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COMPARISON OF TURKEY'S ACADEMIC PUBLICATION PERFORMANCE IN ASTRONOMY EDUCATION WITH OTHER COUNTRIES ACCORDING TO WEB OF SCIENCE DATABASE

Review study

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Abstract

In this study, a bibliometric evaluation of the articles published between 1975 and 2020 in astronomy education in the Web of Science database is aimed to reveal the trend in this field and to compare the articles from Turkey with other countries. During the article search process, the keyword "astronomy" was scanned both in the title and content of the articles. A total of 284 articles were reviewed under the Education/Educational Research category. VOSviewer (V1.6.15) package program was used to create and visualize bibliometric network maps of the articles examined within the scope of the study. In the findings, it was seen that approximately four-fifths of the articles published in the field of astronomy education have been published in the last ten years. It was determined that the most effective country in which publications are made on astronomy education is the USA, and Turkey is in the second place with 25 articles. It is noteworthy that while the average number of citations per publication for all the articles examined is 14.62, the average number of citations for articles originating from Turkey is 3.56. Based on such findings, Turkey's academic publication performance in astronomy education has been tried to be revealed.

Keywords: astronomy education, bibliometric, articles

1. Introduction

Astronomy is one of the oldest sciences in human history. This science, which took the first steps with the first people looking at the sky with curiosity, continued its development with a strong curiosity about understanding the structure of the universe, what kind of past the universe has and what kind of future it will have (MEB, 2012). As astronomy generally requires three-dimensional and abstract thinking, the perception and interpretation of concepts requires effort. To understand astronomical phenomena and events requires the ability to imagine objects from different perspectives and to follow the movement of objects in multidimensional space (Cole, Cohen, Wilhelm & Lindell, 2018; Sontay & Karamustafaoğlu, 2019). Astronomy also requires reasoning skills such as understanding directions, scaling time, and grasping patterns. As a result of its practical applications and theoretical background, astronomy has interacted with almost every field of science (Sontay & Karamustafaoğlu, 2020; Yılmaz & Ünal, 2020). Astronomy continues his research on many subjects that are curious about human beings such as; from the origin of life to the

structure of stars and planets, from our place in time and space to the properties of habitable planets, and from the formation of elements to the boundaries of the universe (Percy, 2006).

Astronomy subjects have always seen as an important element in school curricula. This situation has been increasing in recent years (Berryhill & Slater, 2017; Özaşkın Arslan & Karamustafaoğlu, 2019). In Turkey, with the thought that astronomy education will be effective in raising targeted students, it has started to be taught primarily in science classes (MEB, 2018). While astronomy subjects are included in the curriculum of different countries at different levels, education in this field in Turkey starts in the 3rd grade of primary school. The fact that astronomy is an interdisciplinary science open to new developments and its potential to show that scientific knowledge can change over time also contributes to this idea. The increase in the frequency of astronomy subjects in the curricula of different levels of various countries increases scientific research on astronomy education (Bailey & Slater, 2004; Trumper, 2006; Trundle, Atwood & Christopher, 2007). The increase in scientific studies in the literature requires systematic searches in order to evaluate the results and to determine the trends in the field. In the field of astronomy education, there are many compilation studies created by giving the qualitative or quantitative features of previous national and international studies (Ayvacı & Sezer, 2018; Bailey & Slater, 2004; Doğru, Satar & Çelik, 2019; Ezberci Çevik & Tanık Önal, 2021; Lelliott & Rollnick, 2010; Waller & Slater, 2011).

Bailey and Slater (2004) researched the publications about astronomy education up to 2004; they reviewed more than one hundred articles, books, and web-based materials. In this study, it is focused on the studies on the mental structures and understanding levels of students in directly observable astronomy subjects such as Earth, Moon and Sun. In addition, they examined the studies and findings related to sub-branches such as the structure of the universe and astrobiology. As a result, they suggested that studies on the difficulties experienced by students while learning astronomy should be increased and researches that will reveal the relationship between theory and practice in astronomy classes should continue. Lelliot and Rollnick (2010) analyzed 103 astronomy studies published between 1974 and 2008 with students, teachers, and museum visitors. About 40% of these studies investigated the impact of classroom practices on learning. In addition, they found that 80% of the studies focused on the Earth, gravity, day-night cycle, seasons and the Earth-Moon-Sun relationship. Doğru, Güzeller and Satar (2019) conducted a bibliometric analysis on 271 different sources, which were accessed by searching the Web of Science Core Collection database with the search word "astronomy education" in order to reveal the pattern of scientific communication in astronomy education. They provided quantitative data on various features of studies in the field of astronomy education, such as number and type of articles, number of citations by years, common citation networks, and concept orientations.

