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Menşure ALKIŞ KÜÇÜKAYDIN
Necmettin Erbakan University, Turkey

Yasin Gökbulut
Gaziosmanpaşa University, Turkey

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The Impact of a Research Methods Course on Teacher Candidates' Epistemological Beliefs

Menşure Alkış Küçükaydın
Necmettin Erbakan University
Yasin Gökbulut
Gaziosmanpasa University

Abstract: The epistemological beliefs of teachers impact both their in-class practices and the perceptions and beliefs of the students whose learning is the responsibility of teachers. Therefore, this study aims to investigate and discuss the impact of a course entitled "research methods" which is taught in education faculties in Turkey, on the epistemological beliefs of teacher candidates. The study adopted the mixed-methods sequential explanatory design. Forty-three teacher candidates participated in the study. The data for the study were collected through the "Scientific Epistemological Beliefs Scale (SEBs)", a semi-structured interview form, and another form that included the written opinions of teacher candidates. The findings revealed that the research methods taught to teacher candidates do not have a statistically significant impact on their epistemological beliefs. But the analysis of the semi-structured interviews with teacher candidates and their written comments revealed that the teacher candidates explained the nature of knowledge, its sources, and the way scientists work through the traditional understanding of science.

Introduction

For many years, studies have been conducted in the field of education on the development and implementation of teaching programs for teacher candidates and the evaluation of their effectiveness. These studies addressed issues such as teachers' attitudes, beliefs, knowledge, or teaching practices. Epistemological beliefs are an important cognitive variable affecting the teaching-learning process (Aypay, 2010). In general, the epistemological beliefs of teacher candidates are related to their approach to the information provided during their vocational training, the value they give to knowledge, or how they ignore it (Fives & Buehl, 2008). Epistemological beliefs are one of the variables that impact teachers' teaching approaches and understandings (Hofer, 2004). Schommer (1990) described epistemological belief as individuals' beliefs on what knowledge is and how learning takes place. In addition, Schommer (1994) defined personal epistemology as an interrelated system of five independent dimensions. These dimensions are structure of knowledge, certainty of knowledge, source of knowledge, control of knowledge acquisition, and speed of knowledge acquisition. Personal epistemological beliefs have a significant impact on cognitive and meta-cognitive processes, and these beliefs impact learning not only individually but also as a whole. In addition, epistemological beliefs

influence conceptions of teacher candidates on teaching and learning. These are mainly classified as traditional teaching and learning or constructivist teaching and learning (Cheng, Chan, Tang, & Cheng, 2009).

It is assumed that discussions on the source of knowledge are as old as the beginning of human existence. The controversies in this regard constitute the subject matter of epistemology of knowledge that deals with the validity of knowledge, the accuracy of resources, and how to access resources for accurate knowledge (Çoğaltay, 2016). For Pomeroy (1993), the epistemological beliefs of the individual are a representation of how knowledge is acquired, evaluated, shared, and its validity and reliability are ensured. This representation impacts the scientific beliefs of the individual from a positivist (traditional) and post-modern (non-traditional) perspective. Individuals with a traditional vision view science as presenting fixed truths that are universally objective, replicable, experimental, and based on controlling nature. Individuals with non-traditional views focus on the characteristics of science that are, by its nature, questionable (Pomeray, 1993; Tsai, 2000). At this point, teacher education designers, both in science and other teacher education programs, need to understand and monitor the extent to which current programs support the continuing development of teacher candidates and affect their beliefs (Keys & Bryan, 2001). Lederman (1992) indicated that scientific epistemological beliefs are important for students to understand science and interpret scientific knowledge. Therefore, studies in recent years focused on scientific rather than general epistemological beliefs (Pomeroy, 1993; Tsai, 1997; 2000). Wallace and Kang (2004) explored how teachers' beliefs impact research inquiry practices in science classes. Tsai (2002) looked at teachers' intertwined epistemologies (science learning, teaching, and science) and found that most teachers had traditional scientific beliefs. Chan and Elliot's (2004) study on teacher candidates showed that teacher candidates' beliefs about innate talent and absolute accuracy of knowledge are negatively correlated with the constructivist approach.

