BUEFAD | **2021**, Volume **10**, Issue **3**, 626-638

Bartın University Journal of Faculty of Education

dergipark.org.tr/buefad

DOI: 10.14686/buefad.849351

The Relationships Between Students' Epistemological Beliefs and Conceptions of Learning in Different Science Domains

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Research Article	Received: **29.12.2020**	Revised: **27.08.2021**	Accepted: **02.09.2021**

Abstract

This study aims to investigate the relationships between 9th grade students' epistemological beliefs and conceptions of learning in different science domains (physics, chemistry, biology). A total of 462 students (male=247, female=215) participated in the study. Data were collected with the help of the questionnaires that measure students' epistemological beliefs and conceptions of learning. Pearson correlation analysis was performed to determine the relationships between students' epistemological beliefs and conceptions of learning in different science domains. The results revealed that there were positive and moderate relationships between students' epistemological beliefs in "justification" and "development" dimensions and their higher-level conceptions of learning. However, these beliefs were weakly correlated or not correlated to the students' lower-level conceptions of learning. Similarly, students' epistemological beliefs in "source" and "certainty" dimensions were weakly associated or not associated with their conceptions of learning.

Keywords: Conceptions of learning, epistemological beliefs, science domains

Öğrencilerin Epistemolojik İnançları ile Farklı Fen Disiplinlerine Yönelik Öğrenme Anlayışları Arasındaki İlişkiler

Öz

Bu çalışmanın amacı 9. sınıf lise öğrencilerinin epistemolojik inançları ve farklı fen disiplinlerine (fizik, kimya, biyoloji) yönelik öğrenme anlayışları arasındaki ilişkileri incelemektir. 462 (erkek=247, kız=215) öğrenci çalışmaya katılmıştır. Veriler öğrencilerin epistemolojik inançlarını ve öğrenme anlayışlarını ölçen anketler yardımı ile toplanmıştır. Öğrencilerin epistemolojik inançları ve farklı fen disiplinlerine yönelik öğrenme anlayışları arasındaki ilişkiyi ölçmek için Pearson korelasyon analizi yapılmıştır. Araştırma sonuçları öğrencilerin epistemolojik inançlarından "bilginin doğrulanması" ve "bilginin gelişmesi" ve üst-düzey öğrenme anlayışları arasında pozitif ve orta düzeyde bir ilişki olduğunu ortaya koymuştur. Ancak, bu inançlar öğrencilerin alt-düzey öğrenme anlayışları ile zayıf bir şekilde ilişki göstermişlerdir ya da ilişkisizdir. Benzer bir şekilde, öğrencilerin epistemolojik inançlarından "bilginin kaynağı" ve "bilginin kesinliği", öğrenme anlayışları ile zayıf bir ilişki göstermiştir ya da ilişkisizdir.

Anahtar kelimeler: Öğrenme anlayışları, epistemolojik inançlar, fen disiplinleri

To cite this article in APA Style:

Kapucu, S. (2021). The relationships between students' epistemological beliefs and conceptions of learning in different science domains. *Bartın University Journal of Faculty of Education, 10*(3), 626-638. https://doi.org/10.1016/buefad.849351

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1 | Introduction

Epistemological beliefs and conceptions of learning are important physiological constructs that influence the learning process (Hofer & Pintrich, 1997). Epistemological beliefs are core beliefs and it is difficult to change them. They are closely related to the peripheral beliefs (i.e. beliefs about learning and teaching) (Bahçivan, 2017; Brownlee et al., 2001). Bahçivan (2017) states that epistemological beliefs can influence how the learner and the teacher perceive learning. There can also be significant relationships between epistemological beliefs and conceptions of learning (Liang & Tsai, 2010). Moreover, epistemological beliefs and conceptions of learning can be domain-specific – that is, students can have different beliefs and conceptions about every domain (Tsai, 2004). Epistemological beliefs concern with the beliefs about nature of knowledge and knowing (Hofer & Pintrich, 1997). Conceptions of learning can be considered as interpretations and beliefs about learning (Vermunt & Vermetten, 2004).

Epistemological beliefs can be classified under the four main categories: "certainty of knowledge", "simplicity of knowledge", "source of knowledge", and "justification for knowing" (Hofer & Pintrich, 1997). In the light of this view, Conley et al. (2004) classified epistemological beliefs as follows: (1) "source", (2) "certainty", (3) "development", (4) "justification" in their study. The first dimension "source" is related to the beliefs about knowledge that is transferred from the authority. Secondly, "certainty" refers to beliefs about right answers. Thirdly, "development" includes the beliefs about changing and developing aspects of scientific knowledge. Finally, "justification" is related to the role of experiments in science and how individuals confirm knowledge (Conley et al., 2004).