It is observed that the review studies, which deal with the studies on astronomy education at the national level, have been carried out mostly in the last 5 years. In the meta-analysis study carried out by Bozdemir, Çevik, Altunoğlu and Kurnaz (2017), the effect of the methods used in teaching astronomy subjects on academic success was investigated. In this study, in which quantitative studies were handled, it was concluded that different teaching methods were effective in astronomy education. Descriptive content analysis was carried out in the research conducted by Ayvacı and Sezer (2018) in which studies on astronomy at the national level were examined. In this research, it is aimed to reveal the status of astronomy education in Turkey by considering 15 theses or articles in the context of various themes such as purpose, method and data collection tools. As a result of the study, it was found that the astronomy studies carried out in Turkey were insufficient. In the most recent literature review study on astronomy education in Turkey, Ezberci Çevik and Tanık Önal (2021) focused on

pre-school education. According to the results of this study, in which 20 researches related to the subject were examined, it has been determined that astronomy education in Turkey; increased after 2015, focused on the Sun, Earth and Moon, used more qualitative research methods, and preferred interview, observation and drawing more as data collection tools.

In the national and international literature, it has been seen that bibliometric studies in the field of education have increased in recent years (Hallinger & Chatpinyakoop, 2019; Marín-Marín et al., 2019; Shen & Ho, 2020; Yavuz, Kayalı, & Tutal, 2021). However, as stated above, bibliometric studies on astronomy education are limited in number (Doğru, Güzeller & Satar, 2019; Mandapur, Govanakoppa & Rajgoli, 2011; Wildgaard, 2015). It is thought that this study will contribute to filling this gap in the literature. In this study, it was aimed to reveal the trend in astronomy education and to compare the articles from Turkey with other countries by making a bibliometric evaluation of the articles published between 1975 and 2020 in the Web of Science database, which is widely used by researchers at international level. In this context, answers to the following questions were sought:

1. What is the numerical distribution of the articles on astronomy published in the Education/Educational Research category by years?
2. Which journals are active within the scope of articles published on astronomy in the Education/Educational Research category?
3. Which countries are active within the scope of articles published on astronomy in the Education/Educational Research category?
4. What are the active publication languages within the scope of the articles published on astronomy in the Education/Educational Research category?
5. Which institutions are active within the scope of articles published on astronomy in the Education/Educational Research category?
6. Who are the most influential authors in the articles published on astronomy in the Education/Educational Research category?
7. What is the author co-citation network of articles published on astronomy in the Education/Educational Research category?
8. What are the most cited articles on astronomy in the Education/Educational Research category?
9. What is the keyword network of articles published on astronomy in the Education/Educational Research category?
10. How is the numerical distribution of articles from Turkey published on astronomy in the Education/Educational Research category by years?
11. Which journals are active within the scope of articles from Turkey published on astronomy in the Education/Educational Research category?
12. What are the effective publication languages within the scope of articles from Turkey published on astronomy in the Education/Educational Research category?
13. Which institutions are active within the scope of articles from Turkey published on astronomy in the Education/Educational Research category?
14. Who are the most influential authors within the scope of articles from Turkey published on astronomy in the Education/Educational Research category?

15. What is the author co-citation network of articles from Turkey published on astronomy in the Education/Educational Research category?
16. What are the most cited articles from Turkey on astronomy published in the Education/Educational Research category?
17. What is the keyword network of articles from Turkey published on astronomy in the Education/Educational Research category?

2. Method

In this research, bibliometrics was used to examine Turkey's international publication performance in the field of astronomy education. Bibliometrics is a research method used in library and information sciences. Bibliometrics uses quantitative analysis and statistics to describe the general characteristics of published works within a particular subject, field, institute or country (Pritchard, 1969). Broadus (1987) defines bibliometrics as numerical analysis of published works and/or bibliographies of these works based on many previous definitions. With the help of bibliometric research, the most productive researchers on a subject can be determined, while it is possible to make comparisons between countries (Al, 2008).

The prestige and scope of the database used in bibliometric research is very important (Thompson, 2018). In this study, the search was made in the Web of Science database, one of the world's leading databases. The search process was limited between 1975, when the database was established, and 2020. Grade level restriction was not applied. Scanned indexes were determined as SCI-Expended, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH and ESCI. During the article search process, the keyword "astronomy" was scanned both in the article title and content of the articles. During the scanning process, 29,838 records were found out of a total of 68,390,440 records. Of these records, 14,558 are in the Astronomy & Astrophysics, 4,722 in Optics, and 2,591 in Engineering, Electrical & Electronic categories. A total of 614 records were obtained under the Education/Educational Research category. It was determined that 284 of these records were articles and evaluation was made on these 284 records. Keywords and search criteria were presented in detail in Figure 1.

