1976'DAN 2020'YE KADAR BİLİMDE ARGÜMANTASYON ALANINDAKİ ÇALIŞMALARIN BİBLİOMETRİK ANALİZİ

Nejla ATABEY
Dr. Öğretim Üyesi, Muş Alparslan Üniversitesi, Muş, Türkiye, n.atabey@alparslan.edu.tr
ORCID: 0000-0001-8710-3595

Ayşegül EVREN YAPICIOĞLU
Dr. Araştırma Görevlisi, Muğla Sıtkı Koçman Üniversitesi, Muğla, Türkiye, aevren@mu.edu.tr
ORCID: 0000-0003-0528-8528

ÖZ

Bu çalışmanın amacı, WoS (Web of Science) veri tabanında yer alan argümantasyon ile ilgili makalelerin bibliyometrik özelliklerini analiz etmektir. 26 Mart 2020 tarihinde argümantasyon ile ilgili toplam 2176 makale belirlenmiştir. Yıllara göre makale ve atıf sayıları, makaleleri yayınlayan önde gelen kurum ve ülkeler, ülkeler arasındaki işbirlikleri ve referanslarda en fazla ortak atıf alan makalelerin sayısı betimsel ve bibliyometrik analizler kullanılarak belirlenmiştir. Ayrıca, argümantasyon ile ilgili makalelerde anahtar kelimelerin en sık birlikte kullanılma durumları ortaya konmuştur. Araştırmanın bir sonucuna göre argümantasyon alanında makale sayısı açısından öne çıkan ülke ABD (Amerika) iken, en yüksek bağlantı gücü ve işbirlikleri ile güçlü etkiye sahip ülke İngiltere'dir. Araştırmanın diğer bulguları, argümantasyon alanındaki araştırmaların fen ve fen eğitimi ve matematik eğitimi, matematik ve mantık, yapay zekanın bilgisayar bilimleri ve dilbilimdeki uygulamaları gibi birçok disiplinde yapıldığını ortaya koymuştur. Ancak argümantasyon alanındaki araştırmaların en fazla ilerlemeyi fen eğitiminde gösterdiği söylenebilir. Ayrıca ortak atıflarda en çok atıf yapılan makaleler Driver, Newton ve Osborne (2000)'a ve Osborne, Erduran ve Simon (2004) ile Zohar ve Nemet (2002)'e aittir. Ayrıca, Toulmin'in (1958) "Argümanın Kullanımları" isimli kitabı, dikkat çekici derecede atıf almaktadır. Ayrıca makalelerde en sık birlikte kullanıldığı tespit edilen anahtar kelimeler argümantasyon, soyut argümantasyon, söylem analizi, argümantasyon teorisi, eleştirel düşünme, işlemsel karmaşıklığı ve argümantasyon semantiğidir.

Anahtar kelimeler: Argümantasyon, bibliometrik analiz ve fen eğitimi

BIBLIOMETRIC ANALYSIS OF THE ARTICLES IN THE FIELD OF ARGUMENTATION IN SCIENCE FROM 1976 TO 2020

ABSTRACT

The purpose of the current study is to analyse bibliometric features of the articles on argumentation available in the WoS (Web of Science) database. A total number of 2176 articles on argumentation were determined on the date of 26 March 2020. The number of articles and citations across the years, prominent institutions and countries publishing the articles, collaborations between the countries, having the highest co-citations in the references of the articles were determined through the use of descriptive and bibliometric analyses. Also, the most frequent co-occurrences of the keywords in the articles on argumentation were revealed. As a result of the research, the country that comes to the fore in terms of the number of articles in the field of argumentation is the USA (America), while the UK (England) is a country with high influences in this field in terms of highest link strength and collaborations. Other findings of the study revealed that research in the field of argumentation has been carried out in many disciplines such as science and science education and mathematics education, mathematics and logic, applications of the artificial intelligence in computer science and linguistics. However, it can be said that research in the field of argumentation made the most progress in science education. In addition, the most cited articles in co-citations belong to Driver, Newton and Osborne (2000) and Osborne, Erduran and Simon (2004) and Zohar and Nemet (2002). Also, Toulmin's (1958) book of the "Uses of Argument" receives remarkable citations. Moreover, the co-occurrences of the keywords found to be used the most frequently in the articles are argumentation, abstract argumentation, discourse analysis, argumentation theory, critical thinking, computational complexity and argumentation semantic.

Keywords: Argumentation, bibliometric analysis, and science education.

INTRODUCTION

The academic studies of scientists and researchers in the field of argumentation have been continuing for about 50 years. Argumentation has been used in many fields such as mathematics (Schwarz et al., 2010), history (Monte-Sano, 2016) and geography (Díaz et al., 2020). Therefore argumentation has contributed to many science disciplines, including science education (Erduran & Jimenez-Alexiandre, 2007). Even, argumentation has been accepted as a central dimension of science education (Anwar et al., 2019; Driver et al., 2000; Sadler, 2006). Morever, it is also called as the central goal of science education since it requires carrying out scientific practices including presenting and justifying claims (Berland & McNeill, 2010; Erduran et al., 2015). In fact, it can be stated that on the one hand argumentation is seen both a teaching goal such as a part of knowledge in science curriculum (Erduran & Jimenez-Alexiandre, 2007), on the other hand, a main activity of the science that will be used to evaluate assumptions based on the evidence (Newton et al., 1999). Therefore, no matter what point of view we take into account, it can be stated that science education without argumentation would be incomplete.

Argumentation that has been emphasized to be taught in science classes as a component of scientific literacy (Erduran et al., 2015) is using language to reach a consensus on different views and to justify or rebut a standpoint (van Eemeren et al., 2015). Like van Eemeren et al. (2015), Kuhn and Udell (2003) define argumentation as a dialogic process in which two or more opposite claims are debated. In another definition, argumentation is considered as reasoning about controversial issues that have multiple solutions and can be evaluated with different perspectives (Sadler, 2006). Argumentation is also emphasized as a social activity in which more than one person engages in persuasion and criticism about their ideas (McNeill et al., 2016). From a more holistic point of view, argumentation is defined as an issue to be addressed in education and an outcome of scientific discourse (Bricker & Bell, 2008).

One of the reasons that make argumentation a focus of science education can be attributed to the contributions of it in educational settings. The studies using argumentation in learning environments showed that argumentation increased students' achievement and conceptual understanding (Duran et al., 2017; Okumuş & Ünal, 2012), reduced verbal aggression (Sanders et al., 1994), enhanced critical thinking and argumentation skills (Hasnunidah et al., 2015), developed conceptual understanding (Çetin, 2014) and problem solving skills (Cho & Jonassen, 2002), offered the opportunity to understand the role of values and cultural components in learning science (Duschl et al., 2007), and supported informal reasoning skills (Venville & Dawson, 2010).

