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An Investigation of the Schommers' Epistemological Beliefs Model in Terms of Gender and Academic Success: A Meta-Analysis *

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Abstract

It was determined that epistemological beliefs showed a significant difference by gender in some studies conducted in Turkey using Schommers' Epistemological Beliefs Model while there was no significant difference in some other studies. Similarly, in some studies, epistemological beliefs showed a significant difference by academic success; however, some studies did not show a significant difference. For this reason, the aim of this research is to determine whether epistemological beliefs show a significant difference by gender and also to find out the relationship between epistemological beliefs and academic success through meta-analysis. Therefore, it is expected that this study will help overcome this conflict in the field. For this purpose, 37 studies that were carried out in Turkey between the years 2005-2017 and meet the criteria for inclusion were analyzed by meta-analysis method. 36 studies were included to determine whether epistemological beliefs differ significantly by gender and 7 studies were used to determine the relationship of epistemological beliefs to academic success. Cohen's *d* was employed as the effect size index to examine epistemological beliefs by gender and Pearson's *r* was used to reveal relationship of epistemological beliefs with the academic success. Subgroup analysis was performed to determine the relationship of the epistemological belief sub-factors with the academic success and also whether there was a significant difference according to gender. The effect sizes calculated for gender and success were combined according to the random effects model since the studies were collected from the literature. As a result of the combination, the overall effect size (d=-0.052) calculated for gender was "weak" in favor of men; however, it showed a significant effect (p<.05). This result indicates that men's epistemological belief total scores are higher than women; therefore, women's epistemological beliefs are more developed than men. It was found in subgroup analysis that women's beliefs that learning depends on effort and ability are more developed than men. The overall effect size calculated for success is positive and "low" (r=0.056); but not significant (p>.05). In subgroup

Keywords

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analysis, the effect size on the relationship between the epistemological beliefs and success was found not to be significant (p>.05). As a result of the heterogeneity test ($Q>\chi 2$, p<.05) to determine the presence and degree of the heterogeneity between the effect sizes calculated for gender and success, it was determined that there was a high level of heterogeneity. As a result of the categorical moderator analysis conducted to reveal the independent variables contributing to this heterogeneity, it was found out that the variables chosen for both gender (type of publication, study model, sample group, sampling method, type of scale) and success (type of publication, sampling method) were not significant (p>.05).

Introduction

Today, in the eclectic model and constructivist approach-based curriculum, the uniqueness of the individuals, in other words, their self is highlighted. The experiences of the students play an important role in creating their own self. For this reason, each individual has a different self-learning process and knowledge construct. Some of the knowledge given them in the process of acquiring knowledge can be out of date and change in a short period of time. Therefore, schools now aim to teach individuals how to access knowledge and how to use it as well as presenting the knowledge. In other words, it is expected that teachers should be the ones that make it easier for the students to access the current sources of knowledge, to question and acquire the knowledge. It can be said that this process is closely related to the epistemological beliefs of both students and teachers because these beliefs are associated with the source and structure of knowledge and the nature of learning. In addition, epistemological beliefs are important for acquiring knowledge not only in school but also in the life-long learning of the individual.

Epistemology is a philosophy that examines the sources, nature, authenticity and boundaries of knowledge, and investigates the problems related to knowledge (Türk Dil Kurumu [TDK], 2018). However, the use of the concept of epistemology in education for about a quarter of a century has been supported by epistemological beliefs in order to deeply understand the individual epistemology and then the individuality. According to Labbas (2013), Perry's (1970) experimental study of Harvard College students' intellectual development has been accepted as a pioneering work in this field, and the pace in the field of individual epistemology begins with Schommer's (1990) study. When the literature in national and international scale is reviewed, it is seen that researchers use Schommer's studies, to a large extend, as base on the educational implications of the epistemological belief (Bahçıvan, 2015; Biçer, Er, & Özel, 2013; Borgerding, Deniz, & Anderson, 2017; Cantwell, Bourke, Scevak, Holbrook, & Budd, 2017; İlhan, Demir, & Aslan, 2013; Köse & Dinç, 2012; Madjar, Weinstock, & Kaplan, 2017; Pope & Mooney, 2016; Sadıç & Çam, 2015; Taşkın, 2012). According to Schommer (1994), epistemological beliefs are individuals' beliefs about the source, accuracy and structure of knowledge and speed and control of learning. These beliefs based on the nature of knowledge and learning appear in almost all phases of life of the individual. It is also known that these beliefs are effective in the processes of thinking, learning and decision-making of individuals, however, unfortunately, they are often ignored in educational processes. According to Schommer and Duell (2013), in general, epistemological beliefs are regarded as beliefs about the nature and acquisition of knowledge. Elliott and Chan (1998) also overlap epistemological beliefs with a new concept, describe epistemological beliefs as the nature of knowledge and beliefs about learning, and express that the epistemological beliefs of the teachers influence their lectures and teaching methods. Schommer (2002) pointed out expressions supporting this process, and emphasizing the importance of studying epistemological beliefs, suggests that these studies can guide teachers in designing appropriate teaching styles to students' way of thinking and also facilitate understanding the students and practising the different cognitive-affective theories.

According to Schommer (1994), epistemological beliefs consist of five beliefs, and the development of these beliefs in individuals is seen as a whole. These beliefs are: *(i) Source of knowledge:* From the belief that "knowledge is given by the wise man who knows everything" to the belief that "knowledge is solved / obtained in objective and subjective ways". *(ii) Certainty of knowledge:* From the belief that "knowledge is certain" to the belief that "knowledge is constantly evolving". *(iii) Organization of knowledge:* From the belief that "knowledge is divided into parts" to the belief that "knowledge is integrated and intertwined". *(iv) Control of learning:* From the belief that "learning ability is genetically pre-determined" to "learning ability is gained through experience". *(v) Speed of learning:* From the belief that "learning is fast or never occurs" to "learning is a gradual process".

Having the abovementioned epistemological beliefs can be said to be very important for individuals to understand the source of knowledge, to access knowledge, to organize knowledge, and to explain how they control learning speeds and learning processes. Today, considering the individuals' speed of learning and way of controlling learning have effect in all aspects of knowledge, it can be said that epistemological beliefs play an important role not only in access to knowledge but also in effective processing and use of knowledge. Due to the importance of having epistemological beliefs, Schommer (1990) developed a scale of 63 items about epistemological beliefs covering these five dimensions; however, within the scope of adaptation of the scale into the Turkish educational climate, the scale by Deryakulu and Büyüköztürk (2002, 2005) was composed of 35 items and three factors. These factors are the belief that the learning depends on the effort, the belief that the learning is of the ability, and the belief that there is a single truth. High scores on this scale show immature / undeveloped epistemological beliefs, while low scores indicate mature / developed epistemological beliefs (Schommer, 1990). In the literature, there are a couple of scales which are interpreted the same as Deryakulu and Büyüköztürk's (2002, 2005) but consisting of different sub-dimensions. These scales were developed by Karhan (2007) and Yılmaz-Tüzün and Topçu (2008) according to Schommer's (1990) epistemological beliefs scale.

Students with developed epistemological beliefs are more successful in using knowledge processing strategies, learning and monitoring the meta-cognitive teaching materials, showing academic success, exhibiting positive attitude towards the school, and creating deep, complex thoughts (Deryakulu & Büyüköztürk, 2005). Accordingly, having developed epistemological beliefs requires having the expected level of belief in each of the above belief systems and operating the epistemological beliefs during learning. Similarly, Schommer and Easter (2017) state that awareness of means of knowledge and cognitive flexibility contributes to cognitive processing of difficult and controversial topics. Learning and acquiring knowledge are tiring and difficult processes for learners; however, it can be thought that individuals who have discovered the ways of learning and have developed epistemological beliefs are more successful in learning and acquiring knowledge.

