A MODEL THAT EXAMINES EPISTEMOLOGICAL BELIEFS AND SELF-EFFICACY ON SCIENCE LITERACY

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ABSTRACT

The aim of the research is to investigate to what extent the science literacy of science teacher candidates is explained by their epistemological beliefs and self-efficacy beliefs of science teaching through a model. A model was created and tested to determine the direct and indirect effects of the independent variables on the dependent variables of the research. The causal-comparative design was used in the research, and the study group of the research is composed of 596 university students, 415 of which are female and 181 of which are male. The basic science and technology literacy scale developed by Laugksch and Spargo (1996) and adapted into Turkish language by Yetişir (2007); the science teaching self-efficacy belief scale developed by Riggs and Enochs (1990) and adapted into Turkish language by Özkan, Tekkaya and Çakıroğlu (2002); and the Epistemological beliefs inventory developed by Schommer (1990) and adapted into Turkish language by Deryakulu and Büyüköztürk (2002) were used in the research as data collecting tools. The data obtained from the research were analyzed with SPSS 21 and AMOS software packages. The path analysis was performed for testing the model in the research. It was consequently determined in the research that scientific literacy of science teacher candidates was explained by their epistemological beliefs directly, their science teaching self-efficacy beliefs indirectly. In the study, a conceptual model was suggested for the relationship between the variables (science literacy of science teacher candidates, their epistemological beliefs and their self-efficacy beliefs in science teaching). It was observed that the variable of the belief that there is only one correct was correlation inefficient with independent and the other variables, and this variable wasn't taken into the model.

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STRUCTERED ABSTRACT

The main aim of science teaching is to grow scientific literate individuals. Growing individuals who can decide when faced with a problem on science, who can make suggestions on scientific discussions, know the basic concepts on science and can use these concepts for the problems in their lives, is rather important for developing societies (Çepni, Bacanak and Küçük, 2003).

Although scientists make a lot of definitions about science literacy, a common definition can't be developed. Yet, in general terms, a common and basic concept can be mentioned for the aims in science teaching in the schools (Deboer, 2000; Robert, 1983; as cited in Laugksch, 2000).

The other variable beside science literacy that effects the scientific development of individuals is epistemological beliefs. These beliefs are about the nature of knowledge and learning but not a strict philosophical perception (Schommer, 1998). An extended definition of epistemological belief is the subjective beliefs about what knowledge is and how knowing and learning ocur.

There is a consistent relation between epistemological beliefs and learning and studying strategies of the students. The students who have improved beliefs in learning process use more qualified learning strategies and can be more successful in terms of academic than the students who have unimproved epistemological beliefs (Deryakulu, 2004).

The characteristics that science teachers must have are science literacy and developed epistemological and self-efficacy beliefs. Self-efficacy is one of the concepts that came to forefront in Bandura's social learning theory. Bandura firstly mentioned about this concept in his work "Self-efficacy: Toward a Unifying Theory of Behavioral Change" in 1977 (Bıkmaz, 2004; Pajares, 2002).

Self-efficacy is an important qualification for forming behaviours and individual's judgement about himself for making necessary organisations and sustaining successfully (Bandura, 1997).

The self-efficacy in science education can be defined as the judgment about the students' own skills for participation, motivation and as a result the success of them and effective and fertile science teaching of teachers (Küçükyılmaz and Duban, 2006). So, the low or high self-efficacy of the teachers may affect the applications of the teachers in science education (Schriver and Czerniak, 1999).

In the study, the self-efficacy belief in science education is very important in terms of science teacher candidates. The teacher candidates with high self-efficacy beliefs will be more determined, knowing what he wants and what he must do. In this study, the science literacy of the teacher candidates were explained in terms of the variables, epistemological belief and self-efficacy belief for science teaching, and the reasons and results were discussed comparatively.

CONCEPTUAL FRAMEWORK

It can be said that, as well as teachers' personal characteristics, their educational process at faculty of education has a great role for their scientific literacy. That is why many research has been done about the level of scientific literacy on science teacher candidates. It can be thought that scientific literacy of science teacher candidates is influenced by epistemological beliefs and self-efficacy beliefs. Yet, there is no research in literature.

Searching how science candidate teacher's scientific literacy is predicted by their epistemological beliefs and self efficacy beliefs on science teaching has a crucial role on teacher's education, correcting deficiencies in science teaching field and enlighting for further studies.

METHOD

In this study, casual-comparative research method, one of the scanning models, was used. Casual-comparative researches are for determining the reasons of a natural situation or event and the variables affecting these reasons or the results of an effect

This method was used for explaining the science literacy of teacher candidates depending on the epistemological belief and the variables of self-efficacy belief for science teaching.

Data Collection Tools

The Scale of Basic Science and Technology Literacy: This scale used in the study was developed by Laugksch and Spargo (1996) and adapted to Turkish by Yetişir (2007).

The Scale of Self-Efficacy Belief on Science Teaching: This scale was developed by Riggs and Enochs (1990) and adopted to Turkish by Özkan, Tekkaya and Çakıroğlu (2002).

The Scale of Epistemological Belief: This scale was developed by Schommer (1990) and adopted to Turkish by Deryakulu and Büyüköztürk (2002).

FINDINGS

In the study, a conceptual model was suggested for the relationship between the variables (science literacy of science teacher candidates, their epistemological beliefs and their self-efficacy beliefs in science teaching). It was observed that the variable of the belief that there is only one correct was correlation inefficient with independent and the other variables, and this variable wasn't taken into the model.

The coefficient of concordance for ultimate model was quite above the accepted limit. As CFI, IFI, NFI, TLI and RFI values are over .90 and RMSA is under .05, the model can be evaluated as good fitted (Şimşek, 2007). The fit indices are high in the study, so it can be said that the model has high fit.

DISCUSSION

Discussion for Direct Effects

In generally, it can be stated that the epistemological beliefs of science teacher candidates influences the science literacy directly

As a result of the study, it was found that the belief that learning depends on effort, the sub-dimension of epistemological belief, influenced the nature of science, the sub-dimension of science literacy, directly. Accordingly, it can be said that the more the level of the belief that learning depends on effort in terms of science teacher candidates increases, the more the level of science literacy for the nature of science increases.

The other dimension that explains the nature of science is the belief that learning depends on skill. It was observed that the more the belief that learning depends on skill increased, the more science literacy level for the nature of science increased. But this effect is lower than the dimension of the belief that learning depends on effort. The nature of science includes the concepts of reason and imagination, too. When it is thought that the people who have learning skills can use their reason and imagination more effectively, the relationship between the belief level that learning depends on skill and the perception of the nature of science can be explained.