Tsai (1997) argued that scientific epistemological beliefs will influence individuals' learning situations and shape meta-cognitive learning. The scientific epistemological beliefs of the teachers impact both their in-class practices and the perceptions and beliefs of the students whose learning is the responsibility of teachers (Tsai, 2002). Although the correlations between general epistemological beliefs of teacher candidates and different components have been studied in the literature, the studies focusing on scientific epistemological beliefs of teacher candidates are limited. We found that the studies on the scientific epistemological beliefs in Turkey were limited in their scopes, usually addressing the students in primary school and high schools or teacher candidates. In the studies conducted in primary and high schools, the focus was on the relationship between scientific epistemological beliefs and the PISA success, science/technology literacy (Sadıç & Çam, 2015), learning styles (Güneş, 2014), beliefs (Yeşilyurt, 2013), academic achievement or intellectual risk-taking (Özbay, 2016). Bilecik and Bahçivan (2017) examined the correlation between the scientific epistemological beliefs of science teacher candidates and their knowledge of, and attitudes toward, the environment through a structural equation modeling, and Şahin-Taşkın (2012) studied scientific epistemological beliefs of classroom teacher candidates as a predictor of their approaches to learning. In addition, the relationship between scientific epistemological beliefs and gender, the field of study, academic achievement, learning styles, attitudes toward scientific research, learning/teaching approaches, and attitudes toward biotechnology applications were examined (Bıkmaz, 2017; Çamur, 2016; Demir, 2012; Karakuş ve Aydoğdu, 2014; Şahin- Kürşad, 2015; Terzi, 2005; Tümkaya, 2012). Among the studies conducted abroad on scientific epistemology,

Pomeroy's (1993) study examining the scientific epistemological beliefs of scientists, science teachers, and elementary school teachers is noteworthy. Findings from this study showed that the traditional understanding of science was most prevalent among scientists and the weakest among elementary school teachers. Pomeroy (1993) demonstrated that scientific epistemological beliefs have a vital role in the transition from the traditional understanding of science to the non-traditional understanding of the study. Conley, Pintrich, Vekiri, and Harrison (2004) developed a model on scientific epistemological beliefs at the elementary school level. This model comprises four dimensions: source, justification, development, and certainty of knowledge. The literature review further indicates that scientific epistemological beliefs are an effective factor in learning; therefore, there was a focus on their relationship with academic achievement (Conley et al., 2004; Tsai, 1997).

The current study aims to explore the effects of a course entitled "research methods," which is taught in education faculties in Turkey, on epistemological beliefs of teacher candidates. The research methods course was included in general knowledge courses by the Higher Education Council (HEC) in Turkey and started to be offered as a compulsory course in the undergraduate programs in education faculties as of 2007 (HEC, 2007). With this course, teacher candidates are expected to learn about science and basic concepts (fact, knowledge, absolute, true, false, universal knowledge, etc.), the structure of scientific research, scientific methods and different opinions about these methods, research problem, research model, population and sample, data collection and data collection methods (quantitative and qualitative data collection techniques), and data recording, analysis, interpretation, and reporting (HEC, 2018). Therefore, the effects of this course, which is offered in all undergraduate programs in education faculties, should be examined, not only on science teacher candidates but also on the teacher candidates in other programs. However, whereas the scope of studies on epistemological beliefs abroad was limited to in-service and teacher candidates of science, those in Turkey were limited to pre-school or classroom teacher candidates (Bilecik & Bahçivan, 2017; Çamur, 2016; Luft & Roehring, 2007). From this perspective, the main purpose of this study is to examine the impact of a research methods course, offered in different undergraduate programs in education faculties, on the scientific epistemological beliefs of teacher candidates in the Turkish Language Teaching, and Guidance and Psychological Counseling departments besides science teaching departments. Considering this objective, the research questions were as follows:

1. Is there a significant difference between the pre-and post-test scores of teacher candidates taking a research methods course on the "*Scientific Epistemological Beliefs Scale*" (SEBs) from different departments?
2. What are the opinions of the students who took research methods course about scientific epistemology regarding the dimensions of:
    a) the way scientists study;
    b) the sources and conclusiveness of scientific knowledge; and
    c) the steps of the research.

Method

General Background of Research

This study was adopted as a mixed-methods design, which entails collecting and analyzing quantitative and qualitative data within the scope of a research study (Creswell, 2014).

