Science Education International
34(4), 283-292
https://doi.org/10.33828/sei.v34.i4.4

ORIGINAL ARTICLE

The Role of Subjective Task Value and Prior Achievement in the Relationship between Personal Epistemology and Science Self-efficacy Beliefs: A Moderated Mediation Analysis

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ABSTRACT

The purpose of this study is to test the relationship between seventh-grade students' personal epistemology for science, subjective task value, and science self-efficacy, with prior achievement serving as a moderator. The mediating role of subjective task value is proposed in the prediction of the relationship between personal epistemology for science and science self-efficacy. To achieve this aim, a model that explains the relationships among the specified variables is proposed, and then this model is tested using moderated mediation techniques, controlling for the effects of gender and parental educational background variables. The study sample comprises 312 seventh-grade students, determined through stratified random sampling. The analyses confirm the mediating effect of subjective task value and reveal the moderator effect of prior achievement on the prediction of personal epistemology for science and science self-efficacy. Finally, the results of the study are compared with existing research in the field, and recommendations are provided to researchers and practitioners in science education based on these findings.

KEY WORDS: Personal epistemology for science; prior achievement; science self-efficacy; subjective task value

INTRODUCTION

The vision and the main goal of science education involves educating all individuals as scientifically literate (National Research Council [NRC], 1996, 2012). However, having scientific knowledge alone is insufficient for individuals to become scientifically literate. They also need to possess the necessary motivation and beliefs to apply this knowledge to their everyday lives (Fives et al., 2014; NRC, 1996; Organisation for Economic Co-operation and Development [OECD], 2007). There are several motivation models related to student learning. One of them is the expectancy-value theory, which provides a framework for examining motivation components (Eccles and Wigfield, 2002). Self-efficacy, corresponding to the expectancy component of this theory, is a variable frequently addressed in the science education literature. Self-efficacy is defined as beliefs regarding one's capabilities to organize and execute actions necessary to attain desired outcomes (Bandura, 1997). Self-efficacy beliefs influence individuals' choices, efforts, perseverance, and academic achievement (Britner and Pajares, 2001; Bryan et al., 2011).

Another component of the expectancy-value theory is subjective task value, which represents the value students attribute to while engaging in any scientific activity. Students who perceive science learning as valuable show increased participation in learning tasks and hold favorable judgments about the outcomes of these tasks (Sungur, 2007). Research has demonstrated that subjective task value influences students' academic achievement (Bøe, 2012; Chai et al., 2021; Eccles and Wigfield, 2002) and conceptual understanding (Jones et al., 2015; Johnson and Sinatro, 2013; Yerdelen and Sungur, 2020). Considering the theory, it is expected that a scientifically literate individual values science and feels competent in engaging in scientific activities. In addition, a scientifically literate individual is expected to have a belief that knowledge in science develops and subject to change (*personal epistemology for science*) (Fives et al., 2014).

Personal epistemology refers to individuals' beliefs about knowledge and knowing in a specific domain (Hofer and Pintrich, 1997). These beliefs are related to the nature of knowledge (what knowledge is) and the nature of knowing (how individuals know) (Hofer, 2000). The development of thinking about knowledge and knowing is a prominent research topic in science education (Lin and Tsai, 2017). In fact, a meta-analysis conducted by Greene et al. (2018) revealed that students with more sophisticated epistemological beliefs outperformed those with naive epistemological beliefs.

In the literature, numerous studies have been conducted regarding the components of scientific literacy, namely self-efficacy, subjective task value, and personal epistemological beliefs. The research has demonstrated that students' motivations and epistemological beliefs regarding science influence the learning process (Greene et al., 2018). However, reviewing previous research indicates gaps in the related literature in terms of sample characteristics, evidence, and methodology (Miles, 2017). Specifically, there is a scarcity of comprehensive studies that systematically examine the interrelationships among these variables at the middle school level (Chai et al., 2021; Guo et al., 2022). Investigations undertaken at the middle school level concerning the variables comprising elements of scientific literacy are noteworthy and merit further inquiry. Indeed, additional studies at this educational level have the potential to act as a catalyst for the development and implementation of programs specifically designed to foster scientific literacy in younger learners. Moreover, although previous studies in the relevant literature predominantly suggest a positive relationship between students' motivations and their epistemological beliefs in science (Chai et al., 2021; Guo et al., 2022), there are also studies revealing a negative relationship (Ricco et al., 2010). This disparity necessitates a reexamination of the relationship among the mentioned variables in different contexts. In addition, methodological gaps are apparent in the relevant literature. In studies addressing achievement and the relationship between the specified variables, achievement is often treated as the dependent variable (Chai et al., 2021; Guo et al., 2022). Considering the importance of understanding and interpreting the changes in the relationship among these variables across different levels of prior achievement, this research focuses on investigating these relationships with prior achievement as a moderator for students. In fact, examining how prior achievement moderates the relationship among self-efficacy, subjective task value, and personal epistemological belief variables has yet to be conducted.

LİTERATÜRE REVİEW AND THEORETİCAL FRAMEWORK

Expectancy-Value Theory of Motivation

In the literature on achievement motivation, two fundamental questions that explain students' performance can be found: "Can I do this task?" and "Do I want to do this task, and why?" (Eccles and Wigfield, 2002; Guo et al., 2022). The first question is related to self-efficacy beliefs, which are included in the expectancy-value theory. As a psychological construct, self-efficacy is examined under the framework of Social Cognitive Theory (Cakiroglu et al., 2012). Albert Bandura (1994, p. 71) defines this concept as "a person's judgment about their capabilities to organize and execute courses of action required to attain designated types of performances." In this context, individuals' self-efficacy beliefs regarding their performance significantly influence their efforts to accomplish a task, their ability to overcome challenging situations, their degree of concern when facing difficulty, and their choices (Bandura, 1986; Jacobs, 2005). Bandura claims that self-efficacy beliefs are the most potent predictors of motivation and performance. Individuals' beliefs about their abilities determine how they will utilize their knowledge and skills (Bandura, 1986). Therefore, the impact of self-efficacy on student behaviors is frequently addressed among educational researchers. Recent studies have provided extensive evidence of a strong relationship between academic achievement and self-efficacy (Marsh et al., 2019).

In Bandura's theory, since self-efficacy beliefs are considered context-specific and the definitions of self-efficacy have been expanded to cover specific subject areas (Bandura, 1997). In science education, science self-efficacy is defined as "students' beliefs in their ability to succeed in science classes or activities" (Britner and Pajares, 2006, p. 486). Studies have shown that students with higher science self-efficacy tend to be more attentive in science classes, participate more in experiments, complete their assignments regularly, and demonstrate more incredible patience when faced with challenging tasks. On the other hand, students with low self-efficacy tend to avoid participating in challenging activities or invest less effort in tasks (Britner and Pajares, 2006; Lee et al., 2016). Furthermore, it has been reported that high science self-efficacy is a significant predictor of students' science achievement (Guo et al., 2022; Jansen et al., 2015; Mason et al., 2013; Pamuk et al., 2017; Valentine et al., 2004).