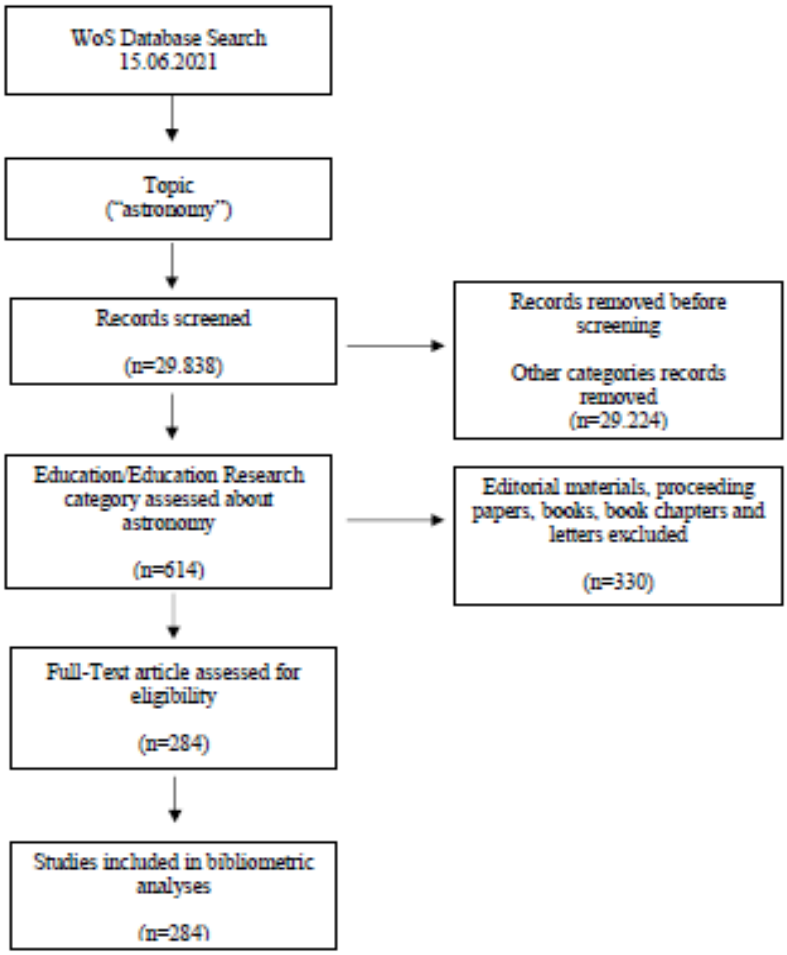

Figure 1. Article selection: PRISMA follow diagram (Page, et. al., 2021).

2.1. Data Collection Tool

The data required during the bibliometric analysis of the study were obtained from the WoS database. In this context, first of all, articles in the category of Education/Educational Research on astronomy were reached. Then, File Format / Tab-delimited (Win) options were selected and the data was downloaded in txt file format. The data in this downloaded file formed the data set of the research. Necessary tables were created based on the downloaded data.

2.2. Data Analysis

The bibliometric analysis method was used in the study. With bibliometric analysis, lots of criteria (keywords, years, journals, countries the most cited authors etc.) were examined. In this context, the data obtained from the file downloaded in txt format were tabulated. Also, VOSviewer (V1.6.15) package program was used to create and visualize bibliometric network maps of the articles examined within the scope of the study. The keyword network map visualized through the program and the publication, author and co-author network maps are presented in figures.

3. Results

The results of different variables related to the articles published in the Education/Educational Research category on astronomy are given below. Firstly, Table 1 contains general descriptive statistical information on the studies reviewed.

Table 1. *General information on the studies reviewed*

Database Summary	Records
Years	1975-2020
Number of records	284
Total number of journals	99
Total number of countries	44
Total number of languages	6
Total number of intuitions	336
Total number of authors	557
Total number of citations	6853
Total number of keywords	556
Average number of citations per publication	14.62

The publication years of the articles published on astronomy in the Education/Educational Research category were examined and presented in Table 2.

Table 2. *Publication years of articles on astronomy in the Education/Educational Research category*

Publication Years	Record Count	Publication Years	Record Count
2020	21	2005	4
2019	22	2004	4
2018	31	2003	4
2017	24	2002	3
2016	28	2001	4
2015	30	2000	3
2014	23	1999	1
2013	12	1998	2
2012	10	1997	1
2011	14	1996	1
2010	12	1995	1
2009	9	1991	1
2008	6	1988	1
2007	7	1982	1
2006	4	Total	284

When Table 2 is examined, it is seen that the first article on astronomy published in the Education/Educational Research category was published in 1982. It is also seen that the highest number of articles were published in 2018 with 31 articles, followed by 2015 with 30 articles. Moreover, it has been determined that 227 (80%) of a total of 284 articles published between 1975 and 2020 were published in the last ten years.

In the Education/Educational Research category, the active journals within the scope of the articles published on astronomy were examined and presented in Table 3.