A mixed-methods sequential explanatory design was utilized in the study. The first step in a sequential explanatory design is the collection and analysis of quantitative data that primarily address the research question. Qualitative data collection and analysis follows this first stage. The researcher interprets how qualitative data can be utilized to explain the quantitative results in the first stage (Creswell & Clark, 2011). A one-group pre-test post-test experimental design was used for the quantitative measures. In this design, the effect of the experiment was tested on a single group. The pre- and post-test scores of the one group were tested for statistical significance in this design (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, & Demirel, 2011). The use of this design is helpful for researchers in forming a cause-effect relationship among dependent and independent variables in educational studies in which a new module is implemented and evaluated (Creswell, 2012). In this study, qualitative data were collected and analyzed to explain and get more in-depth information regarding the quantitative data. Therefore, this study adopted a qualitative case study design and collected data through interviews with teacher candidates and their written opinions. A case study design was preferred as the opinions of teacher candidates regarding scientific epistemology were explored by collecting data from multiple data sources in their natural settings (Yin, 1984).

Participants

The population of this study consisted of teacher candidates studying in undergraduate programs of education faculties in the 2018–2019 academic year. The sample comprised teacher candidates studying in the Department of Turkish Language Teaching and the Department of Guidance and Psychological Counseling in Ereğli Faculty of Education at Necmettin Erbakan University in the fall semester of the academic year 2018–2019. The research methods course was offered as a 2-hour course in the fall term of the second grade in these departments. The teacher candidates in the sample group attended the research methods course during a period of 14 weeks between September 2018 and January 2019. Forty-three teacher candidates participated in the study. All the participants were female teacher candidates. 21 participants in the sample were studying in the Guidance and Psychological Counseling program and 22 in the Turkish Language Teaching program. The qualitative dimension of the study adopted extreme case sampling, which is a type of purposive sampling. It is accepted that within this technique, the deviant cases and examples about the problem will provide the researcher with an opportunity to see the variability more clearly (Büyüköztürk et al., 2011). In this study, four students with the highest and four students with the lowest grades in the research methods course were identified, a semi-structured interview was conducted with eight students from both departments, and they were asked to share their opinions in writing. The real names of the teacher candidates in the interviews were not used in the text, and the participants had pseudonyms T_1, T_2, T_3, T_4 (teacher candidates in Turkish Language Teaching), and P_1, P_2, P_3, P_4 (teacher candidates in Guidance and Psychological Counseling). During the application, the aim of the study was mentioned to the teacher candidates and the voluntary principle was taken into consideration. Told that the data to be obtained from them would be used only for this study.

Instrument and Procedures

The data for this study were collected through the SEBs developed by Pomeroy (1993) and adapted into Turkish by Deryakulu and Bıkmaz (2003). The scale consisted of 5-point Likert-scale 30 items constituting a single factor. Twenty-two of the items in the scale had an affirmative sentence structure that reflected the traditional understanding of science, and eight had a negative sentence structure that represented the non-traditional understanding of science. High scores on the scale pointed to a traditional understanding of science whereas low scores signified a non-traditional understanding of science. The reliability coefficient of the scale was reported (Cronbach alfa) as .91 by Deryakulu and Bıkmaz (2003). In this study, the reliability coefficient of the scale was .71. Özdamar (1999) stated that a reliability coefficient at this rate is moderately reliable and can be used in educational studies. Other data collection tools used in the study were the semi-structured interview form and the written opinions of the teacher candidates. The semi-structured interview form consisted of nine questions prepared by the researches in line with the SEBs. After the interviews with the teacher candidates, the participants submitted a written form to the researchers reflecting their overall opinions about the course.