The other independent variable of the study is the impact of science and technology on society, the sub-dimension of science literacy. The first variable influencing it directly is the belief that learning depends on effort. The more the belief that learning depends on effort increases, the more the perception level for the impact of science and technology on society increases

The other variable that influences the impact of science and technology on society, the sub-dimension of science literacy, directly is the belief that learning depends on skill. But the relationship between them isn't a powerful relation. The reason may be higher beliefs of individuals that learning depends on effort than the belief depends on skill.

The last of independent variable in the model is the science content knowledge, the sub-dimension of science literacy. The first variable that influences the science content knowledge is the belief that learning depends on effort. It is understood that the more the belief that learning depends on effort increases, the more science content knowledge increases. This relation is one of the highest relations in the model. The reason may be that the students with developed beliefs that learning depends on effort are generally the students who study systematically and are successful, and the science content knowledge of these students is developed

The other variable that influences the science content knowledge is the belief that learning depends on skill, but like the other independent variable, its degree of influence is lower than the belief that learning depends on effort. Still, there is a relationship between the belief that learning depends on skill and the science content knowledge. The reason

of this may be that the individuals link their success to learning effects or intelligence.

Discussion for Indirect Effects

At the end of the research, it was observed that the self-efficacy beliefs of science teacher candidates influenced the science literacy indirectly from epistemological beliefs.

When the search model was examined, it was noticed that the personal self-efficacy belief in science teaching influenced the nature of science from the belief that learning depends on effort.

It is understood from the model that the personal self-efficacy belief in science teaching influences the impact of science and technology on society through the belief that learning depends on effort. Science can be said to be related to environment, daily life and nature, so the individuals with high personal self-efficacy belief are expected to have high perception on the impact of science and technology on society.

Also, it is noticed from the model that the personal self-efficacy belief in science teaching influences the science content knowledge from the belief that learning depends on effort

Personal self-efficacy belief influences the nature of science from the belief that learning depends on skill.

From the model, it can be understood that personal self-efficacy belief on science teaching influences the impact of science and technology on society through the belief that learning depends on skill. But this effect is weaker than the effect of belief that learning depends on effort. The reason of this may be that the teacher candidates' having higher beliefs that learning depends on effort

It is occurred that personal self-efficacy belief in science teaching influences the science content knowledge through the belief that learning depends on skill. This effect is weaker than the effect that occurs through the belief that learning depends on effort because it may be that individuals think that effort is more effective than skill in term of reaching the knowledge.

The other variable in the model is the outcome expectation in science teaching. It is the weakest effective variable for science literacy.

The outcome expectation in science teaching influences the impact of science and technology on society through the beliefs that learning depends on effort and skill. Although this effect is higher than affecting the nature of science, it is still weak. Also, the outcome expectation in science teaching influences the science content knowledge through the beliefs that learning depends on effort and skill, and it is again a weak effect. This may be because the effects of science content knowledge and science and technology on society are better perceived by the teacher candidates than the nature of science

CONCLUSION AND RECOMMENDATIONS

In the study carried out for the science teacher candidates, the following conclusions some of which are compatible to the literature and some are different were arrived:

The Results for Direct Effects

As a result of the study, the belief that learning depends on the effort is identified as the variable that directly influences the nature of science. According to this result, the more the teacher candidates have increasing level of beliefs that learning depends on the effort, the higher their perceptions related to the nature of science are. Besides, the other variable that influences the nature of science is the belief that learning depends on skill. Accordingly, the more the teacher candidates have increasing level of beliefs that learning depends on the skill, the higher their perceptions related to the nature of science are. But its effectiveness is weaker than the belief that learning depends on effort.

The other independent variable is the impact of science and technology on society, and the belief that learning depends on effort influences this variable directly. Accordingly, the more the belief that learning depends on effort increases, the more perception levels of the teacher candidates on the impact of science and technology on society increases. Another variable that influences the impact of science and technology on society directly is the belief that learning depend on skill. Accordingly, the more the belief that learning depends on skill increases, the more the perception levels of individuals on the impact of science and technology on society increases, but this effect is weaker than the effect of belief that learning depends on effort.

The other independent variable of the study is the science content knowledge. The belief that learning depend on effort influences this variable directly, so the more the belief that learning depends on effort increases, the more the science content knowledge of the teacher candidates increases. This direct effect is the most powerful effect, too. The other variable that influences the science content knowledge directly is the belief that learning depends on skill. Accordingly, the more the belief that learning depends on skill increases, the more the science content knowledge of the teacher candidates increases.

The Results for Indirect Effects

As a result of the study, personal self-efficacy belief in science teaching influences indirectly the nature of science, the impact of science and technology on society and the science content knowledge through the belief that learning depends on effort. In other words, personal self-efficacy belief in science teaching influences the belief that learning depends on effort directly, and the belief that learning depends on effort influences the nature of science, the impact of science and technology on society and science content knowledge directly.

As a result of the study, personal self-efficacy belief in science teaching influences indirectly the nature of science, the impact of science and technology on society and the science content knowledge through the belief that learning depends on skill. In other words, personal self-

efficacy belief in science teaching influences the belief that learning depends on skill directly, and the belief that learning depends on skill influences the nature of science, the impact of science and technology on society and science content knowledge directly. But this effect is weaker than the mediator variable, the belief that learning depends on effort.

In the study the other indirect effect is the outcome expectation. It influences the nature of science, the impact of science and technology on society and science content knowledge indirectly through the belief that learning depends on effort and the belief that learning depends on skill. This effect is the weakest in the model. This is because there is a weak relationship between the belief that learning depends on skill and the outcome expectation in science teaching.

In the study, a model was formed, which tries to explain the science literacy through epistemological beliefs and self-efficacy beliefs in science teaching. It is concluded that science literacy can be explained by epistemological beliefs and self-efficacy beliefs. The study is limited to the study group. The repeat of the study in other universities can contribute to the generalization of results. Also, epistemological beliefs and self-efficacy belief was used as the descriptors of science literacy in the study. This may be the constraint of the study. In this context, to do the study again by adding variables like motivation and self-regulation may be helpful for healthier knowledge on this subject.

Casual-comparative research model, one of scanning models, was used in this study, but it may contribute to use different experimental and qualitative studies for the generalization of the results. Also, the study was conducted only for the science teacher candidates. If the same study was conducted for class teachers, it may contribute to the results.

