ISSN: 2148-9955

International Journal of Research in Education and Science (IJRES)

www.ijres.net

Development of a Scale on Scientific Epistemological Views and Investigation of Epistemological Views of Prospective Teachers

Gokhan Gunes[1], Kaan Bati[2]
[1]Hakkari University
[2]Hacettepe University

To cite this article:

Gunes, G. & Bati, K. (2018). Development of a scale on scientific epistemological views and investigation of epistemological views of prospective teachers. *International Journal of Research in Education and Science (IJRES), 4*(2), 391-408. DOI:10.21890/ijres.409299

This article may be used for research, teaching, and private study purposes.

Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

Authors alone are responsible for the contents of their articles. The journal owns the copyright of the articles.

The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of the research material.

International Journal of Research in Education and Science

Volume 4, Issue 2, Summer 2018 DOI:10.21890/ijres.409299

Development of a Scale on Scientific Epistemological Views and Investigation of Epistemological Views of Prospective Teachers

Gokhan Gunes, Kaan Bati

Article Info

Article History

Received:
16 January 2018

Accepted:
11 March 2018

Keywords

Scientific epistemological views
Scientific epistemological scale development
Prospective teachers
Prospective teachers' epistemological views

Abstract

The aim of this research was to develop a valid and reliable measurement tool (SSEV) for the determination of the epistemological views of prospective teachers, and to use this scale to elicit the epistemological views of prospective teachers in Turkey. The application was conducted with 930 participants. SSEV was found to account for 48% of the total variance in the participants' epistemological views. SSEV consisted of three sub-dimensions; "authority and accuracy in scientific knowledge", "methodological approach and scientific attitude", and "nature of scientific knowledge". The ω, r, and α reliability coefficients for the whole scale were found to be .868, .838 and .861, respectively. In terms of the results it can be stated that SSEV is a valid and reliable scale to measure teacher candidates' epistemological views. The prospective teachers that constituted the sample of this research generally had mature epistemological views at a slightly higher level than moderate. It was found that the developed/mature epistemological views of the participants were at a high level for the authority and accuracy sub-dimension, above the moderate level for the methodological approaches and scientific attitude, and at a moderate level for nature of scientific knowledge.

Introduction

Individuals' perspectives concerning the definition, structuring, evaluation and formation of knowledge are shaped by their epistemological beliefs (Hofer, 2001). Epistemological belief refers to individual views about the nature of knowledge and knowing (Hofer & Pintrich, 2002) and is the result of a personal assessment concerning how knowledge is obtained and its boundaries and criteria (Perry, 1970). Furthermore, responses to questions, such as "how learning occurs" and "what is learned" also provide information on the epistemological views of individuals (Hofer, 2017). A review of the literature reveals that different sub-dimensions have been defined for epistemological views. Schommer (1990) stated that, epistemological belief consists of the following five sub-dimensions: "source of knowledge", "certainty of knowledge", "organization of knowledge", "control of learning", and "speed of learning". Source of knowledge refers to the belief in or rejection of authority; certainty of knowledge questions whether knowledge is absolute/unchanging or changing/developing; organization of knowledge is related to the knowledge being compartmentalized or integrated; control of learning examines whether learning is genetic or acquired through efforts, and speed of learning is associated with whether learning is rapid or a gradual process that takes place over time (Schommer, 1990). As suggested by Schommer, individuals' epistemological views develop from immature/undeveloped to mature/developed (Kienhues, Bromme & Stahl, 2008; Rodriguez & Cano, 2007; Schommer, 1994). Individuals generally adopt dogmatic thinking (Taşdan Berksoy & Güneş, 2017) whereas as they grow older, their epistemological views also mature and develop with the development of conceptual knowledge at younger ages (Conley, Pintrich, Vekiri & Harrison, 2004). Furthermore, it is known that high-level thinking skills contribute to the development of more mature and advanced epistemological beliefs (Bendixen & Hartley, 2003). Hofer and Pintrich (1997) defined the sub-dimensions of epistemological view as certainty of knowledge, simplicity of knowledge, source of knowledge, and justification of knowing. This shows that while Schommer focused more on knowledge and learning when defining sub-dimensions, Hofer and Pintrich emphasized the concepts of knowledge and knowing. On the other hand, Elder (2002) took into consideration knowledge and its developmental characteristics in his definition of the sub-dimensions of epistemological beliefs (authority, certainty, developing, and reasoning).

The epistemological views of individuals are considered to have an important role in their learning and teaching processes (Paulsen, Wells 1998; Phan 2008). These views influence students' efforts (Cano, Cardelle-Elawar 2004) and academic achievement (Buehl, Alexander 2001). In this context, it can be stated that epistemological views are not only related to the knowledge of individuals, but they also affect their approach, attitudes and behavior concerning success, development, and learning (Güneş, Batı, Katrancı 2017; Kuhn, Cheney, Weinstock 2000). Tsai (2001) stated that students were influenced by their teachers in the development of their epistemological views and that teachers' reflection of their own epistemological views in the classroom environment may have a positive effect on their students. This interaction between the teacher and students is a determining factor for the development of epistemological views of both prospective teachers and their prospective students. In addition, it has also been suggested that the epistemological views of prospective teachers may provide clues as to how they will approach learning activities (Ravindran, Greene, & DeBacker, 2005) and future classroom teaching activities (Brownlee, 2003; Pajares, 1992).

Purpose and Significance of the Study

Several scales have been developed to determine the epistemological beliefs of individuals (Schommer 1990; Elder 2002; Pomeroy, 1993). The "Epistemological Beliefs Questionnaire" (EBQ) developed by Schommer (1990) has 63 items under the four dimensions of innate ability (*ability to learn is innate*), quick learning (*learning happens quickly*), simple knowledge (*knowledge is simple*), and certain knowledge (*knowledge is certain*). Pomeroy (1993) proposed a scale consisting of 50 items and three factors reflecting traditional science understanding, traditional science education understanding, and non-traditional science understanding. Elder (2002) developed a scale consisting of 33 items under four sub-dimensions of authority, certainty, developing and reasoning to determine the epistemological views of fifth-grade students.

Many researchers in Turkey have adapted the scales available in the literature to the Turkish culture to determine the epistemological beliefs of individuals from different age groups (Aydın, Selçuk, Çakmak, İlğan 2017; Aypay, 2011; Deryakulu, Bikmaz, 2003; Dinç, İnel, Üztemur, 2016; Önen 2009). However, in most adaptation studies, the original factors and the distribution of items among these factors were modified (Önen 2009). For example, after Deryakulu and Bikmaz (2003) adapted the Scientific Epistemological Beliefs Survey developed by Pomeroy (1993) to Turkish, the number of items was reduced from 50 to 30, and there was only a single factor as opposed to the original three factors. Although the reliability coefficient of the adapted scale was reported to be 0.91, it was not considered to be useful due to the low content validity. Similarly, in a study by Deryakulu and Büyüköztürk (2005) on the Turkish adaptation of EBQ, the adapted version consisted of 34 items gathered under three factors. Chan and Elliot (2002, 2004) also attempted to adapt EBQ but due to the incompatibility of the factors, they had to develop a new scale of 30 items and four factors. This new scale was later adapted to Turkish by Aypay (2011), but despite the satisfactory results obtained from the statistical analysis, the author commented on the differences between the original and adapted versions in the distribution of the items among factors.

These reports suggest that adaptation of scales on epistemological beliefs to different cultures does not result in a valid and reliable instrument, leading to considerable differences in the number of items and factors, and even to the different distribution of items among factors compared to the original scale (Önen, 2009). Therefore, to accurately determine the epistemological beliefs, rather than adapting the existing scales, it is necessary to develop a new scale which is more suitable for the characteristics of a specific culture. In this study, we aimed to develop a valid and reliable measuring instrument to elicit the epistemological views of prospective teachers in Turkey. The sub-problems of the study were determined as follows:

- Is the Scale on Scientific Epistemological Views (SSEV) a valid and reliable measuring instrument to elicit the epistemological views of prospective teachers in Turkey?
- What are the epistemological views of prospective teachers in Turkey?

