient were used for data analysis. Findings revealed statistically significant differences in the MI domains and epistemological belief dimensions (EBDs) in terms of the branches of PSTs. Also, there is a significant relationship between some MI domains and some EBDs in terms of PST's branches. In addition to these, the findings imply that the cultures, structures, implicit and explicit rules, adaptation strategies and the content that are imposed by each branch influences this relationship between MI and EBDs.

Keywords: Pre-Service Teachers, Teacher Training, Epistemological Beliefs, Multiple Intelligence

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INTRODUCTION

In the 21st century, countries need and want to educate qualified individuals who can think creatively and analytically, deal with problems critically, produce innovative solutions from multiple perspectives, and have collaborative skills (Skjelstad Fredagsvik, 2021). Because it is thought that individuals with these characteristics will play an essential role in the development of their country by adapting to the changes and developments of the era. In this respect, individuals' perceptions of knowledge, in other words, epistemological beliefs, have an essential place (Demir & Akinoglu, 2010; Peffer & Ramezani, 2019).

Epistemology began with Perry's work on mental and moral development and progressed further with Schommer (Aksan, 2006). At this point, it is seen that there are studies that search for some answers to the questions of 'definition of information, how it is formed, how it is evaluated and how knowing occurs' (Hofer, 2002). Thus, Hofer (2001) states that epistemology consists of "…beliefs about the definition of knowledge, how knowledge is constructed, how knowledge is evaluated, where knowledge resides, and how knowing occurs." (p. 355). Schommer (1990), on the other hand, proposes that individuals with undeveloped or immature epistemological beliefs think that knowledge is simple and absolute, learning takes place immediately and the ability to learn is innate and cannot be developed later. Besides, he argues that individuals with advanced or mature epistemological beliefs think that information is complex, changable, learning takes requires time and effort. However, it is seen that many studies have been conducted on how epistemological beliefs are formed and which variables are affected (Mason & Boscolo, 2004; Peffer & Ramezani, 2019; Schommer-Aikins & Easter, 2006). The relationship between individuals and their characteristics is also of interest to researchers especially in recent years (Buehl, 2003). One of these individual characteristics is intelligence.

How intelligence relates to epistemological beliefs is discussed in the "Social-Cognitive Approach to Motivation and Personality" developed by Dweck and Leggett (1988). This system consists of two fundamental dimensions: "Beliefs" and "Objective Orientation" (Dupeyrat & Marine, 2005). In the dimension of beliefs, there is a bipolar beliefs continuum that assumes two perceptions of the individuals: the intelligence is either can be developed or not. The second dimension of the system, goal-oriented, is divided into two levels as learning-oriented and performance-oriented. For the learning-oriented level: it is stated that the intelligence can be developed if the needed effort is given and for the performance-oriented level, the intelligence stated to be not developable. However, as a result of the reflections of existentialist and progressive philosophical approaches, the ways of obtaining information have changed, and Intelligence has been redefined with these changes. Gardner (1993) defines the term of intelligence as: "The ability to solve problems or to create products that are valued within one or more cultural settings" (p. 7). Gardner emphasizes that intelligence cannot be associated with a single factor such as genetics, but that multiple factors such as environmental factors will also affect intelligence (Demirel, 2000). Thus, it is perceived that intelligence is plural and developable, rather than being measured by any numerical data, as areas where individuals can present themselves in daily life (Saban, 2002). According to Gardner (1993) individuals are born with at least eight areas of intelligence: "Verbal-Linguistic Intelligence (VLI)", "Logical-Mathematical Intelligence (LMI)", "Visual-Spatial Intelligence (VSI)", "Musical-Rhythmic Intelligence (MRI)", "Physical-Kinesthetic Intelligence (PKI)", "Social-Interpersonal Intelligence (SII)", "Intrapersonal Self-oriented Intelligence (ISI)" and "Naturalist Intelligence (NI)" being at various levels. Moreover, these domains of intelligence can be developed through different experiences of individuals.