Due to the contributions of argumentation, important education standards and associations such as Next Generation Science Standards (NGSS) and National Research Council (NRC, 2012) state that one of the scientific practices that students should be engaged in is evidence-based argumentation. This emphasize has resulted in many studies focusing on argumentation. Numerous studies on argumentation have led researchers to identify trends in these studies and to conduct research to see them with a bird's eye view. One of these studies

belongs to Kartika et al. (2021) who found that studies on argumentation are mostly with secondary students, Toulmin' argumentation model was used mostly to analyse argumentation quality, researchers from Taiwanise are the ones who mostly studied argumentation in Asia-Pasific Region. In another study, Erduran et al. (2015) found that from 1998 to 2012, articles related to argumentation increased every year, that linguistic aspects of argumentation were more emphasized than epistemic aspects of argumentation in journals (Science Education, International Journal of Science Education, and Journal of Research in Science Teaching) and that the concepts of 'discourse' and 'discussion' were used more than the concepts of 'talk', 'conversation', 'dialogue' and 'negotiation'. In addition Bağ and Çalık (2017) found that the argumentation studies between the years of 2006-2016 focused on the effect of argumentation on achievement and attitudes towards science. Kahraman and Kaya (2021) carried out a thematic content analysis of rhetorical and dialectical argumentation studies in science education. According to the results of the study, rhetorical argumentation studies were more than dialectic argumentation studies, and most of the studies focused on analyzing students' argumentation and improving their argumentation skills. The study of Lin et al. (2014) showed that one of the most studied topics in the Top 10 highly cited papers published between the years of 2008–2012 and 1998-2002 was argumentation. Another recent review belonging to Lee et al. (2009) revealed that argumentation was the research topic in the most of the top 10 most cited articles for the years 1998-2002. The review studies mentioned above give information about the number of argumentation studies, what contents or variables are considered in the context of argumentation, the research methods, data collection tools, grade level, domain of the studies and sample size in argumentation studies.

The thematic or systematic content analysis and review studies are used to determine the trends in a research topic and evaluate scientific publications all over the world. There are such studies (for example, Bağ & Çalık, 2017; Erduran et al. 2015; Kahraman & Kaya, 2021) in the field of argumentation. However, the current research differs from other studies in that it includes bibliometric features such as the number of articles, citations, co-citations, as well as network maps of collaborations in the field of argumentation. Studies on bibliometric analysis studies are detailed in the section below.

Bibliometric Analysis

The concept of bibliometry, which dates back to the 1920s, was first used by Alan Pritchard (Demir & Erigüç, 2018). Pritchard (1969, p. 2) described that "Bibliometrics is the application of mathematics and statistical methods to books and other media of communication". In another definition, Raisig (1962) stated that bibliometric analysis is a combination and interpretation of statistics regarding books and journals. Therefore, it can be specified that bibliometric is a kind of quantitative analysis (Çevik-Ünlü & Alp, 2019). The mathematical and statistical methods used in this quantitative analysis give measures about information related to the results of scientific studies (Erdoğan, 2020). This analysis makes the bibliography of the scientific literature visual and presents models and important information for researchers related to their research topics (Ye et al., 2019).

Bibliometric analysis presents many benefits for researchers. For example, bibliometric analysis gives opportunity to researchers to explore the direction of the developments in a scientific field, the dynamics and structure of the field, and to define the most important topics of research in this field (Demir & Erigüç, 2018). This analysis makes the important journal properties, the published contents, citations and the authors of the studied field more visible (Giménez-Espert & Prado-Gascó, 2019). In addition, by using bibliometric techniques, the most productive researchers, sources, journals, keywords can be determined, the level of interaction between researchers and the reasons of these interactions can be revealed, and in-depth research can be conducted to clarify these reasons (Gürlen et al., 2019). Numerical statistics on the increase in publications over the years as well as the top contributors (authors, countries, etc.), collaboration between authors / institutions, reference values for publications can also be demonstrated using bibliotechnic methods (Şen, 2020). In addition, bibliometry makes it possible to reach a general conclusion about the diversity of research themes and the multidisciplinary character of a research field (Çilhoroz & Arslan, 2018). Also bibliometric studies are beneficial for researchers in terms of being a road map for the scientific studies planned to be carried out in the future and allowing the pursuit of the development of the study field over time (Çevik-Ünlü & Alp, 2019). Therefore, bibliometric analysis is a valuable literature analysis tool (Wang et al., 2014), and can be used to perform a guiding and enlightening study for studies in any field (Şenbabaoğlu & Parıltı, 2019).

Many bibliometric analysis studies have also been carried out in science and science education in order to benefit from the mentioned outcomes above. When the bibliometric studies in education were examined, it was determined that the researchers focused on the key concepts of women in science, classroom dialogue and science teachers etc. For example Dehdarirad et al. (2015) carried out the development and growth of scientific literature on women in science and results revealed that there was an increase in the number of articles and in the number of authors per article, that gender differences were the most studied topic and that education and educational research were the most studied fields, but that the increase in international cooperation was not parallel to these increases. Song et al. (2019) reviewed the literature on classroom dialogue from 1999 to 2018 through WoS database. It has been determined that publications and citations related to classroom dialogue have increased in the last 20 years, the USA is the country that contributes the most in this field, and the most used keywords are 'class', 'discourse', 'student'. Ye et al. (2019) used bibliometric analysis to investigate the development of research on science teachers. The results showed that while the focus was on the attitudes of science teachers between 1960 and 1970, it was on pedagogical content knowledge in the 1980s and on teachers' views of the nature of science from the 1990s to the 21st century. However, it has been determined that recently there has been a shift in the focus towards scientific thinking skills such as argumentation. In addition, argumentation as a science teacher's key competence is one of the mostly used keywords in research on science teachers.

Bibliometric studies in science education also showed that they focused on the key concepts of science curriculum, critical thinking, nature of science, augmented reality, environment-focused theses in computer aided education and STEM (Arıcı et al., 2019; Batur & Özcan, 2020; Bozdoğan, 2020; Demir & Çelik, 2020;

Özkaya, 2019; Sönmez, 2019). For example the study on bibliometric analysis of publications on science curricula (the years of 1970-2019) showed that student access and curriculum design were the most studied topics, and the USA was the country with the most collaboration (Demir & Çelik, 2020). In addition, Batur and Özcan (2020) examined the post graduate theses on the key concept of critical thinking in Turkey and concluded that critical thinking is mostly studied in the field of science education. Bozdoğan (2020) reached a similar conclusion by using the key concept of planetarium in his research. Two of the most frequently used keywords in studies on this subject were determined as science applications and science education. In another study, the trends in research on the nature of science (NOS) in the literature were tried to be determined and the categories of student and teacher concepts about NOS, philosophical aspects of NOS, NOS in the context of socioscientific issues, and NOS in scientific research were the most studied areas on NOS (Jho, 2018).