In the 2000s, many studies were conducted to investigate the students' conceptions of learning, in particular for science domain. In his phenomenological study, Tsai (2004) categorized conceptions of learning science under seven dimensions. Then, Lee et al. (2008) developed a questionnaire that measures students' such conceptions and found six dimensions. In another study (Tsai et al., 2011), these dimensions were also grouped under two main themes as lower-level conceptions of learning science and higher-level conceptions of learning science. While the lower-level ones concern with the memorizing the scientific facts, formulas etc., getting high scores in science exams, taking science tests, and practicing calculations and problem solving, the higher-level ones include attaining knowledge about natural phenomena, applying the knowledge to unknown situations, and understanding scientific knowledge (Tsai et al., 2011). From the dimensions of lower-level conceptions of learning science, "memorizing" refers to memorization of definitions, formulas and laws in science learning; "testing" is related to solving questions based on more remembering in science learning; "calculate and practice" concerns with the calculations and problem solving practices in science learning. In contrast, from the dimensions of higher-level conceptions of learning science, "increase of knowledge" is related to increase in learning scientific knowledge in science; "applying" concerns with learning science by learning by doing; "understanding and seeing in a new way" refers to learning science meaningfully and having a new perspective about science learning (Lee et al., 2008).

There are some studies that examined the relationships between epistemological beliefs and conceptions of learning. Chan (2007, 2011) found that there was a positive and significant relationship between teacher candidates' epistemological belief in "learning effort/process" dimension and their conceptions of learning in all dimensions. Similarly, Otting et al. (2010) determined positive and significant relationships between teacher candidates' epistemological beliefs in "learning effort/process" dimension and their constructivist learning and teaching conceptions. Mardiha and Alibakhshi (2020) have also recently found teachers' epistemological beliefs were highly related to their conceptions of learning and teaching. Khalid et al (2021) also determined positive and significant relationships between prospective teachers' epistemological beliefs and conceptions of learning. However, these studies are not domain specific and only focused on the relationships between pre-service teachers' epistemological beliefs and conceptions of learning.

In addition, there are some other studies that explored the relationships between epistemological beliefs and domain-specific conceptions of learning. Liang and Tsai (2010) examined the relationships between university students' epistemological beliefs and conceptions of learning science. While they found positive and significant relationships between students' epistemological beliefs in "development" and "justification" dimensions and their higher-level conceptions of learning science in "increase of knowledge" "applying" and "understanding and seeing in a new way" dimensions, they determined negative and significant relationships between students' epistemological beliefs in "source" and "certainty" dimensions and their lower-level conceptions of learning science in "memorizing", "testing" and "calculate and practice" dimensions. Ho and Liang (2015) also achieved similar results by examining high schools students' conceptions of learning science. In contrast, Adıbelli Şahin et al. (2016) determined positive and significant relationships between pre-service teachers' epistemological beliefs in "omniscient authority", "certain knowledge", "innate ability" and "quick learning" dimensions and their lower-level conceptions of learning science in "memorizing", "calculate and practice" "testing" dimensions. Moreover, they could not find any significant relationships between pre-service teachers' epistemological beliefs and higher-level conceptions of learning science in "increase of knowledge" and "applying" dimensions. Sadi and Dağyar (2015) studied with high school students and also could not find any significant relationships between many dimensions of epistemological beliefs and conceptions of learning biology. They could only find significant and positive relationships between the students' epistemological beliefs in "source/certainty", "development" and "justification" dimensions and their lower-level conceptions of learning biology in "preparing for exam" dimension. There were also positive and significant relationships between the students' epistemological belief in "development" dimension and higher-level conceptions of learning biology in "applying" dimension, and negative and significant relationships between their epistemological belief in "source/certainty" dimension and lower-level conceptions of learning biology in "calculate and practice" dimension (Sadi & Dağyar, 2015). However, Shen et al. (2018) found negative and significant relationships between the students' epistemological belief in "uncertainty" and lower-level conceptions of learning biology in "memorizing", "testing" and "calculate and practice" dimensions. This epistemological belief was also positively and significantly related to students' higher-level conceptions of learning biology in "increase of knowledge and understanding" and "seeing in a new way" dimensions. Similarly, students' epistemological belief in "justification" dimension was negatively and significantly correlated with their lower-level conceptions of learning biology in "testing" and "calculate and practice" dimensions and positively and significantly correlated with their higher-level conceptions of learning biology in "applying", "increase of knowledge and understanding" and "seeing in a new way" dimensions (Shen et al., 2018).