It is concluded that the science literacy of science teacher candidates can be explained by epistemological beliefs and self-efficacy beliefs in science teaching. In consideration of these results, some measures may be taken and the science literacy of teacher candidates may be increased. Besides, some studies to increase the epistemological beliefs and self-efficacy beliefs in science teaching can be made for raising the science literacy level of students.

Keywords: Scientific Literacy, Epistemological Beliefs, Self-efficacy

FEN OKURYAZARLIĞI ÜZERİNE EPİSTEMOLOJİK İNANÇLAR VE ÖZYETERLİK ETKİSİNİ İNCELEYEN BİR MODEL

ÖZET

Araştırmada fen bilgisi öğretmen adaylarının fen okuryazarlıklarının, epistemolojik inançları ve fen bilgisi öğretimi öz yeterlik inançlarıyla ne düzeyde açıklandığını bir model aracılığıyla incelemek amaçlanmıştır. Araştırmanın bağımlı değişkeni üzerindeki bağımsız değişkenlerin doğrudan ve dolaylı etkilerini belirleyecek bir model oluşturulmuş ve test edilmiştir. Araştırmada nedensel karşılaştırmalı desen kullanılmıştır, araştırmanın çalışma grubunu farklı

üniversitelerden 415 bayan ve 181 erkek olmak üzere 596 üniversite öğrencisi oluşturmaktadır. Araştırmada veri toplama aracı olarak Laugksch ve Spargo (1996), tarafından geliştirilen ve Yetişir (2007), tarafından Türkçe'ye uyarlanan temel fen ve teknoloji okuryazarlık ölçeği, Riggs ve Enochs (1990), tarafından geliştirilen ve Özkan, Tekkayave Çakıroğlu (2002) tarafından Türkçe'ye uyarlanan fen bilgisi öğretimi öz yeterlik inancı ölçeği ve Schommer (1990), tarafından geliştirilen ve Deryakulu ve Büyüköztürk (2002) tarafından Türkçe'ye uyarlanan Epistemolojik inanç ölçeği kullanılmıştır. Araştırmadan elde edilen veriler SPSS 21 ve AMOS programlarıyla analiz edilmiştir. Araştırmada model testi için path analizi yapılmıştır. Araştırma sonucunda fen bilgisi öğretmen adaylarının fen okuryazarlıklarının, epistemolojik inançları bakımından doğrudan, fen öğretimi öz yeterlik inançları bakımından ise dolaylı olarak açıklandığı belirlenmiştir. Çalışmada değişkenler (fen bilgisi öğretmen adaylarının fen okur yazarlığı, epistemolojik inançları ve fen öğretimi alanındaki öz yeterlik inançları) arasındaki ilişki için kavramsal bir model önerilmiştir. Tek bir doğru olduğuna dair inanç değişkeninin bağımsız ve diğer değişkenlerle etkileşimsiz olduğu görülmüş ve bu değişken modele alınmamıştır.

Anahtar Kelimeler: Fen Okuryazarlığı, Epistemolojik İnançlar, Öz Yeterlik İnançları

INTRODUCTION

The main aim of science teaching is to grow scientific literate individuals. Growing individuals who can decide when faced with a problem on science, who can make suggestions on scientific discussions, know the basic concepts on science and can use these concepts for the problems in their lives, is rather important for developing societies (Çepni, Bacanak and Küçük, 2003). Thus, Ministry of National Education stated the vision of teaching program of science lesson as "to grow the students as individuals who are scientific literate" (MEB, 2013).

Although the subject of science teaching about developing the social life is about 400 years old, the concept of science literacy was first raised by Paul DeHart Hurd in 1950s (Hurd, 1958). Although scientists make a lot of definitions about science literacy, a common definition can't be developed. Yet, in general terms, a common and basic concept can be mentioned for the aims in science teaching in the schools (Deboer, 2000; Robert, 1983; as cited in Laugksch, 2000). Çepni, Bacanak and Küçük (2003) defined the science literacy as knowing the concept of science, theory, law and scientific research methods, understanding science, technology and the effects and relations of it on society, using the information learned in school at problem solving in daily life and explaining and making decision about social problems related to science, publishing, reading and understanding scientific works, making discussions, explanation of his own ideas and interpretations on scientific areas and finally having necessary knowledge and skills for thinking objectively, critical and creatively. Also, Bybee et al. (1991) expressed the characteristics of a scientific literate individual as those who can understand the nature, possibility and limits of modern science, can distinguish that science and technology are the products of social culture, can understand that the effects of science and technology change according to cultures, know that science and technology are human activities, and base their decisions to scientific and technological knowledge and progresses.

Individuals' developing their skills related to science literacy is a process that continues lifelong. In this process, the level of individuals' science literacy will constantly be developed under suitable circumstances. Beside this, it must be admitted that every individual's perception level of the concepts may be different and science literacy may change in different levels (Anagün, 2008). Bybee (1999) handled the levels of science literacy in 5 types: scientific illiteracy, nominal, functional, conceptual, procedural and multi-dimensional. In general, it can be admitted that the individuals who are science literates in high levels are more successful in terms of the use of knowledge lifelong and the production of knowledge than the individuals who are science literates in low levels.

The other variable beside science literacy that effects the scientific development of individuals is epistemological beliefs. These beliefs are about the nature of knowledge and learning but not a strict philosophical perception (Schommer, 1998). An extended definition of epistemological belief is the subjective beliefs about what knowledge is and how knowing and learning occur.

There is a consistent relation between epistemological beliefs and learning and studying strategies of the students. The students who have improved beliefs in learning process use more qualified learning strategies and can be more successful in terms of academic than the students who have unimproved epistemological beliefs (Deryakulu, 2004). The development of beliefs related to the nature, generation and development of knowledge, in other words, the correct recognition of knowledge by the students is very important in terms of reaching the new knowledge and structuring them in mind. Different academicians explained the epistemological development of individuals in different ways. For example; Perry discussed the individuals according to their epistemological development in four levels in the model of cognitive and moral development: there is a developmental process (i) from the dualist situation in which knowledge is accepted as exactly true or false, and only the experts have the true knowledge, (ii) to the multiplicity situation where it is noticed that knowledge isn't composed of exact and absolute rights, but it is partly believed that there is a constant knowledge around, and then it is comprehended that even the knowledge of experts isn't certain and every individual has the right of forming his own thought, (iii) after that to the relativist situation where it is believed that knowledge is true or false related to the data, and the individual see himself as the constructor, (iv) finally to the commitment situation in which the individual has strong beliefs to a view flexibly along with the changeability of knowledge among individuals (Schommer, 1998).