As can be seen, many thematic analysis and content alysis methods are used or review studies are found in the literature in science (for example, Bağ & Çalık, 2017; Erduran et al. 2015; Kahraman & Kaya, 2021), no bibliometric study demonstrating research trends related to argumentation, which is defined as the language of science and gains importance as a goal of science education, has not been found. Also the studies of content or thematic analysis method or review studies focus on different time periods, different sub-subject areas of argumentation and different analysis techniques from the current study. The original aspect of the current study is that the articles on argumentation in a long period of time ranging from 1976 to 2020 were examined by means of a bibliometric analysis computer program of Vosviewer. In addition, current study reveals the origin of research on argumentation, the change over the years, the cooperation of prominent countries and instituations and authors in this field, and researchers and publications that have had an impact.

METHOD

Research Model

The current study focuses on bibliometric features of the articles published on the topic of argumentation in WoS database. Therefore, the study was designed as a descriptive study. Descriptive studies are a suitable research model for studies aiming to describe a situation as it is (Karasar, 2020). The descriptive research model can be used to generalize the results by scanning and analyzing as many appropriate scientific studies in the field as possible (Balcı, 2020).

The main research question is "What are the bibliometric features of the articles on argumentation indexed in the WoS database from 1976 to 2020?". The sub-research questions which are constructed by using bibliometric indicators are below.

- How is the distribution of the number of articles across the years on argumentation?
- How is the distribution of the citations made in the articles on argumentation?
- What are the top ten most cited articles on argumentation?
- What are the institutions publishing the highest number of articles on argumentation?

• What is the number of articles published by different countries on argumentation?

• What is the state of collaboration between different countries on argumentation?

• What are the articles that are frequently used as co-citations in the references on argumentation?

• What are the co-occurrences of key words used most frequently in the articles?

• What are the most cited sources and their collaboration in co-citations analyses?

Data Collection

The source of the research data is the articles with a title including the word "argumentation" and indexed in the WoS database. On 26 March 2020, 2176 articles published between the years of 1976 and 2020 (no articles have data based before on the year of 1976) using the concept of "argumentation" were reached. The stages used in the data collection process are as follows:

•When no criteria were used, 14,344 publications on argumentation were reached.

•When the concept of "Argumentation" was scanned as the topic by using quotation marks, there were 14,073 articles.

•2530 articles were reached, when the article was selected as the document type (proceeding paper, book chapter, book review, review, editorial material, early access, book, meeting abstract, letter, correction, note, discussion, data paper, reprint, biographical item and news item categories in the WoS database were excluded from the research.).

•When the indexes of the SCI-Expanded, SSCI, AHCI and ESCI were searched only, 2205 articles were reached.

•When 1976-2020 was selected as the year range and 2021 was excluded, 2176 articles were reached.

Data Analysis

In the data analysis conducted for the first three sub-research questions (1st, 2sd, 3rd and 4th) of the current study, descriptive statistical analysis methods were used. The mentioned research questions were interpreted by using MS Excel program, by means of tables and charts. The VOSviewer program was preferred and bibliometric mapping technique was used to obtain findings for the 5th, 6th and 7th sub-research questions. VOSviewer 1.6.15 is a free computer software used clustering technique to create and display bibliometric maps, allowing the analysis of social collaborations between the publications (van Eck & Waltman, 2010; Waltman et al., 2010; van Eck & Waltman, 2020). Bibliometric analysis is based on the examination of the quantitative characteristics of information published on any platform. The analysis programs that examine social collaborations in publications have emerged with the development of bibliometric research. The VOSviewer program provides the opportunity to examine the collaboration between authors, publications, countries, keywords and journals and includes analysis types such as co-citation, co-authorship, co-occurrence, bibliographic coupling and citation (van Eck & Waltman, 2020). Van Eck and Waltman (2020) emphases that the size of the circles in the network maps created by the VOSviewer program refers to the frequency of the selected analysis unit. According to authors, the colors of the circles show the clusters that are in connection

and the connection lines show the relationships between clusters and the strength of the relationship. The link lines show the relationships between clusters and the strength of the link.

Limitations

The limitations of the study are the use of only the data on the WoS database, the use of articles as the document type and the use of publications between the years of 1976-2020. As the year of 2020 is not over yet, data for this year have not been used. In addition, Science Citation Index expanded (SCI-expanded), Social Science Citation Index (SSCI), Art & Humanities Citation Index (A & HCI) and Emerging Source Citation Index (ESCI) in the WoS database are included in the scope of the current study, while the Conference Proceedings Citation Index-Science (CPCI-S), Conference Proceedings Citation Index- Social Science & Humanities (CPCI-SSH), Book Citation Index- Science (BKCI-S) and Book Citation Index- Social Sciences & Humanities (BKCI-SSH) are excluded.

FINDINGS

A total of 2176 articles were reached on the WoS database, when the articles using the concept of "argumentation" in the title between 1976 and 2020 were examined. The distribution of the number of published articles across the years is presented in Figure 1.
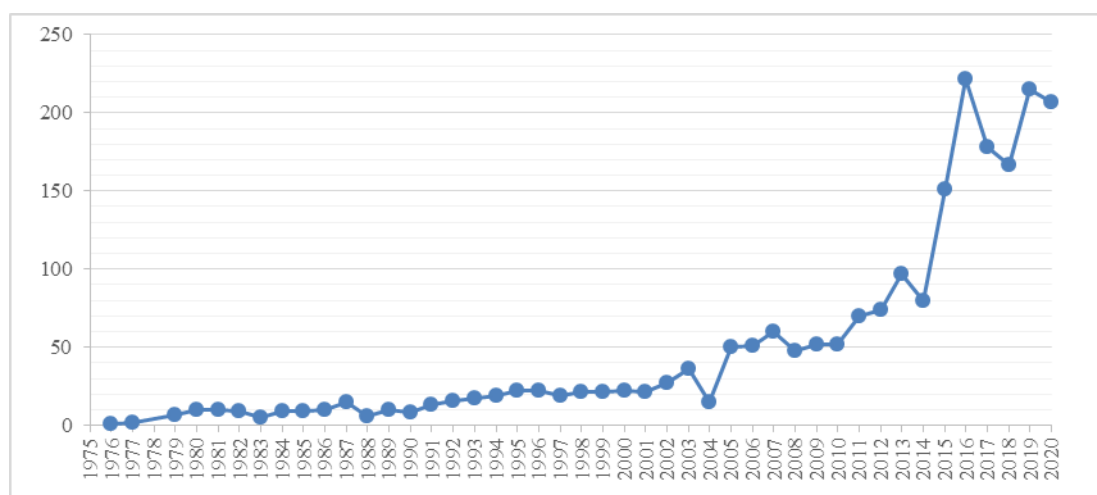

Figure 1. Distribution of the Number of Articles across the Years

When Figure 1 is examined, it is determined that the first article in the field of argumentation was published in 1976 by Wuellner, W. in the "The Catholic Biblical Quarterly (Vol. 38, No. 3, pp. 330-351)" under the title of "Paul rhetoric of argumentation in Roman - alternative to the Donfried-Karris debate over Romans". Yet, studies in the field of argumentation were carried out consistently at minimum levels between 1976 and 2003. Although there has been a decrease in some years since 2002, it was determined that there were increases in the studies conducted in the field of argumentation and the fastest increase was between 2015 and 2016.