In the literature, studies were conducted to determine the epistemological beliefs and intelligence types of teachers, PSTs students separately. As an example, Koç and Memduhoğlu (2017) examined whether there is a significant difference regarding the epistemological beliefs of PSTs according to the variables of grade-level, gender, and department. According to the findings of the study, the epistemological beliefs of the participants were not developed / immature, and these beliefs did not change during their training. In addition, it was seen that these beliefs did not differ in terms of

department, grade-level and gender. Another study with PSTs found that most of the participants had epistemological beliefs that scientific knowledge was proven and would not change (Eick, 2000). In a study conducted by Braten and Stromso (2005), epistemological beliefs did not change according to the field of study, but it was revealed that PSTs believed that intelligence could be developed in comparison to the students of the department of business administration. Looking at the studies in the literature on the identification of types of the intelligence, for example, Gürçay and Eryılmaz (2005) found that the pre-service physics teachers did not have enough knowledge of the types of intelligence. Furthermore, Hamurcu, Günay, and Özyılmaz (2002) aimed to reveal the MI profiles of pre-service science and classroom teachers and found that the participants had differences in their intelligence levels. The findings also showed that VLI was more dominant in pre-service classroom teachers and LMI and VSI domains were more dominant in pre-service science teachers. In addition, Lawrence (2014) conducted a study with 400 PSTs and found that there were differences between regarding gender of PSTs in terms of VLI and first-and second-grade participants in terms of MSI. In a different study, Gracious and Shyla (2012) investigated PSTs' awareness of MI and digital learning. The study found that verbal and naturalist intelligence of the PSTs under the age of 22 were more dominant than the PSTs over the age of 22. Also, it was determined that PSTs from a rural lifestyle were more dominant in verbal, logical, naturalist, and intrapersonal intelligence than the participants from urban life.

In the literature, it is seen that epistemological beliefs are evaluated with academic achievement, locus of control, attitude towards technology, problem-solving skills perceptions, critical thinking, and researchers mainly focused on the theory of multiple intelligence as metacognitive learning strategies (Baş & Özturan-Sağırlı, 2017). In addition, although the relationship between intelligence and epistemological beliefs has been investigated (Dweck & Leggett, 1988), no studies have investigated the relationship between epistemological beliefs and MI types. In this respect, the epistemological beliefs and MI profiles of PSTs, and the relationships between their EBDs and MI profiles will reveal the epistemological beliefs that should be emphasized in the training of PSTs within the framework of MI. Therefore, present study aims to investigate the pre-service science, elementary mathematics and classroom teachers' epistemological beliefs, their MI domains, and the relationship between these intelligence profiles and EBDs.

For this purpose, the answers to the following research questions were sought.

1) What are the relationships between the preservice teachers' domain of MI according to their branches?

2) What are the relationships between epistemological belief dimensions of the preservice teachers according to their branches?

3) What are the relationships between the preservice teachers' multiple intelligence domains and epistemological belief dimensions by branches?

METHOD

Research Design

The descriptive survey model, one of the quantitative research methods, was used to determine the PSTs' epistemological beliefs and MI domains in this study. The reason to prefer this model is to describe the current situation without any intervention (Fraenkel, Wallen, & Hyun, 2012).

Participants

The population of this study was determined as pre-service science, elementary mathematics, and classroom teachers in Eastern Anatolia. In addition, the sample was determined through

convenience sampling method (Fraenkel et al., 2012) by considering factors such as accessibility, cost, and labor. In this context, 457 PSTs who were studying in the faculty of education of a state university in Eastern Anatolia at the departments of science teaching (ST), elementary mathematics teaching (EMT) and classroom teaching (CT) participated in this study on a voluntary basis. Among the participant PSTs, 148 (116 females, 32 males) were enrolled in ST, 124 (82 females, 42 males) were enrolled in EMT, and 170 (109 females, 61 males) were enrolled in CT programs.

Data Collection Tools

There are two different data instruments used in this study. McKenzie's (1999), which afterwards edited by Gary Harms to include Howard Gardner's eighth domains of intelligence and adapted by Oral (2001) was used. This instrument consists of 80 items and eight dimensions: PKI, SII, ISI, LMI, MRI, VLI, NI, and VSI. Oral (2001) determined the Cronbach Alpha value of the instrument as .90. In this study, the calculated Cronbach Alpha values in the respective order of the previous statement, for the dimensions are as follows; .61, .62, .65, .76, .60, .60, .66 and for the whole instrument, it is .92. The second instrument was the "Epistemological Beliefs Questionnaire", which was developed by Schommer (1990) and adapted into Turkish by Aypay (2011). This scale consists of 30 items and four dimensions named 1) learning process/doubt to experts' knowledge, 2) innate/fixed ability, 3) learning effort and 4) certainty of knowledge. As a result of the confirmatory factor analysis, the researcher found that the scale partially provided good fit values. In this study, the reliability coefficient was calculated .88 for the learning process dimension, .82 for the innate ability dimension, .87 for the learning effort dimension, and .70 for the dimension of certainty of knowledge.