This study was conducted with the students attending the research methods course for 14 weeks in the fall term of the 2018–2019 academic year in Ereğli Faculty of Education at Necmettin Erbakan University. The research methods course was taught by the lead author in the Ereğli Faculty of Education at Necmettin Erbakan University. The researcher informed the teacher candidates about the study and administered the instrument as the pre-test at the beginning of the term. During the 14-week research methods course, teacher candidates covered a variety of topics determined by the HEC. The teacher candidates received information about the importance of scientific study in educational research as well as concepts related to scientific research within the course. In addition to these topics, they reviewed master's and Ph.D. theses, research reports, and proceedings and learned how to write a research proposal. Moreover, the teacher candidates were introduced to exemplary papers and poorly written research studies in their fields. The teacher candidates received the articles in their fields in groups and were asked to review them. At the end of the course, all teacher candidates wrote a research proposal clearly showing what they learned in class and submitted their proposals to the student responsible. In their proposals, they were asked to identify a research problem relevant to their field, state the research method to adopt for the given problem, and thus demonstrate how to conduct a research study in practice. Therefore, the research methods course, which is a theoretical course, was transformed into an applied course. At the end of the implementation, the teacher candidates received the same scale as the post-test. After the whole process, four teacher candidates with the highest grades and another four with the lowest grades in their classes on research methods course were interviewed for 30 minutes each. At the end of the interviews, the teacher candidates received a form to write their opinions about the course.

Data Analysis

The data were checked for normality and descriptive statistics values prior to statistical analysis. The result of the Kolmogorov–Smirnov test conducted a level of significance for this purpose was $p>.05$, which allowed the use of parametric tests for analysis in the study. Two-way ANOVA for mixed measures was used to determine if there was a significant difference between

teacher candidates' pre- and post-test scores on the SEBs. The interviews with teacher candidates were analyzed through content analysis. The content analysis includes stages such as coding raw data, identifying themes, organizing codes and themes, and describing and interpreting findings (Yıldırım & Şimşek, 2013).

Results

This section presents the data based on the sub-problems.

Two-way ANOVA for mixed measures was used to see whether there was a significant difference between the pre- and post-test scores of teacher candidates who had taken a research methods course on the SEBs after a 14-week implementation (Table 1). Considering that a higher overall score on the scale indicated a traditional/positivist understanding of science, the teacher candidates adopted a traditional/positivist understanding of science before and after the implementation ($F_{(1,40)}$=1.123, p>.01). However, the effect size calculated (Cohen's *d*, Hedge's *g*, η^2 or η_p^2, etc.) should be reported together with the *p* significance values and it is a priority of a good research report to report by comparing the effect sizes obtained from the current study with the previously obtained effect sizes (American Psychology Association, 2001). Therefore, η_p^2 effect size was calculated in this study. The η_p^2 value obtained from the calculation is .027. These values indicating the small effect sizes but also the necessity of a larger sample (Özsoy & G.Özsoy, 2013). Because of this situation, this finding was explored in detail within the qualitative dimension of the study. The qualitative dimension of the study investigated the students' opinions about scientific epistemology, the way scientists study, how scientific information is produced, the sources of scientific information, and the stages of scientific research.

Source	Sum of Squares	d*f*	Mean Square	F	*p*<
Between subject	1199.726	1			
Group	.000	1	.000	.001	.975
Error	4.142	40	.101		
Within Subject	.237	1			
Measure Time	.237	1	.237	1.829	.184
Measure Group*Measure	.146	1	.146	1.123	.296
Error	5.313	40	.130		
Total	1209.801	85			

*p<.01

Table 1: SEBS Pre-Test and Post-Test Results

Opinions of the Teacher Candidates on the Way Scientists Study

Having an Objective View

The teacher candidates who believed that scientists are objective and neutral thought that scientists' study had a universal value; therefore, the thoughts of a particular class, group, and their own selves could not interfere with their studies. The overwhelming majority of the teacher

candidates who favored this opinion were in the Department of Turkish Language Teaching. The teacher candidate T_1 said: *"The scientist's gender, beliefs, and political views do not influence his/her science. They do not embrace a specific class as they put forward universal facts. I believe scientists are completely objective."* Apart from these opinions, some teacher candidates argued that scientists cannot always be objective, but what science called for was an objective perspective. T_2 expressed this as follows:

> *I think scientists are influenced by all external factors. They must be very careful and comprehensive because their opinions may meddle with their work. The context may influence their opinions. However, if these opinions influence the scientist too much, they also influence the accuracy and reliability of the information. The desired way is that the scientist works on his/her own through experiments and observations without being influenced.*

T_3 approached this issue as follows:

> *For sure, everyone favors certain things in some cases no matter how fervently they disown racism [favoritism]. Even if one keeps himself away from it, or even if he does not talk to anyone about it, it amounts to favoring some over others. That is because this is impossible in [real] life. However, I do not think that this would be the case in science. That is, even if someone wants to favor others, it is not possible because scientific information embraces everyone in the world. It is not exclusive to, say, males or only Muslims. What I mean is that even if scientists want to, they cannot discriminate against others.*

Having a Subjective View

All of the teacher candidates who believed scientists had a subjective view in scientific studies were the students of the Department of Guidance and Psychological Counseling. The teacher candidates who favored this view believed that scientists cannot be objective in any way and that they had biased opinions. In this regard, the teacher candidates maintained that scientific studies are shaped by the society where the scientist lives, his/her gender, and feelings. On this, P_2 said, *"Scientists are certainly influenced by external factors because they are humans, too, and they have feelings and emotions".* Other relevant comments included *"The culture in which the scientist grew up and the administrative staff s/he worked with shape the opinions and actions of the scientist. Otherwise, the scientists become scared of being a scientist"* (P_1); *"Scientists are not objective; they are biased"* (P_4); and *"One's opinions inevitably influence his/her topic of study"* (P_3).

Studying Based on Experiments and Observations

The teacher candidates in both the departments- Turkish Language Teaching and Guidance and Psychological Counseling- believe that scientists mainly rely on experiments and observations in their studies. In particular, teacher Turkish Language candidates believed that in scientific studies, scientists could reach scientific information through observations. On this, T_4 said, "*I think conducting an experiment is not a requirement for scientific information because not all information requires experiments. Observations alone might be sufficient in some studies.*

In my opinion, scientific information must be based on observations". However, the teacher candidates also touched upon the process of proving scientific information. For example, T_2 said:

> *Scientists use reason, observations, and experiments to obtain scientific information. First, opinions are constructed in mind, and they approach this in a lot of ways; they judge them inside themselves. They explore the reasons and results, and later, they resort to experiments and observations, which is the challenging part. This a process that is pretty intensive and requires attention. In the end, the scientist attempts to prove with facts, thus producing scientific information.*

T_3 made a clearer statement by saying:

> "*The only way to obtain scientific information is through experiments. As the name suggests, scientific information cannot be 'scientific' without experiments. There must be a feature that distinguishes scientific information from others. In this case, it is experiments."*

The teacher candidates believed that scientists use experiments and observations in their studies for the sake of objectivity. On this, T_1 said the following:

> *Scientists attain scientific information through experiments and observations. This does not mean that they can carry out experiments and observations only in their own field of study. The scientist may decide to produce something when making an observation. Scientists are careful about always being objective and neutral in reaching scientific information. They choose their methods rationally and accurately.*

The teacher candidates believed that scientists usually used experiments as evidence for information. For example, P_1 said, "*Experiments are a must for a scientific study because they are used for proving something."* In a similar manner, P_2 said, *"I think scientific information and studies must be based on experiments. That's how one can prove it."* Another teacher candidate P_3 argued that scientists' study relies on observations and experiments, but they cannot be objective by saying *"I think scientific research should be supported by experiments. Observations can provide information about some topics included in scientific research. When making observations, the scientist may be biased".* Lastly, regarding the way scientists study, the teacher candidates thought that they work in cooperation. The teacher candidate who expressed this opinion was a student in the Department of Guidance and Psychological Counseling. P_2 said, *"Primarily, scientists essentially work in cooperation. That is why it is normal for them to be influenced by each other."*

Opinions of Teacher Candidates on the Provability and Sources of Scientific Information

This section presents the opinions of the teacher candidates on the provability and sources of scientific information.

Provability of Scientific Information

According to the teacher candidates, for information to be scientific, it must be proven and then accepted by everyone. The analysis of the statements of the teacher candidates in the

interviews and in their written forms revealed that the teacher candidates in both departments believed scientific information must be provable. Relevant excerpts included:

> *I think scientific information is proven information. Its accuracy is ensured. The information acquired is the general information that is proven, general, and accepted by everyone… It is safer to believe in proven, conclusive information than believing in questionable information* (T_4).
> *In my opinion, scientific information is information that is revealed by experts through various experiments and observations and will stay valid until further information is revealed. After scientific information is proven, they are accepted by everyone* (T_2).
> *That the information is accepted by everyone means it is scientific information* (T_4).
> *Scientific information is the information tested and proven by experts* (P_3).
> *I think scientific information is the information whose accuracy is proven through experiments and observations* (T_3).
> *Scientific information is the information that is tested, and whose accuracy is not disputable* (P_1).
> *Scientific information is a body of information whose accuracy is proven. We cannot talk about a subjective approach in producing scientific information. The type of science that deals with proven and logical cases are always an important element. It consists of evidence. That is, it is objective and certain* (T_1).