A total of 29,230 citations were made to 2176 articles in the field of argumentation until 2020. The distribution of the number of citations across the years is presented in Figure 2.
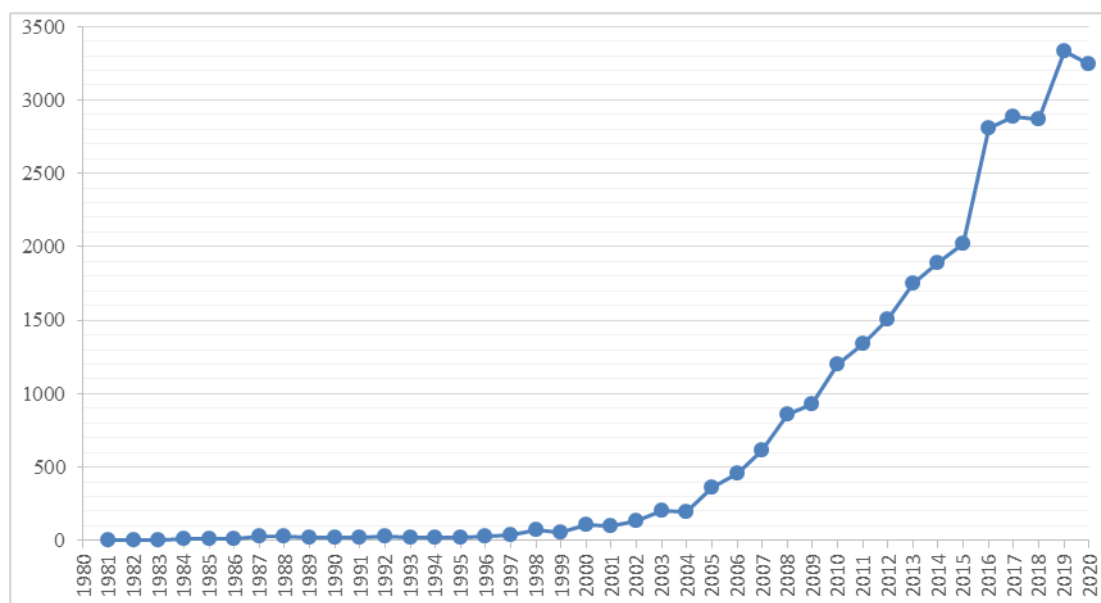

Figure 2. Distribution of the Citations of Articles across the Years

Articles in the field of argumentation were cited for the first time in 1981. The distribution of the number of citations across the years was similar to the distribution of the number of articles. Although there have been decreases in some years, it is generally observed that increases have occurred in the citations in the field of argumentation after 2002. Articles in the field of argumentation received the most citations in 2016. The top ten articles having the most citations are presented in Table 1.

Table 1. The Top Ten Articles of Argumentation Having the Highest Number of Citations

Authour(s)/Year	Title of the Articles	Times Cited
Driver et al. (2000)	Establishing the norms of scientific argumentation in classrooms	925
Yackel and Cobb (1996)	Sociomathematical norms, argumentation, and autonomy in mathematics	733
Osborne et al. (2004)	Enhancing the quality of argumentation in school science	591
Zohar ve Nemet (2002)	Fostering students' knowledge and argumentation skills through dilemmas in human genetics	532
Erduran et al. (2004)	TAPping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse	482
Benc-Capon (2003)	Persuasion in practical argument using value-based argumentation frameworks	398
Bondarenko et al. (1997)	An abstract, argumentation-theoretic approach to default reasoning	360
Newton et al. (1999)	The place of argumentation in the pedagogy of school science	312
Berland and Reiser (2009)	Making Sense of Argumentation and Explanation	278
Simon et al. (2006)	Learning to teach argumentation: Research and development in the science classroom.	271

When Table 1 is examined, it is seen that the most cited articles belong to Driver et al. (2000), Yackel and Cobb (1996), Osborne et al. (2004), Zohar and Nemet (2002), Erduran et al. (2004), Benc-Capon (2003), Bordarenko et al. (1997), Newton et al. (1999), Berland and Reiser (2009), Simon et al. (2006).

When the number of the publications made by organizations in the field of argumentation was examined, it was found the number of organizations having made 20 or more publications in this field is 24. The organizations which have the highest number of publications are presented in Figure 3.
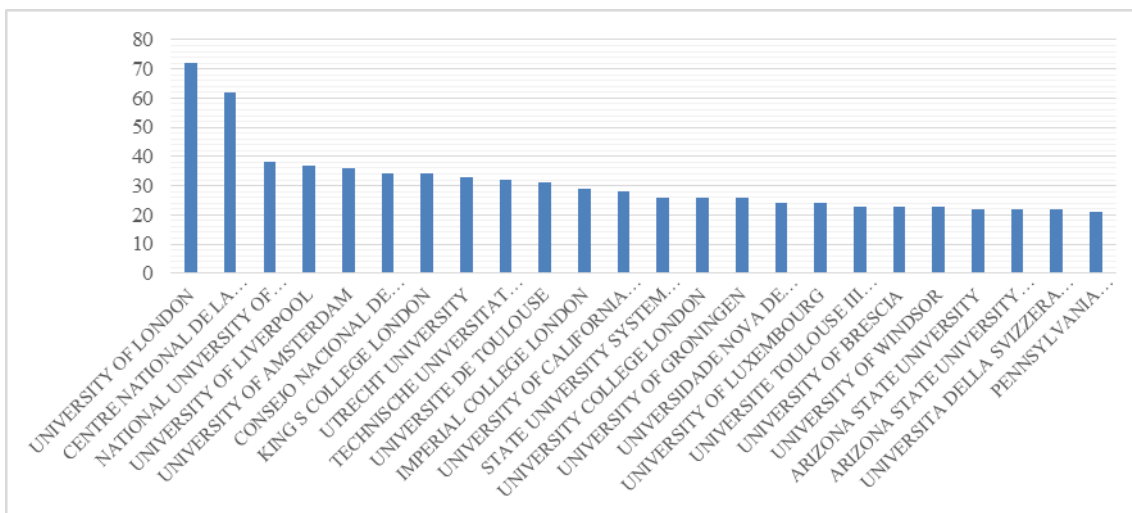