Data Collection

The data of the study were collected on a voluntary basis in 2018. Data instruments were given to the participants at one-week intervals and they were asked to fill them. After the data collection process, the data instruments were matched by the researchers for each participant, and data is entered to the data analysis program.

Data Analysis

SPSS package program was used in the analysis of the collected data. While analyzing the data, whether the variables meet the assumptions of One-way Analysis of Variance (ANOVA) was tested, which is made possible analysis due to the nature of the data. Data were analyzed with ANOVA since the data meets the assumptions. In addition, the Pearson correlation coefficient was used to investigate the relationship between the variables.

RESULTS

First Sub-problem

The findings are presented in the order of each research problem. Table 1 shows the findings obtained as a result of examining MI domains according to the branches of PSTs.

Table 1 Descriptive statistics of PSTs according to MI domains

MI Domain	Branch	N	Mean	STD
PKI	EMT	124	35.68	5.16
	ST	148	36.18	5.59
	CT	170	35.11	6.11
	Total	442	35.63	5.69
SII	EMT	124	32.85	5.22
	ST	148	33.43	5.50
	CT	170	32.72	6.37
	Total	442	33.00	5.77

ISI	EMT	124	36.29	4.81
	ST	148	36.73	5.29
	CT	170	36.15	6.28
	Total	442	36.38	5.56
LMI	EMT	124	38.77	5.05
	ST	148	38.27	5.91
	CT	170	35.43	6.40
	Total	442	37.32	6.06
MRI	EMT	124	29.44	7.72
	ST	148	31.14	7.53
	CT	170	31.64	7.20
	Total	442	30.86	7.50
VLI	EMT	124	31.33	4.95
	ST	148	32.99	5.23
	CT	170	33.84	5.69
	Total	442	32.85	5.42
VSI	EMT	124	36.49	5.53
	ST	148	36.58	6.25
	CT	170	35.26	6.24
	Total	442	36.05	6.07
NI	EMT	124	33.84	5.11
	ST	148	35.86	6.01
	CT	170	34.02	5.83
	Total	442	34.59	5.76

When Table 1 is examined, it is seen that the average MI domains, according to the branches of PSTs, are close to each other. In addition, it is found that the highest mean for the PKI belongs to the pre-service science teachers (PSSTs) (36.18), and the lowest mean belongs to the pre-service classroom teachers (PSCTs) (35.11). This situation is similar in the domains of SII, ISI, and VSI. On the other hand, the highest average in the domain of LMI belongs to pre-service elementary mathematics teachers (PSEMTs)(38.77), while the lowest average belongs to PSCTs (35.43). However, this situation seems to be the opposite in the MRI and VLI intelligence domains. Lastly, the highest mean in the NI domain belongs to the PSSTs (35.86), while the lowest mean belongs to the PSEMTs (33.84). The results presented in Table 2 were obtained as the results of ANOVA and the post-hoc test (Bonferroni) to determine whether these differences between the means were statistically significant.

Table 2 The ANOVA results regarding MI domains of PSTs according to branches

MI Domain	Source of Variance	Sum of Squares	df	Mean Square	F	Sig.	Significant Difference
LMI	Between Groups	999.56	2	499.78	14.44	.000	EMT>CT, ST>CT
	Within Groups	15191.04	439	34.60			
	Total	16190.60	441				
VLI	Between Groups	455.44	2	227.72	8.00	.000	ST>EMT CT>EMT
	Within Groups	12492.88	439	28.46			
	Total	12948.32	441				
MRI	Between Groups	367.07	2	183.54	3.30	.038	CT>EMT
	Within Groups	24415.96	439	55.62			
	Total	24783.03	441				
NI	Between Groups	365.15	2	182.58	5.62	.004	ST>EMT ST>CT
	Within Groups	14264.73	439	32.49			
	Total	14629.88	441				
ISI	Between Groups	27.307	2	13.65	.440	.644	
	Within Groups	13621.62	439	31.03			
	Total	13648.93	441				
SII	Between Groups	43.44	2	21.72	.651	.522	
	Within Groups	14655.59	439	33.38			
	Total	14699.03	441				