As expressed in the literature, epistemological beliefs are a feature associated with the affective (motivation) and cognitive (academic achievement) variables of learning (Aşut and Köksal, 2015; Ayaz, 2009). The relationship of this association with the learning domain and learner characteristics is an important research problem (Aşut & Köksal, 2015). In this context, the relation of epistemological beliefs to different variables has been subject to numerous national and international studies. The literature review reveals that epistemological beliefs were mostly related to academic achievement (Chen & Pajares, 2002; Dursun Sürmeli & Ünver, 2017; Kanadlı & Akbaş, 2015). It is also studied the relationship between the epistemological beliefs and learning-teaching approaches (Aypay, 2011), critical thinking skills (Başbay, 2013), educational beliefs (Bicer et al., 2013; Önen, 2011), studying strategies (Deryakulu, 2004), beliefs about problem solving (Hacıömeroğlu, 2011), self-regulated learning (Braten & Stromso, 2005), emotions (Trevors, Muis, Pekrun, Sinatra, & Muijselaar, 2017), conceptual learning (Getahun, Saroyan, & Aulls, 2016), technological dimensions processes (internet use, preferring digital games, etc.) (Chiu, Liang, & Tsai, 2016). Moreover, there have been many studies investigating whether epistemological beliefs differ significantly by gender (Akgün & Gülmez, 2015; Biçer et al., 2013; Köse & Dinç, 2012).

When the studies on the epistemological beliefs are examined regarding their characteristics, they seem to be article (Belet & Güven, 2011; Dursun Sürmeli & Ünver, 2017), thesis (Aksan, 2006; Yılmaz, 2014) and paper (Demirli, Türel, & Özmen, 2010; Sevgi & Armağan, 2017) in terms of the type of publication. The articles and theses can be said to pass through a better review process. It is revealed that descriptive (Alemdağ, 2015; Topkaya, 2015) and relational (Sapancı, 2012; Yılmaz, 2014) types of research are most preferred in these studies. In descriptive studies, whether the general epistemological belief levels of the participants differ significantly by gender and class level (Demirel, 2014; Tümkaya, 2012) were investigated. On the other hand, in relational studies, the relationship of epistemological beliefs with academic success, learning approach and skills was examined (Başbay, 2013; Önen, 2011; Sapancı, 2012). In respect of the sample group, it is seen that most of the studies are conducted with university students and teacher candidates (Oğuz, 2008; Önen, 2011) while few studies were conducted with teachers (Akyıldız, 2014; Yılmaz, 2014). Considering the sampling method, it is seen that non-probability sampling is mostly preferred (Deniz, 2014; Güngör & Yenel,, 2017; Gürkan, Özgün, & Kahraman, 2017) while several studies employed probability sampling (Akyıldız, 2014; Eren, 2006; Yılmaz, 2014). Studies using probability sampling methods can be said to be more advantageous in terms of generalization than the studies using non-probability sampling methods. The results can be generalized to the universe in probability sampling methods; whereas, it can only be generalized to volunteering participants in non-probability sampling methods since the universe parameters cannot be predicted (Erkuş, 2013). Therefore, in this meta-analysis study, the type of publication, the research model, the sample group, the sampling method and the type of scale were taken as potential moderators due to the likelihood of affecting the results obtained in the primary studies. In this meta-analysis study, the epistemological belief has been investigated in terms of the variables of gender, which is most examined in descriptive studies, and academic success, which is most researched in relational studies.

Gender

Gender is an important and common variable in research problems in almost all areas of social sciences. Gender is a demographic category determined based on an individual's biological sex (Dökmen, 2010, p.20). Özyurt (2014, p. 328) state that there are many researches that the behaviours, interests and attitudes of men and women show difference especially in learning processes and approaches. He presented the researches in the sub-categories of gender and motor development, gender and mental ability, gender and mathematics, gender and verbal skills, gender and scientific studies / motivation, gender and computer, gender and teaching methods, and gender and classroom behaviours. Deryakulu (2014, p.270) expresses that the main factors that influence the development of epistemological beliefs of individuals may be mental development, age, family structure, education and culture, but it has not been strongly proven that the formation of epistemological beliefs is influenced by the gender and field of learning. As a matter of fact, when the results of the studies examining the epistemological beliefs by gender in the literature, it was found that the epistemological beliefs showed a significant difference in favour of women (Kaleci, 2012; Kösemen, 2012; Şahin Taşkın, 2012) while there was no significant difference in some other studies (Akgün & Gülmez, 2015; Arslantaş, 2016; Gülev, 2015). Therefore, there occurs a disagreement in the literature about how the epistemological beliefs differ according to gender. In consequence, coming up with a solution on this gender-related disagreement via a meta-analysis study is thought to contribute to the literature.

Academic Success

Academic success is defined as the level of achievement of students depending on their learning experiences in any discipline (Kanadlı, 2016). Academic success can be a student's achievement in a course as well as a year-end academic average. In this respect, academic success is an important tool for teachers to monitor the progress of their students at the end of a program or instructional processes. It is known that academic success is also influenced by affective and social dimensions as well as cognitive processes and that emotions play an active role in learning (Nartgün & Çakır, 2014; Yakar & Duman, 2017). When the results of studies examining the relationship between epistemological belief and academic success are examined, it is not possible to find a significant relationship between epistemological beliefs and academic success in some studies (Akgün & Gülmez, 2015; Aşut, Özbay, Akkaya, & Ertekin, 2016), while there has been found a significant positive relationship in some others (Asut & Koksal, 2015; Oh, Chung, Han, Woo, & Kevin, 2016; Bendixen & Hartley, 2003). Therefore, it is seen that there is a disagreement in the literature on the relationship between epistemological beliefs and academic achievement. For this reason, studying whether the epistemological beliefs contribute increasing academic success by examining the relationship of epistemological beliefs with academic success with a meta-analysis study may be important in terms of providing more effective learning experiences.

Literature review shows that there is already a meta-analysis study on epistemological beliefs. This study conducted by Alpaslan, Yalvaç and Willison (2017) examined the relationship between epistemological beliefs and self-regulating learning. In this study, a low level but significant effect size was achieved between two variables. It was determined as a result of the moderator analysis that gender and culture are significant moderators. In addition to this study, there is a literature review conducted by Kaleci and Yazıcı (2012). It was found out as a result of this study that descriptive research types were most preferred and the basic independent variables were gender, class level and department.

In conclusion, different from Alpaslan et al. (2017), this meta-analysis study determined whether the epistemological beliefs differ significantly by gender and also the relationship between epistemological beliefs and academic success. By doing so, this study is thought to provide a suggestion for the disagreement on the relationship of epistemological beliefs with gender and academic success, and also to contribute to the studies to be later carried out in conceptual and methodological terms. In this study, the following questions were sought:

1. Do the epistemological beliefs show a significant difference by gender?
2. Do the effect sizes calculated for gender differ significantly according to the type of publication, research model, sample group, sampling method and type of scale?
3. What is the relationship between epistemological beliefs and academic success?

Do the effect sizes calculated for the relationship between epistemological beliefs and academic success show a significant difference according to the type of publication and the sampling method?

Method

In this study, the meta-analysis method was used to calculate the overall effect size in terms of various variables of the studies about epistemological beliefs. Meta-analysis is basically a kind of literature review method that draws the results of experimental studies together and allows them to be expressed as effect sizes (Card, 2012, p.7). However, the meta-analysis method can be used not only for experimental studies but also for calculating the effect size of relational studies (Rosenthal, 1991, p.5). The meta-analysis method covers the collection of research reports, the construction of the coding protocol, the coding of the features and quantitative findings of the studies according to this protocol, and the identification and description of the models in these findings using various statistical methods (Lipsey & Wilson, 2001, p. 1-2).