Method

This research included the validity and reliability analyses of SSEV, a scale developed by the authors to determine the epistemological views of prospective teachers. For this purpose, firstly, the scales developed in the literature for the determination of epistemological views and then beliefs were examined. Then, scale items were formulated based on the most commonly used scales and the sub-dimension of epistemological views defined by Schommer (1990), Hofer and Pintrich (1997), and Elder (2002). During the preparation of items' process, particular attention was paid to ensuring that the scale was culturally appropriate, as explained in the section on the purpose and significance of the study. The validity and reliability statistics of the pilot and main applications of the scale are given in detail in the results section.

Data Analysis

The following statistical tests were undertaken to determine the validity and reliability of SSEV:

- The Davis technique (1992) for content validity
- Calculation of Kolmogorov-Smirnov and Skewness-Kurtosis coefficients as normality tests to determine the fitness for parametric tests
- KMO and Bartlett's test to examine whether the scale was suitable for a factor analysis for construct validity
- Exploratory factor analysis for the examination of construct validity
- Item analyses for reliability (mean score difference between the upper and lower groups, item-total score correlation) and calculation of Cronbach's alpha and McDonald's omega coefficients for internal consistency
- Calculation of descriptive statistics for a large sample in the main application

Study Group

The research on scale development was undertaken in the academic years of 2016-2017 and 2017-2018 with undergraduate students enrolled in the Departments of Early Childhood, Primary, Mathematics and Science Education at three state universities in Turkey. The scale development process consisted of three stages; first pilot, second pilot and the main applications, in which the scale was administered to 145, 350 and 945 prospective teachers, respectively. The responses of nine participants in the first pilot, eight participants in the second pilot, and 15 participants in the main application were not included in the study because they were not appropriate in terms of validity and reliability (no response or the same option marked for each item); thus, the analyses were performed on 136, 342 and 930 participants, respectively. Table 1 shows the distribution of the participants in the pilot and main applications by department.

Table 1. The results of descriptive statistics of the prospective teachers that participated in the pilot and main applications according to their department

Department	First Pilot	Second Pilot	Main Application
Early Childhood Education	45	83	245
Primary Education	25	110	285
Science and Technology Education	46	105	278
Elementary Mathematics Education	20	44	122
Total	136	342	930

Since class and department variables were not included in the scope of the research, no statistical analyses were undertaken for these variables.

Results and Discussion

In this section, the descriptive statistical results of the validity, reliability and factor analyses of the pilot and main applications of SSEV are presented and discussed.

Content Validity

Seven experts were asked to assess the content validity of the candidate scale. The content validity of the scale was measured using the Davis technique (1992) based on the following four options:

A = appropriate,
B = needs minor revision,
C = needs major revision, and
D = not appropriate.
For the calculation of the content validity index (CVI), the following equation is used:

$$\mathrm{CVI} = \frac{\mathrm{A+B}}{\mathrm{n}}$$

Where n indicates the total number of experts. Table 2 presents the results of CVI performed on the item pool consisting of 25 items prepared by the researchers.

Table 2. The results of CVI on SSEV using the Davis technique

Item	Appropriate	Needs minor revision	Needs major revision	Not appropriate	CVI
Item 1	5	1	1	-	.86
Item 2	6	1	-	-	1.00
Item 3	4	2	-	1	.86
Item 4	4	3	-	-	1.00
Item 5	3	3	1	-	.86
Item 6	4	2	-	1	.86
Item 7	4	2	1	-	.86
Item 8	4	3	-	-	1.00
Item 9	4	2	1	-	.86
Item 10	4	2	1	-	.86
Item 11	2	4	-	1	.86
Item 12	5	2	-	-	1.00
Item 13	4	2	1	-	.86
Item 14	4	2	-	1	.86
Item 15	3	3	-	1	.86
Item 16	5	2	-	-	1.00
Item 17	5	1	-	1	.86
Item 18	5	1	1	-	.86
Item 19	4	2	-	1	.86
Item 20	4	3	-	-	1.00
Item 21	4	2	1	-	.86
Item 22	4	3	-	-	1.00
Item 23	4	2	-	1	.86
Item 24	4	2	1	-	.86
Item 25	5	1	-	1	1.00

As shown in Table 2, the CVI values of all 25 items that were planned to be included in SSEV were greater than .80, which means that these items had sufficient content validity for the candidate scale.

First Pilot Application

The first pilot application for the development of SSEV was conducted with 136 participants. Büyüköztürk (2002) stated that a sample size between 100 and 200 is sufficient, especially when the factors are strong and specific, and the number of variables is not high. As a general rule, however, it is also suggested that the sample size should be five times the number of the least observable variables. Considering that the first pilot application was undertaken with a sample group (n = 136) more than five times the number of items (25 * 5 = 125), the sample size was sufficient.

After the first pilot application, a factor analysis was performed and the internal consistency coefficient was calculated to obtain predictive data from the candidate scale of 25 items. According to the results of the analysis, items 11 and 15 were found to negatively affect the power and validity-reliability of the scale due to their poor structure and understandability, and tendency to attach to multiple factors with low loadings. In addition, eight random participants were interviewed after the application concerning the items, and they also stated that they did not fully understand items 11 and 15. These prospective teachers also expressed difficulty in responding to items 5 and 24, and they believed that these items should be simplified. The researchers, therefore, removed items 11 and 15 from the scale and simplified items 5 and 24 before moving on to the second pilot application.

Second Pilot Application

The second pilot application was conducted with 342 participants. The number of samples were 10 times the number of items (23); thus, the minimum criterion for sample size was met. After performing construct validity and reliability analyses, the second pilot scale was finalized. The estimated statistics of missing data in the second application was greater than .05 (p=.105), indicating that the missing data was randomly distributed; thus, this data was assigned the mean value of the series.

Results of Normality Tests on the Second Pilot Application

In the second pilot application, normality tests were performed to determine whether the candidate scale was suitable for parametric tests. Table 3 presents the results of descriptive statistics and normality tests.

Table 3. The results of descriptive statistics and normality tests on the second pilot application of SSEV

	Min.	Max.	Sd	S	$\bar{x}$	$p_{Kolmogorov\text{-}Smirnov}$	Skewness	Kurtosis
SSEV	70.28	115.00	7.89	62.20	96.15	.096	-.135	.176

N=342

As shown in Table 3, in the second pilot application, the candidate scale was found to have a normal distribution based on the Kolmogorov-Smirnov value being greater than .05 (p = .096) and the Skewness-Kurtosis coefficient being in the range of ± 1.96.

Results of Construct Validity of the Second Pilot Application

The construct validity of a data collection tool is determined by a factor analysis (Kerlinger, 1973). This factor analysis is divided into confirmatory and exploratory/explanatory factor analyses, with the former being preferred in adaptation studies and the latter being more appropriate for the development of new scales (Büyüköztürk, 2007). Since this research aimed to develop a new scale, exploratory factor analysis was used. Table 4 presents the results of KMO and Bartlett's test on the suitability of candidate SSEV for factor analysis.

Table 3. The results of KMO and Bartlett's test on SSEV

	Value	Chi-square	Sd	p
KMO	.779			
Bartlett's Test of Sphericity		1422.520	253	.000

As shown in Table 4, SSEV met the criteria for factor analysis based on the KMO value of .779 (>.600), and Bartlett's Test chi-square value of 1422.50 and p of .000 (Field, 2000; Tabachnick & Fidell, 2001). Figure 1 shows the scree plot obtained from the factor analysis of the candidate SSEV performed after the second pilot application.