Table 3. *Journals that have published 3 or more articles on astronomy in the Education/Educational Research category*

Journals	Record Count
1. International Journal of Science Education	38
2. Physical Review Physics Education Research	34
3. Science Education	24
4. Journal of Research in Science Teaching	17
5. Research in Science Education	13
6. Ensenanza De Las Ciencias	10
7. Journal of Science Education and Technology	10
8. Physical Review Special Topics Physics Education Research	10
9. Journal of Baltic Science Education	7
10. Culturel Studies of Science Education	6
11. Minerva	6
12. Computers Education	5
13. Int. Journal of Science Edu. Part B Communication and Public Engagement	5
14. Research in Science Technological Education	4
15. Eurasia Journal of Mathematics Science and Technology Education*	4
16. Research on Teaching Astronomy in The Planetarium	4
17. Springerbriefs in Astronomy	4
18. International Journal of Science and Mathematics Education	3
19. Problems of Education in The 21st Century	3

*Journals originated from Turkey

It has been determined that articles on astronomy have been published in a total of 99 different journals in the Education/Educational Research category. In Table 3, journals that have published 3 or more articles on astronomy are listed in the Education/Educational Research category. When the table is examined, it is seen that the most effective journal on this subject is the International Journal of Science Education with 38 articles. This journal is followed by Physical Review Physics Education Research with 34 articles, Science Education with 24 articles, Journal of Research in Science Teaching with 17 articles and Research in Science Education with 13 articles. Eurasia Journal of Mathematics Science and Technology Education from Turkey is ranking 15th in the list with four articles.

In the Education/Educational Research category, the countries that were active within the scope of the articles published on astronomy were examined and presented in Table 4.

Table 4. *Countries with 3 or more articles on astronomy in the Education/Educational Research category*

Countries	Record Count	Countries	Record Count
1. USA	126	11. Italy	6
2. Turkey	25	12. Brazil	6
3. Australia	22	13. Greece	5
4. England	14	14. France	4
5. Spain	13	15. Germany	4
6. Scotland	12	16. Holland	4
7. Canada	10	17. Sweden	4
8. Taiwan	8	18. New Zealand	3
9. İsrael	7	19. Norway	3
10. South Africa	7		

It has been determined that in the Education/Educational Research category, articles on astronomy have been published from 44 different countries. In Table 4, countries with 3 or more articles on astronomy are listed in the Education/Educational Research category. When the table is examined, it is seen that the most effective country in this regard is the USA with 126 articles. This country is followed by Turkey with 25 articles, Australia with 22 articles and England with 14 articles, Scotland with 12 articles and Canada with 10 articles.

In the Education/Educational Research category, the active publication languages in the articles published on astronomy were examined and presented in Table 5.

Table 5. *Effective publication languages in articles published on astronomy in the Education/Educational Research category*

Languages	Record Count
1. English	263
2. Spanish	14
3. Portuguese	4
4. Icelandic	1
5. Russian	1
6. French	1

When Table 5 is examined, it has been determined that a total of 284 articles on astronomy were published in 6 different languages in the Education/Educational Research category. In this context, it is seen that the most frequently used publication language is English with 263 articles (93%). This publication language is followed by Spanish with 14 articles, Portuguese with 4 articles, Icelandic, Russian and French with 1 article each.

In the Education/Educational Research category, the effective institutions in the articles published on astronomy were examined and presented in Table 6.

Table 6. *Institutions that have published 5 or more articles on astronomy in the Education/Educational Researches category*

Organization	Record Count
Pennsylvania Commonwealth System of Higher Education Pcshe	17
University of Arizona	11
University of Strathclyde	10
Edith Cowan University	9
Penn State University	9
University of Wyoming	9
University of California System	8
University of Kentucky	7
Charles Sturt University	7
Indiana University Bloomington	7
Indiana University System	7
Ohio State University	6
Arcadia University	6
University System of Georgia	6
University of North Carolina	6
North Carolina State University	5
Harvard University	5
University of Colorado System	5

It has been determined that in the Education/Educational Research category, articles on astronomy have been published from 336 different institutions. In Table 6, institutions contributing to the subject area with 5 or more articles in the Education/Educational Research category are listed. When the table is examined, it is seen that the most effective institution on this subject is the Pennsylvania Commonwealth System of Higher Education Pcsthe with 17 articles. This institution is followed by the University of Arizona with 11 articles, the University of Strathclyde with 10 articles, and Edith Cowan University, Penn State University and University of Wyoming with 9 articles each.

In the Education/Educational Research category, the authors who were active within the scope of the articles published on astronomy were examined and presented in Table 7.