Literature Review Procedures

To achieve all the studies conducted in Turkey regarding epistemological beliefs, Google Scholar, Council of Higher Education Thesis Center, ULAKBIM, ERIC and EBSCO databases were searched. The process of scanning articles was performed between July 2017 and January 2018, and the complementary search, in March 2018. In order to find the studies conducted between 2005-2017, the keywords such as "epistemological beliefs", "epistemic beliefs", "epistemological beliefs and genders", "epistemological beliefs and academic success" were entered in Turkish and English. By examining the reference section of the studies related to the subject, it was examined whether there were any unattained studies. By contacting the authors of the theses of which access was restricted, the necessary data was obtained. In addition, the scanning process was carried out by two researchers who have studies in this area, and the studies were gathered by examining whether the studies reached by both researchers overlapped each other's. As a result of this scanning process, 346 studies conducted in Turkey regarding the epistemological beliefs were reached.

Inclusion and Exclusion Criteria for the Studies

In order for a research on epistemological beliefs to be included in this meta-analysis study, *(i)* it needs to be carried out between 2005 and 2017 in Turkey, *(ii)* it should employ a measurement tool appropriate to Schommer's (1990) epistemological beliefs model, and this scale is scored and interpreted likewise, *(iii)* it should examine whether epistemological beliefs show significant differences by gender or *(iv)* have significant relationship with the academic success, *(v)* it needs to report the quantitative data (number of samples, mean, standard deviation, t test and p-value) required to calculate effect sizes, and *(vi)* it needs to use parametric statistical methods. The studies that use models other than Schommer's (1990) epistemological belief model, examine the scientific epistemological beliefs, use measurement tools of which reliability and validity was not reported, and employ nonparametric tests were not included in this meta-analysis study.

Based on the above criteria, 346 studies were examined. When the studies examining scientific epistemological beliefs, using a model other than Schommer's (1990) epistemological belief model, and investigating the variables except for gender and academic success were excluded from the analysis as a result of the scanning, 56 studies remained. Some of these 56 studies were not included in meta-analysis since three of them did not have necessary data to calculate the effect size, twelve of them employed nonparametric tests, four of them used a scale scored differently, and one of them was restricted and permission was not received by the author. 36 studies for gender and seven studies for academic success were included in this meta-analysis study.

The flowchart for the inclusion process of studies is given in Figure 1.

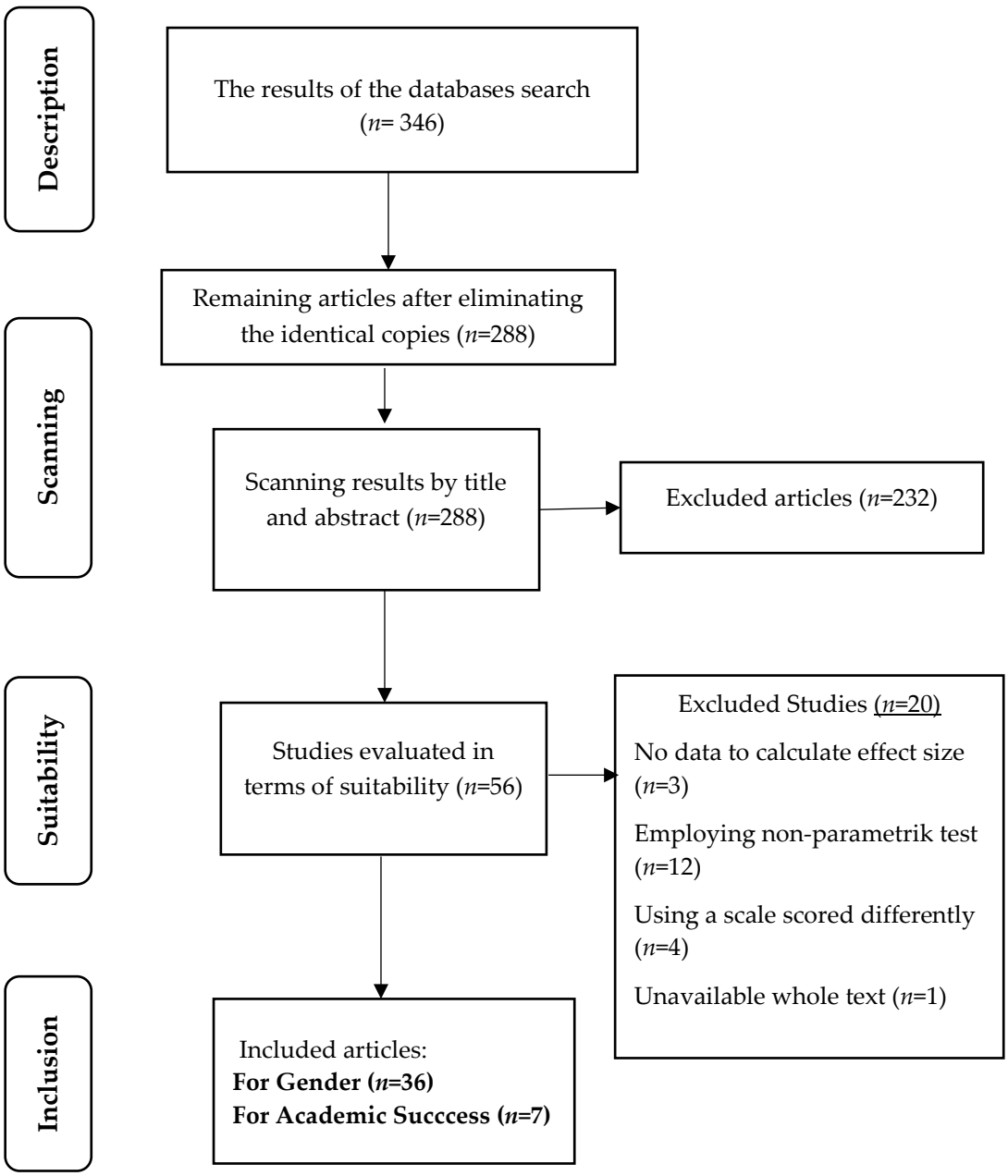

Figure 1. The Flowchart for the Inclusion Process

Coding of the Study Features

The studies included in this meta-analysis study were coded in four categories: *(i)* research report, *(ii)* research designs, *(iii)* measurement of variables, and *(iv)* necessary data for effect sizes.

(i) Research reports

In this category, the surnames of the authors of the study, the publication date of the study, and the publication type were coded. Type of study was classified as articles, theses and papers. The dissertations and papers transformed into articles were coded as articles. The variables examined in the studies were classified as gender and academic success.

(ii) Research designs

In this category, descriptive, relational and experimental design studies in which epistemological beliefs are examined by gender as well as relational studies examining the relation of epistemological beliefs to academic success were coded.

(iii) Measurement of variables

Measurement tools used in measuring epistemological beliefs and academic success were coded in this category.

Scales that were developed by Schommer (1990) and adapted to Turkish were used in measuring epistemological beliefs. It is seen through the literature review that the scales adapted by Deryakulu and Büyüköztürk (2002, 2005), Karhan (2007), Yılmaz-Tüzün and Topçu (2008), Aypay (2011) and Kaymak (2010) were used in measuring epistemological beliefs. Schommer (1990) noted that low scores on epistemological beliefs scale represent mature / developed epistemological beliefs, while high scores indicate immature / undeveloped epistemological beliefs. However, high scores on the scale adapted by Kaymak (2010) show developed / mature beliefs. Similarly, high scores on some sub-factors in the scale adapted by Aypay (2011) express developed / mature epistemological beliefs, while some sub-factors represent undeveloped / immature beliefs. Therefore, the effect sizes calculated for the sub-factors in these scales cannot be drawn together to achieve a significant overall effect size because they are interpreted differently in terms of development. For this reason, studies using these scales were not included in this meta-analysis study. Other scales are interpreted as expressed by Schommer (1990).