Many of the studies that investigated the relationships between students' epistemological beliefs and conceptions of learning are not domain-specific or they are only related to science-domain. Tsai (2004) suggests researchers to focus on domain-specific conceptions of learning due to such domains' specific features. Therefore, studying on conceptions of learning in different domains and their relationships with epistemological beliefs can help researchers to make more robust inferences about these relationships. In fact, students' conceptions of learning in different science domains can differ from each other (Sadi, 2015). Hence, their relationships with epistemological beliefs may also be different from each other. Furthermore, determination of these relationships considering domain-specific features can offer some clues about how to design students' learning environments. For example, positive developments of students' epistemological beliefs in different learning environments (e.g., argumentation, inquiry, cooperative) can also imply positive developments in their conceptions of learning.

As also discussed before, different science domains can have different features. For example, physics subjects can include more calculations and formulas (Bozkurt & Sarıkoç, 2008), and biology subjects can include more memorization of scientific facts or events (Joy et al., 2017). Therefore, students' epistemological beliefs can differently correlate with their conceptions of learning in different science domains. For example, while students' epistemological beliefs may positively correlate with their conceptions of learning biology, they may negatively correlate with their conceptions of learning physics. In addition, the sizes of relationships can differ from each other for each domain. Hence, determination of the relationships between the students' epistemological beliefs and conceptions of learning may also help researchers to better understand the nature of domain-specific science subjects.

The aim of the study and research questions

The aim of this study is to investigate the relationships between 9th grade students' epistemological beliefs and conceptions of learning in different science domains (physics, chemistry, biology). Hence, the following research questions are prepared;

- What are the relationships between 9th grade students' epistemological beliefs and conceptions of learning physics?
- What are the relationships between 9th grade students' epistemological beliefs and conceptions of learning chemistry?
- What are the relationships between 9th grade students' epistemological beliefs and conceptions of learning biology?

2 | Method

The correlation design of quantitative research method was used in the study. The relationships among two or more variables are investigated without any interventions in this research type (Fraenkel et al., 2012). As the relationships between the students' epistemological beliefs and conceptions of learning in different science domains were investigated in this study, this design was chosen. The data obtained were also collected with the help of the questionnaires administered to the students.

Sample

The 9th grade students (male=247, female=215) from one of the cities of the eastern region of Turkey participated in the study. All 9th grade students in the city center comprised target population. Students were selected by using purposive sampling method. This sampling method can allow researchers to reach information-rich cases (Büyüköztürk et al., 2013). Students from four high schools that can represent general profile of the students in the city center were selected. These schools have similar standards in terms of physical facilities and achievement level. This information was obtained by asking experienced teachers and school managers in the city center. In addition, the 9th grade students were chosen because they took basic and common courses. Therefore, students having different perceptions or views about science learning participated in the study.

Data collection

In data collection, two questionnaires were used. The first one Epistemological Belief Questionnaire (EBQ) was designed to identify students' scientific epistemological beliefs by Conley et al. (2004) and first adapted into Turkish by Özkan (2008). In this adapted version it includes three dimensions (Özkan, 2008). However, Bahcivan (2014) found four dimensions for the EBQ similar to original one by also studying with a Turkish sample. This questionnaire is in the form of a Likert-type scale (strongly disagree [1] → strongly agree [5]) and consists of four dimensions: (1) "source", (2) "certainty", (3) "development", (4) "justification" (Bahcivan, 2014; Conley et al., 2004). The Cronbach's alpha coefficients of the EBQ for every dimension were found by implementing it two times. These values after its two implementations were as follows: 0.81, 0.65, 0.57, 0.78 (first one); 0.82, 0.76, 0.66, 0.79 (second one), respectively. The correlation coefficients between every same dimension after its two applications were determined and these were ranged from r = 0.44 to 0.76. Confirmatory factor analysis for the construct validity of the EBQ was also run and some fit indices were examined. It was claimed to find acceptable fit indices as RMSEA = 0.038, CFI = 0.900 and NNFI = 0.89 and RMR = 0.062 (Conley et al., 2004).