Sources of Scientific Information

The teacher candidates made different statements about the sources and the production of scientific information. The teacher candidates in the Department of Guidance and Psychological Counseling usually emphasized non-traditional sources of scientific information. For example, P_1 said, *"[To obtain] scientific information, [scientists] start with their intuitions, make measurements about the subject they are studying, and then present their claims after a comprehensive process of research and thinking".* The Turkish Language teacher candidates, on the other hand, usually referred to experiments and observations as the source of scientific information. For example, T_3 said, *"Scientific information can be reached through several experimental techniques"* and T_2 said, *"Scientific information is born out of thinking, which means its source is the mind. Next, experiments and observations are used to prove it. After all this, scientific information is obtained".* In addition, several Turkish Language teacher candidates stated that experiments or observations cannot always be used as the source of scientific information, but experiments are necessary for the reliability of the information. Relevant statements of the teacher candidates were as follows:

> *When there are experiments in a scientific study, I think it is more reliable and accurate. However, it is possible to carry out a scientific study without making experiments. I conducted a research study by carrying out a literature review in my article (as homework). Even though there were no certain definitions, I learned how to conduct a scientific research study. However, the science that includes experiments is more accurate* (T_1).

> *I think conducting an experiment is not a requirement for scientific information because not all information requires experiments. Observations alone might be sufficient in some studies. I think scientific information must be based on observations* (T_4).

Opinions of the Teacher Candidates on the Stages of the Research

The interviews with the teacher candidates and their written opinions indicated that there are two dimensions regarding the characteristics of the stages followed in the research. In this regard, some of the teacher candidates believed there are clear and explicit stages of conducting a research study whereas others mentioned original research stages are needed for a research study. These dimensions are explained below.

Existence of Clear Stages in the Research

Some of the teacher candidates argued that the rules and techniques scientists adopt in reaching information must be clear and that certain steps must be followed. In this regard, the teacher candidates who favored this view indicated the existence of certain stages to reach scientific information. For example, T_2 said, "*I think there must be a specific route followed in scientific research. One cannot do as he wishes because everything must conform to certain procedures. This route might start with the identification of the problem and continue with the collection of necessary data"*. Moreover, some teacher candidates mentioned the existence of scientific steps as a requirement for reaching clear-cut and certain truths. For example, P_3 said, "*If a study is to be based upon strong foundations, it must gradually follow scientific research methods,"* and T_1 said, "*There must be a certain route in scientific research because science is clear-cut and certain, and one cannot choose a random route; we follow the steps presented by science"*. Another teacher candidate T_3 made a clearer explanation regarding the clear-cut nature of scientific steps and said the following:

> *There must be a route to be followed in scientific research. Just like we go from infancy to childhood and to elderliness, and just like we cannot experience elderliness before childhood, there is an order in everything. Scientific research should develop step by step; there must be a technique, a route.*

Existence of Original Stages in the Research

Some of the teacher candidates participating in this study underscored that sometimes research requires originality by its nature; and therefore, one single route cannot be adopted by all:

> *It is wrong to adopt a single route in scientific research because looking at research from a broader perspective helps us finalize the research more easily and obtain more accurate results. Following one single route makes research deficient in many ways* (T_4).

The teacher candidates who favored originality over one single route in scientific research also referred to certain conditions. One of the teacher candidate P_1 argued that several problems might emerge if a certain route is not followed by saying, "*Scientists can have their unique*

techniques, but following a certain route both makes it possible to reach the truth and provides the world of science with a common scientific route program". In a similar manner, P_2 indicated that a single scientific research step could not be sufficient for the development of scientific creativity by stating, "*I think there might be a route in scientific research, and there might be a plan, but there should not be a compulsory order. If that is the case, even scientists cannot be creative. For this not to happen, and for opinions to be expressed comfortably…"*

The answers of the teacher candidates to the interview are summarized in Table 2.