Table 7. *Authors who have published 4 or more articles on astronomy in the Education/Educational Research category*

Authors	Record Count	Authors	Record Count
Plummer, J. D.	13	Barnett, M.	4
Bryce, T. G. K.	10	Fitzgerald, M.	4
Blown, E. J.	9	Bailey, J. M.	4
Mckinnon, D. H.	7	Kim, M. S.	4
Prather, E. E.	6	Impey, C. D.	4
Slater, T. F.	6	Tatge, C. B.	4
Danaia, L.	5	Morris, J. E.	4
Trundle, K. C.	5	Slater, E.V.	4

It has been determined that 557 different authors have published articles on astronomy in the Education/Educational Research category. In Table 7, authors who contributed to the subject area with 4 or more articles in the Education/Educational Research category are listed. When the table is examined, it is seen that the most active author on this subject is

Plummer, J. D. with 13 articles. This author is followed by Bryce, T. G. K. with 10 articles, Blown, E. J. with 9 articles, Mckinnon, D. H. with 7 articles, and Prather, E. E. and Slater, T. F. with 6 articles each. In the Education/Educational Studies category, the co-citation network of the articles published on astronomy was examined. The obtained results are presented in Figure 2.

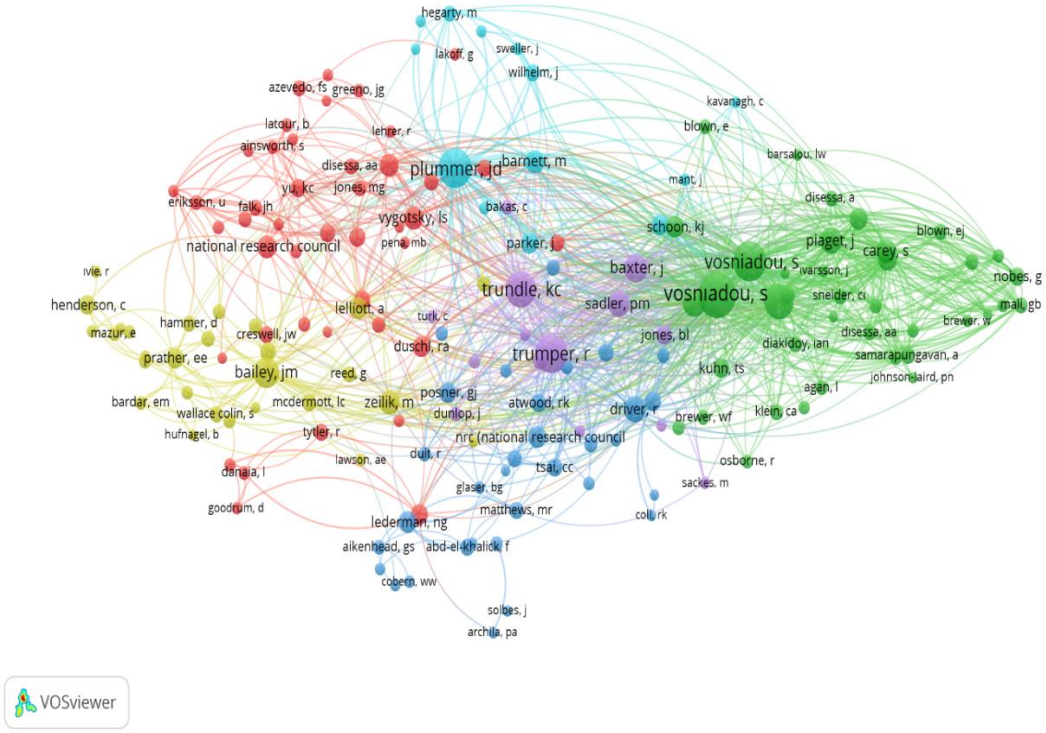

Figure 2. Author co-citation network

It was seen that a total of 6853 different authors were cited in 284 articles published in journals indexed in the Web of Science database on astronomy. Among these authors, Vosniadou, S. is the most cited author with 270 citations. This author followed by Plummer, J.D. (112), Trumper, R. (96), Trundle, K.C. (91), Nussbaum, J. (70), Bailey J. M. (61), Baxter, J. (54), Sharp, J. G.(54), Piaget, J. (51) and Driver, R.(49) and Sadler, P.M. (49) citations. The top 10 most cited articles on astronomy in the Education/Educational Research category were examined and presented in Table 8.