Another questionnaire which is Conceptions of Learning Science Questionnaire (COLS) used in the study was developed to identify students' conceptions of learning science by Lee et al. (2008) and adapted into

Turkish by Bahçivan and Kapucu (2014). The COLS consists of six dimensions: (1) “memorizing”, (2) “testing”, (3) “calculate and practice”, (4) “increase of knowledge”, (5) “applying” and (6) “understanding and seeing in a new way” and is in the form of Likert-type scale (strongly disagree [1] → strongly agree [5]) (Lee et al., 2008). The first three dimensions concern with lower-level conceptions of learning science, and the last three dimensions are related to higher-level conceptions of learning science (Tsai et al., 2011). The Cronbach’s alpha coefficients of the COLS’s each dimension were found as 0.85, 0.91, 0.89, 0.90, 0.84 and 0.91, respectively. The overall alpha was found to be 0.91. The confirmatory factor analysis results also showed reasonable fit with the values: RMSEA=0.060, GFI=0.82, NFI=0.95, NNFI=0.97, CFI=0.97 (Lee et al., 2008). In this study, all the items in the COLS were reorganized by considering physics, chemistry and biology domains without changing the meanings of items for the study. Students were also required to mark one of the choices considering the science domains separately.

Data analysis

Before running the correlation analysis, whether the data in each dimension of the questionnaires is normally distributed was tested. However, the items in the “source” and “certainty” dimensions in the EBQ were reverse coded. Therefore, higher scores mean more positive beliefs. Moreover, reliability and validity of the questionnaires were tested.

For the normality, skewness and kurtosis values of all dimensions were calculated. The values between -1.96 and +1.96 are necessary for the skewness and kurtosis (Can, 2013). In this study, all the values were in these ranges. In Table 1, these values are presented.

Table 1. Normality assumptions

	Dimensions	N	Skewness	Kurtosis
Epistemological Beliefs	S	462	0.097	-1.103
	C	462	-0.105	-0.890
	D	462	-1.005	0.722
	J	462	-1.362	1.628
Conceptions of learning physics	M	462	0.813	0.118
	T	462	0.547	-0.620
	CP	462	-0.332	-0.949
	IK	462	-1.050	0.776
	A	462	-0.958	0.748
	US	462	-1.228	0.894
Conceptions of learning chemistry	M	462	0.686	-0.179
	T	462	0.669	-0.426
	CP	462	-0.278	-1.021
	IK	462	-0.988	0.464
	A	462	-1.143	1.219
	US	462	-1.338	1.360
Conceptions of learning biology	M	462	0.317	1.352
	T	462	0.478	0.397
	CP	462	0.087	-0.152
	IK	462	-1.042	1.004
	A	462	-0.925	0.827
	US	462	-1.062	0.545

Note: The abbreviations used to define dimensions: Source (S); Certainty (C); Development (D); Justification (J); Memorizing (M); Testing (T); Calculate and practice (CP); Increase of knowledge (IK); Applying (A); Understanding and seeing in a new way (US)

As shown in Table 1, skewness and kurtosis values are acceptable. While the skewness values vary between -1.362 and 0.813, the kurtosis values vary between -1.103 and 1.628.

The construct validities of the instruments were tested by running confirmatory factor analysis in the AMOS program (version 21). AMOS outputs were presented in the Appendix. In this analysis, some fit indices (GFI, CFI, TLI, CMIN/df and RMSEA) were calculated. The values for GFI, CFI and TLI above 0.90 (Byrne, 2010), the values for RMSEA between 0 and 0.08, and the values for CMIN/df between 0 and 3 (Schermelleh-Engel et al., 2003) can be acceptable in the factor analysis. Firstly, this analysis was performed on students' responses in the EBQ. GFI, CFI, TLI, CMIN/df and RMSEA values were respectively found as 0.921, 0.929, 0.920, 1.874 and 0.044. GFI, CFI and TLI values were above 0.90. CMIN/df value was between 0 and 3, and RMSEA value was below 0.08 for the EBQ.

Confirmatory factor analyses were also performed for the questionnaires used to determine students' conceptions of learning in different science domains. GFI, CFI, TLI, CMIN/df and RMSEA values were respectively found as 0.900, 0.922, 0.912, 1.928 and 0.045 for conceptions of learning physics; 0.911, 0.911, 0.901, 1.740 and 0.040 for conceptions of learning chemistry; 0.923, 0.945, 0.939, 1.405 and 0.030 for conceptions of learning biology. GFI, CFI and TLI values were above 0.90. CMIN/df values were between 0 and 3, and RMSEA values were below 0.08 in these measurements.