The answer to the question "Do I want to do this task, and why?" reflects students' beliefs about having value or reasons to engage in a particular task (Guo et al., 2022). This structure, called subjective task value (Eccles and Wigfield, 2002), represents students' beliefs about the importance and interestingness of the task (Sungur, 2007). Eccles et al. (1983) identified four components of subjective task value: Intrinsic value, attainment value or importance, utility value or usefulness, and cost. Intrinsic value is similar to intrinsic motivation (Ryan and Deci, 2017) and refers to the pleasure students experience while performing a task. Attainment value represents the importance of performing well. Utility value, similar to instrumental motivation (Chai et al., 2021), is associated with the usefulness of a given task for plans. Cost refers to the trade-off involved in task engagement compared to other activities (Pintrich and Schunk, 2002). In the relevant literature, it has been shown that students with high intrinsic value in science are more engaged in science-related activities (Lin and Schunn, 2016), and consequently, this affects students' science achievement (Burns et al., 2019; Chai et al., 2021). Utility value is not only related to science achievement but also a predictor for career choices (Chai et al., 2021; Canning et al., 2018). Therefore, subjective task value is considered as the driving force behind learning, course selection, and career choices (Yumusak et al., 2007; Wang et al., 2019). An individual can be intrinsically and instrumentally motivated (Hidi and Harackiewicz, 2000). In this study, the intrinsic value and utility value components of subjective task value were used.

Personal Epistemological Belief

Epistemology, one of the main branches of philosophy, deals with the nature, characteristics, and evaluation of knowledge

(Hofer and Pintrich, 1997). In this context, individuals' views on the nature of knowledge and knowing are expressed as personal epistemological beliefs (Hofer and Pintrich, 2002). According to Hofer's (2000) perspective on epistemological theories, personal epistemological beliefs are addressed in two dimensions: beliefs about the nature of knowledge and beliefs about the nature of knowing. Beliefs about the nature of knowledge are defined along two continua: certainty (knowledge is certain, knowledge is tentative) and simplicity (knowledge consists of separate units, knowledge is integrated and complex). Beliefs about knowing are defined in terms of the source of knowledge (authority or constructed by individuals external to the self) and beliefs about the justification of knowledge.

Epistemological beliefs, which significantly impact cognitive and metacognitive processes, affect learning as a whole rather than as a unidirectional way (Aypay, 2010). Schommer states that epistemological beliefs fall on a spectrum ranging from naive to sophisticated (Muis, 2004). According to Schommer (1990), if an individual holds naïve epistemological belief, they believe that knowledge is certain, composed of isolated pieces, transmitted by authority, learning is rapid, and learning ability is fixed and innate. On the other hand, a person with contrasting beliefs is considered to have sophisticated beliefs.

Epistemic beliefs are greatly influenced by how individuals interact with and perceive the knowledge they encounter (Cartiff et al., 2021; Sinatra et al., 2014). In addition, epistemological beliefs directly or indirectly affect nearly all aspects and scopes of human learning behavior (Günes et al., 2017; Pajares, 1992). Meta-analytic and review studies in the literature generally demonstrate that epistemological beliefs affect academic achievement (Greene et al., 2018) and, specifically science achievement (Guo et al., 2022). Studies also show that epistemological beliefs are associated with achievement motivation (Muis et al., 2015; Pintrich, 2002; Oschatz, 2015).

Although the initial studies regarding epistemological beliefs characterized them as a domain-general structure independent of context (King and Kitchener, 1994), Hofer and Pintrich (1997) and many other researchers (Kuhn, 2000; Muis et al., 2006) argued that epistemic beliefs could be considered as context-sensitive. The domain-specific structure of epistemological beliefs is supported by existing research (Hofer, 2000; Muis et al., 2006). Therefore, this study focuses on students' epistemological beliefs in science.

Relations among Self-Efficacy, Subjective Task Value, and Personal Epistemological Beliefs

Epistemological beliefs, which are considered to be an important personal factor that influences students' self-efficacy, are one of the key variables in predicting students' science achievement. Epistemological beliefs, which are stated to be a significant factor in terms of knowledge interpretation, learning, and teaching processes, are positively related to student's academic achievements (Guo et al., 2022; Kampa et al., 2016) as well as their self-efficacy beliefs (Alpaslan, 2017, 2019; Kizilgunes et al., 2009; Muis, 2007; Tsai et al., 2011; Winberg et al., 2019). In a study conducted by Guo et al. (2022) using the PISA 2015 database from 72 countries/regions, the researchers examined how scientific epistemological beliefs in terms of the development and justification of knowledge in science were associated with students' science motivation and achievement. The study revealed that students who held beliefs that knowledge could change and stems from experimentation had higher self-efficacy, and utility value, particularly intrinsic value, in science. Furthermore, it was demonstrated that epistemological beliefs were more strongly associated with science achievement than motivational structures. A similar study by Chai et al. (2021) focused on four countries located in the West and the East (Canada, Finland, Singapore, and Hong Kong) and explored the influence of cultural differences on the relationships among these variables. The researchers found that epistemological beliefs, motivational variables, and their relationships varied depending on the cultural context. Kizilgünes et al. (2009) found that scientific epistemological beliefs, particularly the source and development dimensions, were significantly and positively related to self-efficacy in science learning, while the justification dimension was negatively related to self-efficacy. Tsai et al. (2011) observed that among the four dimensions of epistemological beliefs, only the certainty dimension was significantly associated with self-efficacy in science learning. Alpaslan (2019) conducted a study that revealed all dimensions of epistemological beliefs, except for the source dimension, significantly predicted students' self-efficacy beliefs in physics.

In addition to these studies, some research explores the predictive effects of students' epistemological beliefs on their self-regulated learning (Metallidou, 2013; Muis, 2007). In a self-regulated learning model proposed by, Muis (2007) it was put forward that epistemological beliefs serve as "antecedents to other learning and motivational beliefs" (p. 187). For example, students who believe that scientific knowledge is certain and simple may perceive that there is only one correct way to solve a science problem and that the answer is definite. Consequently, encountering complex problems may decrease self-efficacy expectations for successfully completing such tasks (Alpaslan, 2017). Similarly, students' beliefs that scientific knowledge is authority-based negatively affect their self-efficacy and subjective task values (Bråten et al., 2011; Ravindran et al., 2005). Another study by Muis et al. (2015) further detailed the theoretical relationship between epistemological beliefs and subjective task value. They found that individuals with beliefs closer to the perspective that knowledge is justified through inquiry (i.e., viewing knowledge as constructed in mind) had a higher likelihood of enjoying learning activities, especially when confronted with conflicting learning materials, compared to those with less agreement with this view (Bråten et al., 2011; Guo et al., 2022).

