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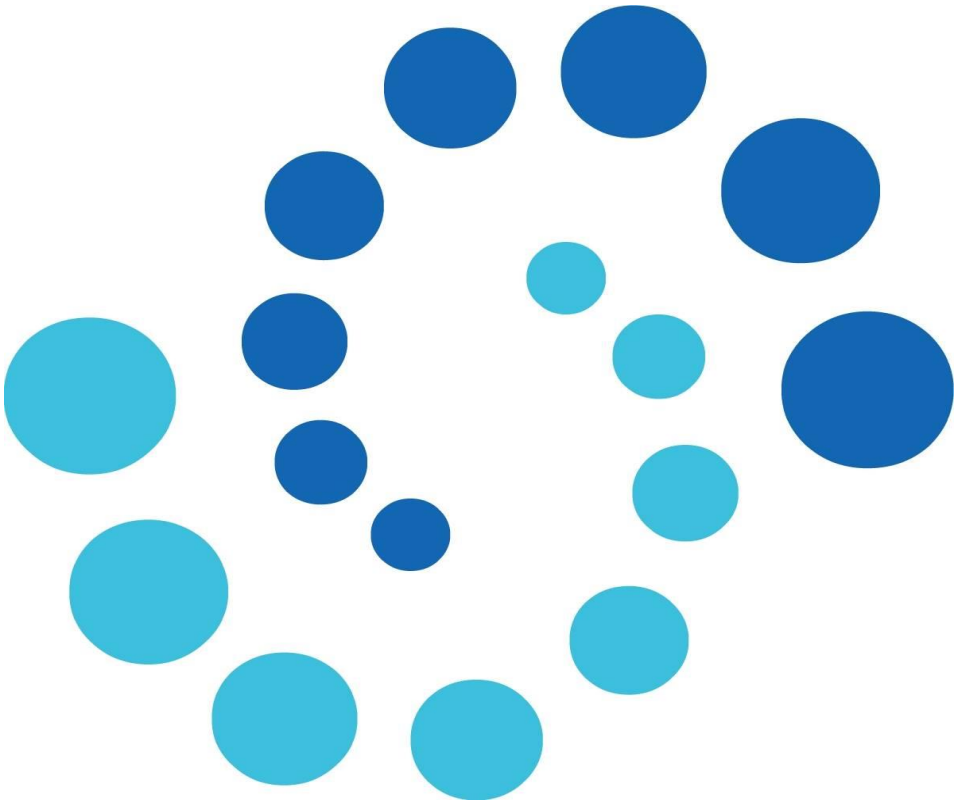
Sınırsız Eğitim ve Araştırma Dergisi



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Sınırsız Eğitim ve Araştırma Dergisinin Mart 2019 sayısını sunmaktan mutluluk duyuyoruz. Sınırsız Eğitim ve Araştırma Derneği (SEAD) olarak 2016 yılından bu yana kesintisiz olarak yayınladığımız Dergimizin amacı, eğitim ve araştırma alanına bilimsel katkı sağlamaktır. Bu amaçla kuramsal ve uygulamalı çalışmaları yayınlama, bilimsel bilgileri ulusal ve uluslararası düzeyde paylaşma, yeni bilgiler üretilmesine ortam hazırlama işlemine öncelik verilmektedir.

Dergimizin Bilim Kurulu yurt içi ve yurt dışında görevli akademisyenlerin katkılarıyla giderek güçlenmektedir. Akademik kalitesinden ödün vermeden yayın hayatına devam eden Dergimizin hazırlanmasına emeği geçen bütün editör, yazar ve hakemlere teşekkür ediyoruz.

Yılda üç sayı olarak yayınlanan Dergimiz çeşitli ulusal ve uluslararası düzeydeki indekslerde taranmaktadır. Bu sayıda eğitimle ilgili 5 bilimsel araştırmaya yer verilmiştir. Dergimiz, eğitim ve araştırma alanına yönelik makalelerin yanı sıra disiplinler arası akademik çalışmaların yer aldığı seçkin bir yayın olarak okuyucularla buluşmaya devam edecektir.

Dergimizin eğitim ve araştırma alanına katkılar getirmesini diliyoruz. Saygılarımızla.

SINIRSIZ EĞİTİM VE ARAŞTIRMA DERNEĞİ

Sınırsız Eğitim ve Araştırma Dergisi, Cilt 4, Sayı 1

The Journal of Limitless Education and Research, Volume 4, Issue1

İÇİNDEKİLER

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Review of National and International Studies on Scientific Argumentation in Education

Dr. Yurdagül BOĞAR, Hakkâri Üniversitesi, yurdagul-bogar@hotmail.com

Abstract: A great many research was done by researchers in order to find out which educational technique is more efficient and what environmental conditions and circumstances are needed for science courses to be more effective and fruitful for students. As a result of such research, it has been observed that teaching methods and techniques for science teaching were being revised in the social context in recent years. In this context, argumentation in science teaching is a very significant method since it broadens visions of students, enables them to understand the nature of science and configure and develop the concepts of science. Therefore, the purpose of this study was to review national and international studies on scientific argumentation in education. The results of the studies revealed that scientific argumentation-based teaching could lead to positive outcomes for students in various topics such as gaining high level thinking skills, improving conceptual understanding, understanding the nature of science, developing positive attitude towards science, improving suitable proficiency for science education, increasing academic achievement, and improving research skills on scientific epistemology.

Key words: Scientific argumentation, Review study, Education

Eğitimde Bilimsel Argümantasyon Üzerine Ulusal ve Uluslararası Çalışmaların İncelenmesi

Özet: Fen derslerinin öğrenciler için daha verimli ve daha etkili olabilmesi için hangi şartların gerekli olduğu, çevre koşullarının nasıl olması gerektiği ya da hangi öğretim yöntemlerinin etkili olduğu konusunda araştırmacılar birçok çalışmalar yapmışlardır. Bu çalışmalar sonucunda, fen eğitiminde kullanılan öğretim yöntem ve tekniklerinin son yıllarda sosyal bağlam açısından tekrar gözden geçirilmeye başlandığı görülmüştür. Bu bağlamda fen eğitiminde argümantasyon; düşünme ufuklarını genişletmesi, sağlam temeller üzerine oturtması, öğrencilerin bilimin doğasını anlamaları, bilimle ilgili kavramları yapılandırmaları ve geliştirmeleri bakımından oldukça önemli bir yöntemdir. Bu nedenle, bu çalışmanın amacı, eğitimde bilimsel argümantasyon üzerine ulusal ve uluslararası çalışmaları gözden geçirmektir. Yapılan çalışmaların sonuçları, bilimsel argümantasyon temelli öğretimin; öğrencilere yüksek düzeyde düşünme becerilerini kazandırmak, kavramsal anlayışı geliştirmek, bilimin doğasını anlamak, bilime karşı olumlu tutum geliştirmek, fen eğitimine uygun yeterliliği geliştirmek, akademik başarıyı artırmak, araştırma becerilerini geliştirmek ve bilimsel epistemoloji geliştirmek gibi çeşitli konularda olumlu sonuçlara yol açabileceğini göstermiştir.