Figure 3. The Number of Articles by Organizations

The top three organizations that published the most articles in the field of argumentation are the University of London (n: 72), The French National Centre for Scientific Research (n:62) (Center National de la Recherche Scientifique) and the National University of the South (n:38) in Argentina. When the countries with the highest number of publications and the cooperation between the authorship (criteria of the minimum one article and one citation) are examined, 73 thresholds according to number of countries are determined. The network map obtained is shown in Figure 4.
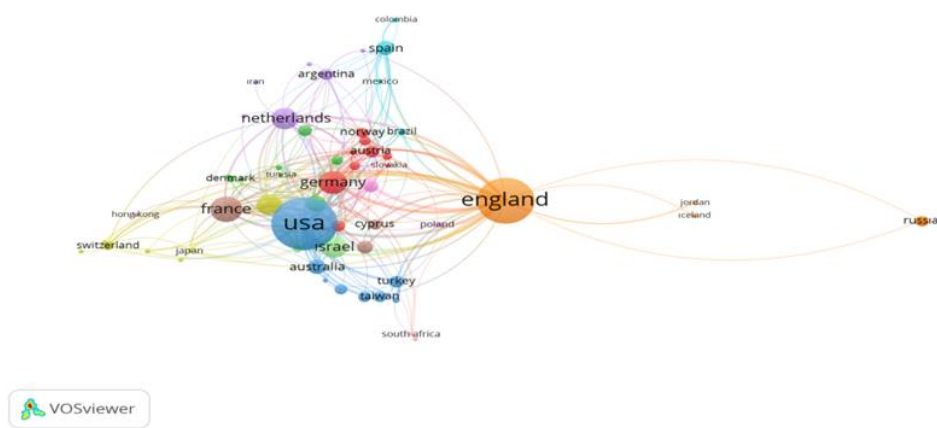

Figure 4. Network Map on Collaborations Between Countries

As can be seen in the Figure 4, countries such as the USA, England, Germany, France, Italy and the Netherlands have the highest number of articles, citations and the highest total link strength. The highest number of articles was published by USA, England and Germany. Although the USA has the highest number of articles and citations, it is seen that England is the main node in yellow cluster according to total link strength. In this respect, top three countries with the highest amount of collaboration among different authors are England [total link strength (TLS): 180], the USA (TLS:120) and Italy (TLS: 97). Researchers in England have stronger collaboration with researchers in Italy (Link strength (LS): 19) and Germany (Link strength:14). The USA is the second country with the highest number of publications on argumentation establishes most powerful collaboration with England (LS:13) and Turkey (LS:12).

When we did the co-citation analyses according to cited references (minimum number of citations of a cited references: 120), 8 thresholds are determined. Network map is below.
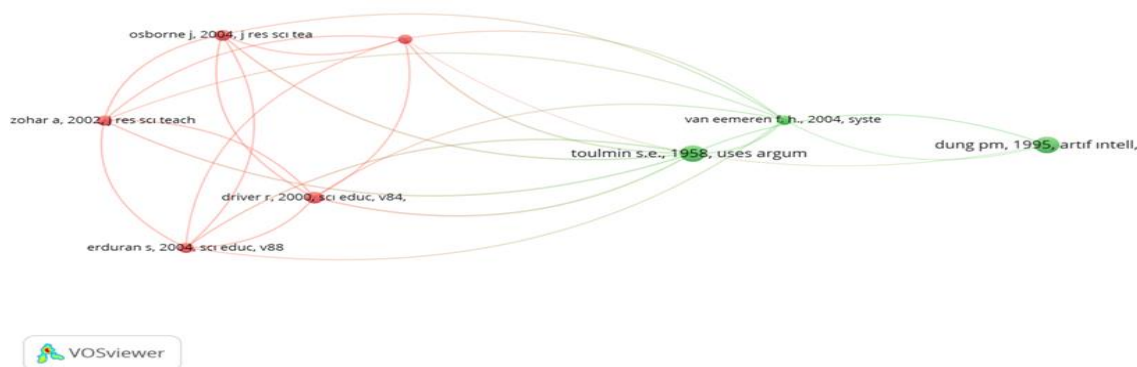

Figure 5. Network Map of the Most Cited References in Co-Citations

As can be seen in Figure 5, articles by Toulmin (1958), Dung (1995) and van Eemeren and Grootendorst (2004) in green cluster come to the fore in the field of argumentation research. In the red cluster, articles by Driver et al. (2000), Osborne et al. (2004) and Zohar and Nemet (2002) have a high impact in the field of argumentation research. When the total link strengths were examined, we reached the articles which are the most cited references in Table 2.

Table 2. The Most Cited References in Co-citations and their Total Link Strength (TLS)

Author(s) and Year	Title of the document	Name of the journal or publishing house	TLS
Toulmin, S. E. (1958)	The uses of arguments	Cambridge university press.	573
Driver et al. (2000)	Establishing the norms of scientific argumentation in classrooms	Science Education, 84(3), 287-312	504
Osborne et al. (2004)	Enhancing the quality of argumentation in school science	Journal of research in science teaching, 41(10), 994-1020	463
Zohar and Nemet (2002)	Fostering students' knowledge and argumentation skills through dilemmas in human genetics	Journal of research in science teaching,	432
Erduran et al.	TAPping into argumentation:	Science Education, 88(6), 915-933	405

(2004)	Developments in the application of Toulmin's Argument Pattern for studying science discourse		
Kuhn (1991)	The skills of argument	Cambridge University press.	273
Van Eemeren and Grootendorst (2004)	A systematic theory of argumentation	Cambridge University press.	114
Dung (1995)	On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and *n*-person games	Artificial Intelligence, 77(2), 321-357	28

As can be seen in Table 2, according to co-citation analysis of cited references in articles, the books that most guided the development of research in the field of argumentation are publications by Toulmin (1958), Kuhn (1991) and van Eemeren and Grootendorst (2004). Also, the articles by Driver et al. (2000), Osborne, Erduran and Simon (2004), Zohar and Nemet (2002), Erduran, Simon and Osborne (2004) and Dung (1995) are the most commonly cited references in the Argumentation articles.

When we did the co-authorship analysis according to authors (minimum number of documents of an author: 1, minimum number of citations: 100), 140 thresholds were determined. Network map is below.
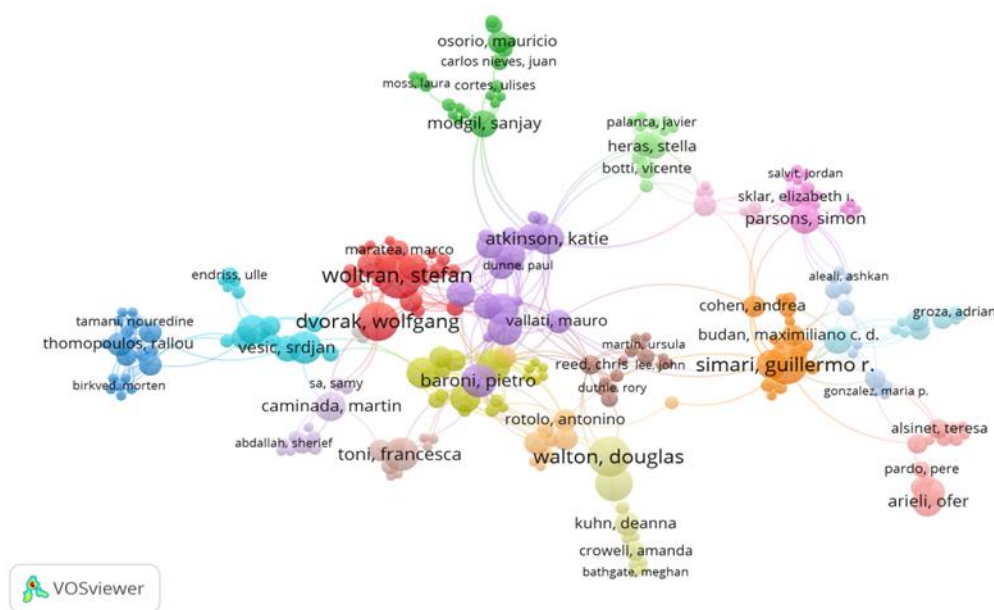