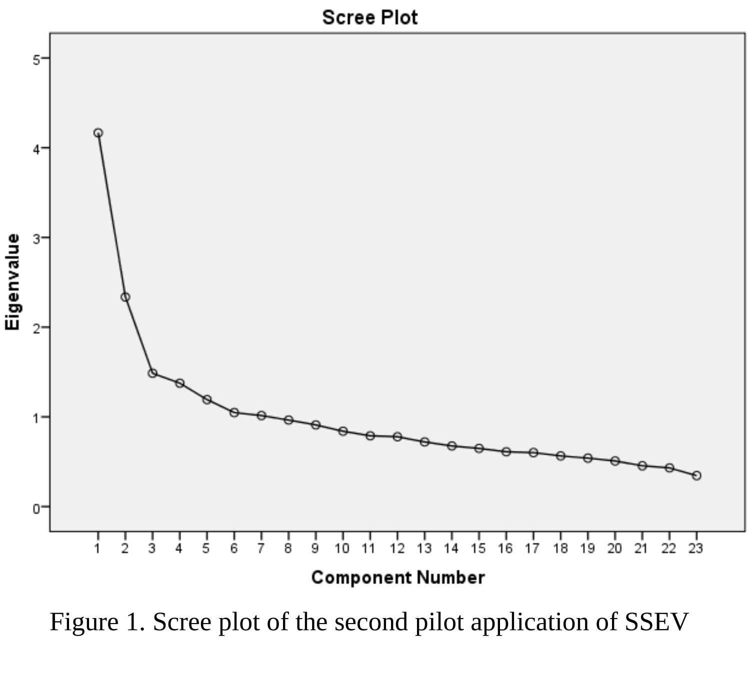

Figure 1. Scree plot of the second pilot application of SSEV

Figure 1 shows a three-factor structure of the candidate scale, and Table 5 presents the distribution of items in terms of their loading on these factors.

Table 5. The results of SSEV factor analysis

	Factor 1	2	3	Variance (percentage)
Item 23	.665			
Item 13	.628			
Item 16	.617			
Item 14	.598			
Item 18	.558			13.48%
Item 12	.503			
Item 4	.449			
Item 22	.415			
Item 11	.300			
Item 6		.657		
Item 5		.575		
Item 19		.541		
Item 3		.535		
Item 20		.525		11.59%
Item 15		.523		
Item 7		.441		
Item 9		.421		
Item 2		.374		
Item 17		.363		
Item 8			.688	
Item 10			.687	9.66%
Item 21			.613	
Item 1			.390	
Total	13.48%	11.59%	9.66%	34.73%

The items of the scale were spread across three factors at a factor loading of .30 to .69 (Table 5). Furthermore, 16 items on the scale had a factor loading of greater than .45. According to Kline (1994), a factor loading of .60 indicates a high-level and .30 to .59 indicates a medium-level loading. However, Büyüköztürk (2007) suggested that for the scales with a small number of items, the threshold value for factor loading could be as low as .30, and a factor loading equal to or greater than .45 would be an indication of the high power of the scale. In addition, factor loading can also be examined statistically as a correlation value. However, it should not be forgotten that as the sample size increases, the likelihood of low correlations being significant also increases (Kline, 1994). In this study, the items with low loading values in the candidate SSEV exhibited moderate to high loading behavior on the factors. According to these results, we decided to retain all the items in the main application of the scale.

The items in SSEV accounted for 34.73% of the total variance. Nine items included in the first factor explained 13.48% of the total variance, 10 items in the second factor accounted for 11.59%, and the four items constituting the last factor accounted for 9.66%. For factor analyses in the social sciences, factors should explain more than 40% of the total variance (Kline, 1994). Although the candidate scale had a slightly lower percentage (approximately 35%), it offers the insight that when administered to a large sample size, the items will explain a sufficient percentage of the total variance.

Results of Scale Reliability in the Second Pilot Application

Table 6 shows the internal consistency coefficients (Cronbach’s alpha) calculated for the reliability analysis of the candidate SSEV after the second pilot application.

Table 6. Internal consistency coefficient of SSEV after the second pilot application

	Cronbach's alpha
Factor 1	.727
Factor 2	.661
Factor 3	.605
SSEV Total	.762

Cronbach's alpha was calculated as .762 for the whole SSEV, and .727, .661 and .605 for Factors 1, 2 and 3, respectively. This value being greater than .70 for the whole candidate SSEV after the pilot application indicates that the reliability of this measurement instrument is sufficient (Büyüköztürk, 2007). Furthermore, although Cronbach's alpha was lower than .70 for Factors 2 and 3, they remained above .50, which means that they are not a major threat to the reliability of the scale (Schmitt, 1996).

Main Application

Tabachnick and Fidell (2001) stated that if there are strong, reliable relationships, only a few prominent factors, and a higher number of samples than variables, a sample size of 50 may be sufficient for a comparative analysis. Kline (1994) argued that a 10:1 respondent-to-item ratio would be useful in developing a more powerful tool. In the study by Büyüköztürk (2002), a large number of samples is recommended to develop a reliable and valid tool. Therefore, the number of participants (n = 930) in the main application of the candidate SSEV was consistent with the sample size recommended in the literature. Before the main data analysis, a missing data analysis was performed, and the p value for the estimated statistic was found to be greater than .05 (p = .613), which indicated that the missing data was randomly distributed; thus, this data was assigned as the mean value of the series.

Results of the Normality Test in the Main Application

Since the main application was carried out with a large sample group (n = 930), it was considered sufficient to only check the skewness and kurtosis coefficient values to determine whether the scale had a normal distribution. Data on descriptive statistics and normality test related to the main application of SSEV is given in Table 7.

Table 7. The results of descriptive statistics and normality test following the main application of SSEV

	Min.	Max.	Sd	S	$\bar{x}$	Skewness	Kurtosis
SSEV	31.00	115.00	12.52	156.64	84.68	-.513	.659

N = 930

As shown in Table 7, the skewness and kurtosis coefficients obtained from the total score of the scale were within the normal distribution value range [-ʐ= -1.95 ≤ ʐ(skewness = -.513, kurtosis = .659) ≤ +ʐ=+1.95] (McKillup, 2012; Tabachnick & Fidell, 2001). The mean SSEV score was calculated as 84.68 with a variance of 156.64 and a standard deviation of 12.52. That the skewness and kurtosis values were within the normal distribution limits and the sample was of sufficient size can be considered as evidence that the developed measuring instrument is parametric (Howitt & Cramer, 2011).

Results of Construct Validity Analysis of the Main Application

Table 8 presents the results of KMO and Bartlett's test undertaken to determine whether the data obtained from the main application of SSEV was suitable for a factor analysis.

Table 8. The results of KMO and Bartlett's test of the candidate SSEV

	Value	Chi-square	Sd	p
KMO	.921			
Bartlett's Test of Sphericity		7250.498	253	.000

The values of KMO (=.921; > .600) and Bartlett's chi-square (7250.498; p=.000) demonstrate that the candidate SSEV meets the criteria for a factor analysis (Field, 2000; Tabachnick & Fidell, 2001). Table 9 shows the results of analysis on the factor loading of the SSEV items.

Table 9. Factor loadings of the SSEV items in the main application

Item	Initial value	Load (extraction)
Item 1	1.000	.310
Item 2	1.000	.489
Item 3	1.000	.480
Item 4	1.000	.421
Item 5	1.000	.571
Item 6	1.000	.544
Item 7	1.000	.447
Item 8	1.000	.588
Item 9	1.000	.435
Item 10	1.000	.522
Item 11	1.000	.442
Item 12	1.000	.514
Item 13	1.000	.578
Item 14	1.000	.510
Item 15	1.000	.453
Item 16	1.000	.559
Item 17	1.000	.434
Item 18	1.000	.508
Item 19	1.000	.456
Item 20	1.000	.400
Item 21	1.000	.448
Item 22	1.000	.458
Item 23	1.000	.525

The distribution of factor loadings ranged from .310 to .588 (Table 9). This indicates that the loading values of the candidate SSEV were above the acceptable lower limit (>30) (Büyüköztürk, 2007; Kline, 1994). Figure 2 presents the scree plot on the results of factor analysis of the data obtained from the main application of SSEV.