The Cronbach's alpha coefficients were also examined in reliability analysis. The overall alphas and dimensions of each questionnaire were calculated. The Cronbach's alpha coefficients of the dimensions of the EBQ "source", "certainty", "development" and "justification" were respectively found as 0.759, 0.790, 0.795 and 0.825. Its overall alpha was also found as 0.865.

In addition, the overall Cronbach's alpha coefficients of conceptions of learning in different science domains and the alphas for each dimension were determined. These Cronbach's alpha coefficients are presented in Table 2.

Table 2. The Cronbach's alpha coefficients of conceptions of learning in different science domains

Conceptions of learning	Physics (α)		Chemistry (α)		Biology (α)	
M	0.733	0.834	0.649	0.798	0.696	0.768
T	0.798		0.740		0.697	
CP	0.790		0.748		0.585	
IK	0.828		0.752		0.783	
A	0.741		0.671		0.699	
US	0.854		0.832		0.842	

As shown in Table 2, the overall Cronbach's alpha coefficients of conceptions of learning in different science domains are as follows: 0.834, 0.798 and 0.768. The Cronbach's alpha coefficients of the dimensions vary between 0.585 and 0.854.

Finally, correlation analysis was performed on SPSS program (version 22) by considering Pearson's correlation coefficient. In this analysis the relationships between epistemological beliefs and conceptions of learning in different science domains were separately investigated. When the results obtained from the correlation analysis were interpreted, Cohen's (1988) suggestions about the size of correlation coefficients were taken into consideration. According the Cohen (1988), the values for correlation coefficients (r) between ±0.10 – ±0.29; ±0.30 – ±0.49; ±0.50 – ±1.0 respectively imply weak, moderate and strong associations.

3 | FINDINGS

In this section the results obtained from correlation analysis were presented. Firstly, the relationships between students' epistemological beliefs and conceptions of learning physics were determined. In Table 3, these relationships are shown.

Table 3. The relationships between students' epistemological beliefs and conceptions of learning physics

			Conceptions of learning physics					
			M	T	CP	IK	A	US
Epistemological beliefs	S	r	-0.061	-0.026	-0.020	0.140**	0.067	0.081
		p	0.188	0.580	0.668	0.003	0.148	0.080
		N	462	462	462	462	462	462
	C	r	0.034	0.073	0.134**	0.124**	0.053	0.035
		p	0.470	0.116	0.004	0.007	0.257	0.451
		N	462	462	462	462	462	462
	D	r	-0.102*	-0.065	0.122*	0.364**	0.356**	0.328**
		p	0.029	0.166	0.009	0.000	0.000	0.000
		N	462	462	462	462	462	462
	J	r	-0.016	0.000	0.281**	0.389**	0.330**	0.396**
		p	0.728	0.994	0.000	0.000	0.000	0.000
		N	462	462	462	462	462	462

** $p<0.01$; * $p<0.05$

As shown in Table 3, there are significant relationships among some dimensions of epistemological beliefs and conceptions of learning physics. There are positive and weak correlations between "source" and "increase of knowledge" (r=0.140, $p<0.01$); "certainty" and "calculate and practice" (r=0.134, $p<0.01$); "certainty" and "increase of knowledge" (r=0.124, $p<0.01$). In addition, there are negative and weak correlation between "development" and "memorizing" (r=-0.102, $p<0.05$); positive and weak correlation between "development" and "calculate and practice" (r=0.122, $p<0.05$); positive and moderate correlation between "development" and "increase of knowledge" (r=0.364, $p<0.01$); positive and moderate correlation between "development" and "applying" (r=0.356, $p<0.01$) and positive and moderate correlation between "development" and "understanding and seeing in a new way" (r=0.328, $p<0.01$). Finally, "justification" positively and weakly correlates with "calculate and practice" (r=0.281, $p<0.01$); positively and moderately correlates with "increase of knowledge" (r=0.389, $p<0.01$); positively and moderately correlates with "applying" (r=0.330, $p<0.01$); and positively and moderately correlates with "understanding and seeing in a new way" (r=0.396, $p<0.01$).

The relationships between students' epistemological beliefs and conceptions of learning chemistry were also investigated. In Table 4, these relationships are shown.