Anahtar Sözcükler: Bilimsel argümantasyon, İnceleme çalışması, Eğitim.

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1. Introduction

The rapid changes and developments in the science and technology fields in the recent years have affected the targets of the contemporary science education as much as their affections in every aspect of our lives. In this context, the basic role of contemporary science education is to prepare students for such a rapidly changing world, to enable them to understand what is going on in the world, to train life-long learning students, and to support them to think like a scientist (Ministry of National Education [MEB], 2013; National Research Council [NRC], 2013). In order to reach this target, it is considered that especially argumentation approach, which enables the students to think like a scientist and which has gained considerable significance in recent years, has an important impact (Driver, Newton & Osborne, 2000; Öğreten, 2014).

Argumentation term was coined by Toulmin in 1958 for the first time. To Toulmin (1958), argumentation is the justification process of the claims under the light of data. Apart from this definition, different descriptions related to argumentation have been made by various researchers. For example, argumentation is described as a holistic process including the perception of a subject or a phenomenon, problem solving, sense-making from scientific processes, decision on a subject, and suggestion, support, critics, problematization and evaluation of opinions with different or similar perspectives by individuals (Kuhn, 1992), and as a basic epistemic application of science (Bricker and Bell, 2008). Also, argumentation within a wide scope concept, is handled in various forms such as scientific argumentation, socio-scientific argumentation, argument-driven inquiry. Because studies on scientific argumentation are the focus to be investigated in this study, it is necessary to define scientific argumentation, as well. Clark, D'Angelo, and Menekse (2009) have described scientific argumentation as the learning process in the science field or in different fields in which students participate to develop a convincing argument by making an evaluation with the processes and criteria in science and to structure valid arguments via the relationships between justification, proofs, and theoretical opinions. The aim of the present study is also to review the national and international studies on scientific argumentation in education.

2. Method

In this study, scientific articles and theses written in national and international context related to scientific argumentation have been reviewed. Thus, this study is a thematic content analysis (meta-synthesis) study. Thematic content analysis is defined as a systematic

comparison, which is used to describe the results of studies on a subject, or the theories, generalizations and interpretations created by the comparison and combination of the findings of these studies (Noblit & Hare, 1988). According to this, thematic content analysis (meta-synthesis) is not an ordinary review of the studies in the field but a methodological approach which depends on the interpretative analysis of the present research findings and from which new information is developed (Aspfors & Fransson, 2015). In the coding process of the accessed studies to fulfil the validation and reliability criteria of the study, an Excel table was employed. The data obtained were described in detail in this way and expert opinion was consulted. Firstly, ten (10) of the downloaded studies chosen randomly were coded by the researcher; then the coding that was performed, assistance was taken from an expert who had qualitative studies on argumentation and it was tried to maintain consistency between independent encoders. When inconsistencies occurred in the studies, they were reviewed and continued until a full consensus was reached. The other encoder was an associate professor with PhD degree in the field of science education and studying argumentation subject in her thesis by using qualitative research method currently working at a state university in İstanbul. In other words, some of the studies which were coded by another researcher and reliability formula suggested by Miles and Huberman (1994) was used by reliability calculation and the agreement percentage between the two coders was calculated to be 92%. This percentage is accepted to reveal that the coding was reliable.

2.1. Data Collection Process and The Criteria for Including Them in The Research

Data in this research was collected by document review method. The reason for choosing this method is in close relation with the purpose of the study because document review is described as the examination of the written materials to reach data related to the phenomenon or phenomena which are targeted for research (Çepni, 2010). Because the subject of the present study is the review of written materials (articles and theses) related to scientific argumentation, it is exactly a document review study. In this study, first, scanning in the international education journals in the Web of Science and ERIC databases by writing keywords such as “scientific argumentation”, “scientific argumentation in education” and “scientific argumentation in science education” in the detailed search tabs. The articles with argumentation concept were accessed in this way. Secondly, scanning was done in the YÖK Thesis Center and ULAKBİM Dergi Park databases to reach national theses and articles by writing the same keywords and these studies were accessed. Finally, the studies reached by the two scanning processes discussed above were gathered together. After this process, to determine

the studies to be reviewed, some selection criteria in accordance with the aim of the study were determined by the researcher. There were five (5) criteria as follows:

• The studies (theses or articles) reviewed had to be conducted between 1990 and 2016

•The samples in the studies (thesis or article) reviewed had to be students. In other words, those scientific argumentation studies conducted with teachers or other samples were not included in the research.

• While the national studies reviewed were chosen among both theses and articles, only articles were chosen among the international studies and the reason for this was the great number of international studies related to this subject.

• Major studies conducted by various researchers in different years related to each code were given as examples in the studies reviewed. For example, studies such as Balcı, 2015; Ceylan, 2010; Cross et al., 2008; Öğreten, 2014; Polat, 2014; Tsai et al., 2015 were given as references in the argumentation studies focusing on academic achievement.

• The studies reviewed had to be based on the data provided first-hand from the related samples (studies except those conducted with compilation, content analysis, meta-analysis methods).

The studies included in the research in accordance with the criteria specified above have been evaluated in terms of the subjects they tackled such as academic achievement, learning, discussion skills, epistemological beliefs and conceptual understanding.

3. National and International Studies on Scientific Argumentation

When the literature is examined, it can be seen that studies related to the usage of scientific argumentation in science education have continued increasingly for the past 30 years (e.g., Aydeniz et al., 2012; Berland & Reiser, 2011; Bricker & Bell, 2008; Ebenezer & Puvirajah, 2005; Erduran & Jimenez-Aleixandre, 2012; Erduran, Simon, & Osborne, 2004; Evagorou & Osborne, 2013; Felton & Kuhn, 2001; Hogan, Nastasi, & Pressley, 1999; Jiménez-Aleixandre, Rodriguez, & Duschl, 2000; Kelly & Takao, 2002; Knight & McNeill, 2012; Lewis & Leach, 2006; McNeill & Krajcik, 2009; McNeill & Krajcik, 2011; Naylor, Keogh, & Downing, 2007; Ogan-Bekiroglu & Eskin, 2012; Okumuş, 2012; Osborne, Erduran, & Simon, 2004a; Park & Kim, 2012; Pedretti & Nazir, 2011; Pimentel & McNeill, 2013; Riemeier, Fleischhauer, Rogge, & Aufschnaiter, 2010; Sampson & Clark, 2008; Şekerci, 2013; Von Aufschnaiter, Erduran, Osborne, & Simon, 2008). In a great majority of conducted studies, scientific argumentation method was

taken as a teaching method used in science classes and its effects were analyzed on variables such as academic achievement, learning, discussion skills, epistemological beliefs, the nature of science, scientific thinking skills, conceptual understanding or students' quality of argument and argumentation was measured in an ordinary class environment (e.g., Acar, 2015; Bricker & Bell, 2008; Boran, 2014; Clark & Sampson, 2008; Çınar, 2013; Evagorou & Avraamidou, 2008; Hanegan, Price, & Peterson, 2008; Jiménez-Aleixandre, Rodriguez, & Duschl, 2000; Polat, 2014; Jonassen & Kim, 2010; Kenyon & Reiser, 2005; Konstantinido et al., 2012; Kuhn & Reiser, 2005; Muratsu et al., 2015; Nussbaum & Sinatra, 2003; Öğreten, 2014; Watson et al., 2004). When these studies' samples and participants of the study are examined in general, it is possible to find studies conducted within a broad scale, beginning from primary education to university level. In this section, results and prominent ones of the scientific argumentation studies done with students were tried to be explained. The contents of the studies reviewed in the scope of this study (codes) and the identities of the studies reviewed are given in Table 1.