On the other hand, in the related literature, there are also studies indicating a negative relationship between epistemological beliefs, self-efficacy, and subjective task value. For example, Ricco et al. (2010) reported that students with sophisticated beliefs about the sources of knowledge had lower self-efficacy and subjective task value performances. The researchers pointed out that students in their sample consisting of low-income middle school students who believed in authority figures and the certainty of knowledge as valid sources of scientific knowledge had higher self-efficacy and subjective task value.

Proposed Model

In this study, based on the aforementioned literature and related theories, a model presented in Figure 1 is proposed to comprehensively reveal the relationships between the specified variables. In this model, fundamental assumptions about middle school students are as follows: (1) Students' personal epistemology for science positively predicts their science self-efficacy belief; (2) Subjective task value plays a mediating role in the effect of students' personal epistemology for science on their science self-efficacy; and (3) The relationships specified in the model vary depending on whether students have high or low prior achievement in science.

Accordingly, in the model, personal epistemology is considered an exogenous independent variable, based on the notion expressed by Schommer-Aikins et al. (2005) that "personal epistemology's powerful influence is likely hidden because many of its effects are indirect rather than direct" (p. 291). Numerous studies demonstrate a positive relationship between the two motivational components focused on in this study (self-efficacy and subjective task value) (Cole and Denzine, 2004; Seo and Taherbhai, 2009). Based on these findings, it is hypothesized that the subjective task value variable will positively impact self-efficacy.

Moreover, in the existing literature, there are numerous studies demonstrating the relationship between gender and parents' educational background variables and the variables included in our study (Eccless and Davis-Kean, 2005; Kıran and Sungur, 2012; Orhan, 2022; Ozkan and Tekkaya, 2011). Therefore, the effects of these variables have been controlled in the analyses.

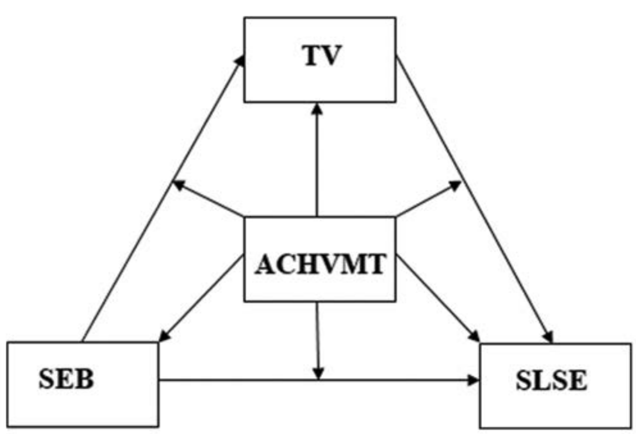

Figure 1: The proposed model (TV: Task value, SLSE: Science self-efficacy, SEB: Personal epistemological belief for science, ACHVMNT: Prior achievement)

One unique aspect of this model involves the consideration of students' prior achievement as a moderator variable. The previous studies have treated achievement as a dependent variable and examined the role of cognitive and motivational variables on predicting achievement (Chai et al., 2021; Guo et al., 2022). The present study, however, focused on how the relationships among personal epistemological beliefs, subjective task value, and self-efficacy will vary depending on students' prior achievement. In fact, according to the relevant literature, students' prior achievement plays a vital role in student motivation and behavior (Garon-Carrier et al., 2016; Regueiro et al., 2017). For example, a study conducted by Hirt et al. (2021) demonstrated the importance of prior achievement in meeting students' different needs and providing an appropriate learning environment. Specifically, one of the study's findings was that students with higher levels of prior achievement but lower levels of performance on a given task had lower levels of joy, emotional regulation, and higher levels of fear, compared to students with higher levels of performance on the task. In addition, students with lower levels of prior achievement and lower levels of performance on the task displayed significantly less intrinsic motivation. Thus, it is reasonable to hypothesize that students' prior achievement moderates the proposed relations in Figure 1.

Research Questions

- Hypothesis 1: Students' SEB positively predicts their SLSE
- Hypothesis 2: TV mediates the effect of SEB on SLSE
- Hypothesis 3: Prior achievement would moderate the direct and indirect relationships between SEB and SLSE through TV. Specifically, prior achievement would moderate the direct effect of SEB on SLSE (Hypothesis 3a), and moderate the mediating influence of TV on the effect of SEB on SLSE (Hypothesis 3b).

METHODS

Research Design and Sample

This research is designed based on quantitative research methods. In this context, the correlational design approach (Fraenkel et al., 2011) is adopted. The population of the study consists of approximately 49,867 seventh-grade students studying in public schools in the central districts of Ankara, the capital city of Turkey the sample of the study consists of 357 seventh-grade students selected using a stratified random sampling method. Data were collected from these 357 students; however, after analyzing the missing data in the dataset, 312 students' data were included in the study. The profile of the sample is presented in Table 1.

Data Collection Tools

In this study, Fives et al. (2014) scientific literacy motivation and beliefs (SLMB) scale consisting of three dimensions was used. The *subjective task value* dimension (6 items) and the

Table 1: Sample profile

Sample	Mother's education level				Father's education level				Gender		Mean prior achievement
	1	2	3	4	1	2	3	4	Female	Male	
n	79	80	113	39	49	68	127	68	164	148	
Total	312				312				312		4.28

*1: Primary school, 2: Middle school, 3: High school, 4: University

science *self-efficacy* dimension (8 items) were associated with the motivation component of the scale. The dimension of *personal epistemological beliefs for science* (11 items) was associated with the belief component of the scale. The scale consists of a total of 25 items on a 5-point Likert format. The exploratory factor analysis conducted by Fives et al. (2014) revealed that the scale has a three-factor structure, and the Cronbach's Alpha reliability coefficients were found to be $\alpha = 0.80$ for subjective task value, $\alpha = 0.72$ for science self-efficacy, and $\alpha = 0.88$ for personal epistemology.

The adaptation of the scale into Turkish was conducted by Sahin and Ates (2018). The researchers performed confirmatory factor analysis (CFA) to examine the construct validity of the scale. The results of CFA showed that the chi-square value ($\chi^2 = 527.06$, n = 500, df = 270, p = 0.00) was statistically significant; (χ^2/df) = 1.95; RMSEA = 0.04, indicating a good fit of the data to the model; CFI = 0.92; TLI = 0.91; SRMR = 0.55, indicating an acceptable fit of the data to the model (Kline, 2005). The Cronbach's Alpha internal consistency coefficient for SLMB was found to be 0.70 for the subjective task value subscale, 0.70 for science self-efficacy, and 0.86 for personal epistemology.