Belenky, Clinchy, Goldberger and Tarule's (1986) models of women's cognition ways, Kuhn's disputative reasoning model, Bakster Magolda's epistemological reflecting model and King and Kitchener's reflector attitude model as well as Perry's model are the other models that explain the epistemological development. When these models are examined separately, it can be observed that they do the similar classifications. These models showed on high levels that in the first dimensions the individual believed that the knowledge is formed by himself with the help of his own life, observations and experiences. Also, individuals were grouped differently according to the attitudes on the knowledge in all models, but there is no information on how to reach to the knowledge. Shommer (1990) remarked that to approach the epistemological beliefs only involving the beliefs about knowledge, and argued that these beliefs are multi-dimensional instead of one-dimensional, they don't include only the beliefs about knowledge but the beliefs on the skills of teaching and learning related to the processes of acquisition and usage of knowledge, so epistemological beliefs must be accepted as a belief system. Also he developed a scale and indicated that epistemological beliefs consisted of four independent dimensions and every dimension has different effects on learning. He named these dimensions as knowledge is simple, knowledge is

certain, learning occurs at once and learning skill is congenital. According to Schommer, while the people who have underdeveloped or immature epistemological beliefs think that knowledge is simple, certain and unchangeable, learning comes true at once, learning skill is congenital and can't be changed later, the people who have mature and developed epistemological beliefs think that knowledge is complicated and changeable, learning takes time and requires effort (Güven and Belet, 2010).

When Schommer's model was examined, it can be observed that the people who have developed epistemological beliefs are more successful on learning, but the people who have underdeveloped epistemological beliefs are unsuccessful because of the judgements about knowledge and learning.

In addition to these, the researches in literature show that epistemological beliefs of teachers are distinctive in the choice of teaching methods they adopted and methods and techniques they used in the class. This naturally affects the learning situation of the students (Deryakulu, 2004). İçen and Akpınar (2016), have reached the result that social science teachers' epistemological beliefs affects their teaching methods. From this point of view, it is a possible situation that the teachers who have developed epistemological beliefs may bring up students who can structure the knowledge properly at the end of teaching process.

The characteristics that science teachers must have are science literacy and developed epistemological and self-efficacy beliefs. Self-efficacy is one of the concepts that came to forefront in Bandura's social learning theory. Bandura firstly mentioned about this concept in his work "Self-efficacy: Toward a Unifying Theory of Behavioral Change" in 1977 (Bıkmaz, 2004; Pajares, 2002).

Self-efficacy is an important qualification for forming behaviours and individual's judgement about himself for making necessary organisations and sustaining successfully (Bandura, 1997). Also, self-efficacy beliefs are the base for motivation, welfare and personal success. The individuals can reach the desired result with their actions as long as they believe (Pajares, 2002). On the basis of self-efficacy, probability of actions to occur is high when individual feels sufficient and there is less probability when individual feels insufficient (Arseven, 2016). Briefly, it can be said that self-efficacy is the belief to individual's own success in a particular process. It can be thought that the individuals who believe to their own success will strive more, not give up and achieve better results in any event.

Teaching self-efficacy is the judgement about teacher's own skills for achieving his goals even for the students who have little motivation and are reluctant (Tschannen, Moren and Hoy, 2001). Similarly, Bandura (1977) defined it as the judgement formed against teachers' own skills related to success of hard students. Besides, the teachers with high self-efficacy belief take care of using different teaching methods in the classes, making researches for developing these teaching methods and techniques, using student-centred strategies and using equipment in the applications. The teachers with low self-efficacy belief teach teacher-centred lessons and read the course books in the classes every time (Henson, 2001; Plourde, 2001). The studies made about the self-efficacy beliefs of teachers generally focused on searching for self-efficacy beliefs. As self-efficacy belief is based on the special teaching situation, the self-efficacy beliefs in special fields have been searched in recent years, too. The general self-efficacy beliefs of the teachers may not reflect the beliefs related to teaching methods in a special field. Besides, it is important that the self-efficacy of the teachers in the special fields is determined, too (Küçükyılmaz and Duban, 2006). One of these special fields is the self-efficacy belief for science education.

The self-efficacy in science education can be defined as the judgment about the students' own skills for participation, motivation and as a result the success of them and effective and fertile science teaching of teachers (Küçükyılmaz and Duban, 2006). So, the low or high self-efficacy of the teachers may affect the applications of the teachers in science education (Schriver and Czerniak, 1999). Teachers who can support students' learning process in science lessons must have developed self-efficacy beliefs (Akçil and Oğuz, 2015).

In the study, the self-efficacy belief in science education is very important in terms of science teacher candidates. The teacher candidates with high self-efficacy beliefs will be more determined, knowing what he wants and what he must do. In this study, the science literacy of the teacher candidates were explained in terms of the variables, epistemological belief and self-efficacy belief for science teaching, and the reasons and results were discussed comparatively.

METHOD

In this study, casual-comparative research method, one of the scanning models, was used. Casual-comparative researches are for determining the reasons of a natural situation or event and the variables affecting these reasons or the results of an effect. The case searched in causal-comparative research method appears independent from the effect of the researcher, and the researcher tries to determine the reasons and effects of this case (Büyüköztürk, Çakmak, Akgün, Karadeniz and Demirel, 2008). This method was used for explaining the science literacy of teacher candidates depending on the epistemological belief and the variables of self-efficacy belief for science teaching.

Research Group

In this study, a model was discussed, which explains the science literacy of teacher candidates depending on the epistemological belief and the variables of self-efficacy belief for science education. The study group for testing the model consists of 596 teacher candidates studying the Department of Science Teaching from Ege University, Erzincan University, Gazi University, Kafkas University and Kırıkkale University. Table 1 is related to the study group, and shows the information of gender, class level, educational level of the parents and income state of the family.

Table 1. Statistical Data Related to the Study Group.

| Variables	Categories	N	%
Gender	1. Male	181	30.4
	2. Female	415	69.6
Class Level	1st Class	158	26.5
	2nd Class	104	17.4
	3rd Class	206	34.6
	4th Class	127	21.3
Educational Level of Father	1. Primary	233	39.1
	2. Secondary	244	40.9
	3. University	107	18.0
Educational Level of Mother	1. Primary	399	66.9
	2. Secondary	161	27.0
	3. University	14	2.3
Income State of the Family	1. Low	207	34.7
	2. Middle	218	36.6
	3. High	115	19.3
Total		596	100

Data Collection Tools

The Scale of Basic Science and Technology Literacy: This scale used in the study was developed by Laugksch and Spargo (1996) and adapted to Turkish by Yetişir (2007). The scale is composed of sub-scales as science content knowledge with 72 items, the effects of science and technology on society with 16 items and the nature of science with 22 items. Yetişir (2007) measured the reliability of the scale by the help of KR20 test and found the reliability as .88. Bademci (2011) indicated that when the scale items were measured bivalent, KR20 Cronbach Alpha will give the same value. So, the reliability test was made again for this study and Cronbach Alpha value was found as .91.