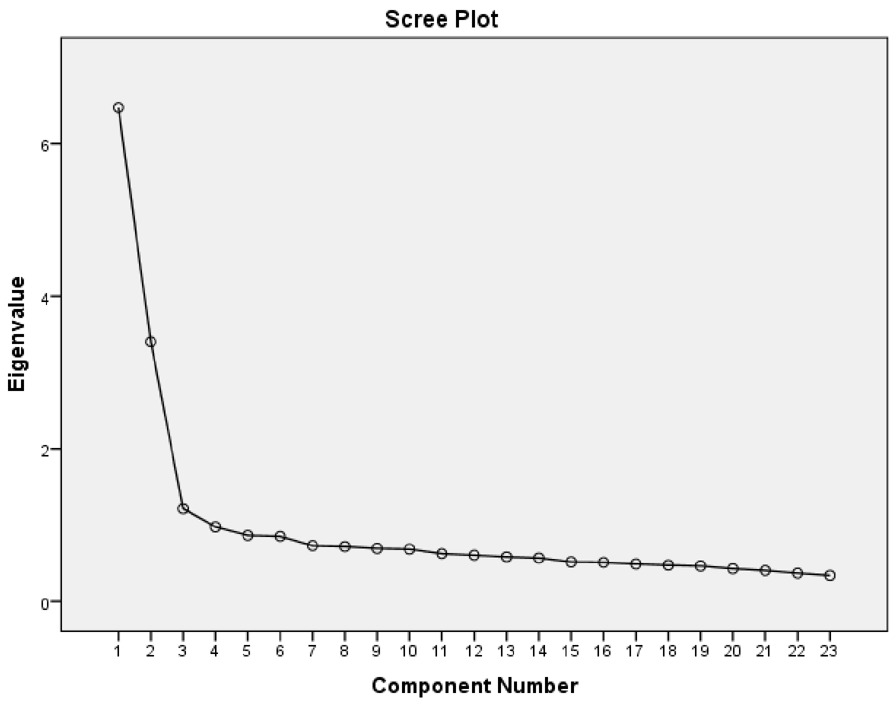

Figure 2. Scree plot of the main application of SSEV

Figure 2 shows a three-factor structure for SSEV. The results of the distribution of items across the three factors are given in Table 10.

Table 10. The results of SSEV factor analysis in the main application

Items		Factor 1	Factor 2	Factor 3	Sub-dimensions	Variance (percentage)
Item 13	All knowledge approved by scientists is certain.	.737			Authority and accuracy in scientific knowledge	20.30%
Item 16	The results of a single study are sufficient to produce scientific knowledge.	.723				
Item 23	Only scientists are responsible for solving scientific problems.	.711				
Item 18	A scientist must comply with common scientific views.	.681				
Item 14	We must believe that the scientific views of scientists are accurate.	.679				
Item 12	Only scientists can discover or invent something.	.670				
Item 11	Scientists may disagree on scientific issues.	.649				
Item 22	Scientific laws do not change.	.642				
Item 4	The knowledge obtained by scientists is certain.	.583				
Item 5	Having prior knowledge ensures the success of scientific research.		.740		Methodological approach and scientific attitude	19.42%
Item 3	Prior knowledge facilitates the discovery of new scientific knowledge.		.689			
Item 6	Scientific findings guide new research.		.681			
Item 19	Combining the results of research strengthens scientific knowledge.		.639			
Item 7	Making an effort is the foundation of learning		.634			
Item 20	A scientific method should be used to produce scientific knowledge.		.610			
Item 15	Making an effort is important for scientific achievement.		.607			
Item 17	Making an effort is more valuable than being skilled.		.601			
Item 2	Curiosity is important for the production of scientific knowledge.		.594			
Item 9	A scientific method is the most reliable way of attaining knowledge.		.558			
Item 8	Scientific knowledge changes over time.			.755	Nature of scientific knowledge	8.50%
Item 10	Scientific knowledge can be disproved by new findings.			.605		
Item 21	Scientific knowledge does not change over time.			.525		
Item 1	Scientific knowledge should be tested again and again.			.501		
∑Variance						48.22%

The factor loading values of the items varied between .501 and .755 (Table 10). Eighteen items having a high factor loading value greater than .60 (Kline, 1994) and the remaining five items having a loading value greater than .45 (Büyüköztürk, 2007) indicate that the developed SSEV has a strong structure. After the main application, SSEV accounted for 48% of the total variance in epistemological views. This value being greater than the lower limit accepted in social sciences (40%) suggests that this measurement tool sufficiently explains variation at a moderately strong level (Kline, 1994). In addition, the number of items in the first and second sub-dimensions and the variance they account for being close to each other indicate that the scale has a balanced structure. Furthermore, the last sub-dimension that consisted of four items was found to have a sufficient contribution to the scale by explaining approximately 8.50% of the total variance [(8.50 / 48.22) * 100] = 18%.

SSEV consisted of three sub-dimensions; "authority and accuracy in scientific knowledge", "methodological approach and scientific attitude" and "nature of scientific knowledge" (Table 10). We determined these sub-dimensions based on the common approaches to epistemological views available in the literature and the sub-dimensions defined by these sources (Elder, 2002; Hofer & Pintrich, 1997; Schommer, 1990). Figure 3 presents the relationships between the sub-dimensions of SSEV and those identified by other researchers.

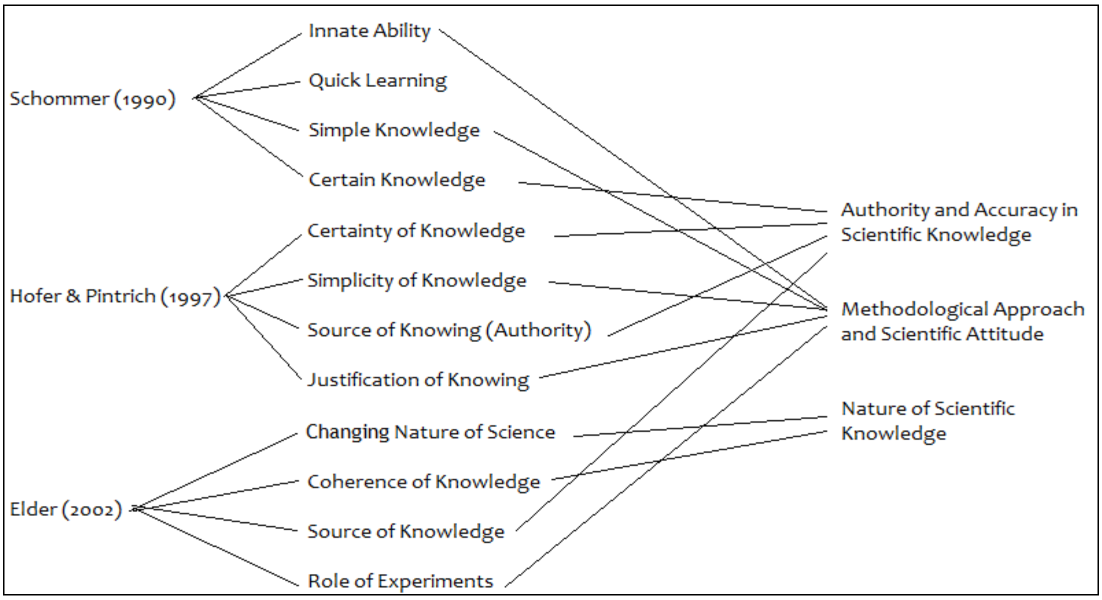

Figure 3. Relationships between the sub-dimensions of SSEV and those defined in the literature

An examination of Figure 3 reveals that the items related to the accuracy and certainty of knowledge and the approach that considers scientific knowledge and scientists as the authority are collected under the same factor. This was interpreted as the belief in the accuracy of scientific knowledge and in the authority that produced this knowledge; therefore, this sub-dimension was called Authority and Accuracy in Scientific Knowledge. The items on the importance of effort, and the power of scientific methods and experiments in the production of knowledge were gathered under the same factor with a high correlation between them. As shown in Figure 1, this sub-dimension was also derived from the three approaches given in the literature. The results of the analysis of this sub-dimension were interpreted as that the respondents did not consider scientific attitude and scientific method as two separate phenomena. Although Elder (2002) defined the source of knowledge and role of experiments as two different sub-dimensions, in SSEV, these were collected under a single sub-dimension, called Methodological Approach and Scientific Attitude.