Table 1.

The contents of the studies reviewed in the scope of this study (codes) and the identities of the studies reviewed

The contents of the studies reviewed (CODES)	The identities of the studies reviewed
Scientific argumentation helps students learn science better	Acar, 2008; Clark & Sampson, 2008; Dawson & Venville, 2010; Erduran et al., 2004; Jimenez-Aleixandre & Pereiro-Munhoz, 2002; Kuhn & Reiser, 2005; Lopez & Gross, 2008; Millar & Osborne, 1998; Osborne, Erduran, Simon, & Monk, 2001; Sandoval & Reiser, 2004; Sadler & Fowler, 2006; Schwarz, Neuman, Gil, & Ilya, 2003; Tümay & Köseoğlu, 2011; Von Aufschnaiter et al., 2008; Zohar & Nemet, 2002.
The relationship between scientific argumentation and academic achievement	Aymen-Peker, Apaydın, & Taş, 2012; Balcı, 2015; Ceylan, 2010; Ceylan, 2012; Cross et al., 2008; Çinici et al., 2014; Demirel, 2015; Doğru, 2016; Erdoğan, 2010; Gültepe, 2011; Gümrah, 2013; Kaya, 2005; Keil, Haney, & Zoffel, 2009; Knight & McNeill, 2012; Niaz, Augilera, Maza, & Liendo, 2002; Okumuş, 2012; Öğreten, 2014; Özer, 2009; Özkara, 2011; Polat, 2014; Thoron & Myers, 2012; Tsai et al., 2015; Türkoğuz & Cin, 2013; Uluay, 2012; Üstünkaya & Savran Gencer, 2012; Yalçın-Çelik, 2010; Yıldız & Unal, 2016; Zohar & Nemet, 2002.
The relationship between scientific argumentation and conceptual understanding	Acar, 2015; Aymen-Peker, Apaydın, & Taş, 2012; Ceylan, 2012; Chinn & Anderson, 1998; Cross, Taasoobshirazi, Hendricks, & Hickey, 2008; Dawson & Venville, 2010; Driver et al., 2000; Gültepe, 2011; Gümrah, 2013; Herrenkohl et al., 1999; Jiménez-Aleixandre et al., 2000; Jimenez-Aleixandre & Pereiro-Munhoz, 2002; Kaya, 2013; Köseoğlu & Tümay,

	2007; Lawson, 2003; Leach, 1999; Niaz, Aguilera, Maza, & Liendo, 2002; Okumuş, 2012; Osborne, 2010; Osborne, Erduran, & Simon, 2004a; Osborne, Erduran, & Simon, 2004b; Ozdem, Ertepinar, Cakiroglu, & Erduran, 2013; Öztürk, 2013; Sadler & Fowler, 2006; Simon & Johnson, 2008; Şekerci, 2013; Türkoğuz & Cin, 2013; Uluçınar-Sağır & Kılıç, 2013; Üstünkaya & Savran Gencer, 2012; Von Aufschnaiter, Erduran, Osborne, & Simon, 2008; Waldrip, Prain, & Sellings, 2013; Yeh & She, 2010; Zohar & Nemet, 2002.
The relationship between scientific argumentation and conceptual change	Aslan, 2010; Demirci, 2008; Dole & Sinatra, 1998; Eryilmaz, 2002; Golden, 2011; Köseoğlu, Tümay, & Akben, 2007; Niaz et al., 2002; Nussbaum & Sinatra, 2003; Özer, 2009; Tekeli, 2009; Thorley & Treagust, 1987; Tümay & Köseoğlu, 2011; Uluçınar-Sağır, 2008; Yeşiloğlu, 2007.
The relationship between scientific argumentation and students' science process skills	Aslan, 2010; Çınar, 2013; Demir, 2014; Duschl & Osborne, 2002; Ebenezer & Puvirajah, 2005; Gümrah, 2013; Tan & Temiz, 2003.
The relationship between scientific argumentation and attitude towards science	Altun, 2010; Balcı, 2015; Ceylan, 2012; Çakır, 2011; Erdoğan, 2010; Gogolin & Swartz, 1992; Küçük, 2012; Özkara, 2011; Tekeli, 2009; Uluçınar-Sağır, 2008; Waldrip, Prain, & Sellings, 2013; Yalçın-Çelik, 2010; Yeşiloğlu, 2007; Yıldız & Unal, 2016.
The relationship between scientific argumentation and various thinking skills	Acar, 2015; Acar & Patton, 2012; Çınar, 2013; Dawson & Venville, 2010; Demir, 2014; Deveci, 2009; Doğru, 2016; Driver, Newton, & Osborne, 2000; Duschl, Ellenbogen, & Erduran, 1999; Duschl & Osborne, 2002; Erduran et al., 2004; Erduran, Ardac, & Yakmaci-Guzel, 2006; Eşkin, 2008; Fischer et al., 2014; Glassner & Schwarz, 2007; Gültepe, 2011; Iordanou, 2010; Jimenez-Aleixandre, Bullgallo-Rodriguez, & Duschl, 1997; Joiner & Jones, 2003; Kelly et al., 1998; Kuhn et al., 1997; Kuhn & Udell, 2003; Lawson, 2003; Munford, 2002; Nussbaum & Sinatra, 2003; Osborne et al., 2004a; Öğreten, 2014; Richmond & Striley, 1996; Sampson, Grooms, & Walker, 2011; Saraçoğlu et al., 2011; Schweizer, 2002; Teichert & Stacy, 2002; Tekeli, 2009; Tonus, 2012; Trend, 2009; Tümay & Köseoğlu, 2011; Watson, Swain, & McRobbie, 2004; Zohar, 1996; Zohar & Nemet, 2002.
The relationship between scientific argumentation and students' understanding of the nature of science	Altun, 2010; Balcı, 2015; Bell & Linn, 2000; Boran, 2014; Ceylan, 2012; Çetin, Erduran, & Kaya, 2010; Gümrah, 2013; Kaya, 2005; Kenyon & Reiser, 2006; McDonald, 2010; McDonald & McRobbie, 2012; Nussbaum & Bendixen, 2003; Sampson & Clark, 2006; Sandoval & Millwood, 2008; Simon, Richardson, Howell-Richardson, Christodoulou, & Osborne, 2009; Şekerci, 2013; Tekeli, 2009; Tümay & Köseoğlu, 2011; Uluçınar-Sağır & Kılıç, 2013; Von Aufschnaiter et al., 2008; Yerrick, 2000; Yeşiloğlu, 2007.
The relationship between scientific argumentation and	Boran, 2014; Doğru & Kıyıcı, 2005; Driver et al., 2000; Erduran, 2008; Evagorou & Osborne, 2009; Kuhn, 1992;