Table 8. *Top 10 most cited articles on astronomy in the Education/Educational Research category*

Article Title	Author(s)	Pub. Year	Journal	N.C.	N.C./ Years
1. Sage, guide or ghost? The effect of instructor intervention on student participation in online discussion forums	Mazzolini, M. Maddison, S.	2003	Computers & Education	172	9.05
2. Predictors of well-structured and ill-structured problem solving in an astronomy simulation	Shin, N. Jonassen, D.H. McGee, S.	2003	Journal of Research in Science Teaching	152	8.00
3. Use of research-based instructional strategies in introductory physics: Where do faculty leave the innovation-decision process?	Henderson, C. Dancy, M. Niewiadomska-Bugaj, M.	2012	Physical Review Special Topics-Physics Education Research	128	12.80
4. Will MOOCs transform learning and teaching in higher education? Engagement and course retention in online learning provision	de Freitas, S.I. Morgan, J. Gibson, D.	2015	British Journal of Educational Technology	121	17.29
5. Preservice elementary teachers' conceptions of moon phases before and after instruction	Trundle, K.C. Atwood, R.K. Christopher, J.E.	2002	Journal of Research in Science Teaching	108	5.40
6. Psychometric models of student conceptions in science: Reconciling qualitative studies and distractor-driven assessment instruments	Sadler, P.M.	1998	Journal of Research in Science Teaching	108	4.50
7. Virtual solar system project: Building understanding through model building	Barab, S.A. Hay, K.E. Barnett, M. et al.	2000	Journal of Research in Science Teaching	100	4.50
8. Designing Curricula For Conceptual Restructuring - Lessons From The Study of Knowledge Acquisition in Astronomy	Vosniadou, S.	1991	Journal of Curriculum Studies	91	2.94
9. The use of a computer simulation to promote scientific conceptions of moon phases	Bell, R.L. Trundle, K.C.	2008	Journal of Research in Science Teaching	82	5.86
10. Building a Learning Progression for Celestial Motion: Elementary Levels from an Earth-Based Perspective	Plummer, J.D. Krajcik, J.	2010	Journal of Research in Science Teaching	73	6.80

N.C.: Number of Citations

It was determined that 284 articles published on astronomy in the Education/Educational Research category received a total of 4151 citations and the average number of citations per publication was 14.62. When Table 8 is examined, the most cited study in the

Education/Educational Research category is the article titled "Sage, guide or ghost? The effect of instructor intervention on student participation in online discussion forums" published in the Computers & Education journal by Mazzolini and Maddison. A total of 172 citations were made to the article published in 2003, with an annual citation average of 9.05. This article is followed by the article titled “Predictors of well-structured and ill-structured problem solving in an astronomy simulation” published by Shin, Jonassen and McGee in the Journal of Research in Science Teaching in 2003 with a total of 152 citations and an average of 8.00 citations. The article with the highest average of citations is the article titled “Will MOOCs transform learning and teaching in higher education? Engagement and course retention in online learning provision” published by deFreitas, Morgan and Gibson in the British Journal of Educational Technology in 2015. This article received a total of 121 citations, with an annual average of 17.29 citations.

The keyword network of articles published on astronomy in the Education/Educational Research category was also looked. In the process, it was determined that a total of 556 different keywords were used in the articles. The scientific network map of the keywords is presented in Figure 3.