Finally, it was determined that the items concerning the changing nature, falsifiability and coherence of scientific knowledge could be collated under one factor. Elder's work (2002) was the basis of these characteristics of scientific knowledge, but unlike the other sub-dimensions, this sub-dimension only referred to Elder (2002). When creating an item pool for SSEV, it was considered that item 1 (see Table 10) would be associated with the process of knowledge production. However, according to the factor analysis, this item had a high correlation with and was under the same factor as falsifiability and changeability of knowledge. Since the respondents considered this item as being related to the nature of scientific knowledge, this sub-dimension was called Nature of Scientific Knowledge.

Results of Reliability Analysis of the Main Application

Results of Item Analysis Based on the Mean Scores of the Upper and Lower Groups

Table 11 presents the results of the t-test on the differences in the mean scores of 251 participants constituting 27% of the upper and lower groups of SSEV (930 * 27/100 ≈ 251). All the items significantly contributed to the scale.

Table 11. The t-test results of the differences in the mean item scores of the 27% upper and lower groups

Item	Group	N	x̄	sd	t	p
1	Lower Group	251	2.7284	1.10543	-8.147	.000
	Upper Group	251	3.3144	1.23645		
2	Lower Group	251	2.8725	1.08059	-20.494	.000
	Upper Group	251	4.5339	.69415		
3	Lower Group	251	2.8946	1.12875	-14.538	.000
	Upper Group	251	4.2333	.92421		
4	Lower Group	251	3.3147	1.13161	-9.241	.000
	Upper Group	251	4.1514	.88147		
5	Lower Group	251	2.9274	1.10689	-20.853	.000
	Upper Group	251	4.6016	.62661		
6	Lower Group	251	3.0478	1.24808	-19.929	.000
	Upper Group	251	4.7450	.51257		
7	Lower Group	251	2.8631	1.09305	-17.274	.000
	Upper Group	251	4.3451	.80805		
8	Lower Group	251	3.1535	1.35699	-9.556	.000
	Upper Group	251	4.1952	1.06852		
9	Lower Group	251	2.8207	1.08246	-21.210	.000
	Upper Group	251	4.5538	.71000		
10	Lower Group	251	2.7630	1.12235	-8.087	.000
	Upper Group	251	3.8725	.96888		
11	Lower Group	251	3.2709	1.22895	-11.505	.000
	Upper Group	251	4.3227	.76645		
12	Lower Group	251	3.1076	1.17999	-17.166	.000
	Upper Group	251	4.5854	.68407		
13	Lower Group	251	3.0797	1.29986	-17.738	.000
	Upper Group	251	4.6496	.52573		
14	Lower Group	251	3.0797	1.14962	-16.317	.000
	Upper Group	251	4.4303	.63097		
15	Lower Group	251	2.7410	1.14920	-22.572	.000
	Upper Group	251	4.5896	.60244		
16	Lower Group	251	3.1554	1.25370	-15.959	.000
	Upper Group	251	4.5498	.58696		
17	Lower Group	251	2.8406	1.17920	-19.582	.000
	Upper Group	251	4.5289	.68944		
18	Lower Group	251	3.2988	1.28155	-13.030	.000
	Upper Group	251	4.5221	.75517		
19	Lower Group	251	2.8566	1.26939	-20.309	.000
	Upper Group	251	4.6574	.60178		
20	Lower Group	251	2.7630	1.13143	-11.703	.000
	Upper Group	251	3.8725	.98777		
21	Lower Group	251	2.7291	1.15166	-15.417	.000
	Upper Group	251	4.1912	.96503		
22	Lower Group	251	3.1355	1.36146	-11.617	.000
	Upper Group	251	4.2789	.76021		
23	Lower Group	251	3.2427	1.25550	-12.303	.000
	Upper Group	251	4.3583	.69796		

Item-Total Score Correlation

The correlation coefficients calculated in the item analysis for the main application of the scale ranged from .215 to .598. Büyüköztürk (2007) stated that $.30 \leq r \leq .39$ indicated a “good item” and $r \geq .40$ indicated “a very good item". According to the item-total correlation analysis, 16 items in the scale were "very good". Of the remaining items, four had values smaller than but close to .30, and three were "good items". According to these results, the item that constituted the scale generally made a positive contribution to the reliability of SSEV.

Table 12. The results of correlation analysis on SSEV items-total score

Item	Correlation r [n=930]	(Lower 27% – Upper 27%) t $[n_1=n_2=215]$
1	.249	-8.147^{**}
2	.566	-20.494^{**}
3	.447	-14.538^{**}
4	.288	-9.241^{**}
5	.582	-20.853^{**}
6	.598	-19.929^{**}
7	.536	-17.274^{**}
8	.226	-9.552^{**}
9	.549	-21.210^{**}
10	.215	-8.087^{**}
11	.379	-11.505^{**}
12	.511	-17.166^{**}
13	.528	-17.738^{**}
14	.496	-16.317^{**}
15	.580	-22.572^{**}
16	.498	-15.959^{**}
17	.552	-19.582^{**}
18	.415	-13.030^{**}
19	.553	-20.309^{**}
20	.371	-11.703^{**}
21	.428	-15.417^{**}
22	.366	-11.617^{**}
23	.441	-12.303^{**}

$^{**}p = .000$

Results of Pearson's Correlation Analysis between the SSEV Sub-Dimensions

After the pilot and main applications, SSEV was found to have a three-factor structure. Pearson's correlation analysis was undertaken to provide an understanding of the correlation between the factors obtained and the whole scale, and the results are presented in Table 13.

Table 13. The results of Pearson's product-moment correlation analysis on the relationship between SSEV sub-dimensions

	Methodological approach and scientific attitude	Nature of scientific knowledge	SSEV Total Score
Authority and accuracy in scientific knowledge	$.405^{**}$	$-.152^{**}$	$.722^{**}$
Methodological approach and scientific attitude		$.368^{**}$	$.893^{**}$
Nature of scientific knowledge			$.388^{**}$

N = 930, $^{**}p = .000$

The sub-dimensions of authority and accuracy in scientific knowledge and methodological approach and scientific attitude had a significant and high correlation with the whole scale (r = .722 and r = .893, respectively), and nature of scientific knowledge had a statistically significant but medium-level correlation (r = .388) as shown in Table 13. According to these results, the highly correlated sub-dimensions had a similar and compatible structure with the whole SSEV. The medium-level correlation of the third sub-dimension might be due to the relatively lower number of items under this sub-dimension (n = 4). The third sub-dimension consisting of only four items may have caused the relationship level to drop below the moderate level. However, the correlation of this sub-dimension with the whole scale was almost .40, which can be regarded as a sign of its compatible structure.