Figure 6. Network Map on Co-authorship Analysis

When Figure 6 is examined, Woltran Stefan (Austria), Wolfgang Dvorak (Austria), Walton Douglas (Canada), Kuhn Deanna (America), Simari Guillermo (Arjentina), Baroni Pietro (Italy), and Katie Atkinson (England), Sangay Modgil (England), Mauricio Osorio (Mexico), Francesca Toni (England), Martin Caminada (England), Amgoud Leila (France) are the authors with high ability of collaboration on argumentation articles. The authors Woltran Stefan and Simari Guilermo have the highest number of documents and the highest total link strength in argumentation. When the co-occurrences of the keywords (criterion of a minimum number of occurrences

of a key word: 2) were examined, a total of 163 thresholds and 20 clusters were reached. The network structure is shown in Figure 7.
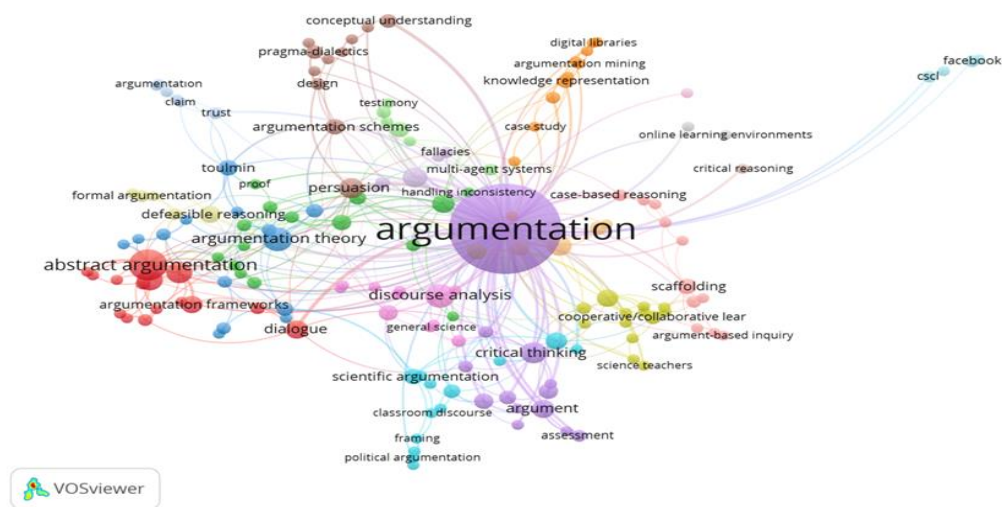

Figure 7. Network Map on the Co-occurrences of Keywords

When the sizes of the circles are examined in the Figure 7, it is seen that the number of the articles using the following key words is high: argumentation, abstract argumentation, discourse analysis, argumentation theory, critical thinking, computational complexity and argumentation semantic. The key words included in the 20 clusters constructed on the basis of the co-occurrence of key words used in the articles on the argumentation are presented below.

Table 3. Clusters Related to Co-occurrence of Key Words

Cluster No	Key Word(s)
1	Abstract argumentation, argumentation framework, argumentation semantics, complexity, computational complexity, dialogue, equivalence, fixed parameter tractability, practical reasoning, semantics, scepticism, value based argumentation framework
2	Abduction, assumption based argumentation, assumption based reasoning, default reasoning, dispute, dung, explanations, handling in consistency, logic programming, non-monotonic reasoning, preferences, proof, proof procedure, values
3	Argumentations system, argumentation theory, argumentation based negotiation, Autonomous agent, computational model of argument, dialogue games, evidence theory, logical argumentation, probabilistic reasoning, risk assessment, structure argumentation, Toulmin, theory, uncertainty.
4	Collaborative argumentation, computer mediated communication, cooperative/collaborative learning, elementary education, evaluation methodologies, higher education, improving classroom teaching, interactive learning environment, pedagogical issues, science teachers, secondary education, south Africa, teaching and learning strategies.
5	Argument, argumentation, argumentation skills, assessment, chemistry, collaboration, critical thinking, epistemology, nature of science, professional development, science practices, scientific literacy, socioscientific issue.
6	Classroom discourse, cooperative grouping, faming, inquiry, laboratory work, physical chemistry, physical science, political argumentation, science education, scientific argumentation, sociocultural, strategic manoeuvring, talk show.
7	Argumentation mining, artificial intelligence, case study, decision support, digital libraries, discourse, information storage and retrieval, justification, knowledge representation, machine learning, social media.
8	Argumentation schemes, argumentative writing, conceptual understanding, critical discourse analysis, critical questions, deliberation, design, persuasion, pragma-dialectics, socio-scientific

	issues, transfer.
9	Argumentation in discourse, argumentativity, conceptual change, dialevctical argumentation, discourse analysis, European parliament, general science, language of science and classrooms, middle school science, rhetoric and rhetorical argumentation.
10	Argument based inquiry, case libraries, case based reasoning, conceptions of learning, decision making, epistemological beliefs, middle school, online argumentation, problem solving, scaffolding, science learning,
11	Defeasible argumentation, defeasible logic programming, evidence, legal reasoning, multi agent system, testimony.
12	Argumentation, claim, data, trust, warrants, writing argument.
13	Algorithms, defeasible reasoning, formal argumentation, logic based argumentation, nonmonotonic logic.
14	Analogy, argumentative discourse, Bayesian probability, fallacies, reasoning.
15	Argumentative knowledge construction, CSCL, facebook, learning.
16	Collaboration scripts, collaborative learning, computer supported collaborative learning, heuristic worked examples.
17	Critical reasoning
18	Semantic web
19	Online learning environment
20	Self-explanation.