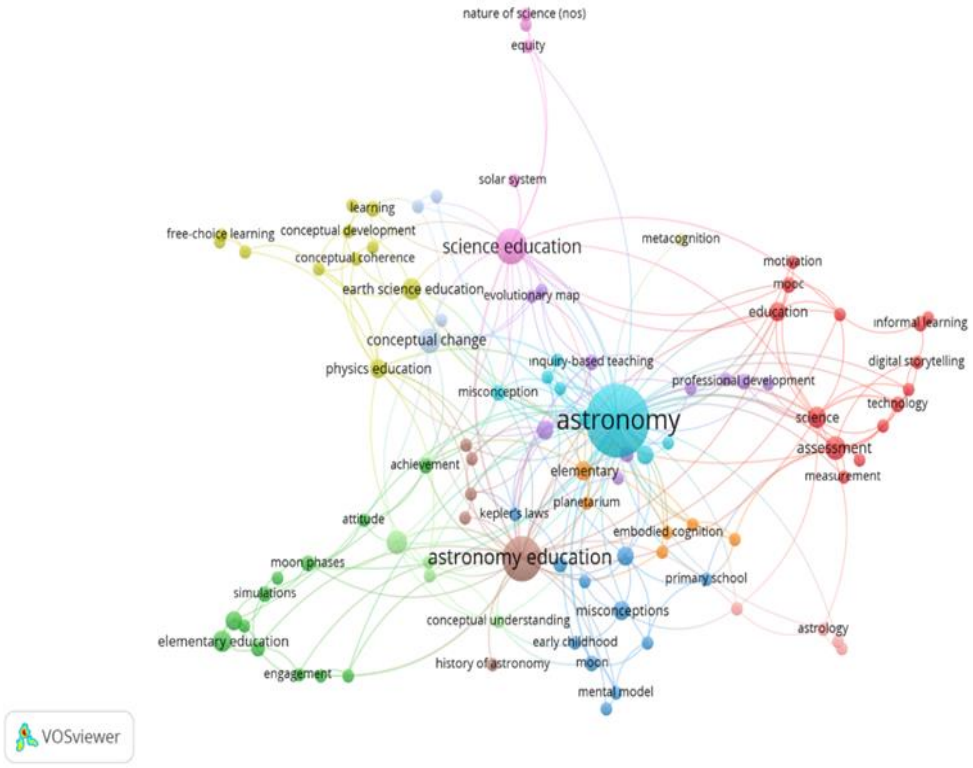

Figure 3. Keywords network of articles

When Figure 3 is examined, it is seen that the most frequently used keywords in the articles are "astronomy" (58) and "astronomy education" (22). These keywords are followed by "science education" 14 times, "primary education" 9 times, “conceptual change” 7 times, “evaluation” and “teacher education” 6 times, “science” and “earth science education” 5 times, "physics education", "high school", "astronomy concepts", "education", "interactive learning environments", "primary school" and "misconceptions" 4 times, respectively.

In the Education/Educational Research category, the publication years of the articles published from Turkey on astronomy were examined and presented in Table 9.

Table 9. *Publication years of articles published from Turkey on astronomy in the Education/Educational Research category*

Publication Year	Record Count	Publication Year	Record Count
2020	2	2012	----
2019	---	2011	1
2018	3	2010	---
2017	2	2009	---
2016	6	2008	---
2015	2	2007	1
2014	5	2006	---
2013	3		

When Table 9 is examined, it is seen that the first article on astronomy published from Turkey in the Education/Educational Research category was published in 2007. Respectively, it is seen that the highest number of articles were published in 2016 with 6 articles, followed by 2014 with 5 articles. It has been determined that 24 of the 25 articles published from Turkey between 1975 and 2020 were published in the last ten years. In the Education/Educational Research category, the journals in which articles from Turkey on astronomy were published were examined and presented in Table 10.

Table 10. *Journals in which articles from Turkey on astronomy were published in the Education/Educational Researches category*

Journals	Record Count
1. Journal of Baltic Science Education	5
2. Eurasia Journal of Mathematics Science and Technology Education	3
3. International Journal of Science Education	2
4. Journal of Science Education and Technology	2
5. Computers Education	1
6. Contributions From Science Education Research	1
7. Cukurova University Faculty of Education Journal	1
8. Educational Sciences Theory Practice	1
9. Eğitim ve Bilim	1
10. International Journal of Educational Sciences	1
11. International Journal of Game Based Learning	1
12. Issues in Educational Research	1
13. Journal of Educational Research	1
14. Kuram ve Uygulamada Eğitim Bilimleri	1
15. Pegem Eğitim ve Öğretim Dergisi	1
16. Physical Review Physics Education Research	1
17. Research in Science Technological Education	1
Total	25

It has been determined that articles from Turkey on astronomy were published in 17 different journals in the Education/Educational Research category. Table 10 indicates that the most effective journal on this subject is the Journal of Baltic Science Education with 5 articles. This journal is followed by Eurasia Journal of Mathematics Science and Technology Education with 3 articles, International Journal of Science Education and Journal of Science Education and Technology with 2 articles each. All 25 articles published from Turkey on astronomy in the Education/Educational Research category were published in English.

In the Education/Educational Research category, the institutions that were active in the articles published from Turkey on astronomy were examined and presented in Table 11.

Table 11. *Institutions in Turkey with 2 or more articles on astronomy in the Education/Educational Research category*

Institutions	**Record Count**
Çukurova University	3
Balıkesir University	2
Hacettepe University	2
Marmara University	2
Mehmet Akif Ersoy University	2
Ondokuz Mayıs University	2

It has been determined that in the Education/Educational Researches category, articles on astronomy have been published from 22 different institutions in Turkey. Table 11, institutions that contributed to the subject area with 2 or more articles in the Education/Educational Research category are listed. It is seen that the most effective institution in this regard is Çukurova University with 3 articles. This institution is followed by Balıkesir University, Hacettepe University, Marmara University, Mehmet Akif Ersoy University and Ondokuz Mayıs University with 2 articles each. In the Education/Educational Research category, the authors who were active within the scope of the articles published from Turkey on astronomy were examined and presented in Table 12.

Table 12. *Authors from Turkey who have published 2 or more articles on astronomy in the Education/Educational Studies category*

Authors	**Record Count**
Kalkan, H.	2
Korur, F.	2
Türk, C.	2
Uçar, S.	2

It has been determined that 45 different authors from Turkey have published articles on astronomy in the Education/Educational Research category. In Table 12, authors who contributed to the subject area with 2 or more articles in the Education/Educational Research category are listed. Table 12 shows that the most active authors on this subject area are Kalkan, H., Korur, F., Türk, C. and Uçar, S., with 2 articles each. In the Education/Educational Research category, the author co-citation network of articles from Turkey published in journals indexed in the Web of Science database on astronomy was examined. The obtained results are presented in Figure 4.