Table 14. The results of one-way ANOVA on the SSEV sub-dimension scores

	Source of variation	Sum of squares	df	Mean squares	F	p
SSEV	Inter-group	350424.53	2.00	175212.27	4919.64	.000
	Intra-group	99258.44	2787	36.62		
	Total	449682.97	2789			

Statistically significant differences between the sub-dimensions of a scale show that they have a strong ability to differentiate between the factors of that scale. Therefore, in this study, we also performed a one-way analysis of variance (ANOVA) on the sub-dimension scores to determine whether they differed significantly (Table 14). After this analysis revealed significant differences between the sub-dimension scores, a post-hoc Scheffe test was used to further analyze this differentiation. According to the comparison of the three sub-dimensions (Table 15), they all significantly differed from each other (p = .000) in terms of their measuring ability to differentiate between the factors.

Table 15. The results of post-hoc (Scheffe) analysis on the SSEV sub-dimension scores

I Sub-dimension	J Sub-dimension	Differences of means (I-J)
Authority and accuracy in scientific knowledge	Methodological approach and scientific attitude	-1.660**
	Nature of scientific knowledge	22.900**
Methodological approach and scientific attitude	Authority and accuracy in scientific knowledge	1.660**
	Nature of scientific knowledge	24.560**
Nature of scientific knowledge	Authority and accuracy in scientific knowledge	-22.900**
	Methodological approach and scientific attitude	-24.560**

**p = .000

Results of the SSEV Reliability Analysis

Peterson and Kim (2013) suggested that Cronbach's alpha alone may not be sufficient in demonstrating the reliability of a measuring instrument, and recommended the use of composite internal consistency techniques in combination. Therefore, McDonald's omega (ω), Spearman's Brown correlation coefficient (r), and Cronbach's alpha (α) were calculated, and the results are presented in Table 16.

Table 16. Results of the reliability analysis of SSEV

SSEV Sub-dimension	ω	r	α
Authority and accuracy in scientific knowledge	.864	.839	.866
Methodological approach and scientific attitude	.860	.848	.861
Nature of scientific knowledge	.591	.535	.582
SSEV Total	.868	.838	.861

The coefficients of ω, r and α obtained from three different reliability tests on the whole SSEV were. 800, .838 and .861, respectively, indicating the high reliability of the scale (Domino and Domino, 2006). Concerning the sub-dimensions, the ω, r and α coefficients were .864, .839 and .866, respectively for authority and accuracy in scientific knowledge; .860, .848 and .861, respectively for methodological approach and scientific attitude; and .591, .535 and .582, respectively for nature of scientific knowledge. Although the coefficient values of the third sub-dimension were lower than .60 and below the recommended value of .70 for high reliability, for a four-item sub-dimension, it can be considered acceptable (Loewenthal, 2004). Considering that Cronbach's alpha internal consistency coefficient of a newly developed or adapted measuring instrument may be as low as .60 (Nunnally, 1978), the values of the three reliability tests on the total SSEV being greater than .800 indicate that the scale has strong reliability (Urbina, 2004).

Table 17 presents the sub-dimensions and their items in the final version of the scale that was confirmed to be valid and reliable according to the analyses performed after the main application.

Table 17. SSEV items by sub-dimension

Sub-dimension	Items									
Authority and accuracy in scientific knowledge	4*	11	12*	13*	14*	16*	18*	22*	23*	
Methodological approach and scientific attitude	2	3	5	6	7	9	15	17	19	20
Nature of scientific knowledge	1	8	10	21*						

*reverse-coded items

Results of Descriptive Statistics on the Epistemological Views of Prospective Teachers

One of the sub-problems of this research was determining the epistemological views of prospective teachers (from primary education departments) that participated in the main application of SSEV. Table 18 presents the participants' mean scores with standard deviations. According to these results, the prospective teachers had a higher mean score in the sub-dimension of authority and accuracy in scientific knowledge compared to the other sub-dimensions.

Table 18. Descriptive statistics of the epistemological views of the prospective teachers

	Min.	Max.	Range	sd	S	$\bar{x}$
Authority and accuracy in scientific knowledge	9.00	45.00	36.00	6.52	42.57	35.31
Methodological approach and scientific attitude	10.00	50.00	40.00	7.38	54.46	36.97
Nature of scientific knowledge	4.00	20.00	16.00	3.13	9.82	12.41
SSEV Total	31.00	115.00	84.00	12.52	156.64	84.68

The calculation of the percentages of the prospective teachers' SSEV total and sub-dimension scores is given below:

Authority and accuracy in scientific knowledge: $$\frac{\bar{x} - Min}{Range} \times 100 \rightarrow \frac{35.31 - 9.00}{36.00} \times 100 = 73.08\%$$

Methodological approach and scientific attitude: $$\frac{\bar{x} - Min}{Range} \times 100 \rightarrow \frac{36.97 - 10.00}{40.00} \times 100 = 67.43\%$$

Nature of scientific knowledge: $$\frac{\bar{x} - Min}{Range} \times 100 \rightarrow \frac{12.41 - 4.00}{16.00} \times 100 = 52.56\%$$

SSEV total: $$\frac{\bar{x} - Min}{Range} \times 100 \rightarrow \frac{84.68 - 31.00}{84.00} \times 100 = 63.90\%$$

According to these calculations, the mean scores of the participant prospective teachers in the sub-dimension of authority and accuracy in scientific knowledge (73.08%) were higher than their scores of the whole scale and other sub-dimensions. The lowest mean score of the participants was 52.56% obtained from the sub-dimension of nature of scientific knowledge. When SSEV was evaluated as a whole, the mean percentage for mature epistemological views was 63.90%, slightly above the middle level.

In terms of the results of analysis, the prospective teachers had more developed/mature scientific epistemological views in the sub-dimension of authority and accuracy in scientific knowledge than in other sub-dimensions. Schommer (1994) also reported that prospective teachers had mature epistemological views concerning the denial of authority. In addition, the mean scores obtained from the methodological approach and scientific approach sub-dimension were higher than those of the first sub-dimension, but higher compared to the third sub-dimension and the whole scale. In the second sub-dimension, the prospective teachers were observed to have a positive attitude in relation to the idea that learning requires effort. This has also been reported by other studies (Alpay, 2011; Bicer, Er, Özel, 2013; Güneş, Batı, Katrancı, 2017). In contrast, other studies conducted in Turkey revealed immature epistemological views of prospective teachers about this idea (Eroğlu & Güven, 2006; Gürol, Altunbaş, Karaarslan, 2010; Köse & Dinç, 2012). In this context, our results on the association between learning and effort were different from the literature. However, compared to other sub-dimensions of epistemological views, the prospective teachers had a more conservative approach towards the changing and developing nature of knowledge included in the sub-dimension of nature of scientific knowledge. This resistance to the change and development of knowledge observed in this research is similar to the previous reports on prospective teachers who had the belief that there is a single truth (Chai, Khine & Teo, 2006; Deryakulu & Büyüköztürk, 2005; Gürol, Altunbaş, Karaaslan, 2010; Koç Erdamar & Bangir Alpan, 2011; Oğuz, 2008; Öngen, 2003). In a study conducted in Turkey, Terzi, Şahan, Çelik and Zöğ (2015) reported that prospective teachers had moderately mature epistemological views of a single truth and revealed different findings within this sub-dimension.

Conclusion

This study was conducted to develop a new scale on scientific epistemological views appropriate for the Turkish culture. In this process, the sub-dimensions of epistemological views included in the scales which are commonly used in Turkey, were incorporated under a single structure. For the development of the scale, two pilot applications and one main application were undertaken, and the data from the main application was used to examine the epistemological views of prospective teachers enrolled in primary education departments. A pool of items was created based on the items included in the measurement tools developed by the above-mentioned authors. Seven field experts evaluated the content validity of the tool using the Davis technique, and the CVI of the scale items was calculated. Considering that the CVI values of 25 items in the item pool ranged from .86 to 1, it was decided to include all the items in the candidate scale.