When the keywords in Table 3 were examined, it was determined that the argumentation studies in the literature are not limited to science and science education, but also to applications of the artificial intelligence in computer science, the branches of mathematics and logic science, and language science in academic research. When we did the co-citations analyses according to cited source (minimum number of citation of a source: 100), 73 thresholds and four cluster were determined. Network map is below.
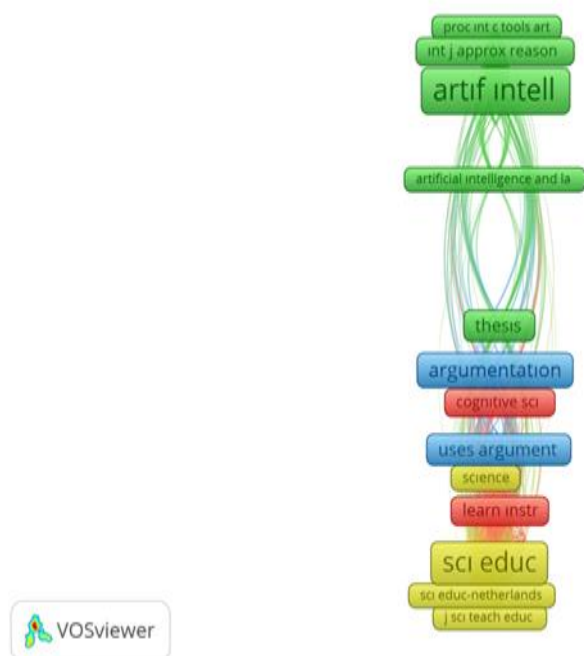

Figure 8. Network Map According to Cited Source

When figure 8 is examined, it is seen that although the journals of "Artificial Intelligence", "Science Education" and "Journal of Research in Science Teaching" have the highest number of citations, the Journals of "Science

Education" and "Journal of Research in Science Teaching" are remarkable sources in terms of total link strength. When the publication sources of the articles titled as argumentation are examined, the journals with titles having words such as education, psychology, cognition and discourse are in the red cluster; journals with titles having words such as artificial intelligence and logic computation are in the green cluster; journals with titles having words such as rhetoric, argumentation, speech are in blue cluster; journals with titles having words such as science, math or technology education are located in the yellow cluster. Yellow and green clusters are remarkable sources of publication on argumentation.

CONCLUSION and DISCUSSION

This study aims to analyse bibliometric features of the articles on argumentation available in the WoS database. In this connection, a total of 2176 articles on argumentation have been determined on the date of 26 March 2020. One of the results of the study showed that the first article on argumentation was published in 1976 and although there has been a decrease in some years, it was determined that there has been an increase in the studies conducted on argumentation since 2002 and the fastest increase was between 2015 and 2016. The results of the study of Erduran et al. (2015) showed that there was an increase in articles published between 1998 and 2014 on argumentation in Journals of Science Education, Journal of Research in Science Teaching and International Journal of Science Education, and these results support the current study's results by revealing that argumentation-oriented studies have been a focus of science research for two decades. The results of the study conducted by Lee et al. (2009), which revealed argumentation was an important research topic in science education between 1998 and 2007, also supports the results of the current study. The reason for this increased interest in the 2000s on argumentation can be attributed to the emphasis on requirement of argumentation as a part of science education in different countries' national reports after the 2000s. For example, in the UK (United Kingdom), the National Science Curriculum has defined argumentation as an important educational purpose with documents called "Ideas and Evidence" (2004) and "How Science Works" (2007) (Erduran et al., 2015). In the book titled Inquiry and the National Science Education Standards (National Research Council, 2000), it is emphasized that science is not just about facts, it includes explanation and testing of the facts and communicating the emerging ideas to others, and the role of the evidence in reaching conclusions. In Turkey, with the changes in Ministry of National Education Science Teaching Program in 2013, argumentation has been explained as one of the learning environments where students are active and its usage in classrooms is strongly emphasized (MoNE, 2013). This emphasis on curricula and important educational institutions may have caused argumentation to attract greater interest as a subject of research. With the concrete reflection of argumentation on science curricula (Erduran and Msimanga, 2014; Kuhn and Moore, 2015), it can be interpreted that argumentation has become the focus of researchers, which causes an increase in research articles about pedagogical applications of it in science education.

The second finding of the study is that citations to articles focused on argumentation have started to increase since the early 2000s and the most citations were made in 2016. Similarly, Lin et al. (2014) revealed that argumentation-focused studies are among the most cited studies between 1998 and 2007 in the International

Journal of Science Education, the Journal of Research in Science Teaching, and the Science Education especially for the years 2000, 2002, 2004, 2008, 2009. The finding of the study conducted by Lee et al. (2009), who found that the most cited studies between 2002 and 2007 were on argumentation, also supports the finding of the current study. The reason for this situation can be evaluated as a result of the emphasis on argumentation in science education in National Research Council (NRC, 2000), and English Science National Curriculum after the 2000s. Increased emphasis on argumentation may have led to a rise in argumentation-focused studies, and hence in citations made to argumentation-focused studies. The fact that the highest number of argumentation-focused studies were conducted in 2016 and that the highest number of citations to these argumentation-focused studies were made this year justify our conclusion.

The third finding of the study is that the study of Driver et al. (2000) is the most cited study according to WoS data. It can be stated that this study is important in terms of revealing how argumentation can be incorporated into in science education and the relationship between argumentation and conceptual, epistemological and social structure of science. In addition, it was found that the studies of Yackel and Cobb (1996), Osborne et al. (2004), Zohar and Nemet (2002), Erduran et al. (2004), Newton et al. (1999), Berland and Reiser (2009), Simon et al. (2006), Benc-Capon (2003), Bondarenko et al. (1997) are the most cited articles on argumentation. The studies focused on argumentation in science education provide information about its practical applications in science classes, and explain the functioning of Toulmin's argument model in discourses in science education (Berland and Reiser, 2009; Erduran et al., 2004; Newton et al., 1999; Osborne et al., 2004; Simon et al., 2006) can be said to have guided the studies in the field of argumentation in science education. On the other hand, it can be stated that the publication by Yackel and Cobb (1996) comes to the fore among studies on mathematical argumentation in math education and the studies by Benc-Capon (2003) and Bondarenko et al. (1997) are important in terms of examining the value-containing aspects of persuasive arguments, and examining the logical side of arguments. Therefore, the most citations made to these studies can be attributed to their pioneering and guiding role in argumentation studies in terms of using and evaluating argumentation in classrooms.

Another finding of the study is that the top three organizations that published the most articles in the field of argumentation are the University of London (n: 72), The French National Centre for Scientific Research (n:62) (Center National de la Recherché Scientifique) and the National University of the South (n:38) in Argentina. The fact that many researchers such as Driver, R., Osborne, J., Erduran, S., and Simon, S., and Shangay, M. who can be stated to have a pioneering role in argumentation studies in science, are working in the UK may have resulted in relatively more emphasis put on argumentation in universities in the UK. On the other hand, the fact that the The French National Centre for Scientific Research is one of the most important research institutions and a reference point in the world on research and development may have caused it to be a pioneer and guide for the forthcoming articles on argumentation. In addition, the fact that authors such as Amgoud, L., Villata S., who have conducted research on argumentation in areas such as computer science, artificial intelligence and logic and information system, have worked in this institution may explain this

situation. The fact that the author named Simari Guilermo, who works in fields such as computer science and artificial intelligence applications of the argumentation in Argentina worked at National University of South may explain that there are the high number of publication on argumentation in this branch.