Table 4. The relationships between students' epistemological beliefs and conceptions of learning chemistry

			Conceptions of learning chemistry					
			M	T	CP	IK	A	US
Epistemological beliefs	S	r	0.004	-0.012	-0.069	0.056	0.053	0.045
		p	0.939	0.791	0.141	0.232	0.254	0.339
		N	462	462	462	462	462	462
	C	r	0.118*	0.112*	0.091	0.043	-0.023	-0.027
		p	0.011	0.016	0.051	0.356	0.622	0.565
		N	462	462	462	462	462	462
	D	r	-0.068	-0.043	0.099*	0.286**	0.274**	0.265**
		p	0.147	0.356	0.034	0.000	0.000	0.000
		N	462	462	462	462	462	462
	J	r	-0.049	0.017	0.229**	0.319**	0.254**	0.343**
		p	0.289	0.708	0.000	0.000	0.000	0.000
		N	462	462	462	462	462	462

** $p<0.01$; * $p<0.05$

As shown in Table 4, "certainty" positively and weakly correlates with "memorizing" (r=0.118, $p<0.05$) and "testing" (r=0.112, $p<0.05$). In addition, "development" positively and weakly correlates with "calculate and practice" (r=0.099, p<0.05); "increase of knowledge" (r=0.286, $p<0.01$); "applying" (r=0.274, $p<0.01$); and "understanding and seeing in a new way" (r=0.265, $p<0.01$). Finally, there are positive and weak correlation between "justification" and "calculate and practice" (r=0.229, $p<0.01$); positive and moderate correlation between "justification" and "increase of knowledge" (r=0.319, $p<0.01$); positive and weak correlation between "justification" and "applying" (r=0.254, $p<0.01$), and positive and moderate correlation between "justification" and "understanding and seeing in a new way" (r=0.343, $p<0.01$).

Lastly, the relationships between students' epistemological beliefs and conceptions of learning biology were examined. These relationships are shown in Table 5.

Table 5. The relationships between students' epistemological beliefs and conceptions of learning biology

			Conceptions of learning biology					
			M	T	CP	IK	A	US
Epistemological beliefs	S	r	0.006	0.017	-0.061	0.147**	0.074	0.148**
		p	0.894	0.713	0.189	0.001	0.111	0.001
		N	462	462	462	462	462	462
	C	r	0.025	0.105*	0.079	0.147**	0.055	0.120**
		p	0.597	0.024	0.089	0.002	0.238	0.010
		N	462	462	462	462	462	462
	D	r	0.021	0.016	0.010	0.328**	0.316**	0.314**
		p	0.647	0.730	0.838	0.000	0.000	0.000
		N	462	462	462	462	462	462
	J	r	0.013	0.057	0.148**	0.339**	0.296**	0.356**
		p	0.778	0.225	0.001	0.000	0.000	0.000
		N	462	462	462	462	462	462

**$p<0.01$; *$p<0.05$

As shown in Table 5, there are significant relationships among some dimensions of epistemological beliefs and conceptions of learning biology. "Source" is positively and weakly correlated with "increase of knowledge" (r=0.147, $p<0.01$) and "understanding and seeing in a new way" (r=0.148, $p<0.01$). Similarly, "certainty" is positively and weakly correlated with "testing" (r=0.105, $p<0.05$); "increase of knowledge" (r=0.147, $p<0.01$) and "understanding and seeing in a new way" (r=0.120, $p<0.01$). There are also positive and moderate correlations between "development" and "increase of knowledge" (r=0.328, $p<0.01$); "development" and "applying" (r=0.316, $p<0.01$); "development" and "understanding and seeing in a new way" (r=0.314, $p<0.01$). Finally, "justification" is positively and weakly correlated with "calculate and practice" (r=0148, $p<0.01$); positively and moderately correlated with "increase of knowledge" (r=0.339, $p<0.01$); positively and weakly correlated with "applying" (r=0.296, $p<0.01$); and positively and moderately correlated with "understanding and seeing in a new way" (r=0.356, $p<0.01$).