The first pilot application was conducted with 136 participants and revealed that two items in the candidate scale were not appropriate, and reduced the validity and reliability values. In addition, in the interviews with eight randomly selected prospective teachers, it was found that the participants had difficulty understanding two more items and they considered that these items needed simplification. After the first pilot application, the researchers simplified the two items mentioned by the interviewed participants, and removed the other two items that had a statistically significant negative effect on the validity and reliability of the scale. The second pilot application was undertaken with 342 participants using the new version of the scale consisting of 23 items. The results of the normality analysis for the determination of whether the scale met the criteria for parametric tests showed that the scale had a normal distribution (Kolmogorov-Smirnov test $p = .096 > .05$, skewness 135, kurtosis .176).

The candidate SSEV was found to meet the criteria for factor analysis for construct validity [KMO value = .779 > 600, Bartlett's test chi-square 1422.50 and $p = .000$]. According to the scree plot obtained from the factor analysis, the candidate SSEV had a three-factor structure, and factor loadings ranged from .30 to .69. Nine items in the first factor accounted for 13.48% of the total variance, 10 items constituting the second factor accounted for 11.59% of the total variance, and four items constituting the last factor accounted for 9.66% of the total variance. As a result of the second pilot, it was found that Cronbach's alpha values of the candidate scale were .762 for the whole scale, .727 for the first factor, .661 for the second factor, and .605 for the last factor. The internal consistency coefficient measured for the whole scale was .70, indicating that it is a reliable measuring instrument and the internal consistency coefficients of the sub-dimensions were all above .50; thus, they did not seriously threaten the reliability of the scale. At the end of the second pilot application, the structure of the candidate scale, factor loadings of items, and their reliability were found to be sufficient to move on to the main application without any revision.

The main application was carried out with 930 participants, and the normality test indicated a normal distribution, which allowed parametric procedures (skewness 513, kurtosis .659). The candidate SSEV was also found suitable for factor analysis for construct validity [KMO value = .921 >600, Bartlett's test chi-square 7250.498 and $p = .000$]. The factor loadings of SSEV items varied between .310 and .588; thus, they were above the acceptable lower limit (> 30). The scree plot obtained from the factor analysis revealed a three-factor structure, in which the factor loadings varied between .501 and .755. After the main application, SSEV accounted for 48% of the total variance in epistemological views. Furthermore, the number of items in the first and second sub-dimensions and the percentages of variance they accounted for being close to each other (about 20% for each sub-dimension), which indicated that the scale had a balanced structure. The explanatory total variance of these two sub-dimensions corresponded to approximately 40% whereas the last sub-dimension consisting of four items had a contribution of only 8% to the total variance. In the definition of SSEV sub-dimensions, we took into consideration the measurement instruments developed by Elder (1999), Hofer and Pintrich (1997) and Schommer (1990), and named the three sub-dimensions as "authority and accuracy in scientific knowledge", "methodological approach and scientific attitude", and "nature of scientific knowledge". The items were analyzed for the construct validity of SSEV, and the mean scores of the upper and lower 27% groups showed that all the items significantly contributed to the scale ($p = .000$). In addition, the calculated item-total correlation coefficients were within the range of .215≤ r ≤ .598. Only four items remained below < .30 and all the other items were considered "good items", which meant that the majority of the items in the scale positively contributed to its reliability. The analysis of correlation between the sub-dimensions revealed that the sub-dimensions were statistically significantly related to the whole scale (r = .722, .893 and .388, respectively) (p = .000). In particular, the strong correlation of the first and second sub-dimensions with the scale suggested that the sub-dimensions were in high agreement with the scale. In addition, the ANOVA test performed to differentiate between the sub-dimensions provided statistically significant results (p = .000). Finally, the ω, r and α internal consistency coefficients of SSEV were calculated as .868, .838 and .861, respectively for the whole scale, .864, .839 and .866, respectively for the first sub-dimension, .860, .848 and .861, respectively for the second sub-dimension, and .591, .535 and .582, respectively for the last sub-dimension. The combined internal consistency coefficients confirmed that SSEV was a reliable measure.

One of the sub-problems of this research was to determine the epistemological views of prospective teachers. According to the results of analysis, the prospective teachers had more developed/mature scientific epistemological views in the sub-dimension of authority and accuracy in scientific knowledge than in other sub-dimensions. However, compared to other sub-dimensions of epistemological views, the prospective teachers had a more conservative approach towards the changing and developing nature of knowledge included in the sub-dimension of nature of scientific knowledge. This resistance to the change and development of knowledge observed in this research is similar to the previous reports on prospective teachers who had the belief that there is a single truth.

Recommendations

The scale developed in this research (SSEV) consists of 23 items and three sub-dimensions, and was shown to be a valid and reliable scale for determining the epistemological views of prospective teachers. However, considering that the epistemological views of individuals influence their attitudes and understanding concerning knowledge, learning and effort, this research needs to be repeated with other age groups. Furthermore, more emphasis should be placed on scale development than scale adaptation. As stated in the purpose of the research, scale adaptation has many drawbacks, such as the adapted content not matching the original scale and the insufficient construct validity of the adapted version. Therefore, for the epistemological scale development studies targeting adolescent or adult students in Turkey, it is far more beneficial to consider the items and sub-dimension of SSEV, rather than the scales developed for other cultures. The final point that will guide further research is that epistemological understanding is not a belief, but a view. We observed that some studies in the literature refer to epistemological beliefs, rather than epistemological views. However, the concept of belief contains dogmatic characteristics that do not fit with the nature of scientific knowledge. For this reason, it is considered to be more appropriate to use the word 'view' than 'belief'.

References

Aydın, S., Selçuk, G., Çakmak, A., & İlğan, A. (2017). Epistemolojik inançlar ölçeği Türkçe formunun geçerlik ve güvenirlik çalışması. *Bartın Üniversitesi Eğitim Fakültesi Dergisi*, *6*(3), 1166-1188.

Aypay, A. (2011). Epistemolojik inançlar ölçeğinin Türkiye uyarlaması ve öğretmen adaylarının epistemolojik inançlarının incelenmesi. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi*, *12*(1), 1-15.

Bendixen, L., & Hartley, K. (2003). Successful learning with hypermedia: The role of epistemological beliefs and metacognitive awareness. *Journal of Educational Computing Research, 28*(1), 15-30.

Biçer, B., Er, H., ve Özel, A. (2013). Öğretmen adaylarının epistemolojik inançları ve benimsedikleri eğitim felsefeleri arasındaki ilişki. *Eğitimde Kuram ve Uygulama*, *9*(3), 229-242.

Brownlee, J. (2003). Changes in primary school teachers' beliefs about knowing: A longitudinal study. *Asia Pacific Journal of Teacher Education, 31*(1), 87-98.

Buehl, M. M., & Alexander, P. A. (2001). Beliefs about academic knowledge. *Educational Psychological Review, 13*(4), 385-418.

Büyüköztürk, Ş. (2007). *Veri analizi el kitabı* (8.baskı). Ankara: PegemA Yayıncılık.

Büyüköztürk, Ş. (2002). Faktör analizi: Temel kavramlar ve ölçek geliştirmede kullanımı. *Kuram ve Uygulamada Eğitim Yönetimi, 32*, 470-483.

Cano, F., & Cardelle-Elawar, M. (2004). An integrated analysis of secondary school students' conceptions and beliefs about learning. *European Journal of Psychology of Education*, *19*(2), 167-187.

Chai, C. S., Khine, M. S., & Teo, T., (2006). Epistemological beliefs on teaching and learning: A survey among preservice teachers in Singapore. *Educational Media International*, *43*(4), 285- 298.

Chan, K. W., & Elliott, R. G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education, 20*(8), 817-831.