The first of these scales was adapted by Deryakulu and Büyüköztürk (2002, 2005) to Turkish for undergraduate students. This scale is composed of 35 items in 3 factors, which are “Belief that the learning depends on the effort, Belief that the learning depends on the ability”, and "Belief that there is a single truth". The second one was adapted by Karhan (2007) for teacher candidates. This scale consists of 38 items in 3 factors, which are “The expert is the source of knowledge and learning depends on ability”, “Learning does not depend on effort”, and “Knowledge is single and precise”. The third was adapted for teacher candidates by Yılmaz and Topçu (2008). This scale consists of 63 items and has a four-factor structure as "Fixed Ability", "Simple Knowledge", "Quick Learning" and "Definite Knowledge". The sub-dimensions of the scales were coded as the acronym of the sub-dimensions.

Academic success was measured using the academic success tests developed for any subject area and the year-end average of the students at any teaching level. When coding about academic success, the students' academic success at the end of the year was coded as the overall success while academic success in any field was coded as the academic success in that field.

(iv) Necessary data for effect sizes

Mean, standard deviation, and sample sizes for men and women were coded in research reports to determine whether epistemological beliefs differ significantly by gender. The t test result and sample size were coded in the research reports that do not provide this information. In the research reports giving the results of F test, first the result of t test was obtained by taking the square root of the result of F test and then coding was done. Pearson Correlation Coefficients between variables were coded in research reports to determine the relationship of epistemological belief with academic success.

(v) Dâhil edilen çalışmaların betimsel özellikleri

The sample average of the studies included in this study is 350. 49 (minimum 58, maximum 608) and the total sample size is 14221 participants. 7715 (54.3%) of this sample are female and 6506 (45.7%) are male. In addition, according to the coding form, 66.7% of the studies (*f*=24) are articles, 25% (*f*=9) are theses and 8.3% (*f*=3) are papers. Descriptive research model was used in 52.8% of these studies (*f*=19) and relational research model in 47.2% (*f*=17). 86.1% (*f*=31) of the individual studies were conducted with university students and 13.9% (*f*=5) with teachers. A scale adapted by Deryakulu and Büyüköztürk (2002, 2005) was used in 80.6% of the studies (*f*=29) while 11.1% (*f*=4) employed Karhan (2007) and 8.3% (*f*=3) used Yılmaz-Tüzün and Topçu (2008).

Coder reliability

According to Lipsey and Wilson (2001, p. 86), coding of 20 or more studies is recommended for prediction of a consistent reliability between coders. In order to determine the reliability of the coding, 20 studies included in the meta-analysis were randomly selected, and two coders were requested to code them along with the coding form. The coder reliability was calculated as 100% with the formula $\text{Compatibility Ratio} = \frac{\text{Number of Compatible Studies}}{\text{Total Number of Studies}}$ formula (Orwin & Vevea, 2009).

Data Analysis Strategies

Cohen's d was used as the effect size index to determine whether epistemological beliefs differ significantly by gender. Cohen's *d* expresses the difference between the two group averages in terms of the general standard deviation and is more appropriate for larger samples than 20 (Cooper, 2010, p. 163-168). Since the sample size of the primary studies included in this meta-analysis was greater than 20, Cohen's *d* was preferred. Cohen's *d* is interpreted as "weak" between 0-0.20, "low" between 0.21-0.50, "medium" 0.51-1.0, "strong" if greater than 1.0 (Cohen, Manion, & Morrison, 2007, pp.521). In this study, the positive (+) effect sizes refer to 'in favour of women', and the negative (-) effect sizes mean 'in favour of men'.

The Pearson correlation coefficient (*r*) was used to determine the relationship between epistemological beliefs and academic achievement. However, since the *r*-index, which can be a value between ± 1, shows a non-normal distribution with values greater than ± 0.25 and values close to ± 1, calculation of effect sizes is recommended by converting *r* indexes to related Fisher's *Z* scores (Cooper, 2010, p.173). For this reason, effect size of each study was first found by calculating Fisher's *Z* scores, and then this value was transformed into *r* index and interpreted. This index is interpreted as "low" if the value of *r* varies around 0.1, "medium" if *r* varies around 0.3, and "large" if *r* varies more than 0.5 (Cohen, 1988, p.79-80).

Epistemological belief scales are composed of different sub-dimensions. In some studies, the results were reported on the total score of the scale whereas, in some studies, the results were reported according to the sub-dimensions of the scales. For this reason, there are independent subgroups in the majority of studies included in this study. Two methods are used when determining the analysis unit in such cases (Borenstein, Hedges, Higgins, & Rothstein, 2013): *(i)* If the data for each independent subgroup in a study is collected from different samples, subgroups are selected as the analysis unit. *(ii)* If the data for each independent group is collected from the same sample, the study is selected as the analysis unit. In this meta-analysis study, since data on subgroups were collected from the same samples, studies were selected as analysis units. In this case, the effect size of the study is calculated by drawing together the effect sizes of the subgroups in each study.

In the meta-analysis method, after calculating the effect size of individual studies, the effect size is calculated by drawing these effect sizes together according to the model of fixed or random effects model. Borenstein et al. (2013) suggested to be used the random effects model if individual studies are obtained from the literature. Therefore, in this study, the overall effect size was combined according to the random effects model; however, heterogeneity test was conducted to determine the presence and degree of heterogeneity between studies. The significance of *Q* statistics calculated in this test ($p<.05$) shows that the studies are heterogeneous. On the other hand, the *Q* statistic does not indicate the level of heterogeneity (Card, 2012). The I^2 index is used for this purpose. The I^2 index is interpreted as "low" by 25%, "medium" by 50% and "high" by 75% (Higgins, Thompson, Deeks, & Altman, 2003).

Subgroups analysis was performed to determine whether the overall effect size calculated for gender showed significant difference in the sub-dimensions of the scales. However, in order to be able to determine this, all scales need to have the same sub-dimensions. For this reason, the most used scale in the studies included in meta-analysis was chosen to achieve this. This scale was adapted by Deryakulu and Büyüköztürk (2002, 2005) and consists of the sub-dimensions of "Belief that the learning depends on the effort", "Belief that the learning depends on the ability" and "Belief that there is a single truth". Similarly, the sub-dimensions of the same scale were used to determine whether the overall effect

size calculated for the relationship of epistemological beliefs with academic success differed significantly from the sub-factors.

The funnel diagram, Duval and Tweedie's trim and fill and Egger's regression intercept were used to determine if there was a bias and whether this bias had an effect on the results in the studies included in meta-analysis. Meta-analysis was done using Office programs, Comprehensive Meta-Analysis [CMA 2.0] software and R metafor (Viechtbauer, 2017) package.

Results

Findings related to gender variable

The effect sizes calculated to determine whether epistemological beliefs differ significantly by gender, common effect size according to random effect model, lower and upper limits in %95 confidence intervals (CI) and the *p*-values of *Z* test are given in Figure 2.