students' epistemological beliefs	Kuhn & Reiser, 2005; Nussbaum, Sinatra, & Pokiquin, 2008; Osborne et al., 2004b; Ryu & Sandoval, 2012; Sampson & Clark, 2006.
The relationship between scientific argumentation and students' argumentation quality	Berland, 2008; Chin & Osborne, 2008; Çetin, Kutluca, & Kaya, 2013; Çiftçi, 2016; Çinici et al., 2014; Deveci, 2009; Erduran et al., 2004; Eskin, 2008; Glassner, Weinstock, & Neuman, 2005; Gültepe, 2011; Iordanou, 2010; Katchevich, Hofstein, & Mamlok-Naaman, 2013; Kaya, 2013; Kim & Song, 2006; Kind, Wilson, Hofstein, & Kind, 2010; Kuhn, 1991; Öğreten, 2014; Perkins et al., 1991; Puvirajah, 2007; Walker et al., 2012; Wellom & Anderson, 1999; Yerrick, 2000; Zohar & Nemet, 2002.

Scientific argumentation is a process that maintains students accomplish new learnings. For this reason, there are great number of studies proposing that in order to learn science lessons better and correlate it with their own lives, facilitating scientific argumentation environments is necessary (e.g., Acar, 2008; Clark & Sampson, 2008; Dawson & Venville, 2010; Lopez & Gross, 2008; Sadler & Fowler, 2006; Tümay & Köseoğlu, 2011; Zohar & Nemet, 2002). Additionally, it is put forward that argumentation process helps students learn science (Erduran et al., 2004; Jimenez-Aleixandre & Pereiro-Munhoz, 2002; Kuhn & Reiser, 2005; Millar & Osborne, 1998; Osborne, Erduran, Simon, & Monk, 2001; Sandoval & Reiser, 2004; Schwarz, Neuman, Gil, & Ilya, 2003; Von Aufschnaiter et al., 2008), guide them to constitute and understand the knowledge (e.g., Aydeniz, Pabuccu, Cetin, & Kaya, 2012; Aymen-Peker, Apaydın, & Taş, 2012; Driver et al., 2000; Osborne, Erduran, & Simon, 2004b; Perkins, Farady, & Bushey, 1991; Yerrick, 2000)

One of the variables that it's relation with scientific argumentation is taken into account is academic achievement. Thus, it is remarkable that there are a lot of studies in the literature analyzing the relationship between scientific argumentation and academic achievement (e.g., Balcı, 2015; Ceylan, 2010; Cross et al., 2008; Çinici et al., 2014; Demirel, 2015; Doğru, 2016; Gümrah, 2013; Okumuş, 2012; Öğreten, 2014; Özer, 2009; Polat, 2014; Tsai et al., 2015). In a great majority of these studies it can be concluded that in science education, scientific argumentation has a great importance and effect in improvements of the achievement of students in different education level (e.g., Aymen-Peker, Apaydın, & Taş, 2012; Ceylan, 2012; Cross et al., 2008; Doğru, 2016; Erdoğan, 2010; Gültepe, 2011; Kaya, 2005; Keil, Haney, & Zoffel, 2009; Knight & McNeill, 2012; Niaz, Augilera, Maza, & Liendo, 2002; Öğreten, 2014; Özkara, 2011; Thoron & Myers, 2012; Tsai et al., 2015; Türkoğuz & Cin, 2013; Uluay, 2012; Üstünkaya & Savran Gencer, 2012; Yalçın-Çelik, 2010; Zohar & Nemet, 2002). As an example, Polat (2014) in his study investigated the effect of the scientific argumentation on students' academic

achievement. 25 students in 7th grade, 12 boys and 13 girls, receiving education at a primary school constitute the sample of the study. In experiment group, during the lessons, worksheets, developed in accordance with scientific argumentation technique and having properties of reliability and validity, were used; while in control group, lessons were taught according to their course books by the researcher. In the study, an achievement test, consisting of 30 multiple choice questions, was used as a data collecting tool. The study took 10 hours and achievement tests were used in the beginning as a pre-test and at the end as a post-test. As a result of the study, a significant difference was seen between experiment and control group in favor of experiment group. Along with these studies, although they are rare, there are some studies claiming that scientific argumentation does not have an effect on students' academic achievement (e.g., Demirel, 2015; Gümrah, 2013; Yıldız & Unal, 2016). For example, Demirel (2015) tried to define the effect of the scientific argumentation-based activities on 8th grade students' academic achievement. In the study, a quasi-experimental research design with pre-test and post-test was used. 19 students in the experimental group and 16 in the control group, in total 35 students constitute the sample of the study. Data of the study were collected through achievement test and semi-structured interviews. The research was completed in 7 weeks (4 hours in a week). As a result of the study, it was concluded that there is not a meaningful difference in terms of students' academic achievement.

In the related literature, there are enough studies in number conducted with students in different ages and analyzing the relationship between scientific argumentation and conceptual understanding (e.g., Ceylan, 2012; Chinn & Anderson, 1998; Cross, Taasoobshirazi, Hendricks, & Hickey, 2008; Driver et al., 2000; Gümrah, 2013; Kaya, 2013; Lawson, 2003; Niaz, Aguilera, Maza, & Liendo, 2002; Osborne, Erduran, & Simon, 2004a; Ozdem, Ertepinar, Cakiroglu, & Erduran, 2013; Öztürk, 2013; Sadler & Fowler, 2006; Simon & Johnson, 2008; Yeh & She, 2010). In some of the studies, it was put forward that since teaching science courses based on argumentation gives students the opportunity to interact with the concept as an individual or in a group, it helps them develop concepts on their own, in other words improve their conceptual understanding (Acar, 2015; Aymen-Peker, Apaydın, & Taş, 2012; Dawson & Venville, 2010; Gültepe, 2011; Herrenkohl et al., 1999; Jiménez-Aleixandre et al., 2000; Jimenez-Aleixandre & Pereiro-Munhoz, 2002; Köseoğlu & Tümay, 2007; Leach, 1999; Okumuş, 2012; Osborne, 2010; Osborne, Erduran, & Simon, 2004b; Şekerci, 2013; Türkoğuz & Cin, 2013; Uluçınar-Sağır & Kılıç, 2013; Üstünkaya & Savran Gencer, 2012; Von Aufschnaiter, Erduran, Osborne, & Simon, 2008; Waldrip, Prain, & Sellings, 2013; Yeh & She, 2010; Zohar & Nemet,