The Scale of Self-Efficacy Belief on Science Teaching: This scale was developed by Riggs and Enochs (1990) and adopted to Turkish by Özkan, Tekkaya and Çakıroğlu (2002). It is composed of sub-scales as personal self-efficacy belief in science teaching with 13 items and outcome expectation in science teaching with 10 items. As a result of the reliability and validity study made by Özkan, Tekkaya and Çakıroğlu (2002), Cronbach Alpha reliability value for the sub-factor of personal self-efficacy belief in science teaching was calculated as .79, and Cronbach Alpha reliability value for the sub-factor of outcome expectation in science teaching was calculated as .86. The reliability values for this study was calculated again and Cronbach Alpha reliability value for the sub-factor of personal self-efficacy belief in science teaching was calculated as .80, and Cronbach Alpha reliability value for the sub-factor of outcome expectation in science teaching was calculated as .67.

The Scale of Epistemological Belief: This scale was developed by Schommer (1990) and adopted to Turkish by Deryakulu and Büyüköztürk (2002). It is composed of sub-scales as the belief that learning depends on effort with 16 items, the belief that learning depends on skill with 9 items and the belief that there is only one correct with 9 items. As a result of the reliability and validity study made by Deryakulu and Büyüköztürk (2005), Cronbach Alpha reliability value for the sub-factor of the belief that learning depends on effort was calculated as .84, Cronbach Alpha reliability value for the sub-factor of the belief that learning depends on skill was calculated as .69, Cronbach Alpha reliability value for the sub-factor of the belief that there is only one correct was calculated as .64, and the total Cronbach Alpha reliability value became .81. The reliability values for this study was calculated again and Cronbach Alpha reliability value for the sub-factor of the belief that learning depends on effort was calculated as .88, Cronbach Alpha reliability value for the sub-factor of the belief that learning depends on skill was calculated as .78, Cronbach Alpha reliability value for the sub-factor of the belief that there is only one correct was calculated as .60, and the total Cronbach Alpha reliability value became .81.

The Analysis of Data

In the study, the path analysis technique was used, and the model in Figure 1 was tested.
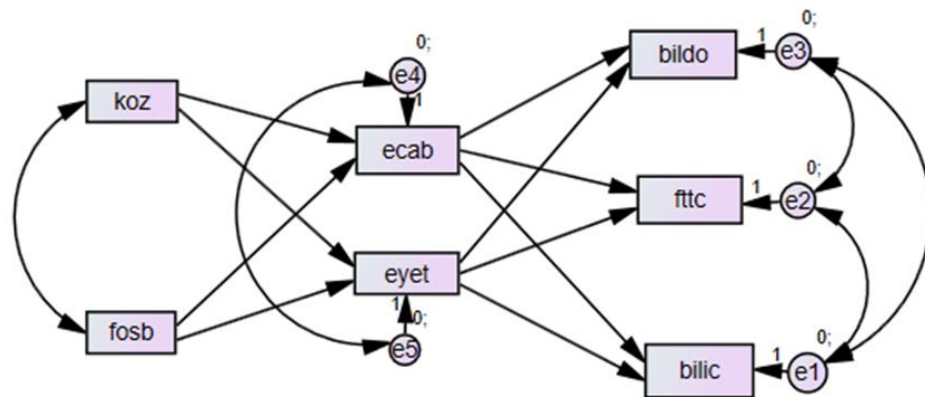
koz: the belief of personal self-efficacy in science teaching. **fosb:** the outcome expectation in science teaching. **ecab:** the belief that learning depends on effort. **eyet:** the belief that learning depends on skill. **bilic:** Science content knowledge. **fttç:** The impact of science and technology on society .**bildo:** The nature of science.

Figure 1. Hypothesis Model

Before the testing of hypothesis model, the relationship of research variables was examined for linearity measurement (Table 2).

Table 2. The correlational relationship between the research variables.

Variables	1	2	3	4	5	6	7	8
koz (1)	1							
fosb (2)	.36	1						
ecab (3)	.37	.36	1					
eyet (4)	.25	.10	.27	1				
Bilic (5)	.34	.26	.56	.34	1			
fttc (6)	.23	.16	.40	.23	.68	1		
bildo(7)	.30	.28	.40	.20	.63	.50	1	
etek (8)	.06	.06	-.07	.35	.06	.11	-.01	1
TOTAL	559	559	559	559	559	559	559	559

koz: the belief of personal self-efficacy in science teaching. **fosb:** the outcome expectation in science teaching. **ecab:** the belief that learning depends on effort. **eyet:** the belief that learning depends on skill. **bilic:** Science content knowledge. **fttç:** The impact of science and technology on society .**bildo:** The nature of science. **etek:** the belief that there is only one correct.

When the Table 2 was examined, it was observed that there is a significant relationship between the dependant and independent variables. The correlation value (.80) between independent variables is the sign of multicollinearity problem (Çokluk, Şekercioğlu and Büyüköztürk, 2012). Table 2 showing the correlation analysis result was examined again in order to understand whether there is binary-multiple variability. As there is no correlation coefficient over .80 between the variables, it is possible to say that there is no multi variability problem between the variables.

The way of process

The data collecting tools in the study will be gathered on a single form. The forms will be duplicated according to the number of students. The places will be identified for conduction by taking into consideration the conduction facility, and the scales will be conducted to the teacher candidates providing the permission got from academicians. For getting correct results, enough time will be given to the participants. Within the context of the research, the forms unfilled and incomplete will be left out of assessment. The data will be written to SPSS programme, and the data will be prepared for analysis. The data written incorrect will be cleaned, and undervaluation and normality tests will be made. The reliability points of the tests will be calculated again, and the analysis above will be made.

FINDINGS

In the study, a conceptual model was suggested for the relationship between the variables (science literacy of science teacher candidates, their epistemological beliefs and their self-efficacy beliefs in science teaching). It was observed that the variable of the belief that there is only one correct was correlation inefficient with independent and the other variables, and this variable wasn't taken into the model.