The prior achievement scores of the students used in the study indicate the end-of-year average science scores in the 6^{th} grade.

Procedure

Before the administration of the data collection tool, necessary permissions were obtained from the Turkish Ministry of Education (letter dated March 08, 2016, numbered 14588481-605.99-E.2703609). During the administration, all participants were informed about the purpose of the study. It was stated that the data obtained from students would not be used elsewhere and that the scores they would receive due to the research would not affect their grades. Only volunteers participated in the study.

Data Analysis

The data obtained in the research were analyzed using IBM SPSS version 23.0 statistics program. The PROCESS macro was used to test the mediation and moderated mediation models specified in the research hypothesis (Hayes, 2013). The mediation effects in the model were tested with bias-corrected bootstrapping (n = 5,000) and 95% confidence intervals (CI).

FINDINGS

Preliminary Analysis

Before the main analyses, missing data analysis was conducted. According to the results, the missing data was <5%. According to Tabachnick and Fidell (2015), if missing data is equal to or <5% in a random pattern, handling of missing data methods yields comparable results. In this study, considering missing data patterns based on Little's MCAR test, list-wise deletion was decided to be carried out. Using remaining data, firstly, the underlying assumptions of the main analyses were checked. To examine univariate normality skewness and kurtosis values were examined. As seen in Table 2, univariate normality was supported. For the absence of univariate outliers, z-scores were computed.

On the other hand, as an indication for multivariate normality and absence of multivariate outliers, mahalanobis distances were calculated. Results indicated that these assumptions were satisfied. For the multicollinearity assumption, bivariate correlations among the variables were explored and no multicollinearity was detected (Table 2). To examine the linearity assumption, scatterplots were created and it was ensured that variables are linearly related to each other. Then, after satisfying all assumptions, main analyses were conducted.

Descriptive Analyses

Table 2 presents the descriptive statistics and correlation coefficients among variables.

Examining the skewness and kurtosis coefficients in Table 2, it can be observed that these coefficients fall within the ± 1 boundaries. This indicates that the scores do not deviate significantly from a normal distribution (Mertler and Vannatta, 2017). According to the results of the Pearson correlation analysis among variables, a positive and significant relationship was found between the subjective task value and science self-efficacy variables ($r = 0.65$, $p < 0.05$), a negative and significant relationship between the subjective task value and personal epistemological belief variables ($r = -0.18$, $p < 0.05$), and a positive and significant relationship between the subjective task value and prior achievement variables ($r = 0.13$, $p < 0.01$). There was a negative and significant relationship between science self-efficacy and personal epistemological belief variables ($r = -0.14$, $p < 0.01$), a positive and significant relationship between science self-efficacy and prior achievement ($r = 0.37$, $p < 0.05$), and a positive and significant relationship between personal epistemological belief and prior achievement variables ($r = 0.25$, $p < 0.05$). In this context, as students' prior achievement scores increase, the average scores of the subjective task value, science self-efficacy, and personal epistemological belief also increase. Similarly, as students' science self-efficacy belief scores increase, their subjective task value scores also increase. As students' science self-efficacy belief and subjective task value scores increase, their personal epistemological belief scores decrease.

Mediation Analyses

Hypotheses 1 and 2 were tested by controlling for the effects of gender and parental education status variables. Table 3 presents the analyses regarding the mediating effect of SEB on SLSE.

When examining Table 3, it can be observed that SEB has a significant negative direct effect on subjective task value (β = −0.19, SE = 0.04, $p < 0.05$). In contrast, its effect on SLSE is not statistically significant in the negative direction (β = −0.03, SE = 0.03, $p > 0.05$). However, when considering the total effects in Table 3, it is seen that the negative effect of SEB on SLSE is statistically significant (B = −0.11, SLSE = 0.04, $p < 0.05$). This indicates that students with sophisticated epistemological beliefs have lower levels of science self-efficacy beliefs, thus rejecting Hypothesis 1. When examining Table 4, it can be observed that the direct effect of SEB on SLSE is statistically non-significant (β = −0.03, SLSE = 0.03, $p > 0.05$). However, when considering the total effects, this effect becomes statistically significant (B = −0.11, SLSE = 0.04, $p < 0.05$). This indicates that the subjective task value significantly mediates the prediction relationship between SEB and SLSE, thus accepting Hypothesis 2.

Moderation Analyses

Hypotheses 3a and 3b were tested by estimating a moderated mediation model (model 59) with PROCESS macro, controlling for gender and parental educational background as control variables (Hayes, 2013). The analysis results regarding the moderating effect of prior achievement on the variables included in Model 4 are presented in Table 5.

As shown in Table 5, students' prior achievement has a positive and statistically significant predictive effect on subjective task value (B = 0.14, SE = 0.04, $p < 0.05$). In addition, their personal epistemological beliefs have a negative and statistically significant predictive effect on subjective task value (B = −0.16, SE = 0.04, $p < 0.05$). The variance explained by the subjective task value through other variables is 8% which is statistically significant.

In addition, according to the findings reported in Table 5, the predictive effect of students' prior achievement on science self-efficacy beliefs is positive and statistically significant (B = 0.22, SE = 0.03, $p < 0.05$). Similarly, the predictive

Table 2: Descriptive statistics and correlations among variables

Number	Variables	Mean	SD	Skewness	Kurtosis	1	2	3	4
1	TV	4.14	0.56	−0.96	1.07	1	0.65**	−0.18**	0.13*
2	SLSE	3.86	0.61	−0.18	−0.35		1	−0.14*	0.37**
3	SEB	3.17	0.80	−0.22	−0.25			1	0.26**
4	ACHVMNT	-	-	-	-				1

*p<0.01, **p<0.05. n=312. TV: Task value, SLSE: Scientific literacy self-efficacy, SEB: Personal epistemological belief for science, ACHVMNT: Prior achievement, SD: Standard deviation

Table 3: Testing the mediating effect of personal epistemological belief for science on scientific literacy self-efficacy

Predictors	On TV				On SLSE			
	β	SE	95% CI		β	SE	95% CI	
			LL	UL			LL	UL
Gender	0.09	0.06	−0.02	0.22	0.03	0.05	−0.07	0.14
FE	0.04	0.04	−0.05	0.10	0.15*	0.03	0.04	0.16
ME	0.03	0.04	−0.05	0.09	−0.05	0.03	−0.09	0.03
SEB	−0.19*	0.04	−0.21	−0.05	−0.03	0.03	−0.09	0.04
TV					0.64*	0.05	0.60	0.79
R^2	0.05*				0.44			
F	3.59				48.15			

*p≤0.05. TV: Task value, SLSE: Scientific literacy self-efficacy, SEB: Personal epistemological belief for science, SE: Standard error, CI: Confidence interval

Table 4: Total, Direct Effects on SLSE?