2002). For example, in a study conducted by Waldrip and his colleagues (2013), the effect of scientific argumentation method was analyzed whether students can understand movement topic conceptually during their physics lesson. Students were asked to do some reasoning related to some claims focused on both the process and the result. In order to collect data; observation, transcripts (written documents) including student-teacher interaction and interviews were used in this study. As a result of the study, they emphasized that students' interaction with reasoning activities concerning various claims and questioning both their own and other students' presentations has a positive effect on their conceptual understanding in movement subject and maintaining a positive introduction with the subject. Similarly, Aydeniz, Pabuccu, Cetin and Kaya (2012) investigated the effect of teaching properties of gases and behaviors of gas particles with argumentation method on students' conceptual understanding in a study conducted with 108 university students. Findings collected as a result of the evaluation of pre-and post-tests showed that experiment group's post-test results are considerably better than control group, there is a significant rise between experiment group's pre and post test results, and students in the experiment group changed %80 of the alternative ideas defined in their pre-tests, on the other hand in control group this ratio is less than %50. In some studies, though it was revealed that scientific argumentation applications do not have an effect on conceptual understanding or do not improve students' conceptual understanding skills (Çınar, 2013; Kaya, 2009; Patronis et al., 1999). For example, it was figured out at Çınar (2013)'s study conducted with 5th grade students there is a significant rise in posttests of both experiment and control groups. However, the researcher found that there is not a difference between conceptual understanding post-test points of experiment and control groups. According to Çınar (2013), the reason behind that is the effect of some lessons taught based on constructivist approach throughout the unit.

There are also studies investigating the effect of scientific argumentation on conceptual change (e.g., Demirci, 2008; Dole & Sinatra, 1998; Eryilmaz, 2002; Golden, 2011; Köseoğlu, Tümay, & Akben, 2007; Niaz et al., 2002; Nussbaum & Sinatra, 2003; Uluçınar-Sağır, 2008; Yeşiloğlu, 2007). In most of the studies conducted, it was concluded that scientific argumentation has positive effect on students' conceptual change (e.g., Aslan, 2010; Dole & Sinatra, 1998; Eryilmaz, 2002; Nussbaum & Sinatra, 2003; Özer, 2009; Tekeli, 2009; Thorley & Treagust, 1987; Tümay & Köseoğlu, 2011; Yeşiloğlu, 2007). To exemplify, in a study conducted by Aslan (2010) with 48 students in 9th grade, the effect of scientific argumentation on students' conceptual change and their construction of concepts in a correct way was analyzed.

Throughout the lessons, scientific argumentation method was used in experiment group and traditional teaching method was used in control group. As a result of the study, it was determined that students taught with scientific argumentation method are more successful in constructing the concepts in a correct way and executing meaningful conceptual change compared to students taught with traditional teaching method.

Some researchers conducted studies on whether scientific argumentation has an effect on students' science process skills or not (e.g., Aslan, 2010; Çınar, 2013; Demir, 2014; Duschl & Osborne, 2002; Ebenezer & Puvirajah, 2005; Gümrah, 2013; Tan & Temiz, 2003). In some of the studies done on this subject, it was found that there is a meaningful relationship between scientific argumentation and students' science process skills. For instance, Demirel (2014) in his study investigated the effect of applying problem and argumentation-based methods in chemistry lessons on students' academic achievement, science process skills and scientific reasoning aptitudes. For this purpose, one of the quasi- experimental research designs, a non-equivalent pre-and post-test control group design was used. Findings revealed that problem-based education is more effective in improving students' academic achievement and science process skills than teaching lessons according to the current program. Besides, it was found that argumentation method is more effective in developing students' academic achievement, science process skills, scientific reasoning aptitudes than teaching lessons according to existing program. In addition to these claims, scientific argumentation-based method is more effective than problem-based method in increasing students' science process skills. Also, in some of the studies, it was determined that scientific argumentation does not have a meaningful effect on students' science process skills (Gümrah, 2013). For example, in her study Gümrah (2013) wanted to determine the effect of argumentation method on academic achievement, conceptual understanding, their opinions of the nature of science concepts, science process, communication and argument skills of 9th-grade students. In the study, data were collected through both qualitative and quantitative methods. Quantitative data were analyzed using parametric tests. Qualitative data were analyzed using Toulmin's Argument Pattern. Findings of the study showed a significant difference in favor of the experiment group in terms of conceptual understanding. On the other hand, it was seen that there is not a meaningful difference between control and experiment group in terms of science process and communication skills.

When relationship between scientific argumentation and attitude towards science is examined, in some studies, meaningful and positive relationship between these two were found

(Balcı, 2015; Çakır, 2011; Erdoğan, 2010; Gogolin & Swartz, 1992; Küçük, 2012; Tekeli, 2009; Waldrip, Prain, & Sellings, 2013; Yalçın-Çelik, 2010; Yıldız & Unal, 2016). To exemplify, Yıldız & Unal (2016) investigated in their studies if scientific argumentation has effect on students' academic achievement and their attitudes towards Biology lessons. During the study, quasi-experimental design was used. Sample of the study consists of 67 students in 9th level, 22 boys and 45 girls. Study took 8 weeks to complete and lessons were taught by using traditional teaching method to control group but experiment group were taught by using argumentation method integrated with case study examples. Results of the study showed us that in the beginning students of the control and experiment groups had had similar attitudes towards their environment and academic achievements, after the study experiment group's students' academic achievements and their attitudes towards environment increased in a positive way. Although in some studies significant relationship between academic achievement and attitude towards science could not be found (Altun, 2010; Ceylan, 2012; Özkara, 2011; Uluçınar-Sağır, 2008; Yeşiloğlu, 2007). As an example, Özkara (2011) in his study, conducted with 48 students 8th-grade, concluded that activities in pressure subject based on scientific argumentation change academic achievement in a meaningful level, ensure information to be persistent however could not constitute significant difference in terms of their attitude towards science and their opinion about knowledge.