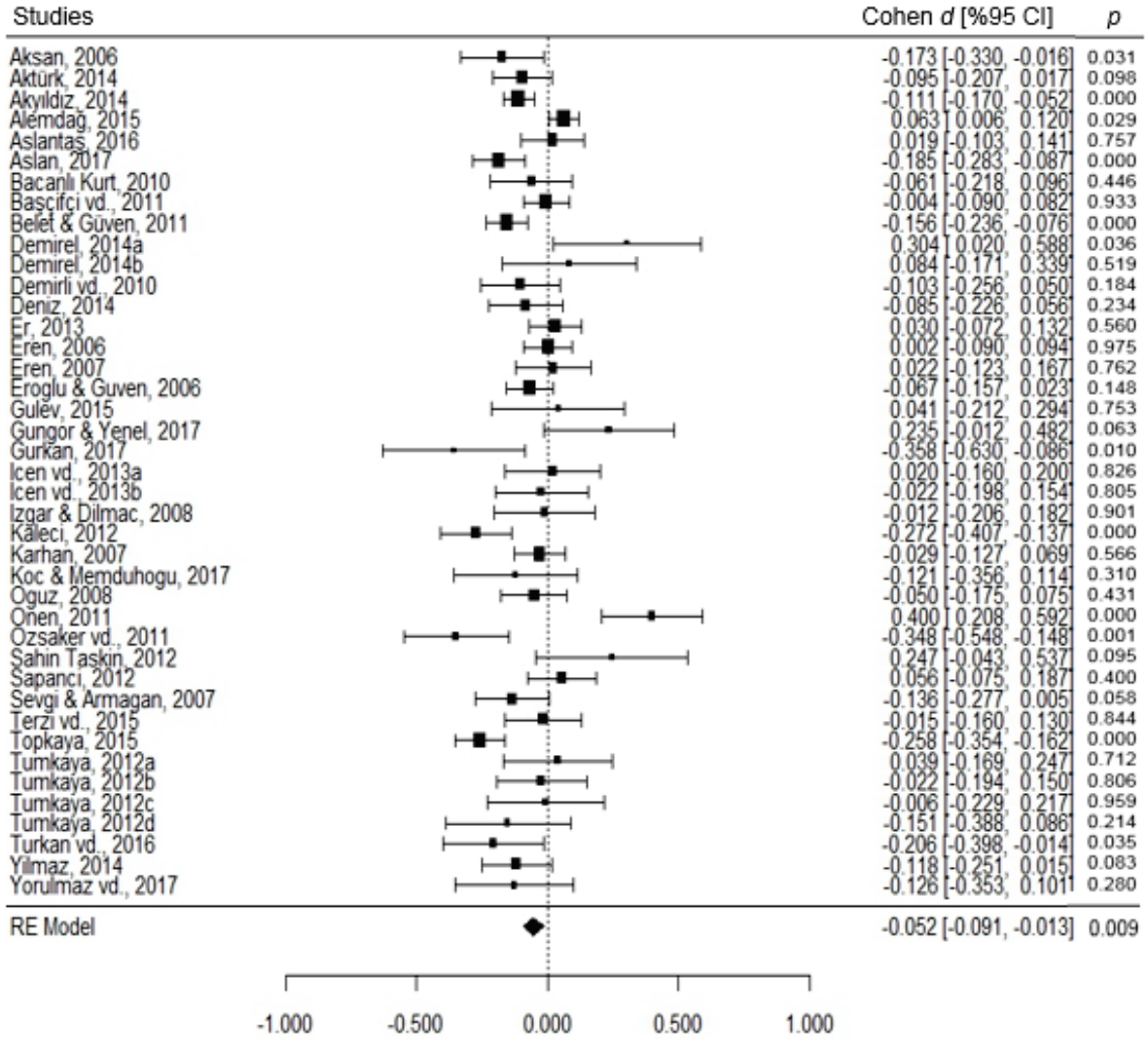

Figure 2. The Forest Plot of the Included Studies

As shown in Figure 2, 36 studies included in meta-analysis yielded 41 effect sizes. 31.7% (*f=13)* of the calculated effect sizes are in favour of the women and 68.3% *(f=28)* in favour of the men. While 29.3% *(f=12)* of effect sizes are significant at 0.05 confidence level, 70.7% *(f=29)* are not significant. Of the effect sizes calculated according to accepted effect size classification in this study, 78.1% (*f=33*) are in "weak" range and 21.9% *(f=9)* are in the "small" range.

It can be seen in Figure 2, the overall effect size (Cohen's *d*) was calculated as -0.052 (-0.091, -0.013) when 41 effect sizes were combined according to the random effects model. According to the classification of Cohen et al. (2007), the effect size was found to be "weak"; but, it is a significant effect size (p<.05). This value is negative indicating it is in favor of men. Accordingly, men's epistemological belief average can be alleged to be higher than of women.

Subgroup analysis for gender variable

Subgroup analysis was performed to determine whether the calculated overall effect size showed a significant difference according to the sub-factors of the epistemological belief (belief that learning depends on effort, belief that learning depends on ability and belief that there is a single truth). In this analysis, 10 studies with different sub-factors were excluded from the analysis. Subgroup analysis results are given in Table 1.

Table 1. Subgroup Analysis Result

Sub-group name	*k*	Cohen *d*	95% Confidence Interval			Heterogeneity		
			Lower Lim.	Upper Lim.	*Z(p)*	Q_b	*df*	*p*
Sub-groups	87	-0.087	-0.138	-0.036	0.001	3.189	2	0.203
Effort-Dependent Belief	29	-0.112	-0.203	-0.022	0.015			
Ability-Dependent Belief	29	-0.193	-0.345	-0.040	0.013			
Single Truth Belief	29	-0.052	-0.119	0.016	0.132			

As seen in Table 1, the *Qb* value was found insignificant (p>.05) suggesting that there is no significant difference in the overall effect size calculated between epistemological belief sub-factors. However, when each sub-factor was examined, it was found that the belief that the learning depends on effort (d = -0.112) and ability (d = -0.193) was favourable for men (p<.05) while the belief that there is a single truth (d = -0.052) was found insignificant (p>.05).

Heterogeneity test and moderator analysis for gender variable

The heterogeneity test was done to find out the presence and degree of the heterogeneity between the calculated effect sizes. The heterogeneity test result is given in Table 2.

Table 2. Heterogeneity Test Result for Gender

Model	*k*	Cohen *d*	Std. Error	95% CI		Heterogeneity			
				Lower Limit	Upper Limit	*Q*	*df*	*p*	I^2
Random Effect	41	-0.055	0.020	-0.091	-0.013	135.000	40	0.000	70.37

As seen in Table 2, heterogeneity test is significant (p<.05). *Q* value is 137.084 with 40 degrees of freedom. The chi-square table has 40 degrees of freedom and the critical value at 0.05 level is about 55.758. Therefore, it can be said that the variance between the studies is not only due to sampling error, but also because of the characteristics of the studies since the *Q* value is greater than the critical value. I^2 index shows that the heterogeneity between studies is "high" with a value of 70%. It was decided at this point to perform categorical moderator analysis to specify the variables contributing to heterogeneity. In this analysis, the type of publication (thesis, article, paper), the research model (descriptive, relational), sample group (student, teacher) and type of scale [Deryakulu and Büyüköztürk (DB), Karhan (K), Yılmaz-Tüzün and Topçu (YTT) were used as categorical variables. The results of categorical moderator analysis are given in Table 3.