PKI	Between Groups	91.33	2	45.66	1.415	.244
	Within Groups	14171.34	439	32.28		
	Total	14262.66	441			
VSI	Between Groups	171.238	2	85.62	2.335	.098
	Within Groups	16096.629	439	36.67		
	Total	16267.867	441			

When Table 2 is examined, it is seen that the PSTs' branches differ statistically according to the domains of LMI, VLI, MRI, and NI. In the domain of LMI, there is a significant difference between the mean scores of PSEMTs and PSSTs against the mean score of PSCTs [F(2, 441)= 14.44, p<.05]. In the domain of VLI, there is a significant difference between the mean scores of the PSSTs and PSCTs against the mean score of PSEMTs [F(2, 441)= 8.00, p<.05]. In the domain of MRI, there is a significant difference between the PSCTs and the PSEMTs in favor of the PSCTs [F (2, 441) = 3.30, p <.05]. Finally, there is a difference in favor of PSSTs in the domain of NI compared both to PSEMTs and PSCTs [F (2, 441) = 5.62, p <.05]. However, although there was a difference between the mean scores of PSTs, there was no statistically significant difference in terms of ISI, SII, PKI, and VSI domains.

Second Sub-problem

The findings obtained by examining the epistemological beliefs of the PSTs according to their branches, are given in Table 3.

Table 3 The mean scores for EBDs of PSTs according to their branches

EBDs	Branch	N	Mean	STD
Learning process/Doubt to experts' knowledge	EMT	124	44.50	6.13
	ST	148	44.17	5.12
	CT	170	22.01	6.34
	Total	442	35.74	12.36
Innate/Fixed ability	EMT	124	21.28	4.90
	ST	148	19.44	5.51
	CT	170	28.58	4.99
	Total	442	23.47	6.57
Learning effort	EMT	124	19.43	2.92
	ST	148	19.52	3.05
	CT	170	10.56	3.21
	Total	442	16.05	5.32
Certainty of knowledge	EMT	124	15.33	3.70
	ST	148	15.34	3.11
	CT	170	20.31	3.43
	Total	442	17.25	4.17

When Table 3 is examined, it is seen that the mean scores for the learning process/doubt to experts' knowledge dimension of the PSCTs (22.01) are lower than the scores of the PSEMTs (44.50) and PSSTs (44.17). In terms of innate/fixed ability dimension, mean scores of PSCTs (25.58) were higher than that of PSEMTs (21.28), and PSEMTs have a higher mean score than those of PSSTs (19.44). In the learning effort dimension, it was seen that the mean scores of PSEMTs (19.43) and PSSTs (19.52) were higher than that of PSCTs (10.56). Finally, in terms of the certainty of knowledge, it is seen that PSCTs have a higher mean score (20.31) than both of PSEMTs (15.33) and PSSTs (15.34). ANOVA results and post-hoc (Bonferroni) test results, which are to determine whether these differences between branches are statistically significant, are presented in Table 4.

Table 4 ANOVA results of the EBDs by branches of the PSTs

EBDs	Source of Variance	Sum of Squares	df	Mean Square	F	Sig.	Significant difference
Learning process / Doubt to expert knowledge,	Between Groups	52094.54	2	26047.27	749.68	.000	EMT>CT ST>CT
	Within Groups	15252.80	439	34.74			
	Total	67347.34	441				
Innate / Fixed ability	Between Groups	7424.27	2	3712.14	140.17	.000	EMT>ST CT>ST CT>EMT
	Within Groups	11626.07	439	26.48			
	Total	19050.34	441				
Learning effort	Between Groups	8326.48	2	4163.24	139.49	.000	EMT>CT ST>CT
	Within Groups	4158.57	439	9.47			
	Total	12485.04	441				
Certainty of knowledge	Between Groups	2585.73	2	1292.86	111.43	.000	CT>EMT CT>ST
	Within Groups	5093.67	439	11.60			
	Total	7679.40	441				

When Table 4 is examined, it is seen that all EBDs differ statistically according to the branches of PSTs. In terms of the learning process, there is a significant difference between the mean scores of PSEMTs and PSSTs against the mean score of PSCTs [F (2, 441) = 749.68, p <.05]. This shows that PSSTs and PSEMTs have a prominent tendency to believe that *"The process of obtaining information is valuable",* and *"Even the information coming from the experts should be questioned".*

Findings regarding the innate/fixed ability dimension show that there is a difference in favor of the PSCTs against both PSSTs and PSEMTs, and also, there is a significant difference between the PSEMTs and PSSTs in favor of PSEMTs [F (2, 441) = 140.17, p <.05]. Therefore, the belief that *"Innate abilities limit one's capabilities"* is more evident in PSCTs than other branches; also, PSEMTs' respective beliefs are more prominent than that of PSSTs.