In the literature, it was emphasized in the studies, which analyze the relationship of scientific argumentation with various thinking skills or its effect on these skills (e.g., Acar, 2015; Acar & Patton, 2012; Dawson & Venville, 2010; Duschl, Ellenbogen, & Erduran, 1999; Duschl & Osborne, 2002; Glassner & Schwarz, 2007; Gültepe, 2011; Kelly et al., 1998; Tekeli, 2009; Tümay & Köseoğlu, 2011), that scientific argumentation has an important place in developing high level thinking skills such as scientific thinking skills (Acar, 2015; Acar & Patton, 2012; Trend, 2009; Schweizer, 2002), critical thinking skills (Gültepe, 2011; Lawson, 2003; Saraçoğlu et al., 2011; Tonus, 2012), scientific discussion skills (Acar, 2008; Deveci, 2009; Erduran et al., 2004; Iordanou, 2010; Kuhn et al., 1997; Munford, 2002; Okumuş, 2012; Osborne et al., 2004a; Öğreten, 2014), reasoning skills (Demirel, 2014; Erduran, Ardac, & Yakmaci-Guzel, 2006; Eşkin, 2008; Fischer et al., 2014; Nussbaum & Sinatra, 2003; Özer, 2009; Teichert & Stacy, 2002; Zohar, 1996), logical thinking skills (Acar, 2015; Doğru, 2016), research skills or abilities (Driver, Newton, & Osborne, 2000; Richmond & Striley, 1996), creative thinking skills (Demir, 2014), communicational skills (Kuhn & Udell, 2003) and scientific thinking skills (Deveci, 2009). For example, Doğru (2016) in her study investigated the effect of scientific argumentation-based classroom activities on 5th

grade students' academic achievement, logical thinking skills and willingness to discuss. For this purpose, one of the quasi-experimental research designs, pre-and post-test control group design was used. Whilst in the experiment group lessons were taught according to scientific argumentation-based classroom activities, in the control group lessons were taught according to the existing program. In the study, the data were collected through achievement test about substances, logical thinking group test and argumentation questionnaire. As a conclusion of the study, it was revealed that argumentation based inner class activities is effective in increasing students' academic achievement, logical thinking skills and their willingness towards discussion. Apart from these studies, there are also some studies concluded that scientific argumentation does not have effect on students' reasoning skills (Dawson & Venville, 2010; Zohar & Nemet, 2002), discussion skills (Jimenez-Aleixandre, Bullgallo-Rodriguez, & Duschl, 1997; Sampson, Grooms, & Walker, 2011; Watson, Swain, & McRobbie, 2004), critical thinking skills (Çınar, 2013; Joiner & Jones, 2003; Saraçoğlu et al., 2011) or does not develop these skills.

One of the variables that scientific argumentation's effect analyzed is students' understanding of the nature of science (e.g., Boran, 2014; Çetin, Erduran, & Kaya, 2010; Gümrah, 2013; Kaya, 2005; McDonald, 2010; McDonald & McRobbie, 2012; Nussbaum & Bendixen, 2003; Sandoval & Millwood, 2008; Simon, Richardson, Howell-Richardson, Christodoulou, & Osborne, 2009; Von Aufschnaiter et al., 2008; Yerrick, 2000; Yeşiloğlu, 2007). Most of these studies conducted with students from different education levels show us that there is a meaningful or positive relationship between scientific argumentation and students' understanding of the nature of science (e.g., Altun, 2010; Balcı, 2015; Bell & Linn, 2000; Kenyon & Reiser, 2006; Sampson & Clark, 2006; Sandoval & Millwood, 2008; Tekeli, 2009; Tümay & Köseoğlu, 2011; Uluçınar-Sağır & Kılıç, 2013). For example, Sandoval and Millwood (2008) in their study claimed students who understand scientific argumentation can understand the nature of science, people who can not practice science cannot really participate in scientific argumentation and they stated there is a strong connection between scientific argumentation and the nature of science. When Simon, Richardson, Howell-Richardson, Christodoulou and Osborne (2009) defining scientific argumentation, they revealed the connection between scientific argumentation and the nature of science. Throughout education based on scientific argumentation, they emphasized students use evidence to support their claims, internalize scientists' argumentative applications by evaluating other individuals' claims, in this way argumentation is a communication tool that helps them develop their practices related to knowledge and the nature of science. In some studies, on the other hand, it was revealed that scientific

argumentation method does not have an effect on students' understanding of the nature of science (Ceylan, 2012; Şekerci, 2013; Yeşiloğlu, 2007). In these studies, that scientific argumentation methodhad no significant effect on students' understanding of the nature of science was interpreted differently. As an example, according to Yeşiloğlu (2007) holistic structure in education cannot be maintained while multiple variables are measured at the same time, and it could be the reason for this condition. On the other side, again according to Yeşiloğlu (2007), teacher's having a traditional understanding of the nature of science may lead this unexpected outcome. In Ceylan's (2012) opinion, unless there is a significant difference in experiment group, this may be because of the fact that students have not encountered with the notions placed in the nature of science scale in their previous experience. However, Şekerci (2013) stated that development of the nature of science understanding is possible with long-term practices, and explained that as a result of short practice time, meaningful difference could not be observed in experiment group.

In the science teaching literature, there are some studies claiming that argumentation process affects students' epistemological beliefs (e.g., Boran, 2014; Doğru & Kıyıcı, 2005; Driver et al., 2000; Erduran, 2008; Evagorou & Osborne, 2009; Kuhn, 1992; Kuhn & Reiser, 2005; Nussbaum, Sinatra, & Pokiquin, 2008; Osborne et al., 2004b; Sampson & Clark, 2006).For example, Ryu and Sandoval (2012) created a classroom environment, where they can get positive experiments in terms of forming qualified scientific argumentations for students aged between 8 and 10, in a study aimed at evaluating whether scientific argumentation-based teaching process affects students' epistemic beliefs, incase it affects how it works. Researchers determined that scientific argumentation-based teaching process increase argumentation skills of individuals and besides that students' tendency towards using epistemic criteria improved compared to preliminary conditions.

In studies trying to define students' argument and argumentation qualities by using scientific argumentation method in a classroom environment, it was investigated either the method's effect on students' argumentation quality or whether it improves their argumentation quality or not (e.g., Chin & Osborne, 2008; Çetin, Kutluca, & Kaya, 2013; Çiftçi, 2016; Çinici et al., 2014; Glassner, Weinstock, & Neuman, 2005; Katchevich, Hofstein, & Mamlok-Naaman, 2013; Kim & Song, 2006; Kind, Wilson, Hofstein, & Kind, 2010; Öğreten, 2014). As a result of most of these studies, it could be seen that the more students get used to scientific argumentation process and understand how to use concepts, the more they will make the process productive and as the process proceeds quality of the argumentations that they could form in the beginning

will improve (e.g., Berland, 2008; Deveci, 2009; Erduran et al., 2004; Eskin, 2008; Gültepe, 2011; Iordanou, 2010; Kaya, 2013; Kuhn, 1991; Perkins et al., 1991; Puvirajah, 2007; Walker et al., 2012; Yerrick, 2000; Zohar & Nemet, 2002). Jonassen and Kim (2010), in their study, proposed methods and guidelines for developing students' argumentation skills along with problems that students experience when constructing arguments and found that if students can evaluate alternative arguments, they will better support their arguments and supply more justifications for their solutions to the problems. In a similar way, Jiménez-Aleixandre et al. (2000) looked into high school biology students' capacity to improve arguments in different science contexts. The study looked into the identification of use by the students of epistemic operations specific to the science domain. Toulmin's argumentation structure was used by the researchers to analyze student arguments. They found that students spend a lot of time on procedural events and relatively less time on meeting the stated objectives of the lesson. The research also reported that the students developed a diverse of arguments with mixed sophistication levels. Besides these studies, although they are few in number, in the literature there are also other studies concluded students in lower grades can participate in simple discussions and that's why their argumentation level is lower (Wellom & Anderson, 1999).