Direct and indirect relations were suggested in the model. Science literacy is thought to affect the sub-dimensions of science content knowledge, the impact of science and technology on society and the nature of science, and epistemological belief is thought to affect the sub-dimensions of the belief that learning depends on effort and the belief that learning depends on skill. As indirect effects, the personal self-efficacy belief in science teaching was assumed to influence the science content knowledge, the impact of science and technology on society and the nature of science indirectly through the belief that learning depends on skill. The other hypothesis is that personal self-efficacy belief in science teaching influences indirectly the science content knowledge, the impact of science and technology on society and the nature of science through the belief that learning depends on effort.

It is accepted that the outcome expectation in science teaching influences the impact of science and technology on society and the nature of science indirectly through the belief that learning depends on skill. It is assumed that the outcome expectation in science teaching influences indirectly the science content knowledge, the impact of science and technology on society and the nature of science through the belief that learning depends on effort.

To test the validity of this hypothesis, path analysis was made and the results were showed in Figure 2.
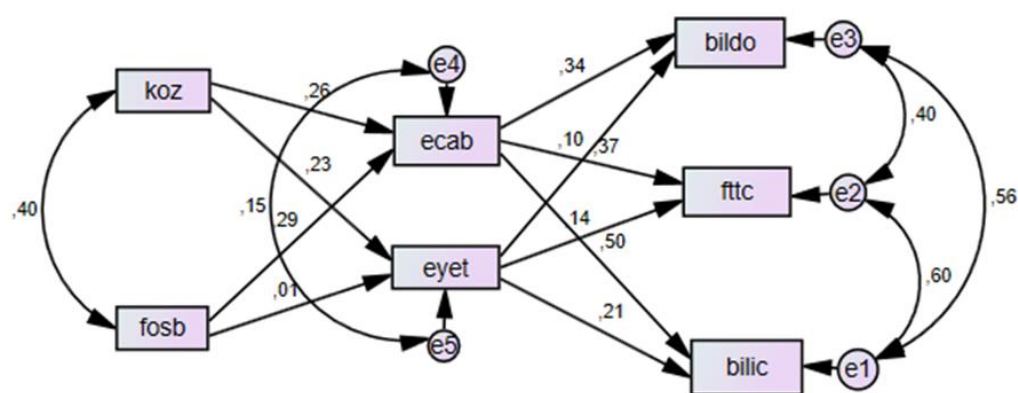
koz: the belief of personal self-efficacy in science teaching. **fosb:** the outcome expectation in science teaching. **ecab:** the belief that learning depends on effort. **eyet:** the belief that learning depends on skill. **bilic:** Science content knowledge. **fttç:** The impact of science and technology on society .**bildo:** The nature of science.

Figure 2. Path Diagram For the Model

The coefficient of concordance for ultimate model was quite above the accepted limit. As CFI, IFI, NFI, TLI and RFI values are over .90 and RMSA is under .05, the model can be evaluated as good fitted (Şimşek, 2007). The fit indices are high in the study, so it can be said that the model has high fit. The fit values were given in Table 3.

Table 3. The Fit Coefficients of ultimate model

Fit Indices for the Model	Fit Coefficients
RMSA- E (root mean square error of approximation)	**.05**
χ^2 / **sd** (chi square / degrees of freedom)	**2.49**
CFI (comparative fit index)	**.98**
IFI (incremental fit index)	**.98**
NFI (Normed fit index)	**.97**
TLI (not normed fit index)	**.96**
RFI (Relativist fit index)	**.95**

The findings for direct, indirect and total effects from the study were given in Table 4. When the table is examined, it can be observed that science literacy affects the epistemological beliefs directly and the belief of self-efficacy in science teaching indirectly.

Table 4. Findings for direct, indirect and total effects

	koz			fosb			eyet			ecab		
	1	2	3	1	2	3	1	2	3	1	2	3
bilic	.00	.17	.17	.00	.14	.14	.20	.00	.20	.49	.00	.49
fttc	.00	.12	.12	.00	.10	.10	.13	.00	.13	.36	.00	.36
bildo	.00	.11	.11	.00	.10	.10	.10	.00	.10	.34	.00	.34
eyet	.23	.00	.23	.06	.00	.06	.00	.00	.00	.00	.00	.00
ecab	.25	.00	.25	.29	.00	.29	.00	.00	.00	.00	.00	.00

1: direct effect; 2: indirect effect; 3: total effect

koz: the belief of personal self-efficacy in science teaching. **fosb:** the outcome expectation in science teaching. **ecab:** the belief that learning depends on effort. **eyet:** the belief that learning depends on skill. **bilic:** Science content knowledge. **fttç:** The impact of science and technology on society. **bildo:** The nature of science.

Findings for Direct Effects

The values of influence in Figure 2 that explains the science literacy of science teacher candidates were given in Table 4. According to this table, the findings for direct effect are: the belief that learning depends on skill, the sub-dimension of epistemological belief, influences the science content knowledge, the sub-dimension of science literacy with .20; the belief that learning depends on skill, the sub-dimension of epistemological belief, influences the impact of science and technology on society, the sub-dimension of science literacy with .13; the belief that learning depends on skill,

the sub-dimension of epistemological belief, influences the nature of science, the sub-dimension of science literacy with .10 directly.

Also the other direct effects are; the belief that learning depends on effort, the sub-dimension of epistemological belief, to the science content knowledge, the sub-dimension of science literacy with .49; the belief that learning depends on effort, the sub-dimension of epistemological belief, to the impact of science and technology on society , the sub-dimension of science literacy with .36; and the belief that learning depends on effort, the sub-dimension of epistemological belief, to the nature of science, the sub-dimension of science literacy with .34.

Findings for Indirect Effects

The values of indirect influence of the model in Figure 2 that explains the science literacy of science teacher candidates were given in Table 4. According to this table: the belief of personal self-efficacy in science teaching, the sub-dimension of self-efficacy belief in science teaching, influences the science content knowledge, the sub-dimension of science literacy, with .17; the belief of personal self-efficacy in science teaching, the sub-dimension of self-efficacy belief in science teaching, influences the impact of science and technology on society , the sub-dimension of science literacy with .12; the belief of personal self-efficacy in science teaching, the sub-dimension of self-efficacy belief in science teaching, influences the nature of science the sub-dimension of science literacy with .11 through epistemological belief indirectly.

Also, the outcome expectation in science teaching, the sub-dimension of self-efficacy belief in science teaching influences the science content knowledge, the sub-dimension of science literacy with .14; the outcome expectation in science teaching, the sub-dimension of self-efficacy belief in science teaching influences the impact of science and technology on society , the sub-dimension of science literacy with .10; and the outcome expectation in science teaching, the sub-dimension of self-efficacy belief in science teaching influences the nature of science the sub-dimension of science literacy with .10 through epistemological belief indirectly.