Table 3. Categorical Moderator Analysis Result

Categorical Moderators	*k*	Cohen *d*	95% CI		Heterogeneity			
			Lower Limit	Upper Limit	*Z(p)*	Q_b	*df*	*p*
Publication type	**41**	**-0.052**	**-0.091**	**-0.014**	**0.008**	**0.288**	**2**	**0.866**
Article	27	-0.056	-0.106	-0.005	0.030			
Thesis	11	-0.033	-0.115	0.048	0.424			
Paper	3	-0.063	-0.150	0.023	0.151			
Research Model	**41**	**-0.052**	**-0.092**	**-0.013**	**0.009**	**0.134**	**1**	**0.715**
Descriptive	23	-0.046	-0.098	0.006	0.082			
Relational	18	-0.061	-0.121	-0.001	0.046			
Scale type	**41**	**-0.065**	**-0.097**	**-0.033**	**0.000**	**0.947**	**2**	**0.623**
DB (2002, 2005)	32	-0.057	-0.104	-0.010	0.019			
K (2007)	5	-0.076	-0.121	-0.032	0.001			
YTT (2008)	4	0.009	-0.180	0.199	0.925			
Sample group	**41**	**-0.072**	**-0.105**	**-0.040**	**0.000**	**3.139**	**1**	**0.076**
Student	38	-0.047	-0.090	-0.004	0.031			
Teacher	3	-0.107	-0.157	-0.057	0.000			
Sampling Method	**41**	**-0.059**	**-0.088**	**-0.031**	**0.000**	**0.155**	**1**	**0.694**
Probability	11	-0.063	-0.097	-0.029	0.000			
Non-probability	30	-0.050	-0.104	0.003	0.066			

As a result of the categorical moderator analysis in Table 3, the type of publication, research model, type of scale and sample group categories are not significant moderators that contribute to heterogeneity (p>.05). When the effect sizes of subcategories are examined, the effect sizes are significant in favour of men in the article as the type of study, the relational model as research model, Deryakulu and Büyüköztürk (2002, 2005) and Karhan (2007) as type of scale, the students and teachers as sample group and probability method as the sampling method (p<.05).

Publication bias for gender variable

Firstly, the funnel plot was examined to determine whether the overall effect size calculated for gender was due to publication bias. When there is no bias, it is expected in this diagram that the studies will be distributed symmetrically around the overall effect size (Borenstein et al., 2013, p. 273).

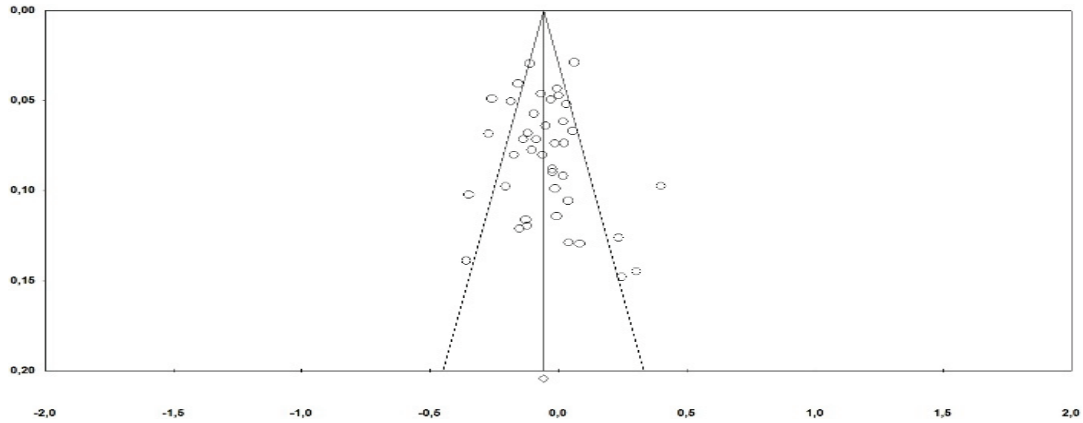

Figure 3. The Funnel Plot for Gender

Figure 3 shows that the effect sizes calculated for gender is distributed approximately asymmetrically around the overall effect size, which indicates that there may be publication bias for gender variable. The Duval and Tweedie's trim and fill method was used to determine whether this asymmetry causes publication bias. This method estimates what the effect size (corrected effect size) would be if the funnel diagram were exactly symmetrical.

Table 4. Duval ve Tweedie's Trim and Fill for Gender

Random Effect Model	Trimmed Studies	Cohen *d*	Lower Limit	Upper Limit	*Q* değeri
Observed Effect		-0.052	-0.091	-0.013	134.999
Corrected Effect	3	-0.070	-0.112	-0.029	169.200

As seen in Table 4, the observed effect size for the gender variable was -0.052 (-0.091, -0.013), while the corrected effect size was calculated as -0.070 (-0.112, -0.029). As there is an insignificant difference between observed and corrected effect sizes, it can be said that there is no publication bias.

However, because the interpretation of funnel plot is subjective (Borenstein et al., 2013, p. 273), Egger's regression intercept of the diagnostic tests was applied to determine the bias more precisely. Egger's intercept test is used to determine whether the asymmetry in the funnel diagram is significant. The calculated intercept value with this test is expected to be zero; however, if the value differs significantly from zero, it shows that there is bias (Card, 2012, p. 267).

Table 5. Egger's Intercept Test Result for Gender

Variable	Intercept (B_0)	Standart Error	Lower Limit	Upper Limit	*t*- value	*df*	*p*-value two-tailed
Gender	0.307	0.693	-1.094	1.709	0.443	39	0.660

As seen in Table 5, the value of the intercept (B_0) was calculated as 0.307 for gender. When the significance level of the intercept values is examined, it is seen that it is not significant at the 95% confidence level ($p > .05$). According to this, it can be said that there is no publication bias.

Findings related to academic success variable

The effect sizes (Fisher's *Z*) calculated for the relationship of epistemological belief with academic success and the *p*-values of *Z* test are given in Figure 4.

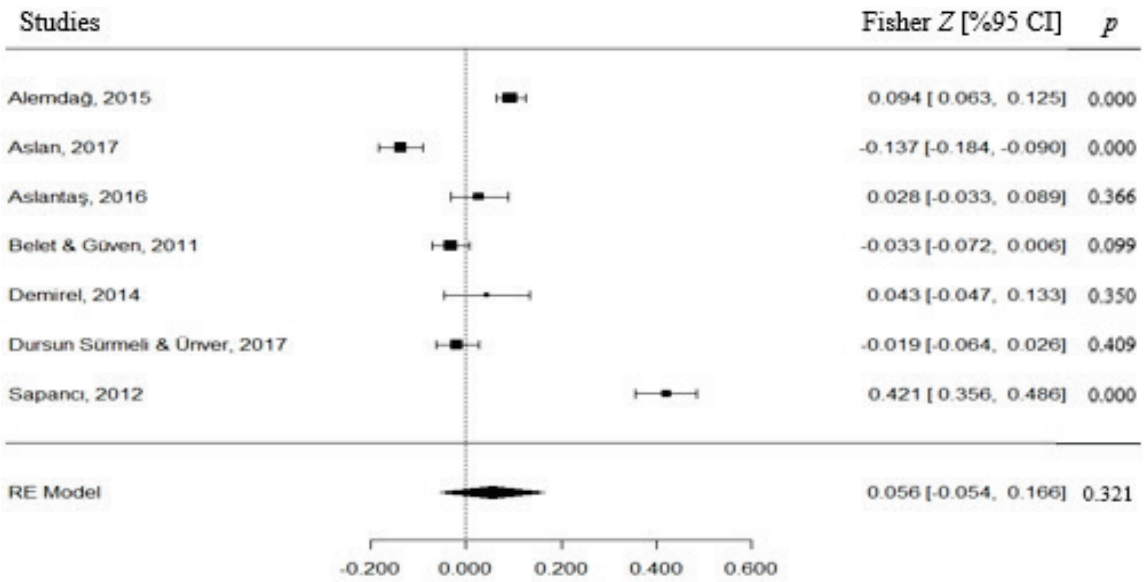

Figure 4. The Forest Plot of the Included Studies

As seen in Figure 4, 42.9% *(f=3)* of the calculated effect sizes are significant ($p > .05$) while 57.1% *(f=4)* are not significant ($p < .05$). When the *r* to *Z* table (Cooper, 2010, p. 174) is examined, the calculated Fisher's *Z* values were found to be approximately equal to Pearson's *r* values. According to this, when the effect sizes of the studies were evaluated in terms of the level of relationship, 85.7% *(f=6)* were low and 14.3% *(f=1)* was moderate.