Regarding the learning effort dimension, there was a significant difference between the mean scores of the PSEMTs and PSSTs against the mean scores of PSCTs [F (2, 441) = 139.49, p <.05]. This shows that PSCTs are more distant from the belief that the process of learning something really requires a long time and effort.

Finally, there is a difference in terms of the Certainty of knowledge between the PSCTs and other branches, favoring PSCTs [F (2, 441) = 111.43, p <.05]. This reveals PSCTs tend to believe more that scientific knowledge is absolute and unchanging.

Third Sub-problem

The findings in Table 5 presents the relationships between the PSTs' MI domains and EBDs.

Table 5 Relationships between PSTs' MI domains and EBDs

MI Domains	Branch	Learning process	Innate / Fixed ability	Learning effort	Certainty of knowledge
PKI	EMT				
	ST	.266**	-.233**		
	CT	-.204**	.163*		
SII	EMT				
	ST	.201*			
	CT				
ISI	EMT	.235**			
	ST	.370**			
	CT	-.238**	.247**		.182*
LMI	EMT	.259**		.276**	
	ST	.330**			
	CT	-.215**		-.237**	
MRI	EMT				
	ST	.177*	-.256**		
	CT				
VLI	EMT				
	ST	.249**			
	CT	-.153*	.157*		
VSI	EMT				
	ST	.179*	-.183*		
	CT		.180*		
NI	EMT				
	ST	.267**	-.171*		
	CT	-.214**	.164*		.174*

When Table 5 is examined, it is seen that there are significant, albeit low, relationships between some MI domains and some EBDs according to the branches. When the learning process dimension of epistemological belief is taken into consideration for PSCTs, it is seen that there are negatively low-level relationships with the domains of PKI, ISI, LMI, VLI, and NI. This is seen as an increase in the mean scores of the PSCTs in the indicated intelligence fields corresponding to a decrease in points regarding the beliefs of *"Process of obtaining information is valuable"* and the *"The information specified by the experts should also be questioned".* However, when the learning process dimension is considered for PSSTs, it is evident that there is a low-level positive relationship with all MI domains. A similar situation exists for PSEMTs. For PSEMTs, it was found that there was a low level of a positive relationship with ISI and LMI domains. In other words, the increase in the scores of both PSSTs and PSEMTs in the indicated areas of intelligence was found to correspond with the increase in the belief points that *"The process of obtaining information is"* valuable and that *"The information should be questioned".*

When the innate/fixed ability dimension of epistemological belief is examined, it becomes clear that there is a low-level of positive relationship between PSCTs' PSI, ISI, VLI, VSI, and NI domains. In other words, the increase in the scores of the PSCTs in the respective intelligence areas corresponds to the increase in the belief points that "The innate abilities of individuals will limit their capability". However, there are negatively low-level relationships with the domains of PKI, MRI, VSI, and NI for the PSSTs. Therefore, the increase in the scores of the respective intelligence domains corresponds to the decrease in the belief points.

When the learning effort dimension is considered, there is a low-level positive relationship with the LMI domain for PSEMTs, whereas it is negative for PSCTs. This shows that the increase in the belief scores that process of learning requires a long time and effort corresponds to an increase of scores in the domain of LMI for PSEMTs, whereas it corresponds to the decrease in PSCTs. Finally, it was found that there was a low level of positive relationships between the certainty of knowledge and the ISI and NI domains of the PSCTs. In other words, it can be seen that the increase in the score of

the PSCTs in the related intelligence fields corresponds to the increase in their belief that the information is absolute and unchanging.

DISCUSSION, CONCLUSION, AND IMPLICATIONS

Conclusions of the study which examines the epistemological beliefs, MI domains, and the relationship between MI domains and EBDs concerning the branches of the PSTs presented extensively under respective sub-headings.