Effect estimate	Unstandardized regression coefficient	SLSE	P	95% CI	
				LL	UL
Total Effect of SEB on SE	−0.11	0.04	<0.05	−0.20	−0.03
Direct Effect of SEB on SE	−0.02	0.03	0.51	−0.09	0.04

SLSE: Scientific literacy self-efficacy, SEB: Personal epistemological belief for science, SE: Standard error, CI: Confidence interval

Table 5: Testing the moderated mediating effect of personal epistemological belief for science on scientific literacy self-efficacy

Predictors	On TV				On SE			
	Unstandardized regression coefficient	SE	95% CI		Unstandardized regression coefficient	SE	95% CI	
			LL	UL			LL	UL
Gender	0.11	0.06	−0.02	0.23	0.06	0.05	−0.04	0.15
FE	−0.01	0.04	−0.08	0.07	0.05	0.03	−0.01	0.11
ME	0.01	0.04	−0.06	0.08	−0.04	0.03	−0.10	0.01
ACH	0.14*	0.04	0.06	0.22	0.22*	0.03	0.15	0.28
SEB	−0.16*	0.04	−0.24	−0.08	−0.08*	0.03	−0.15	−0.02
SEB × ACH	0.07	0.05	−0.03	0.16	0.15*	0.04	0.07	0.22
TV					0.63*	0.05	0.54	0.72
TV × ACH					0.07	0.06	−0.05	0.19
R^2	0.08*				0.52*			
F	4.50				41.11			

*p≤0.05. TV: Task value, SEB: Personal epistemological belief for science, SE: Standard error, CI: Confidence interval

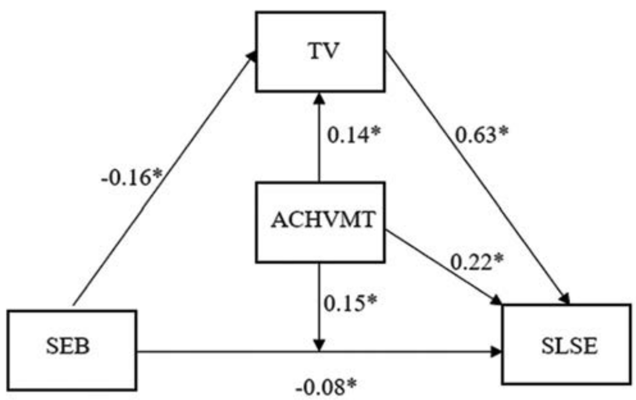

Figure 2: The path coefficients of the model

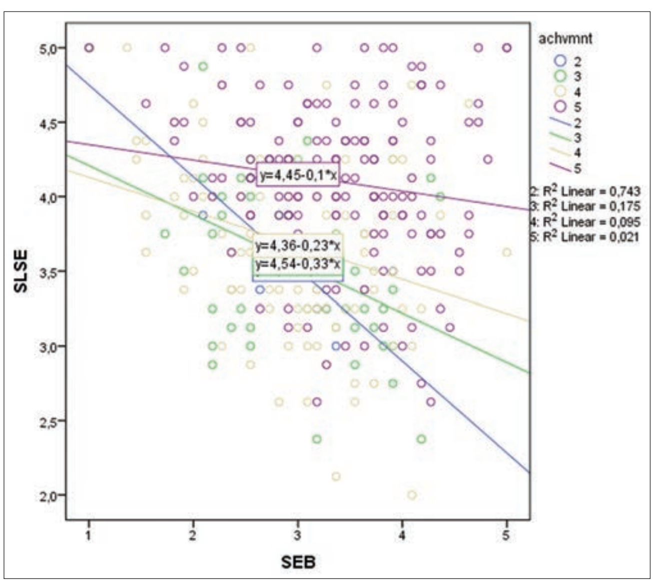

Figure 3: The moderated mediating effect of prior achievement on SE of SEB

effect of subjective task value on science self-efficacy beliefs is positive and statistically significant (B = 0.63, SE = 0.05, p < 0.05). On the other hand, students' personal epistemological beliefs in science have a negative and statistically significant predictive effect on science self-efficacy beliefs (B = −0.08, SE = 0.03, p < 0.05). The variance explained by science self-efficacy beliefs through other variables is 52%, which is statistically significant. The path coefficients in the model are shown in Figure 2.

When examining the moderating effects of prior achievement, the interaction effect of prior achievement and personal epistemological beliefs on subjective task value was found to be non-significant (B = 0.07, SE = 0.05, p > 0.05). Similarly, the interaction effect of prior achievement and subjective task value on science self-efficacy beliefs was not found to be statistically significant (B = 0.07, SE = 0.06, p > 0.05). However, the interaction effect of prior achievement and personal epistemological beliefs on science self-efficacy beliefs is positive and statistically significant (B = 0.15, SE = 0.04, p < 0.05). A detailed examination of this interaction is presented in Figure 3.

In Figure 3, it can be observed that the negative predictive effect of personal epistemological beliefs on science self-efficacy is lower for students with higher prior achievement compared to those with lower prior achievement.

CONCLUSION AND DISCUSSION

This research tested a model that explains the relationship between middle school seventh-grade students' science self-efficacy beliefs and personal epistemological beliefs for science, with subjective task value as the mediator and prior achievement as the moderator. The proposed model predicted a mediator effect of subjective task value in the relationship between epistemological beliefs and self-efficacy, and the analysis confirmed this mediator effect. This finding is consistent with previous studies examining the relationship between subjective task value and science self-efficacy beliefs (Cole and Denzine, 2004; Seo and Taherbhai, 2009).