4 | Discussion & Conclusion

The results of this study showed that there were positive relationships between students' epistemological beliefs and higher-level conceptions of learning in different science domains (physics, chemistry, biology). Students' epistemological beliefs in "development" and "justification" dimensions were positively and significantly correlated with their higher-level conceptions of learning in "increase of knowledge", "applying" and "understanding and seeing in a new way" dimensions. The results of some studies (Ho & Liang, 2015; Liang & Tsai, 2010; Shen et al., 2018) support these findings. For instance, Liang and Tsai (2010) found positive and significant relationships between students' epistemological beliefs in "development" and "justification" dimensions and their higher-level conceptions of learning science. Similarly, Shen et al. (2018) found that students' epistemological belief in "justification" dimension was positively and significantly correlated with their higher-level conceptions of learning biology. Furthermore, according to the results of this study, increase in the students' epistemological beliefs in "development" and "justification" dimensions may imply increase in their higher-level conceptions of learning in different science domains. In other words, increase in students' positive beliefs about changing and developing aspect of science, the change in scientists' views on their ideas over time and the role of experiments in science may imply the increase in their higher-level conceptions of learning in different science domains. These higher-level conceptions of learning can be as follows: acquiring new knowledge about natural phenomena, applying to newly acquired knowledge to unknown situations, and making learning meaningful and relating it to daily life by having a new perspective (Lee et al., 2008). In this regard, students' higher-level conceptions of learning in different science domains can develop with the developments in their epistemological beliefs in "development" and "justification" dimensions. Maybe, the opposite situation can also be valid. Therefore, the possible learning activities that may cause the development of such psychological constructs can contribute to development of both constructs. Lee and Hannafin (2016) discussed that student-centered learning methods can positively influence the development of epistemological beliefs and conceptions of learning. Hence, teachers are advised to use student-centered learning methods in their classrooms to improve both students' epistemological beliefs and higher-level conceptions of learning in different science domains.

Another important result in this study was that the sizes of correlation coefficients between epistemological beliefs and conceptions of learning in different science domains were different from each other. For example, sizes of correlation coefficients between epistemological beliefs in "development" and "justification" dimensions and the higher-level conceptions of learning physics were higher than the sizes of correlation coefficients between these epistemological beliefs and other conceptions of learning in the science domains which are chemistry and biology. This can be interpreted that there can be differences in the relationships between epistemological beliefs and domain-specific conceptions of learning. In fact, students' perceptions about different science domains can differentiate from each other. For example, Joy et al. (2017) indicated that biology subjects can include more memorization. Hence, researchers should try to identify students' domain-specific conceptions of learning instead of investigating conceptions of learning in general as also suggested by Tsai (2004).

In addition, there were weak or no relationships between students' epistemological beliefs in "source" and "certainty" dimensions and their higher-level conceptions of learning in different science domains. Similarly, Sadi and Dağyar (2015) determined weak or no relationships between many epistemological beliefs and conceptions of learning biology that student have. On the contrary, some researchers (Ho & Liang, 2015; Liang & Tsai, 2010) explored positive and moderate relationships between students' epistemological beliefs and higher-level conceptions of learning science. When the claims of Tsai (2004) are also considered, there should be significant and positive relationships between sophisticated epistemological beliefs and higher-level conceptions of learning. The ideas of Brownlee et al. (2001) on these relationships also support this claim. Ho and Liang (2015) viewed epistemological beliefs as students' opinions about nature of knowledge and conceptions of learning as their views about learning. They determined positive and moderate relationships between students' epistemological beliefs and higher-level conceptions of learning science. However, in this study such relationships could not be found. The reason for this can be attributed to fact that the participants in this study may not have more positive epistemological beliefs in the dimensions "source" and "certainty". As discussed before, the use of learning activities that based on more student learning approaches in the lessons can contribute more desirable relationships between students' epistemological beliefs and conceptions of learning in different science domains.

The results of this study also showed that there were weak or no relationships between students' epistemological beliefs and lower-level conceptions of learning in "memorizing", "testing" and "calculate and practice" dimensions in different science domains. This result is also in line with the results obtained by Sadi and Dağyar (2015). However, Ho and Liang (2015) determined negative and moderate relationships between students' epistemological beliefs and lower-level conceptions of learning science. Liang and Tsai (2010) also achieved similar results. Shen et al. (2018) also found that there were significant and negative relationships between many epistemological beliefs and lower-level conceptions of learning biology. These contradictory results can be arisen from two reasons. The first one can be that students may not have more sophisticated epistemological beliefs. The second one can be that students' lower-level conceptions of learning in different science domains can be high.