Dimensions	**Teacher Candidate(s)**
Opinions of the teacher candidates on the way scientists study	
Having an objective view	T_1, T_4
Having an objective and subjective view	T_2
Having a subjective view	T_3, P_1, P_2,P_3,P_4
Studying based an experiments and observations	T_1,T_2,T_3,T_4 and P_1, P_2,P_3,P_4
Opinions of the teacher candidates on the provability and sources of scientific information	
Provability of scientific information	T_1,T_2,T_3,T_4 and P_1, P_2,P_3,P_4
Traditional sources of scientific information	T_1,T_2,T_3,T_4
Non-traditional sources of scientific information	P_1, P_2,P_3,P_4
Opinions of the teacher candidates on the stages of the research	
Existence of clear stages in scientific research	T_1,T_2,T_3
Existence of original stages in scientific research	T_4, P_1, P_2,P_3,P_4

Table 2: Summary of Qualitative Findings

Discussion, Conclusions and Implications

In this study where the effects of research methods course on scientific epistemological beliefs were investigated, it was seen that the findings obtained from the SEBs scale were not significant in terms of their effect levels. According to Schommer (1990), teacher candidates start university with immature epistemological beliefs, and changes are observed in their beliefs as they receive training. In a study investigating whether the scientific epistemological beliefs of primary school teacher candidates changed over the years, Bıkmaz (2017) found no significant difference regarding the beliefs of teacher candidates over a period of four years. In another study with primary school and pre-school teacher candidates, Çoğaltay (2016) found no difference between the scientific epistemological beliefs of teacher candidates before and after the research methods course and stated that the effect of the course on the epistemological beliefs of teacher candidates was insignificant. In their study with primary school teacher candidates, Karakuş and Aydoğdu (2014) showed that the research methods course was effective in transforming the scientific epistemological beliefs of teacher candidates into constructive beliefs, but the effect was not very strong. This finding is common in the relevant literature and implies that the research methods course is not sufficient in developing non-traditional scientific epistemological beliefs (Şahin- Kürşad, 2015; Şahin- Taşkın, 2012; Pomeroy,1993). In this study, the data were collected from both qualitative and quantitative instrument tools. In the qualitative part of the study, it was seen that there were some changes in scientific epistemological beliefs as a result of interviews with teacher candidates. This may be related to the low number of participants in the sample group or teacher candidates may have had the opportunity to better express their views during the interview. In other words, a research methods course offered to teacher candidates may have been sufficient to contribute to the development of

scientific epistemology, but the scale used may not have been achieved due to the small sample size.

The semi-structured interviews and their written opinions showed that regarding the way scientists study, the teacher candidates in the Department of Turkish Language Teaching believe scientists study in an objective manner. Furthermore, the teacher candidates in this department usually used expressions that reflected the traditional understanding of science in their responses to other questions. First, this can be explained by the different teaching programs (HEC, 2007) offered to teacher candidates. During their undergraduate studies, the teacher candidates in the Department of Guidance and Psychological Counseling undertook a three-hour course on the history of science every week to learn about the nature of science, scientific myths, the study of scientists, and the innovations in science overages. Therefore, their more informed approach to the way scientists study and the factors influencing their study might have affected their scientific epistemological beliefs. The responses of the teacher candidates in the Department of Guidance and Psychological Counseling in the interview reflected a smaller amount of traditional understanding compared with those in the Department of Turkish Language Teaching. Teacher candidates in the Department of Guidance and Psychological Counseling who are more interested in human behaviors and psychological factors, they may have thought that scientists are more impacted by human factors. According to Luft (2007), field-specific teaching programs offered to teacher candidates have an impact on beliefs. In fact, some programs enhance traditional beliefs whereas others promote non-traditional beliefs. However, Tsai (2002) asserted that teacher education programs need enrichment for the development of scientific beliefs and supporting teacher candidates in this regard.