The Findings for Total Effect

The values of total influence of the model in Figure 2 that explains the science literacy of science teacher candidates were given in Table 4. According to this table: the belief that learning depends on skill, the sub-dimension of epistemological belief, influences the science content knowledge, the sub-dimension of science literacy with .20; the belief that learning depends on skill, the sub-dimension of epistemological belief, influences the impact of science and technology on society, the sub-dimension of science literacy with .13; the belief that learning depends on skill, the sub-dimension of epistemological belief, influences the nature of science the sub-dimension of science literacy with .10 totally.

The belief that learning depends on effort, the sub-dimension of epistemological belief, has the effect on the science content knowledge, the sub-dimension of science literacy, with .49; the belief that learning depends on effort, the sub-dimension of epistemological belief, has the effect on the impact of science and technology on society, the sub-dimension of science literacy with .36, and the belief that learning depends on effort, the sub-dimension of epistemological belief, has the effect on the nature of science the sub-dimension of science literacy with .34 totally.

The belief of personal self-efficacy in science teaching, the sub-dimension of self-efficacy belief in science teaching, influences the science content knowledge, the sub-dimension of science literacy, with .17; the belief of personal self-efficacy in science teaching, the sub-dimension of self-efficacy belief in science teaching, influences the effect on the impact of science and technology on society, the sub-dimension of science literacy with .12; and the belief of personal self-efficacy in

science teaching, the sub-dimension of self-efficacy belief in science teaching, influences the effect on the nature of science the sub-dimension of science literacy with .11 totally.

The outcome expectation in science teaching, the sub-dimension of self-efficacy belief in science teaching influences the science content knowledge, the sub-dimension of science literacy, with .14; the outcome expectation in science teaching, the sub-dimension of self-efficacy belief in science teaching influences the impact of science and technology on society, the sub-dimension of science literacy with .10; and the outcome expectation in science teaching, the sub-dimension of self-efficacy belief in science teaching influences the effect on the nature of science the sub-dimension of science literacy with .10 totally.

DISCUSSION

Discussion for Direct Effects

In generally, it can be stated that the epistemological beliefs of science teacher candidates influences the science literacy directly. When the literature was examined, Erdem, Yılmaz and Akkoyunlu (2008) was noticed in their studies that there is a significant relationship between the dimensions of the beliefs that learning depends on effort and learning depends on skill and self-efficacy belief of knowledge literacy. Also, in the study made by Chen and Pajares (2010) for 6th class students, it was found that there is a direct relationship between the science skill and the nature of scientific knowledge. While the epistemological beliefs for complication of scientific knowledge is directly related to science success and self-efficacy, more naïve epistemological beliefs, low academic performance and self-sufficiencies are related directly. Besides, Izgar and Dilmaç (2008) stated that there is a significant relationship between self-efficacy and the sub-dimensions of epistemological beliefs.

Effort is defined as power and study revealed to do any job (TDK, 2015). So, the nature of science includes the change of knowledge and validity of it by experiments and evidences, and to realise it is possible by effort. From this point of view, it can be said that there is a relationship between the increase of belief level that learning depends on effort, and the perception of the nature of science.

As a result of the study, it was found that the belief that learning depends on effort, the sub-dimension of epistemological belief, influenced the nature of science, the sub-dimension of science literacy, directly. Accordingly, it can be said that the more the level of the belief that learning depends on effort in terms of science teacher candidates increases, the more the level of science literacy for the nature of science increases.

The other dimension that explains the nature of science is the belief that learning depends on skill. It was observed that the more the belief that learning depends on skill increased, the more science literacy level for the nature of science increased. But this effect is lower than the dimension of the belief that learning depends on effort. The nature of science includes the concepts of reason and imagination, too. When it is thought that the people who have learning skills can use their reason and imagination more effectively, the relationship between the belief level that learning depends on skill and the perception of the nature of science can be explained.

The other independent variable of the study is the impact of science and technology on society, the sub-dimension of science literacy. The first variable influencing it directly is the belief that learning depends on effort. The more the belief that learning depends on effort increases, the more the perception level for the impact of science and technology on society increases. Science and technology has been developed and changed the life. It is possible to keep pace with this change by learning the use of scientific developments and technology. So, effort is needed. From this point of

view, the more the belief that learning depends on effort develops, the easier their following the science and technology and their perception of the effect on society will be. Thus, the relationship can be explained between the level of belief that learning depends on effort and the perception of the impact of science and technology on society.

The other variable that influences the impact of science and technology on society, the sub-dimension of science literacy, directly is the belief that learning depends on skill. But the relationship between them isn't a powerful relation. The reason may be higher beliefs of individuals that learning depends on effort than the belief depends on skill. Accordingly, Erdamar and Alpan (2011) stated that the belief that learning depends on effort is more developed than the belief that learning depends on skill.

The relationship between the belief that learning depends on skill and the impact of science and technology on society may be explained by thinking that some individuals are more vulnerable to use the science and literature.

The last of independent variable in the model is the science content knowledge, the sub-dimension of science literacy. The first variable that influences the science content knowledge is the belief that learning depends on effort. It is understood that the more the belief that learning depends on effort increases, the more science content knowledge increases. This relation is one of the highest relations in the model. The reason may be that the students with developed beliefs that learning depends on effort are generally the students who study systematically and are successful, and the science content knowledge of these students is developed. According to Schommer (1990) the individuals with developed epistemological beliefs are more successful in terms of academic.

The other variable that influences the science content knowledge is the belief that learning depends on skill, but like the other independent variable, its degree of influence is lower than the belief that learning depends on effort. Still, there is a relationship between the belief that learning depends on skill and the science content knowledge. The reason of this may be that the individuals link their success to learning effects or intelligence.

Discussion for Indirect Effects

At the end of the research, it was observed that the self-efficacy beliefs of science teacher candidates influenced the science literacy indirectly from epistemological beliefs.

When the search model was examined, it was noticed that the personal self-efficacy belief in science teaching influenced the nature of science from the belief that learning depends on effort. There is no study in literature about this indirect effect. But, Akgün, Özden, Çinici, Sonekinci and Aygün (2014) found a relation between science and technology literacy and self-efficacy in their studies. Besides, Köse and Dinç (2012) found a significant relationship between the belief that learning depends on effort and biology self-efficacy perceptions in their studies.