Figure 4 shows that the overall effect size (Fisher's *Z*) was calculated as 0.056 (-0.054, 0.166) when the seven effect sizes were combined according to the random effects model. This value is 0.056 according to *r* to *Z* transformation and is not significant as seen in the table ($p>.05$). Accordingly, it can be concluded that there is no significant relationship between the students' total epistemological beliefs and academic success.

Subgroup analysis for academic success variable

A subgroup analysis was conducted to determine whether the calculated overall effect size was significantly different according to the sub-factors of epistemological belief (belief that the learning depends on the effort, belief that the learning depends on the ability, and belief that there is a single truth). One study with different sub-factors was excluded from the analysis. The results of the subgroup analysis are given in Table 6.

Table 6. Subgroup Analysis Results

Subgroup Name	*k*	Fisher *Z*	95% CI.			Heterogeneity		
			Lower Lim.	Upper Lim.	*Z(p)*	Q_b	*df*	*p*
Sub-factors (Total)	6	0.024	-0.024	0.073	0.329	0.942	2	0.625
Effort-Dependent Belief	6	0.084	-0.107	0.276	0.387			
Ability-Dependent Belief	6	0.067	-0.069	0.203	0.333			
Single Truth Belief	6	0.013	-0.042	0.067	0.650			

As seen in Table 6, the Q_b value was found insignificant ($p>.05$) suggesting that there is no significant difference in the overall effect size calculated between epistemological belief sub-factors. However, when relationship of each sub-factor with academic success is examined, it is seen theie relationship is not significant ($p>.05$). It can be said that academic success does not have a significant relationship with the belief that the learning depends on effort, that the learning depends on ability and that there is a single truth.

Heterogeneity test and moderator analysis for academic success variable

The heterogeneity test was done to find out the presence and degree of the heterogeneity between the effect sizes calculated for the relationship between epistemological belief and academic success. The heterogeneity test result is given in Table 7.

Table 7. Heterogeneity Test Result for Academic Success

Model	*k*	Fisher *Z*	Standard Error	95% Interval		Heterogenity			
				Lower Limit	Upper Limit	*Q*	*df*	*p*	I^2
Random Effect	7	0.056	0.056	-0.055	0.166	215.053	6	0.000	97.210

As seen in Table 7, heterogeneity test was significant ($p<.05$). The *Q* value is 215.053 with 6 degrees of freedom. The critical value at 6 degrees of freedom and 0.05 significance level in the Chi-square chart is about 12.592. Thus, since the *Q*-value is higher than the critical value, the studies can be said to be heterogeneous. The I^2 index with a value of 97.2% indicates that the heterogeneity between studies is "quite high". It was decided at this point to perform categorical moderator analysis to determine the variables that contribute to heterogeneity. Since the number of effect size was less than the gender variable, the studies could only be compared in terms of the type of publication (thesis, article) and sampling method (probability, non-probability).

Table 8. Categorical Moderator Analysis Results

Categorical Moderators	*k*	Fisher *Z*	95% CI			Heterogeneity		
			Lower Lim.	Upper Lim.	*Z(p)*	Q_b	*df*	*p*
Publication type	**7**	**0.085**	**0.051**	**0.0119**	**0.000**	**0.193**	**1**	**0.660**
Article	5	0.051	-0.106	0.207	0.525			
Thesis	2	0.087	0.052	0.122	0.000			
Sampling Method	**7**	**-0.019**	**-0.077**	**0.039**	**0.521**	**2.930**	**1**	**0.087**
Probability	2	0.256	-0.064	0.577	0.117			
Improbable	5	-0.028	-0.087	0.031	0.347			

Table 8 shows that, as a result of the categorical moderator analysis, the type of publication and sampling method are not significant moderators that contribute to heterogeneity (p>.05). Examining the effect sizes of subcategories, only the effect size calculated for the thesis in the type of publication gave a significant effect size which is in favor of men (p<.05).

Publication bias for academic success

Firstly, the funnel plot was examined to determine whether the overall effect size calculated for academic success was due to publication bias.

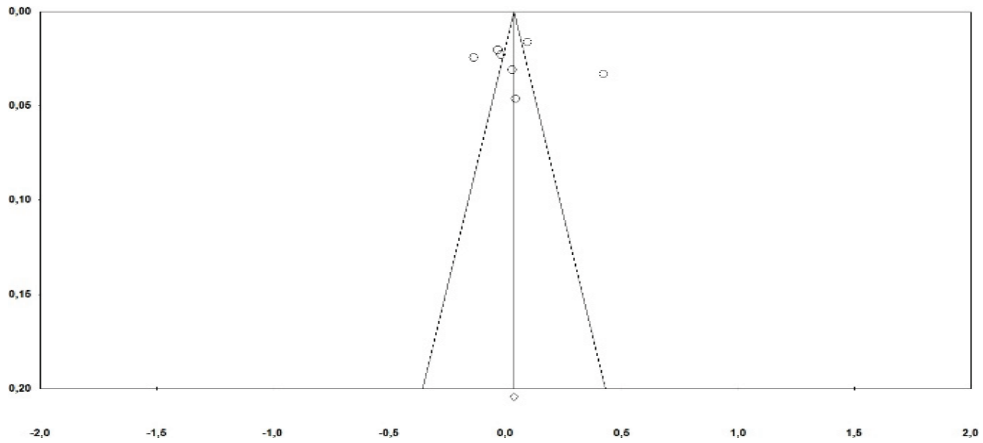

Figure 5. Funnel Plot for Academic Success

Figure 5 shows that the effect sizes calculated for academic success are distributed asymmetrically around the overall effect size, which indicates that there may be publication bias for success variable. The Duval and Tweedie's trim and fill method was used to determine whether this asymmetry causes publication bias.

Table 9. Duval and Tweedie's Trim and Fill for Academic Sucess

Random effect model	Trimmed Studies	Fisher *Z*	Lower limit	Upper limit	*Q* value
Observed effect		0.056	-0.054	0.166	218.922
Corrected effect	0	0.056	-0.054	0.166	218.922

As seen in Tablo 9, the observed and corrected effect sizes for the academic success variab was calculated as 0.056 (-0.054, 0.160). As there is no difference between observed and corrected effect sizes, it can be said that there is no publication bias. Finally, Egger's intercept test of the diagnostic tests was applied to determine the bias more precisely.

Table 10. Egger's Intercept Test Results for Academic Success

Variables	Intercept (B_0)	Standard Error	Lower Limit	Upper Limit	*t*- value	*df*	*p*-two tailed
Academic Success	3.554	8.282	-17.735	24.844	0.429	5	0.686

As seen in Table 10, the value of the intercept (B_0) was calculated as 3.554 for academic success. When the significance levels of the intercept value is examined, it is seen that it is not significant at the 95% confidence level (p> .05). According to this, it can be said that there is no publication bias.