The interviews with teacher candidates showed that the teacher candidates in both the departments -Turkish Language Teaching and Guidance and Psychological Counseling- believe that scientists mainly rely on experiments and observations in their studies. Whereas the teacher candidates in the Department of Guidance and Psychological Counseling indicated that scientists use their own ideas and intuition, the Turkish Language teacher candidates usually referred to experiments and observations as the source of scientific information. This means that the teacher candidates believed scientists tested their ideas through experiments. In a study with students in the 8^{th} grade, Tsai (1997) concluded that the students with a constructivist understanding respected the individual intuitions of scientists, but they argued that previous or current theories had an impact on their opinions. Luft (2007) defined beliefs as propositions that individuals believe to be correct and argued that beliefs might be without evidence as they are based on individual judgments and evaluations. The reason why the teacher candidates believed experiments and observations constituted the foundations of the work of scientists might be that they considered science to be composed of only natural sciences. That is, since during the 14-week research methods course, the teacher candidates engaged in a research study, conducted a review of literature after identifying a problem in their field of study, adopted a method, and presented a research proposal. However, they did not consider their studies to be a scientific practice. This might be explained by the fact that a traditional understanding of science is dominant in every teaching stage of the Turkish education system, and the students are expected to perceive quantitative information obtained only through experiments and observations to be accurate and reliable. In addition, the perception that the positivist paradigm, which is dominant in this education system, is the only valid way of producing scientific information that turns into a strict belief and is not affected by an undergraduate course (Çoğaltay, 2016). Indeed, Richardson (1996) mentioned that scientific epistemological beliefs cannot be transformed

quickly and easily. As Lederman (1992) proposed, the history and philosophy of science should have a greater part in scientific activities. Although it has content on how to carry out a research study, the results of this research may show that the research methods course fails to push teacher candidates out of the boundaries of their traditional understanding.

Regarding the nature of scientific information, the teacher candidates argued that scientific information must be provable. The teacher candidates with a traditional understanding of science did not mention the dynamic nature of scientific information; instead, they emphasized the accuracy and validity of the information. However, it was seen that there were also common answers between the departments, and these responses were related to non-traditional scientific beliefs. This may be related to the beliefs of teacher candidates from the past. Therefore, it may be said that belief change studies should be extended over a longer period of time. Tsai (1997) stated that epistemological beliefs are products of the formal education structure. Therefore, the teaching programs, course books, the epistemological beliefs of teachers, and the teaching strategies used in the classroom within this educational structure push individuals into traditional beliefs. The fact that the teacher candidates usually identified problems that required quantitative measures in their research proposals presented as a part of the course shows they wanted to be on the safe side.

In the interviews, as the last question, the teacher candidates were asked whether there were certain routes to follow in scientific research. Some of the teacher candidates believed there are clear and explicit stages of conducting a research study whereas others emphasized original research stages are needed for a research study. The perceptions of the teacher candidates that there must be a certain route for scientific research might be related to the course content. Within the course, the teacher candidates were asked to write a proposal including the sections of introduction, methods, findings, discussion and conclusion, and references, which might have led them to believe that all research studies should strictly follow these steps. In interviews with students, Luft (1997) asked how scientists presented their opinions and grouped the student responses as constructive opinions and experimental opinions. While students with experimental views mentioned certain procedures of scientific research, those with constructivist views stated each scientist adopts different techniques to test their opinions. Chan and Elliot (2004) found that undeveloped epistemological beliefs lead to rote learning whereas developed epistemological beliefs are effective on deep learning. According to Demir (2012), teachers have critical thinking skills and they need awareness about the dynamic and original nature of scientific knowledge in scientific epistemology to develop this skill. Therefore, as Chan and Elliot (2004) suggested, it is important deepening in epistemological beliefs.

First, the lack of a course on the history of science in the new undergraduate teacher education program (HEC, 2018) is a considerable deficiency. We propose that this topic should be covered within the scientific research methods course, and the weekly hours for this course should be increased. It should not be forgotten that teacher education programs should support teacher candidates in order to develop epistemological beliefs.

Sometimes teacher candidates may not be able to criticize their epistemological beliefs or they may reject related practices by not being aware of this situation. (Bıkmaz,2017). In this study, teacher candidates failure to change their traditional understanding during the research methods course. For this reason, teacher educators may need to provide new experiences that will create awareness for teacher candidates.

Moreover, a review of relevant literature indicated that the scientific epistemological beliefs of teachers in any field in Turkey are yet to be investigated. Considering this gap, the

beliefs of teachers teaching natural and social sciences could be explored extensively to determine the current state, and a model could be developed based on the results obtained.

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