Inferences for MI Domains

Institutions are structures that try to adopt the information needed to be known, the culture must be internalized, and the explicit or implicit rules must be abided for individuals (Chevallard & Sensevy, 2014). Therefore, it is possible for students who study in different programs at the university to be influenced by the culture of the relevant program. Also, students might develop in the domains of MI necessary for the knowledge and skills that they need to acquire in this direction. The findings of this study support these ideas. When the LMI results of the PSTs were examined, the average scores of both PSEMTs and PSSTs were higher than those of the PSCTs. The main reason behind this situation might be that both PSEMTs and PSSTs are much more engaged in instructional practices that require LMI. Supporting these results, Çeliköz (2017) stated that the programs PSTs were studying affected their dominant intelligence domains. In this context, when the classroom teaching and mathematics teaching programs were compared for the LMI domain, the study found that there was a significant difference in favor of mathematics teaching. In another study conducted on university students, Oral (2001) found that the dominant institutional approach of various programs in MI domains has an impact on the MI domains of individuals in the institution. When an institutional structure is assigned to the programs, it is stated that the MI domains of mathematics and classroom teachers tend to differ. It is stated that this situation stems from courses that teachers are obliged to teach in line with their branches. In this respect, it is implied that mathematics teachers associate their students' success concerning MI profiles with LMI (Yenilmez & Bozkurt, 2006). It was pointed out that the area studied at the graduate level may affect the intelligence profile of individuals (Güneş & Gökçek, 2010). Erdem and Keklik (2020) imply that institutionalization starts at the high school level and draws attention to the fact that the MI scores of PSTs might be affected not only by the education they received at the undergraduate level but also by the branching in high school. From these explanations, it can be said that each institution tries to provide its members with significant amount of knowledge and skills related to the dominant intelligence acknowledged by the institution. In the present study, it was found that there was no significant difference between the programs in terms of VSI, ISI, SII, and PKI scores. This can be explained by the fact that these programs support previously mentioned areas of intelligence in an identical way or not at all. Differing from these results, when the mean scores of VSI of PSSTs and PSCTs were compared, it was found that there was a significant difference in favor of PSSTs in the literature (Hamurcu et al., 2002).

When the findings of VLI were examined, it was found that the average scores of the PSEMTs were lower than both the PSSTs and PSCTs. It is thought that this is because both PSCTs and PSSTs engage in more learning experiences that can provide the development of the VLI domain. Similar to the findings of this study, Hamurcu et al. (2002) found in their study that classroom teacher candidates had a more dominant VLI domain than PSTs. One of the important implications these findings is that the profiles of intelligence types are shaped according to the undergraduate education of the students in their departments.

When the results of the NI were examined, the average scores of the PSSTs were higher than both the PSEMTs and PSCTs. Supporting these results, many studies report significant differences in favor of ST when compared with other programs (Güneş & Gökçek, 2010; Ocak, Ocak, & Leblebiciler, 2005). This difference might be due to the courses consist of applications regarding

physics, chemistry, and biology disciplines in which many investigations are made on different aspects of nature or beings in nature.

When the results of MRI were examined, there was a significant difference in favor of PSCTs when the scores of PSCTs and PSEMTs were compared. In this case, it can be said that having a music instruction course in the CT training is effective. Putting an emphasis on the use of music is an feasible tool in teaching the course contents (Council of Higher Education [CoHE], 2018a). The use of music as a tool for teaching seems to be feasible in various subjects, but it can also be stated that it is not easy for most contexts. In an example of this, Doğan and Alkış (2007) stated that CT candidates might have difficulty in using MRI in social studies courses.

Inferences on EBDs

Epistemological beliefs are said to be closely related to differences between academic disciplines (Päuler-Kuppinger & Jucks, 2017). Since professional knowledge and general culture courses are generally abundant in these, specific field courses of the branches (CoHE, 2018b), which make up about half of the curricula, can be shown as the main reason for the differentiation in the programs. In each program, approaches to motivating students, facilitating learning through cognition and instruction can be dramatically differentiated (Pintrich, 2003). This situation can be explained by the fact that each program has its own culture, the changes in the production, development, and diffusion of knowledge and the differentiation of the transformation of knowledge for teaching purposes (Chevallard, 2019; Bosch, Hausberger, Hochmuth, Kondratieva & Winsløw, 2021). All these variables may cause differences in the epistemological beliefs of individuals studying in different programs. The findings of this study support this claim. In this study, conclusions regarding the results of the sub-dimensions of Schommer's (1990) EBDs for PSEMTs, PSSTs, and PSCTs are given below and discussed.