One interesting finding of the study is that students' personal epistemological beliefs about science had a negative and statistically significant predictive effect on subjective task value and science self-efficacy beliefs. In this study, personal epistemological beliefs were conceptualized regarding certainty of knowledge and source of knowledge. These two constructs are related because if a person unquestioningly relies on authorities for knowledge, they are unlikely to accept that there can be multiple answers to the same question (Schommer, 1990). While numerous studies in the literature have shown a positive relationship between epistemological beliefs and subjective task value and self-efficacy beliefs (Chai et al., 2021; Guo et al., 2022), some studies present the opposite results (Ricco et al., 2010). The results of this study are consistent with the findings of Ricco et al. (2010). The researchers found that Hispanic middle school students from low-income backgrounds with naive epistemological beliefs regarding certainty and source of knowledge had higher self-efficacy beliefs and subjective task value scores. The researchers suggested that this result could be attributed to the students' developmental level and socioeconomic and cultural factors. In a theoretical perspective where personal epistemological beliefs are treated as unidimensional, researchers refer to hierarchically ordered stages from absolutist to multiples and finally evaluativist (Kuhn and Weinstock, 2002). In this context, researchers state that individuals in early adolescence do not have an evaluativist epistemological perspective (Hallet et al., 2002). Another explanation provided by the researchers is related to the socioeconomic and cultural conditions of the sample used in the study. The literature suggests that cultural factors influence changes in students' epistemological beliefs (Hofer, 2008; Yang, 2016). These studies indicate that individuals raised in cultures emphasizing respect for elders and authority figures are more likely to believe that knowledge comes from authorities such as teachers, books, and experts. Yang (2016) revealed in their research that there are cultural differences in epistemic beliefs in the context of science learning. Specifically, American and Taiwanese students were found to have more sophisticated epistemic beliefs, while Turkish and Chinese students were more likely to trust authority. The findings of this study support the results of these studies. Indeed, it is possible that the cultural influence on individuals' epistemological beliefs also affects the relationship between epistemological beliefs and motivational variables.

Another interesting finding obtained in this research is that the magnitude of the predictive effect of personal epistemological beliefs for science on science self-efficacy beliefs decreases among students with higher prior achievement. Both the descriptive and moderation analysis results indicate that students with higher prior achievement have more sophisticated epistemological beliefs, and the magnitude of the negative predictive effect between personal epistemological beliefs and science self-efficacy is considerably lower in these students compared to students with lower prior achievement. This finding is similar to the results of Ricco et al. (2010), where a similar relationship was found between students' sophisticated epistemological beliefs and their achievements. This can be explained by the cognitive development of students with higher achievement being more advanced compared to their peers, resulting in a more evaluativist epistemic view (Kuhn and Weinstock, 2002). Another explanation for this is the adoption and increasing prevalence of the constructivist learning approach in science education curricula in Turkey since 2005.

Overall the findings that students with higher prior achievement have more sophisticated epistemological beliefs and that the negative predictive effect of personal epistemological beliefs on science self-efficacy is lower for these students, reveal the importance of the implementation of the interventions enhancing students' science achievement. The findings also revealed a positive association between students' prior science achievement and their self-efficacy. Thus, enhancing students' science achievement through appropriate interventions can also contribute to students' science self-efficacy which is an important variable in student-related outcomes. Moreover, the activities used in the science classes should be challenging and promote students' curiosity. According to the finding demonstrating a positive link between subjective task value beliefs and self-efficacy in science, it is also recommended to implement strategies that help students realize the relevance of what they learned in science classes to their daily lives. In future studies, after the implementation of such interventions over a long period, the model proposed in the present study can be retested with the samples involved in these studies. In addition, future studies can also examine the role of culture in explaining the proposed relations. To make better, in-depth explanations, mixed-method designs can be employed.

There are several limitations to this study. First, the proposed model explained only 52% of the variance in science literacy self-efficacy. To elaborate the model, the variables related to students' emotions and cognitions, such as anxiety and cognitive strategy use, can be integrated into the model. In addition, the role of students' goal orientations in the proposed relations can be examined. Second, in this study, students' average science achievement at the end of the 6^{th} grade was used to measure science prior achievement. This study did not control the validity of the grades reported by students. Lastly, this study focused on the dimensions of the source of knowledge and certainty of knowledge when considering epistemological beliefs, while other dimensions of epistemological beliefs were not addressed. Future studies can test models that incorporate all dimensions of epistemological beliefs.

REFERENCES

Alpaslan, M.M. (2017). The relationship between personal epistemology and self-regulation among Turkish elementary school students. *The Journal of Educational Research*, 110(4), 405-414.

Alpaslan, M.M. (2019). Examining relations between physics related personal epistemology and motivation in terms of gender. *The Journal of Educational Research*, 112(3), 397-410.

Aypay, A. (2010). Teacher education students' epistemological beliefs and their conceptions about teaching and learning. *Procedia-Social and Behavioral Sciences*, 2(2), 2599-2604.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. New Jersey: Prentice-Hall.

Bandura, A. (1994). Self-efficacy. In: Ramachaudran, V.S. (Ed.), *Encyclopedia of Human Behavior*. United States: Academic Press, pp. 71-81.

Bandura, A. (1997). *Self-efficacy: The Exercise of Control*. United States: W. H. Freeman.

Bøe, M.V. (2012). Science choices in Norwegian upper secondary schools: What matters? *Science Education*, 96, 1-20.

Bråten, I., Britt, M.A., Strømsø, H.I., & Rouet, J.F. (2011). The role of epistemic beliefs in the comprehension of multiple expository texts: Toward an integrated model. *Educational Psychologist*, 46(1), 48-70.

Britner, S.L., & Pajares, F. (2001). Self-efficacy beliefs, motivation, race, and gender in middle school science. *Journal of Women and Minorities in Science and Engineering*, 7, 271-285.

Britner, S.L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching*, 43(5), 485-499.

Bryan, R.R., Glynn, S.M., & Kittleson, J.M. (2011). Motivation, achievement, and advanced placement intent of high school students learning science. *Science Education*, 95(6), 1049-1065.

Burns, E.C., Martin, A.J., & Collie, R.J. (2019). Examining the yields of growth feedback from science teachers and students' intrinsic valuing of science: Implications for student- and school-level science achievement. *Journal of Research in Science Teaching*, 56, 1060-1082.

Cakiroglu, J., Capa-Aydin, Y., & Hoy, A.W. (2012). Science teaching efficacy beliefs. In: Fraser, B.J., Tobin, K., & McRobbie, C.J., (Eds.), *Second International Handbook of Science Education*. Berlin: Springer, pp. 449-461.

Canning, E.A., Harackiewicz, J.M., Priniski, S.J., Hecht, C.A., Tibbetts, Y., & Hyde, J.S. (2018). Improving performance and retention in introductory biology with a utility-value intervention. *Journal of Educational Psychology*, 110(6), 834-849.

Cartiff, B.M., Duke, R.F., & Greene, J.A. (2021). The effect of epistemic cognition interventions on academic achievement: A meta-analysis. *Journal of Educational Psychology*, 113(3), 477-498.

Chai, C.S., Lin, P.Y., King, R.B., & Jong, M.S.Y. (2021). Intrinsic motivation and sophisticated epistemic beliefs are promising pathways to science achievement: Evidence from high achieving regions in the east and the west. *Frontiers in Psychology*, 12, 448.