Discussion and Conclusion

In this meta-analysis study to determine whether the epistemological beliefs showed a significant difference according to gender, and to overcome the conflict in the field, 36 studies that met the inclusion criteria brought out 41 effect sizes. After combining the effect sizes according to the random effects model, the lower limit of the overall effect size was calculated as -0.091 and the upper limit was -0.013 and -0.052. Since there is no "0" effect size between the upper and lower limits, the Z test examining the hypothesis that "effect size is zero" was found significant (p<.05). Negative effect size stands for favouring men. These results show that the total scores of men on the epistemological belief scale are higher than those of women. However, according to Schommer (1990), high scores on the scale express immature/undeveloped epistemological beliefs, while low scores show mature/developed epistemological beliefs. It can be said that the epistemological beliefs of women are more developed/matured than men since the overall effect size is significant although it is low. Though there is not a meta-analysis study to be compared with this finding, the results obtained in a meta-analysis study conducted by Alpaslan et al. (2017) to determine the relationship between epistemological beliefs and self-regulating learning contradicts this finding. Alpaslan et al. (2017) found that the relationship between epistemological belief and self-regulated learning showed a significant difference in favour of men. According to them, the reason for this is that women prevent themselves from self-regulating as they are more likely to obey social rules in the social environment than men. The women who have been prevented from self-regulating may hinder the development of their epistemological beliefs. However, it was determined in this meta-analysis study that women's epistemological beliefs are more developed than men.

A subgroup analysis was conducted to determine which of the sub-dimensions (belief that the learning depends on effort and ability, and that there is single truth) caused this difference in terms of gender and whether the overall effect size differed significantly according to the sub-factors. In order to be able to perform subgroup analysis, the studies involved in the meta-analysis must be conducted through the same scale. For this reason, the studies (29 studies) of which data were collected with the scale developed by Deryakulu and Büyüköztürk (2002, 2005) were included meta-analysis. As a result of the subgroup analysis, there is no significant difference between subgroups in terms of effect sizes (Q_b<χ^2; p>.05). When the subgroups were examined individually among themselves, it was found that the belief that the learning depends on effort (d=-0.112) and ability (d=-0.193) was significant for men (p<.05); whereas, the belief that there is single truth did not show any significant difference according to gender (p>.05). It can be said according to this result that the beliefs of the women that learning depends on effort and ability are more developed/mature than the men. The findings obtained in the studies by Akyıldız (2014), Gürkan et al. (2017), Oğuz (2008) and Özşaker, Canpolat, and Yıldız (2011) support this result. Deryakulu (2014), on the other hand, came to the conclusion that this finding could be attributed to the fact that women's achievements in the social structure depend more on their efforts while men's achievements are more associated with their abilities. It is also stated that women might believe more strongly that the learning could take place over time, depending on the effort, and that learning ability is something that could be improved. It can be interpreted that the society's view of men and women as well as what men and women attributed to the learning may be influential in the development of epistemological beliefs of individuals.

Heterogeneity test was performed to determine the presence and degree of heterogeneity among the effect sizes calculated for gender. It was found that the heterogeneity test was significant (Q>χ2; p<.05) and there is a high level heterogeneity between the studies (I^2=70.37). This result shows that the variance is not only due to sampling error but also to the characteristics of the studies. At this stage, it should be determined which characteristics of the studies contribute to this variance. For this purpose, categorical moderator analysis was performed to determine whether the type of publication

(article, thesis, paper), research model (descriptive, relational), sample group (student, teacher), sampling method (probability, non-probability) and the type of scale (Deryakulu & Büyüköztürk, Karhan, Yılmaz-Tüzün & Topçu) were a significant moderator. As a result of this analysis, it was determined that these moderators were not significant (p>.05). It can be said with regard to these results that the chosen moderators do not contribute to the difference between the effect sizes calculated for gender variable (women, men).

In order to determine the relationship between epistemological beliefs and academic success, the effect sizes of seven studies were calculated. Three of the studies gave a significant effect size while four did not. When the effect sizes are combined according to the random effects model, the lower limit of the overall effect size is calcuated -0.055 and the upper limit as 0.166 and 0.056. However, Z test result shows that this effect size is not significant (p>.05). This finding is supported by the results of the study by Akgün and Gülmez (2015). Similarly, in a study by Barnard, Lan, Crooks and Paton (2008), they could not find a significant relationship between the students' epistemological beliefs and their academic success. According to them, epistemological beliefs are an important mediator in making the relationship between students' academic success and self-regulated learning skills significant.

A subgroup analysis was conducted to determine whether this effect size, which was calculated between epistemological beliefs and academic success, differs significantly according to the sub-factors. For this purpose, the scale adapted by Deryakulu and Büyüköztürk (2002, 2005) was employed again. It was determined as a result of the subgroup analysis that the effect size was not significantly different (Q>χ^2; p<.05) according to the sub-factors. Similarly, when the relationship of each sub-factor to academic success is examined, these relations are not significant (p>.05). It can be said that academic success has no significant relationship with the belief that the learning depends on effort and ability, and that there is only one truth. The findings of the primary studies by Dursun Sürmeli and Ünver (2017) and by Belet and Güven (2011) support this result. Similarly, it is stated in the study by Rastegara, Jahromib, Haghighic, and Akbaria (2010) that epistemological beliefs would have an indirect effect on students' academic performance in mathematics. According to these results, it can be suggested that epistemological beliefs are not directly related to the academic success of the students but it can indirectly contribute to the increase of academic success.

The heterogeneity test was conducted to determine the presence and degree of the heterogeneity between the effect sizes calculated for academic success. It was concluded as a result of the test that the effect size of the studies was not only due to sampling error (Q>χ^2; p<.05) and that there was a very high heterogeneity between the studies (I^2=97.2). At this stage, categorical moderator analysis was performed to specify the moderators that contributed to the variance between the studies. However, due to the low number of studies, it was only investigated whether the type of publication and sampling method contributed to the variance. As a result of the analysis, it was determined that the type of publication and sampling method were not a significant moderator. It can be said, with regard to this result, that the type of publication and sampling method do not make a significant difference between the effect sizes calculated for the relationship of epistemological belief with academic success.

As a result, it can be said that this meta-analysis study, even if not strongly, have resolved the conflict, arising in individual studies of national literature, whether epistemological beliefs show a significant difference by gender. It was determined according to this that total epistemological belief scores showed a significant difference according to gender and that the women's belief that learning depends on effort and ability was more developed than men's. Similarly, it was found in this study that students' epistemological belief total scores and sub-factor scores are not significantly related to academic success. Accordingly, even if the students have the belief that the learning depends on effort rather than ability and that the truth is not constant but changing, it was found that this is not associated with only academic success.

Suggestions and Limitations

As a result of this research, the following suggestions, along with some limitations, can be made: *(i)* Epistemological beliefs were found to show a significant difference in favour of men according to gender. However, the calculated effect size is very small according to Cohen's classification. This seems to be a limitation in making generalizations. For this reason, the inclusion of both the national and international primary studies in the subsequent meta-analysis study may lead to stronger results. *(ii)* Since the men's epistemological beliefs are less developed than women, training can be made to improve their epistemological beliefs. For this purpose, both the subjects about the nature of science can be taught in secondary and high school education programs and the courses such as history of science and philosophy of science in teacher education programs may contribute to the development of epistemological beliefs of men and women. *(iii)* To determine the relationship of epistemological beliefs to academic success, seven studies that met inclusion criteria were included in this meta-analysis study. The low number of studies constitutes a limitation on the generalizability of the obtained effect size. Therefore, more primary studies that examine the relationship of epistemological beliefs to academic success are needed. *(iv)* It was determined in this study that epistemological beliefs have no significant relationship with academic success. Based on this result, it is not true that "epistemological beliefs do not affect academic success". Primary studies prepared with experimental designs are needed in order to obtain a result based on the causal relationship. For this reason, it is recommended that researchers working on this area should examine the effect of a training program designed to develop epistemological beliefs on academic success.

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