Firstly, it is seen that the average scores of PSCTs are lower than those of both PSEMTs and PSSTs in terms of the learning process/doubting experts' knowledge dimension. This shows that PSSTs and PSEMTs give more value to understanding the essence of the lessons than to acquiring information, and their thoughts on the belief of *"The need for that even the information coming from the experts should be questioned"* is outweighing. On the other hand, lower scores of PSCTs may be due to the low-level of the content regarding the addressed grade of instruction and the need for superficial information for this. This difference may be revealed by the fact that PSSTs enroll courses that emphasize the nature of science, and PSEMTs have mathematics history in their curriculum, whereas undergraduate programs of PSCTs do not have a course relative to this context. Supporting this, Lindblom-Ylanne and Lonka (1999) pointed out that the limitations of the curriculum might affect students' process of acquiring information. Similarly, Schraw (2001) stated that epistemological beliefs are related to domain-specific, and this limits the use of the tools of the domain-general. In this context, the profession of teaching can be considered as a domain-general, whereas individual teacher training programs can be considered as domain-specific.

Concerning the innate/fixed ability, individuals have the idea that their innate abilities limit their capabilities and that there is not much to go beyond this limit. For this dimension, the mean scores of PSCTs were higher than those of both PSEMTs and PSSTs. Moreover, the mean scores of PSEMTs were higher than those of PSSTs. The reason for this may be the prevalence of self-beliefs of individuals. This may be due to the dominant belief that PSCTs cannot learn mathematics. In support of this conclusion, Güveli, İpek, Atasoy, and Güveli (2011) stated that CT candidates perceive mathematics as a challenging course. On the other hand, self-beliefs of PSEMTs regarding that they are less successful in verbal fields might have been influential in this regard. Parallel to these results, Can and Arabacıoğlu (2009) reported that mathematics and science teacher candidates were differentiated when the subdimension of epistemological belief depends on ability, in favor of science teachers. In the same study, the source of this difference was related to the laboratory applications carried out by the ST candidates after the theoretical endeavors. In this context, it is thought that

thanks to the experiments carried out by PSSTs, they may have developed an insight into how knowledge is formed by practicing the topics covered in various theories.

In the learning effort dimension, it was determined that the average scores of the PSEMTs and PSSTs were higher than that of the PSCTs. Contrary to the results obtained in this study, in some studies, it is stated that there is no significant difference in the degree of the program variable in the belief dimension regarding *"learning depends on effort and ability"* (Eroğlu & Güven, 2006; Jehng, Johnson, & Anderson, 1993). In another study conducted with teachers, when social studies teachers and other branches were compared in terms of department variable, a difference was found in favor of social studies teachers in the sub-dimension of learning among the EBDs (Kaya & Ekiçi, 2017).

In the dimension of certainty of knowledge, the ideas that *"scientific knowledge is definite and absolute,"* and that *"scientists reveal facts as a result of their research"* are dominant in individuals. Analyses show that PSCTs have a higher level of this belief than both PSEMTs and PSSTs. The reason for this concerning the PSSTs; by enrolling in the nature of science course (CoHE, 2018c), they may gain an understanding of scientific knowledge is changeable in the process. It is also evident that it is feasible for the PSEMTs to take courses in the history of mathematics, philosophy of mathematics and, to gain experience about the development of many concepts in mathematics and their development as a mathematical object, during their training (CoHE, 2018d). As an example of this situation, the change and development of the numbers used by different civilizations during the history, therefore, making the numbers more feasible in the discipline of mathematics, can be given (Burton, 2011). On the other hand, in the CT curriculum, the absence of the emphasis on the epistemology of knowledge regarding the context of their specific field education courses (CoHE, 2018a) supports these claims. However, contrary to the results obtained in this study, in a study conducted on ST, it was stated that pre-service teachers developed the belief that scientific knowledge would not change (Eick, 2000).