Apart from variables mentioned above, some other studies analyzing the connection between scientific argumentation and other variables such as students' willingness to discuss (Balcı, 2015; Çınar, 2013; Doğru, 2016; Erdoğan, 2010; Hakyolu, 2010), their self-efficacy skills (Öztürk, 2013), decision making (Kardaş, 2013; Maloney & Simon, 2006; Tonus, 2012), problem-solving (Cho & Jonassen, 2002; Kardaş, 2013), asking questions (Veerman, Andriessen, & Kanselaar, 2002), environmental literacy (Fettahlıoğlu, 2012) were also detected.

When the literature is examined, Toulmin model was generally used in the national and international studies conducted with students (e.g., Altun, 2010; Berland & McNeill, 2012; Erduran & Jimenez-Aleixandre, 2007; Erduran, Simon, & Osborne, 2004; Jiménez-Aleixandre, Rodriguez, & Duschl, 2000; Kardaş, 2013; Kutluca, 2012; Maloney & Simon, 2006; Özkara, 2011; Simon, Erduran, & Osborne, 2006). This model is taken as more favored compared to other models because it gives more importance to rebuttals, comparing data and evidences, defending the claim in harmony, giving importance to backings. However, there are some scientific argumentation studies in the literature of science which explain Toulmin model is ineffective in analyzing argumentation in small-group discussions in classroom environment and conducted by using different models (Berland, 2008; Clark & Sampson, 2008; Kelly & Takao, 2002; McNeill et al., 2006; Sandoval, 2003; Zohar & Nemet, 2002).

4. Conclusions and Discussion

In this study, the researcher has tried to evaluate national and international studies on scientific argumentation in education. The results of the researches which were attempted to be explained in summary above have revealed that scientific argumentation studies have concentrated on certain contents both in national and international literature. In the studies reviewed, majority of the researchers have argued that scientific argumentation enabled the students to learn better because in the scientific argumentation process, the students ask questions, they evaluate each other's opinions and they receive feedback. This plays a considerably important role in structuring the knowledge of the students and enables them to learn better naturally. The presence of a big number of studies focusing on the relationship between scientific argumentation and academic achievement is another conclusion of this study. In general, the researchers have revealed that scientific argumentation has a positive effect on the academic achievements of the students. The reason for this may be their learning by understanding the concepts and phenomena related to the subject, the creation process of the concepts and the relationships between the concepts through scientific argumentation and this process leading to an increase in their achievement levels. Also, a result showing the presence of studies revealing the impact of scientific argumentation on the conceptual understanding and conceptual changes of the students was reached. These studies display that scientific argumentation has a positive effect on the conceptual understanding of students because in classroom settings focused on scientific argumentation, students are actively included in the creation process of knowledge and can carry out their activities with the materials appropriate for the method. Also, any student can confirm his/her argument by discussing the subject or hypothesis in question and confute the other arguments presented or he/she may become aware of his/her mistakes in an opinion and learn the real meaning of the concept; all these enable the student to develop conceptually. Additionally, another conclusion that was reached was the presence of studies that examined scientific argumentation and scientific process skills or scientific argumentation and attitude towards science in their content. However, these studies are limited in number when compared to those problematizing the relation between scientific argumentation and achievement or scientific argumentation and conceptual understanding. Based on this, it can be said that the researchers were more interested in the relationship between scientific argumentation and academic achievement or between scientific argumentation and conceptual understanding.

Another result obtained was the positive impact of education based on scientific argumentation on the development of high-level thinking skills of the students (e.g., scientific reasoning skills, logical thinking skills, critical thinking skills, problem-solving skills). High level cognitive skills of the students such as analysis, synthesis and assessment develop because the teacher, instead of giving information in ready form, ensures that the students explain their opinions by discussing them with others and structure the knowledge better by showing proof or support. It is inevitable for the students, who have developed high level cognitive skills, to develop high level thinking skills. Furthermore, there is a great number of studies showing that education based on scientific argumentation is effective on the quality of the argument produced by students. The general trend of these studies is the positive influences of education based on scientific argumentation on the argument quality of the students because as students get used to scientific argumentation process and understand how related concepts can be used, they can make the process more productive and the quality of the arguments they could create at the beginning increases as the process progresses. In addition to these, the presence of studies tackling the relationship between scientific argumentation and the nature of science or the relationship between scientific argumentation and epistemological beliefs was another conclusion reached.

One of the most striking and interesting results of this study was that when the studies (articles or theses) were reviewed, most of them were conducted in the education of science. For the rest of the studies, most were also conducted in the education of physics, chemistry and biology that make up the science field and studies carried out in mathematics education, classroom education and Turkish education were also encountered even if these were rare. The result revealing that most of the studies reviewed were conducted in the education of science field and by researchers of science education is not surprising when the update in the education program and the starting points of the studies conducted abroad in this field are considered. When the similarity of the scientific argumentation process to structuring process of scientific knowledge, elements making up science literacy and the expectations of the current educational system from the students are taken into consideration, frequent use of scientific argumentation applications may be recommended especially in science and science-related lessons. In the present study, national and international studies related to scientific argumentation in education were reviewed within the scope of certain criteria including students as the sample. In the future studies on this subject, the researchers can work with teachers or other participant groups as samples.

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Eğitimde Bilimsel Argümantasyon Üzerine Ulusal ve Uluslararası Çalışmaların İncelenmesi

GENİŞ ÖZET

Bu çalışmada da eğitimde bilimsel argümantasyon üzerine ulusal ve uluslararası bağlamda yapılan bilimsel makaleler ve tezler incelenmiştir. Bu nedenle çalışma bir tematik içerik analizi (meta-sentez) çalışmasıdır. Bu araştırmada veriler, doküman incelemesi yöntemi ile toplanmıştır. Çalışmada bilimsel argümantasyon konusu ile ilgili yazılı kaynakların (makaleler ve tezler) incelenmesi söz konusu olduğundan, çalışma tam anlamıyla doküman incelemesi çalışmasıdır. Bu çalışmada ilk olarak; Web of Science ve ERIC veri tabanlarında yer alan uluslararası eğitim dergilerindeki gelişmiş arama sekmelerine "bilimsel argümantasyon", "eğitimde bilimsel argümantasyon" ve "fen eğitiminde bilimsel argümantasyon" gibi anahtar sözcükler yazılarak taramalar gerçekleştirilmiştir. Bu şekilde argümantasyon kavramının yer aldığı makalelere ulaşılmıştır. İkinci olarak, ulusal alanda yapılmış olan tez ve makalelere ulaşmak için YÖK Ulusal Tez Merkezi ve ULAKBIM Dergi Park veri tabanlarında aynı anahtar kelimeler yazılarak taramalar yapılmış ve çalışmalara ulaşılmıştır. Son olarak; yukarıda belirtilen iki tarama sürecinde ulaşılan çalışmalar bir araya getirilmiştir. Bu süreçten sonra, incelenecek çalışmaların belirlenmesi amacıyla yazar tarafından çalışmanın amacına uygun olarak bir takım seçim ölçütleri belirlenmiştir. Bu ölçütler beş (5) tane olup aşağıdaki şekildedirler:

• İncelenen çalışmaların (tez veya makale) 1990 ve 2016 yılları arasında yapılmış olması.