As a conclusion, this study showed there can be some different relationships between students' core epistemological beliefs and different conceptions of learning. Instead of studying conceptions of learning in general, researchers should focus on domain-specific conceptions further. In addition, considering that the students' epistemological beliefs vary across different disciplines (Lonka et al., 2021), domain specific epistemological beliefs should also be determined and their relationships with conceptions of learning can be investigated. Hence, the relationships between students' domain-specific epistemological beliefs and conceptions of learning can be better understood.

Statements of publication ethics

Ethics committee approval was received from Ağrı İbrahim Çeçen University. (Approval Date: September 8, 2020, No: 119)

Conflict of interest

The author confirms that there is no conflict of interest.

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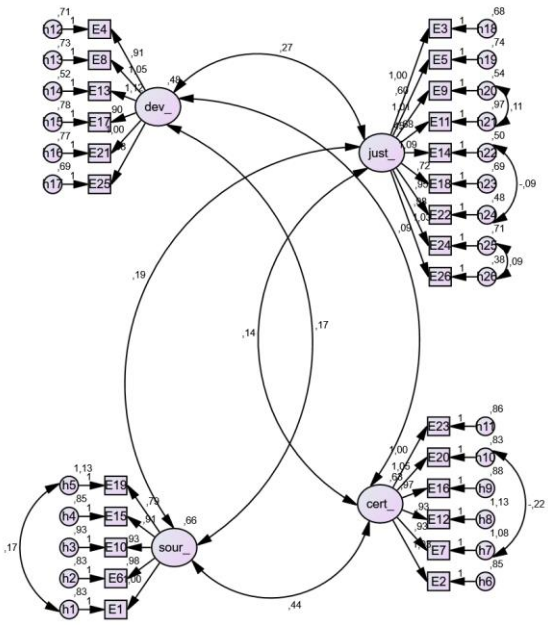
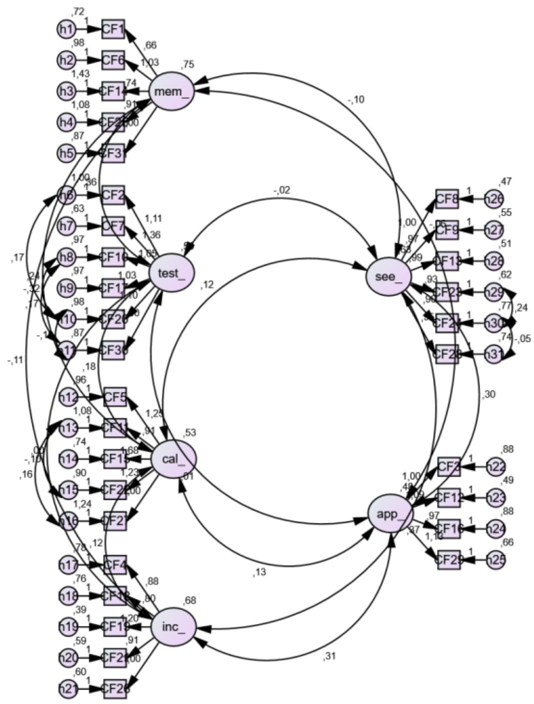
Appendix: Confirmatory Factor Analyses Diagrams

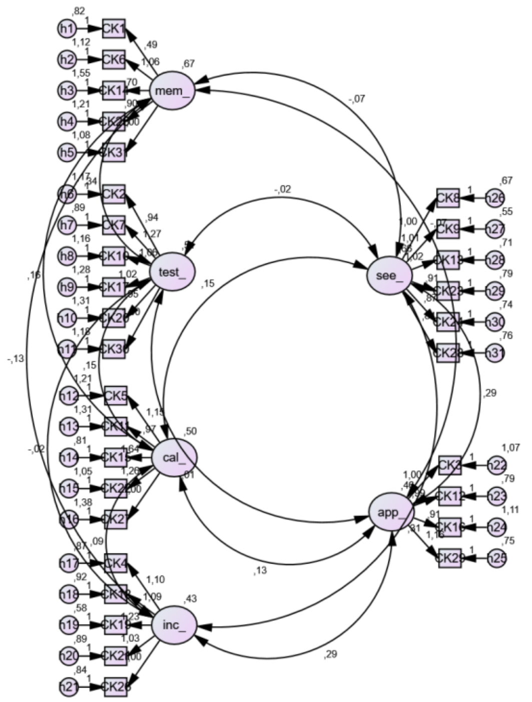
Epistemological Beliefs



Conceptions of Learning Physics



Conceptions of Learning Chemistry



Conceptions of Learning Biology