Epistemological beliefs with its dimensions have been examined in terms of the program variable with the university students many times. While some studies found a significant difference (Can & Arabacıoğlu, 2009; Deryakulu & Büyüköztürk, 2005; Hofer, 2000; Terzi, 2005; Tümkaya, 2012), others reported the opposite (Koç & Memduhoğlu, 2017). However, it was determined that the participants of the study reported no significant difference conducted with the science and physics teacher candidates. Authors also noted that insignificant differences in terms of epistemological beliefs might due to the close relationship of these programs in terms of the field the education courses.

Inferences on the Relationships Between MI and EBDs

Findings reveal significant low-level relationships between some MI domains and some EBDs in terms of program variables of PSTs. First of all, the most prominent relationship among PSTs is observed between the MI domains and the learning process dimension of epistemological beliefs. Considering the learning process dimension, the low level of an inverse relationship between PSCTs' PKI, ISI, LMI, VLI, and NI domains is evident. In this dimension, it was determined that there was a positively low-level relationship in all intelligence domains of PSSTs and a low level of positive relationship in ISI and LMI domains of PSEMTs. These results can be interpreted as a process or activity that may lead to an increase in any domain of intelligence of PSSTs might have positive reflections on their beliefs about the learning process and doubt to expert knowledge. In this context, it can be stated that training to be provided to PSSTs in line with MI theory will allow them to learn a topic more deeply; therefore, facilitate their academic achievements. Supporting this conclusion, Yalmanci and Gozum (2013) stated that more successful results were obtained on the instruction of enzymes topic on PSSTs with an education that in line with MI theory compared to traditional instruction. A similar situation is also evident for the two intelligence dimensions in which significant differences were determined among the PSEMTs. However, when it comes to PSCTs, it can be said that this process is reversed in general. In other words, it is thought that an intervention that leads to an

increase in the MI domains of the PSCTs would correspond to a decrease in their beliefs about *the process of acquiring knowledge* and *doubting the knowledge of experts.*

Secondly, when the innate/fixed ability dimension of epistemological belief was examined, it was found that there was a low level of a positive relationship between intelligence domains of PSCTs except for the MRI, LMI, and SII domains. The reason for the emergence of this situation can be related to using of teacher-centered approaches in teaching practices (Tanrıseven Üredi & Üredi, 2009; Ünal & Akpınar, 2006) and to a large extent the cause of this refers to institutions providing teacher education. The emergence of teacher-centered approaches as reflections of the expectations of teachers in teaching situations rather than students' self-confidence (Brousseau, 2002) is also known. This sovereign approach can be explained by the fact that, when the relevant intelligence domains of the PSCTs develop, the ability to learn information may be subject to an institutional limitation due to the acknowledged education system. For PSSTs, this emerged as a low-level negative relationship in the domains of PKI, MRI, VSI, and NI.

When the learning effort dimension is considered, there is a low positive relationship with the LMI domain for PSEMTs, whereas it is inverse for PSCTs. This can be explained by the institutional necessity for PSEMTs that they have to teach more abstract objects in the field education courses of the curriculum, and a more active effort is needed to understand these mathematical objects. For PSCTs, this relationship may be influenced by their requirement of less effort to perceive them since the age group they address is at the level of concrete operations, and the most fundamental concepts in field education (mathematics teaching) are often acquired through concrete objects.

Findings show that though being low-level, there are many relationships between teacher candidates' epistemological beliefs and MI profiles in terms of the program. These relationships, for each program, come together in the same direction (positive or negative) when MI profiles are intersected with any dimension of epistemological belief, suggesting that there may be underlying phenomena causing this situation. However, no other study examining the relationship between teacher candidates' MI profiles and epistemological beliefs was found. In this sense, it is foreseen that qualitative inquiries with different participant groups and disciplines may reveal the source of these relationships.

From a different point of view, due to the intensity of the courses related to its specific field (CoHE, 2018b), it is understood that each program in the teacher training-related departments provides training explicitly in their respective fields. However, it can be said that this prominent approach is evolving towards an interdisciplinary direction. Therefore, research on STEM education can be given as an example. Interdisciplinary teaching approaches in teacher training departments may affect PSTs' epistemological beliefs and MI profiles. This understanding may bring a new breath to the literature and provide a more solid ground for emerging research. Concluding these, we suggest that researchers investigate how interdisciplinary approaches affect individuals' epistemological beliefs and MI domains.

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