Another result of the present study is that the top three countries with the highest collaboration among different authors are England [total link strength (TLS): 48], the USA (TLS:39) and Germany (TLS:19). One of the reasons for this finding is that researchers in the UK (e.g. Erduran, S., Simon, S., and Osborne, J.) and in the USA (e.g. Berland, L. K., Reiser, B. J., Yackel, E., and Cobb, P.) are leading and the most cited researchers in the field of argumentation. The high link strength found for Germany is because it establishes collaborations with leading names in the field of argumentation both in the UK and the USA. However, it can be said that these researchers are generally not the first author in the articles, causing researchers in Germany to have little visibility in the field of argumentation.

Another finding of the study is that the research articles by Toulmin (1958) and Dung (1995) are remarkable in the research field of argumentation. Some of the reasons for this may be the general use of the Toulmin's model (1958) in science education and that it is the first argumentation model proposed (Aktamış & Hiğde, 2015). As a matter of fact, Toulmin's (1958) model has been used in many studies as a fundamental source to define and analyze argumentation. In addition, the article of the Dung (1995) entitled as "On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games" explores the ways of applying argumentation to computer-based sciences and the importance given to computer-based research in the information and technology age we live in may have supported the publication of similar studies. On the other hand, Dung (1995) developed abstract argumentation theory and this theory has a pioneering role in the use of argumentation in computer, mathematics, and logic. In addition, the inclusion and central role of argumentation by Driver et al. (2000) in science education and designing and evaluation of learning environments that support the teaching and learning of argumentation in scientific contexts by Osborne et al. (2004) have provided bases for in-class enactment of argumentation. Besides, it can be stated that the study by Zohar and Nemet (2002) investigating the effect of lessons taught to foster students' argumentation and content knowledge through dilemmas within the scope of the genetics unit is a pioneering example for many science educators in the context of using dilemmas and evaluating argumentation and has been capitalized on widely in the relevant literature.

Another finding of the study is that the most cited references in co-citations are Toulmin's (1958) study named "The uses of arguments", Driver et al.' (2000) study named "Establishing the norms of scientific argumentation in classrooms" and Osborne et al.' (2004) study named "Enhancing the quality of argumentation in school science". Based on this finding it can be said that Toulmin's book "The uses of argument" is one of the main sources in the field of argumentation since it is the first study defining elements of argumentation and explaining how to analyse it. On the other hand, the study by Driver et al. (2000) synthesized many studies on argumentation and presented a holistic perspective related to definition of argumentation, its development, its contributions to science, and the difficulties experienced by students with argumentation in science lessons.

Osborne et al. (2004) contributed to the literature with the professional development they designed for using argumentation in classrooms and the rubric they developed to evaluate the argumentation quality, and they have been used widely in many subsequent studies. Therefore, studies on argumentation may have referred to these studies in order to define and evaluate argumentation and to emphasize the enactment of argumentation in-class.

Another finding of the study is that the number of the articles using the key words of argumentation such as abstract argumentation, discourse analysis, argumentation theory and critical thinking is high. It is not surprising that the most commonly used keywords in the argumentation-focused studies are argumentation and argumentation theory. In addition, the fact that argumentation is a verbal activity (Goldman 1994; Van Eemeren & Grootendorst, 2004), a diological process (Kuhn & Udell, 2003; McNeill et al., 2016), and a social process carried out through discourse (Berland & Reiser, 2011) may have led to the focus on discourse analysis in studies on argumentation, and therefore discourse analysis has been used as a keyword. In addition, one of the reasons for the frequent use of the keyword "abstract argumentation" can be attributed to the results of the current study showing that argumentation has been frequently used in the fields of artificial intelligence in computer science, the branches of mathematics and logic science and Dung (1995), whose study field is abstract argumentation and who is among the most cited authors in the field of argumentation, also supports this finding. On the other hand, the fact that the concept of critical thinking that is among the most frequently used keywords in argumentation-oriented studies can be attributed to the fact that argumentation offers excellent opportunities to develop critical thinking since critical thinking is defined as examining any belief or information in the light of evidence and consequences (Glaser, 1941) and argumentation is also defined as a process in which evidence, alternative explanations, and scientific claims are evaluated in order to reach information (Driver et al., 2000).

Another finding of the study is that the argumentation studies in the literature are not limited to science and science education, but also conducted on applications of the artificial intelligence in computer science, in the branches of mathematics and logic science, and language science in academic research. The acceptance of argumentation as the way to reach scientific knowledge (Driver et al., 2000) and as the language of science (Tippet, 2009) may explain the usage of argumentation for the purpose of reaching information in different scientific fields, defending or declaring the obtained information or claim.

Another finding of the study is that the Journal of Science Education and Journal of Research in Science Teaching are remarkable sources in science education in terms of total link strength. Lin et al. (2014) examined publications in three journals in their study of research trends in science education, and two of these three journals are the International Journal of Science Education and the Journal of Research in Science Teaching, and these results support the results of the present study. It can be stated that these journals are among the journals that guide many studies, that have a high impact value and that include the publications of the most renowned researchers in the field, and this might have led them to provide remarkable resources in the field of argumentation.

RECOMMENDATIONS

This study presents a general framework of leading countries, organizations, authors, articles, references, journals and keywords in the field of argumentation. It has also identified authors and countries with high collaborative power. First of all, it can be said that the research on argumentation has spread from England to the whole world. It is very important to retrace back to the origin of studies in one field in order to understand how research has evolved. In this respect, Toulmin's (1958) book "The uses of argument" should definitely be examined. In order to get to the bottom of argumentation studies in Computer Science such as Artificial Intelligence, logic, and computers, it would be appropriate to take a look at the studies of Dung P. M. (Dung, 1995; Bordarenko et al., 1997). Researchers who want to study in the field of argumentation in science education are recommended to review the articles (Driver et al., 2000; Osborne et al., 2004; Zohar and Nemet, 2002; Erduran et al., 2004; Newton et al., 1999; Simon et al., 2006) to understand the theoretical background. In addition, they can contact researchers such as Driver, R., Osborne, J., Erduran, S., and Simon, S., who have left their mark with their research in the field of argumentation in science education. Those who plan to research in areas such as artificial intelligence, logic and computation are recommended to review the articles of Woltran Stefan, Wolfgang Dvorak, and Simari Guilermo.

One of the most difficult decisions researchers often make is about the research topic. For researchers who want to work in this field, it is recommended to take a look at the clusters of keywords presented in Table 3. It is recommended that researchers in science education utilize the journals of "Science Education" and "Research in Science Teaching", which have a high number of publications and impact in the field of argumentation. In addition, it is recommended that researchers working in the field of computer science consider and utilize the journal of "Artificial Intelligence" on argumentation applications.

ETHICAL TEXT

"In this article, the journal writing rules, publication principles, research and publication ethics, and journal ethical rules were followed. The responsibility belongs to the author (s) for any violations that may arise regarding the article. "

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