Cole, J.S., & Denzine, G.M. (2004). I'm not doing as well in this class as I'd like to: Exploring achievement motivation and personality. *Journal of College Reading and Learning*, 34(2), 29-44.

Eccles, J.S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, 53(1), 109-132.

Eccles, J.S., Adler, T.F., Futterman, R., Goff, S.B., Kaczala, C.M., Meece, J.L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In: Spence, J.T. (Ed.), *Achievement and Achievement Motivation*. United States: W. H. Freemanm, pp. 75-146.

Eccless, J.S., & Davis-Kean, P.E. (2005). Influences of parents' education on their children's educational attainments: The role of parent and children perceptions. *London Review of Education*, 3(3), 191-204.

Fives, H., Huebner, W., Birnbaum, A.S., & Nicolich, M. (2014). Developing a measure of scientific literacy for middle school students. *Science Education*, 98(4), 549-580.

Fraenkel, J.R., Wallen, N.E., & Hyun, H.H. (2011). *How to Design and Evaluate Research in Education*. United States: McGraw-Hill Humanities/Social Sciences/Languages.

Garon-Carrier, G., Boivin, M., Guay, F., Kovas, Y., Dionne, G., Lemelin, J.P., & Tremblay, R.E. (2016). Intrinsic motivation and achievement in mathematics in elementary school: A longitudinal investigation of their association. *Child Development*, 87, 165-175.

Greene, J.A., Cartiff, B.M., & Duke, R.F. (2018). A meta-analytic review of the relationship between epistemic cognition and academic achievement. *Journal of Educational Psychology*, 110(8), 1084.

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

Guo, J., Hu, X., Marsh, H.W., & Pekrun, R. (2022). Relations of epistemic beliefs with motivation, achievement, and aspirations in science: Generalizability across 72 societies. *Journal of Educational Psychology*, 114(4), 734.

Hallet, D., Chandler, M.J., & Krettenaur, T. (2002). Disentangling the course of epistemic development: Parsing knowledge by epistemic content. *New Ideas in Psychology*, 20, 285-307.

Hayes, A.F. (2013). Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-based Approach. New York: Guilford Press.

Hidi, S., & Harackiewicz, J.M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research*, 70(2), 151-179.

Hirt, C.N., Karlen, Y., Merki, K.M., & Suter, F. (2021). What makes high achievers different from low achievers? Self-regulated learners in the context of a high-stakes academic long-term task. *Learning and Individual Differences*, 92, 102085.

Hofer, B.K. (2000). Dimensionality and disciplinary differences in personal epistemology. *Contemporary Educational Psychology*, 25(4), 378-405.

Hofer, B.K. (2008). Personal epistemology and culture. In: Khine, M.S. (Ed.), *Knowing, Knowledge and Beliefs*. Berlin: Springer, pp. 3-22.

Hofer, B.K., & Pintrich, P. (Eds.). (2002). *Epistemology: The Psychology of Beliefs about Knowledge and Knowing.* Mahwah, NJ: Lawrence Erlbaum.

Hofer, B.K., & Pintrich, P.R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, 67(1), 88-140.

Jacobs, J.E. (2005). Twenty-five years of research on gender and ethnic differences in math and science career choices: What have we learned? *New Directions for Child and Adolescent Development*, 110, 85-94.

Jansen, M., Scherer, R., & Schroeders, U. (2015). Students' self-concept and self-efficacy in the sciences: Differential relations to antecedents and educational outcomes. *Contemporary Educational Psychology*, 41, 13-24.

Johnson, M.L., & Sinatra, G.M. (2013). Use of task-value instructional inductions for facilitating engagement and conceptual change. *Contemporary Educational Psychology*, 38(1), 51-63.

Jones, S.H., Johnson, M.L., & Campbell, B.D. (2015). Hot factors for a cold topic: Examining the role of task-value, attention allocation, and engagement on conceptual change. *Contemporary Educational Psychology*, 42, 62-70.

Kampa, N., Neumann, I., Heitmann, P., & Kremer, K. (2016). Epistemological beliefs in science-a person-centered approach to investigate high school students' profiles. *Contemporary Educational Psychology*, 46: 81-93.

King, P.M., & Kitchener, K.S. (1994). *Developing Reflective Judgment: Understanding and Promoting Intellectual Growth and Critical Thinking in Adolescents and Adults*. San Francisco: Jossey-Bass.

Kıran, D., & Sungur, S. (2012). Middle school students' science self-efficacy and its sources: Examination of gender difference. *Journal of Science Education and Technology*, 21(5), 619-630.

Kizilgunes, B., Tekkaya, C., & Sungur, S. (2009). Modeling the relations among students' epistemological beliefs, motivation, learning approach, and achievement. *The Journal of Educational Research*, 102(4), 243-256.

Kline, R.B. (2005). *Principles and Practice of Structural Equation Modeling*. New York: Guilford Press.

Kuhn, D. (2000). Metacognitive development. *Current Directions in Psychological Science*, 9, 178-181.

Kuhn, D., & Weinstock, M. (2002). What is epistemological thinking and why does it matter? In: Hofer, B., & Pintrich, P. (Eds.), *Personal Epistemology: The Psychological Beliefs about Knowledge and Knowing*. Mahwah: Laurence Erlbaum Associates, pp. 123-146.

Lee, C.S., Hayes, K.N., Seitz, J., DiStefano, R., & O'Connor, D. (2016). Understanding motivational structures that differentially predict engagement and achievement in middle school science. *International Journal of Science Education*, 38(2), 192-215.

Lin, P.Y., & Schunn, C.D. (2016). The dimensions and impact of informal science learning experiences on middle schoolers' attitudes and abilities in science. *International Journal of Science Education*, 38(17), 2551-2572.

Lin, T.J., & Tsai, C.C. (2017). Developing instruments concerning scientific epistemic beliefs and goal orientations in learning science: A validation study. *International Journal of Science Education*, 39(17), 2382-2401.

Marsh, H.W., Pekrun, R., Parker, P.D., Murayama, K., Guo, J., Dicke, T., & Arens, A.K. (2019). The murky distinction between self-concept and self-efficacy: Beware of lurking jingle-jangle fallacies. *Journal of Educational Psychology*, 111, 331-353.

Mason, L., Boscolo, P., Tornatora, M.C., & Ronconi, L. (2013). Besides knowledge: A cross-sectional study on the relations between epistemic beliefs, achievement goals, selfbeliefs, and achievement in science. *Instructional Science*, 41, 49-79.

Mertler, C.A., & Vannatta, R.A. (2017). *Advanced and Multivariate Statistical Methods*. Los Angeles: Pyrczak.