•İncelenen çalışmaların (tez veya makale) örneklemlerinin öğrenciler olması. Diğer bir ifadeyle, öğretmenlerle veya diğer örneklemlerle yapılan bilimsel argümantasyon çalışmaları araştırmaya dahil edilmemiştir.

• İncelenen çalışmalar da ulusal hem tez hem de makalelere yer verilirken, uluslararası çalışmalarda sadece makalelerin ele alınması. Bunun nedeni ise, ele alınan konu ile ilgili yapılan uluslararası tezlerin oldukça fazla olmasıdır.

• İncelenen çalışmalar da (tez veya makale) her kod ile ilgili farklı yıllarda ve farklı araştırmacılar tarafından yapılan belli başlı çalışmalar örnek verilmiştir. Örneğin; akademik başarıya odaklanan argümantasyon çalışmalarında, Balcı, 2015; Ceylan, 2010; Cross et al., 2008; Öğreten, 2014; Polat, 2014; Tsai et al., 2015 gibi çalışmalara referans verilmiştir.

• İncelenen çalışmaların ilgili örneklemlerden ilk elden sağlanan veriye dayalı olması.

Bu çalışmada, araştırmacı eğitimde bilimsel argümantasyon üzerine ulusal ve uluslararası çalışmaları değerlendirmeye çalışmıştır. Yukarıda özet olarak açıklanmaya çalışılan araştırmaların sonuçları, bilimsel argümantasyon çalışmalarının hem ulusal hem de uluslararası literatürde belli içeriklerde toplandığını ortaya koymuştur. Ele alınan çalışmalarda, araştırmacıların büyük bir çoğunluğu bilimsel argümantasyonun öğrencilerin daha iyi öğrenmesine olanak sağladığını ileri sürmüşlerdir. Çünkü bilimsel argümantasyon sürecinde öğrenciler sorular sorar, birbirlerinin fikirlerini değerlendirir ve geri bildirim alırlar. Bu durum öğrencilerin bilgilerinin yapılandırmasında oldukça önemli bir rol oynar ve doğal olarak daha iyi öğrenmelerine imkân sunar. Bilimsel argümantasyon ile akademik başarı arasındaki ilişkiye odaklanan çok sayıda çalışma olduğu da ulaşılan bir başka sonuçtur. Genelde araştırmacılar bilimsel argümantasyonun öğrencilerin akademik başarıları üzerinde pozitif bir etkisi olduğunu ortaya koymuşlardır. Bilimsel argümantasyonun öğrencilerin kavramsal anlamaları ve kavramsal değişimleri üzerine etkisini ortaya koyan çalışmalarında olduğu sonucuna ulaşılmıştır. Bu çalışmalar bilimsel argümantasyonun öğrencilerin kavramsal anlamaları üzerine olumlu etkisi olduğunu göstermektedir. Çünkü bilimsel argümantasyon odaklı sınıf ortamlarında, öğrenci bilginin oluşma sürecine etkin bir şekilde dâhil olur ve yönteme uygun materyallerle kendi etkinliğini yapabilir. Ayrıca öğrenci eldeki konuyu ya da hipotezi tartışarak kendi savını doğrulayabilir, sunulan diğer savları çürütebilir ve kendi yanlış fikirlerini fark edip kavramın gerçek anlamını öğrenebilir tüm bunlar öğrencinin kavramsal olarak gelişmesine olanak sağlar. Ayrıca, ele alınan çalışmaların içeriklerinde bilimsel argümantasyon ile bilimsel süreç becerilerinin veya bilimsel argümantasyon ile fene karşı tutumun incelendiği çalışmaların olduğu da ulaşılan bir başka sonuçtur. Fakat bu çalışmalar, bilimsel argümantasyon ile başarı arasındaki ilişki veya bilimsel argümantasyon ile kavramsal anlama arasındaki ilişki çalışmalarına göre daha sınırlı sayıdadır. Bu sonuçtan yola çıkarak, araştırmacıların daha çok bilimsel argümantasyonun akademik başarı ile ilişkisi veya bilimsel argümantasyonun kavramsal anlama ile ilişkisi ile ilgilendikleri söylenebilir.

Elde edilen sonuçlardan bir diğeri, bilimsel argümantasyona dayalı öğretimin öğrencilerin üst düzey düşünme becerilerinin (akıl yürütme becerileri, eleştirel düşünme becerileri, problem çözme becerileri) gelişmesindeki olumlu etkisidir. Üst düzey bilissel becerileri gelişen öğrencilerin üst düzey düşünme becerilerinin gelişmesi de kaçınılmazdır. Dahası, bilimsel argümantasyona dayalı öğretimin öğrencilerin oluşturdukları argüman kalitesi üzerinde etkili olduğunu gösteren araştırmalarda fazladır. Bu araştırmaların genel eğilimi bilimsel argümantasyonun öğrencilerin argüman kalitesi üzerinde olumlu etkilere sahip olduğudur.

Bunlara ek olarak, bilimsel argümantasyon ile bilimin doğası arasındaki ilişkiyi ele alan veya bilimsel argümantasyon ile epistemolojik inançlar arasındaki ilişkiyi ele alan çalışmalarında yapıldığı ulaşılan bir başka sonuç olarak karşımıza çıkmaktadır.

Bu çalışmanın en göze çarpan ve ilgi çekici sonuçlarından biri, ele alınan çalışmalar (tez veya makale) incelendiğinde bu çalışmaların büyük bir kısmının fen eğitimi alanında yapıldığıdır. Geriye kalan çalışmaların çoğu da feni oluşturan fizik, kimya ve biyoloji eğitimi alanında yapılmış olup nadir de olsa matematik eğitimi, sınıf eğitimi ve Türkçe eğitimi alanında yapılan çalışmalarda karşımıza çıkmaktadır. Yapılan bu çalışmada, eğitimde bilimsel argümantasyon ile ilgili ulusal ve uluslararası çalışmalar belli ölçütler dahilinde incelenmiştir. Örneğin araştırmanın ölçütlerinden biri, incelenen çalışmaların örnekleminin öğrenciler olmasıdır. Bundan sonra bu konuda çalışma yapacak olan araştırmacılar, örneklem olarak öğretmenlerle veya daha farklı katılımcı grupları ile çalışılabilirler.