From this point, it can be said that the individuals thinking that learning depends on effort, have high self-efficacy beliefs, too. Also, the individuals' high perception related to the nature of science, who believe that learning depend on effort, can be related to high perception of individuals on the nature of science, who have high personal self-efficacy beliefs.

It is understood from the model that the personal self-efficacy belief in science teaching influences the impact of science and technology on society through the belief that learning depends on effort. Science can be said to be related to environment, daily life and nature, so the individuals with high personal self-efficacy belief are expected to have high perception on the impact of science and technology on society.

Also, it is noticed from the model that the personal self-efficacy belief in science teaching influences the science content knowledge from the belief that learning depends on effort. Bandura, Edams and Beyer (1977) stated that the higher self-efficacy beliefs of individuals were, the more active they would be on effort. From this view point, it can be expected that the individuals who believe that he can teach science better (in other words, who have high self-efficacy beliefs) can effort enough for teaching and have the necessary science content knowledge.

Personal self-efficacy belief influences the nature of science from the belief that learning depends on skill. Leithwood (2007) explained the self-efficacy as the belief depending on personal skills and capacity. In literature, there is no study about this indirect effect, but Gürol, Altunbaş and Karaaslan (2010) found a significant relationship between the belief that learning depends on skill and the self-efficacy on science teaching. The individuals who have high beliefs of personal self-efficacy on science teaching are expected to have the willing on experiments, examinations and observations. These can be related to the nature of science directly and one of the reasons of relationship between self-efficacy belief and the nature of science.

From the model, it can be understood that personal self-efficacy belief on science teaching influences the impact of science and technology on society through the belief that learning depends on skill. But this effect is weaker than the effect of belief that learning depends on effort. The reason of this may be that the teacher candidates' having higher beliefs that learning depends on effort.

It is occurred that personal self-efficacy belief in science teaching influences the science content knowledge through the belief that learning depends on skill. This effect is weaker than the effect that occurs through the belief that learning depends on effort because it may be that individuals think that effort is more effective than skill in term of reaching the knowledge.

The other variable in the model is the outcome expectation in science teaching. It is the weakest effective variable for science literacy. Thus, Bandura (1986) noticed that self-efficacy expectations forecast better behaviour than outcome expectations. There is no study on this indirect effect in the literature. The outcome expectation in science teaching of teacher candidates influences the nature of science through the beliefs that learning depends on effort and skill, but this effect is the weakest in the model. This is because the candidates have not enough experience and their low outcome expectations in science teaching.

The outcome expectation in science teaching influences the impact of science and technology on society through the beliefs that learning depends on effort and skill. Although this effect is higher than affecting the nature of science, it is still weak. Also, the outcome expectation in science teaching influences the science content knowledge through the beliefs that learning depends on effort and skill, and it is again a weak effect. This may be because the effects of science content knowledge and science and technology on society are better perceived by the teacher candidates than the nature of science.

CONCLUSION AND RECOMMENDATIONS

In the study carried out for the science teacher candidates, the following conclusions some of which are compatible to the literature and some are different were arrived:

The Results for Direct Effects

As a result of the study, the belief that learning depends on the effort is identified as the variable that directly influences the nature of science. According to this result, the more the teacher candidates have increasing level of beliefs that learning depends on the effort, the higher their perceptions related to the nature of science are. Besides, the other variable that influences the nature

of science is the belief that learning depends on skill. Accordingly, the more the teacher candidates have increasing level of beliefs that learning depends on the skill, the higher their perceptions related to the nature of science are. But its effectiveness is weaker than the belief that learning depends on effort.

The other independent variable is the impact of science and technology on society, and the belief that learning depends on effort influences this variable directly. Accordingly, the more the belief that learning depends on effort increases, the more perception levels of the teacher candidates on the impact of science and technology on society increases. Another variable that influences the impact of science and technology on society directly is the belief that learning depend on skill. Accordingly, the more the belief that learning depends on skill increases, the more the perception levels of individuals on the impact of science and technology on society increases, but this effect is weaker than the effect of belief that learning depends on effort.

The other independent variable of the study is the science content knowledge. The belief that learning depend on effort influences this variable directly, so the more the belief that learning depends on effort increases, the more the science content knowledge of the teacher candidates increases. This direct effect is the most powerful effect, too. The other variable that influences the science content knowledge directly is the belief that learning depends on skill. Accordingly, the more the belief that learning depends on skill increases, the more the science content knowledge of the teacher candidates increases.

The Results for Indirect Effects

As a result of the study, personal self-efficacy belief in science teaching influences indirectly the nature of science, the impact of science and technology on society and the science content knowledge through the belief that learning depends on effort. In other words, personal self-efficacy belief in science teaching influences the belief that learning depends on effort directly, and the belief that learning depends on effort influences the nature of science, the impact of science and technology on society and science content knowledge directly.

As a result of the study, personal self-efficacy belief in science teaching influences indirectly the nature of science, the impact of science and technology on society and the science content knowledge through the belief that learning depends on skill. In other words, personal self-efficacy belief in science teaching influences the belief that learning depends on skill directly, and the belief that learning depends on skill influences the nature of science, the impact of science and technology on society and science content knowledge directly. But this effect is weaker than the mediator variable, the belief that learning depends on effort.

In the study the other indirect effect is the outcome expectation. It influences the nature of science, the impact of science and technology on society and science content knowledge indirectly through the belief that learning depends on effort and the belief that learning depends on skill. This effect is the weakest in the model. This is because there is a weak relationship between the belief that learning depends on skill and the outcome expectation in science teaching.

In the study, a model was formed, which tries to explain the science literacy through epistemological beliefs and self-efficacy beliefs in science teaching. It is concluded that science literacy can be explained by epistemological beliefs and self-efficacy beliefs. The study is limited to the study group. The repeat of the study in other universities can contribute to the generalization of results. Also, epistemological beliefs and self-efficacy belief was used as the descriptors of science literacy in the study. This may be the constraint of the study. In this context, to do the study again by

adding variables like motivation and self-regulation may be helpful for healthier knowledge on this subject.

Casual-comparative research model, one of scanning models, was used in this study, but it may contribute to use different experimental and qualitative studies for the generalization of the results. Also, the study was conducted only for the science teacher candidates. If the same study was conducted for class teachers, it may contribute to the results.

It is concluded that the science literacy of science teacher candidates can be explained by epistemological beliefs and self-efficacy beliefs in science teaching. In consideration of these results, some measures may be taken and the science literacy of teacher candidates may be increased. Besides, some studies to increase the epistemological beliefs and self-efficacy beliefs in science teaching can be made for raising the science literacy level of students.

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