Chan, K. W., & Elliott, R. G. (2002). Exploratory study of Hong Kong teacher education students' epistemological beliefs: Cultural perspectives and implications on beliefs research. *Contemporary Educational Psychology, 27*(3), 392-414.

Conley, A. M., Pintrich, P. R., Vekiri, I., & Harrison, D. (2004). Changes in epistemological beliefs in elementary science students. *Contemporary Educational Psychology, 29*(2), 186-204.

Davis, L. L. (1992). Instrument review: Getting the most from a panel of experts. *Applied Nursing Research, 5,* 194-197.

Deryakulu, D., & Bıkmaz, F. H. (2003). The validity and reliability study of the scientific epistemological beliefs survey. *Journal of Educational Sciences & Practices, 2*(4), 244-257.

Deryakulu, D. & Büyüköztürk, Ş., (2005). Examining factorial structure of the Epistemological Beliefs Questionnaire: Comparison of epistemological beliefs with respect to gender and program. *Eğitim Araştırmaları Dergisi, 18*, 57-70.

Dinç, E., İnel, Y., & Üztemur, S. S. (2016). Epistemik İnanç Ölçeği: Türkçeye uyarlama, geçerlik ve güvenirlik çalışması. *Kırşehir Eğitim Fakültesi Dergisi*, *17*(3), 767-783.

Domino, G., & Domino, M. L. (2006). *Psychological testing: An introduction.* Cambridge: Cambridge University Press.

Elder, A. D. (2002). Characterizing fifth grade students' epistemological beliefs in science. In P. R. Pintrich (Ed.), Personal epistemology: The psychology of beliefs about knowledge and knowing (pp. 347–364). Mahwah, NJ, USA: Lawrence Erlbaum Associates.

Eroğlu S. E. ve Güven K. (2006). Üniversite öğrencilerinin epistemolojik inançlarının bazı değişkenler açısından incelenmesi. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 16,* 295-312.

Field, A. (2000). *Discovering statistic using SPSS for Windows*. London – Thousand Oaks– New Delhi: Sage Publications.

Güneş, G., Batı, K., & Katrancı, M. (2017). An examination of the epistemological views and learning styles of pre-service teachers. *The International Journal of Progressive Education, 13*(3), 112-128.

Gürol, A., Altunbaş, S. ve Karaarslan, N. (2010). Öğretmen adaylarının öz yeterlik inançları ve epistemolojik inançları üzerine bir çalışma. *E-Journal of New World Sciences Academy. Education Sciences, 5*(3), 1395-1404.

Hofer, B. K. (2017). Shaping the epistemology of teacher practice through reflection and reflexivity. *Educational Psychologist, 52*(4), 299-306. DOI: 10.1080/00461520.2017.1355247

Hofer, B. K. (2001). Personal epistemology research: Implications for learning and teaching. *Journal of Educational Psychology Review, 13*, 353–383.

Hofer B. K., & Pintrich, P. R. (2002). *Personal epistemology: The psychology of beliefs about knowledge and knowing.* Mahwah, NJ: Erlbaum.

Howitt, D., & Cramer, D. (2011). *Introduction to SPSS statistics in psychology: For version 19 and earlier (Fifth edition).* London: Pearson Education Limited.

Kerlinger, F. N. (1973). *Foundations of behavioral research.* (Second ed.) London: Holt, Rinehart and Winston.

Kienhues, D., Bromme, R., & Stahl, E. (2008). Changing epistemological beliefs: The unexpected impact of a short-term intervention. *British Journal of Educational Psychology, 78,* 545–565.

Kline, P. (1994). *An easy guide to factor analysis*. UK: Routledge.

Koç Erdamar, G., ve Bangir Alpan, G. (2011). Öğretmen adaylarının epistemolojik görüşleri. *E-Journal of New World Sciences Academy, 6*(4), 2689-2698.

Köse, S. ve Dinç, S. (2012). Fen ve teknoloji öğretmen adaylarının biyoloji özyeterlilik algıları ile epistemolojik inançları arasındaki ilişki. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *9*(18), 121-141.

Kuhn, D., R. Cheney, & M. Weinstock. (2000). The development of epistemological understanding. *Cognitive Development, 15*(3), 309–328.

Loewenthal, K. M. (2004). *An introduction to psychological tests and scales* (2 ed.). Hove, UK: Psychology Press.

McKillup, S. (2012). *Statistics explained: An introductory guide for life scientists (Second edition)*. United States: Cambridge University Press.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

Oğuz, A. (2008). Investigation of Turkish trainee teachers' epistemological beliefs. *Social Behavior and Personality, 36*(3), 709-720.

Önen, E. (2009). Ölçme değişmezliğinin yapısal eşitlik modelleme teknikleri ile incelenmesi. *Yayımlanmamış Doktora Tezi, Ankara: Ankara Üniversitesi, Eğitim Bilimleri Enstitüsü*.

Öngen, D. (2003). Epistemolojik inançlar ile problem çözme stratejileri arasındaki ilişkiler: Eğitim fakültesi öğrencileri üzerine bir çalışma. *Eğitim Araştırmaları Dergisi, 3*(13), 155-62.

Pajares, M. F. (1992). Teacher's beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*(3), 307–332.

Paulsen, M. B., & Wells, C. T. (1998). Domain differences in the epistemological beliefs of college students. *Research in Higher Education, 39*(4), 365-384.

Perry, W. G. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. New York: Holt, Rinehart & Winston.

Peterson, R. A., & Kim, Y. (2013). On the relationship between coefficient alpha and composite reliability. *Journal of Applied Psychology, 98*(1), 194-198.

Phan, H. P. (2008). Predicting change in epistemological beliefs, reflective thinking and learning styles: A longitudinal study. *British Journal of Educational Psychology, 78,* 75-93.

Pomeroy, D. (1993). Implications of teachers' beliefs about the nature of science: Comparison of the beliefs of scientists, secondary science teachers, and elementary teachers. *Science education*, *77*(3), 261-278.

Ravindran, B., Greene, B. A., & DeBacker, T. K. (2005). The role of achievement goals and epistemological beliefs in the prediction of pre-service teacher's cognitive engagement and application learning. *Journal of Educational Research, 98*(4), 222-233.

Rodriguez, L., & Cano, F. (2007). The learning approaches and epistemological beliefs of university students: A cross-sectional and longitudinal study. *Studies in Higher Education, 32*(5), 647-667.

Schmitt, N. (1996). Uses and abuses of coefficient alpha. *Psychological Assessment, 8*(4), 350-353.

Schommer, M. (1994). Synthesizing epistemological belief research: Tentative understandings and provocative confusions. *Educational Psychology Review*, *6*(4), 293-319.

Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology, 82,* 498–504.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (Fourth Edition). Boston: Ally and Bacon.

Taşdan Berksoy, A., & Güneş, G. (2017). Children's epistemological views according to their learning center preferences. *Education 3-13, International Journal of Primary, Elementary and Early Years Education,* 1-12. doi.org/10.1080/03004279.2017.1365094

Terzi, A. R., Şahan, H. H., Çelik, H. ve Zöğ, H. (2015). Öğretmen adaylarının epistemolojik inançları ile eleştirel pedagoji ilkeleri arasındaki ilişki. *Eğitim ve Öğretim Araştırmaları Dergisi, 4*(1), 344-356.

Tsai, C. C. (2001). A review and discussion of epistemological commitments, metacognition, and critical thinking with suggestions on their enhancement in internet-assisted chemistry classrooms. *Journal of Chemical Education, 78,* 970–974.

Urbina, S. (2004). *Essentials of psychological testing*. New Jersey: John Wiley & Sons. Inc.

Author Information

Gokhan Gunes
Hakkari University, Faculty of Education,
Department of Early Childhood Education
Turkey
Contact e-mail: *gokhangunes@hakkari.edu.tr*

Kaan Bati
Hacettepe University, Faculty of Education,
Department of Science Education
Turkey