Metallidou, P. (2013). Epistemological beliefs as predictors of self-regulated learning strategies in middle school students. *School Psychology International*, 34(3), 283-298.

Miles, D.A. (2017). A taxonomy of research gaps: Identifying and defining the seven research gaps. In: *Doctoral Student Workshop: Finding Research Gaps-research Methods and Strategies*. Dallas, Texas, pp. 1-15.

Muis, K.R. (2004). Personal epistemology and mathematics: A critical review and synthesis of research. *Review of Educational Research*, 74(3), 317-377.

Muis, K.R. (2007). The role of epistemic beliefs in self-regulated learning. *Educational Psychologist*, 42(3), 173-190.

Muis, K.R., Bendixen, L.D., & Haerle, F.C. (2006). Domain-generality and domainspecificity in personal epistemology research: Philosophical and empirical reflections in the development of a theoretical framework. *Educational Psychology Review*, 18(1), 3-54.

Muis, K.R., Pekrun, R., Sinatra, G.M., Azevedo, R., Trevors, G., Meier, E., & Heddy, B.C. (2015). The curious case of climate change: Testing a theoretical model of epistemic beliefs, epistemic emotions, and complex learning. *Learning and Instruction*, 39, 168-183.

National Research Council. (1996). *National Science Education Standards*. Washington, DC: National Academy.

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: National Academies.

Organisation for Economic Co-operation and Development. (2007). *PISA 2006: Science Competencies for Tomorrow’s World*. Vol. 1. Paris: Organisation for Economic Co-operation and Development.

Orhan, A. (2022). Üniversite öğrencilerinin epistemolojik inançlarının bazı demografik değişkenlere göre incelenmesi [Investigating university students’ epistemological beliefs in terms of some demographic variables]. *Yükseköğretim ve Bilim Dergisi*, 12(2), 391-401.

Oschatz, K. (2015). Epistemological beliefs and motivation. In: Wright, J.D. (Ed.), *International Encyclopedia of the Social and Behavioral Sciences*. Netherlands: Elsevier, pp. 887-893.

Ozkan, Ş., & Tekkaya, C. (2011). How do epistemological beliefs differ by gender and socio-economic status? *Hacettepe University Journal of Education*, 41, 339-348.

Pajares, F. (1992). Teachers’ beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 307-332.

Pamuk, S., Sungur, S., & Oztekin, C. (2017). A multilevel analysis of students’ science achievements in relation to their self-regulation, epistemological beliefs, learning environment perceptions, and teachers’ personal characteristics. *International Journal of Science and Mathematics Education*, 15(8), 1423-1440.

Pintrich, P.R. (2002). Future challenges and directions for theory and research on personal epistemology. In: Hofer, B.K., & Pintrich, P.R. (Eds.), *Personal Epistemology: The Psychology of Beliefs about Knowledge and Knowing*. Mahwah: Erlbaum, pp. 389-414.

Pintrich, P.R., & Schunk, D.H. (2002). *Motivation in Education: Theory, Research, and Applications*. New Jersey: Merrill, Prentice Hall.

Ravindran, B., Greene, B.A., & Debacker, T.K. (2005). Predicting preservice teachers’ cognitive engagement with goals and epistemological beliefs. *The Journal of Educational Research*, 98, 222-233.

Regueiro, B., Valle, A., Nú˜nez, J.C., Ros´ario, P., Rodríguez, S., & Su´arez, N. (2017). Changes in involvement in homework throughout compulsory secondary education. *Culture and Education*, 29(2), 254-278.

Ricco, R., Pierce, S.S., & Medinilla, C. (2010). Epistemic beliefs and achievement motivation in early adolescence. *Journal of Early Adolescence*, 30, 350-340.

Ryan, R.M., & Deci, E.L. (2017). *Self-Determination Theory. Basic Psychological Needs in Motivation, Development and Wellness*. New York: The Guilford Press.

Sahin, F., & Ates, S. (2018). Ortaokul öğrencilerine yönelik bilimsel okuryazarlık ölçeği adaptasyon çalışması [Adaptation of the scientific literacy scale developed for middle school students]. *Gazi University Journal of Gazi Educational Faculty*, 38(3), 1173-1205.

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

Schommer-Aikins, M., Duell, O.K., & Hutter, R. (2005). Epistemological beliefs, mathematical problem solving beliefs, and academic performance of middle school students. *Elementary School Journal*, 105, 289-304.

Seo, D., & Taherbhai, H. (2009). Motivational beliefs and cognitive processes in mathematics achievement, analyzed in the context of cultural differences: A Korean elementary school example. *Asia Pacific Education Review*, 10, 193-203.

Sinatra, G.M., Kienhues, D., & Hofer, B.K. (2014). Addressing challenges to public understanding of science: Epistemic cognition, motivated reasoning, and conceptual change. *Educational Psychologist*, 49(2), 123-138.

Sungur, S. (2007). Modeling the relationships among students’ motivational beliefs, metacognitive strategy use, and effort regulation. *Scandinavian the Journal of Educational Research*, 51, 315-326.

Tabachnick, B.G., & Fidell, L.S. (2012), *Using Multivariate Statistics*. United Kingdom: Pearson.

Tsai, C.C., Ho, H.N.J., Liang, J.C., & Lin, H.M. (2011). Scientific epistemic beliefs, conceptions of learning science and self-efficacy of learning science among high school students. *Learning and Instruction*, 21(6), 757-769.

Valentine, J.C., DuBois, D.L., & Cooper, H. (2004). The relation between self-beliefs and academic achievement: A meta-analytic review. *Educational Psychologist*, 39(2), 111-133.

Wang, M.T., Ye, F., & Degol, J.L. (2017). Who chooses STEM careers? Using a relative cognitive strength and interest model to predict careers in science, technology, engineering, and mathematics. *Journal of Youth and Adolescence*, 46(8), 1805-1820.

Winberg, T.M., Hofverberg, A., & Lindfors, M. (2019). Relationships between epistemic beliefs and achievement goals: developmental trends over grades 5–11. European *Journal of Psychology of Education*, 34(2), 295-315.

Yang, F.Y. (2016). Learners’ epistemic beliefs and their relations with science learning exploring the cultural differences. In: Chiu, M.H. (Ed.), *Science Education Research and Practices in Taiwan*. Berlin: Springer.

Yerdelen, S., & Sungur, S. (2020). Preservice science teachers’ conceptions of sound: The role of task value beliefs. *Science Education International*, 31(3), 295-303.

Yumusak, N., Sungur, S., & Cakiroglu, J. (2007). Turkish high school students’ biology achievement in relation to academic self-regulation. *Educational Research and Evaluation*, 13(1), 53-69.