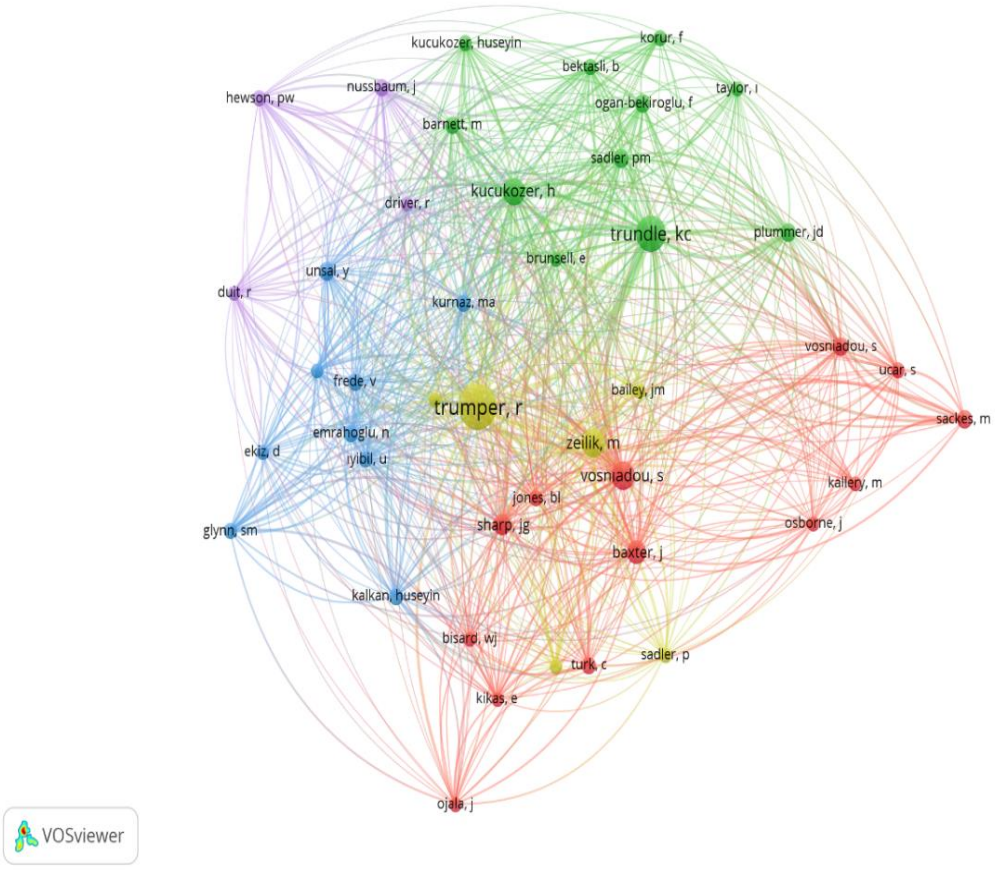

Figure 4. Author co-citation network of articles from Turkey

In the study, it was seen that a total of 767 different authors were cited in 25 articles from Turkey published in journals indexed in the Web of Science database on astronomy. Among these authors, Trumper, R. is the most cited author with 53 citations. This author followed by Trundle, K. C. with 33 citations, Vosniadou, S. with 28 citations, Zeilik, M. with 20 citations, Küçüközer, H. with 19 citations, Baxter, J. with 13 citations, Sharp, J. G. with 11 citations, Oğan-Bekiroğlu F. with 9 citations, Plummer, J. D., Sadler, P.M., Sackes, M., Ünsal, Y., and Singh, C. with 8 citations each. In the Education/Educational Researches category, the top 5 most cited articles from Turkey published on astronomy were examined and presented in Table 13.

Table 13. *Top 5 most cited articles from Turkey published on astronomy in the Education/Educational Research category*

Article Title	Authors	Pub. Year	Journal	N.C.	N.C./ Years
A Study on Identifying the Misconceptions of Pre-service and In-service Teachers about Basic Astronomy Concepts	Kanlı, U.	2014	Eurasia Journal of Mathematics Science and Technology Education	17	2.13
The Effect of Planetariums on Teaching Specific Astronomy Concepts	Turk, C. & Kalkan, H.	2015	Journal of Science Education And Technology	10	1.43
Surveying Turkish high school and university students' attitudes and approaches to physics problem solving	Balta, N., Mason, A.J. & Singh, C.	2016	Physical Review Physics Education Research	9	1.50
Changes in Preservice Teacher Attitudes Toward Astronomy Within a Semester-Long Astronomy Instruction and Four-Year-Long Teacher Training Programme	Ucar, S. & Demircioglu, T.	2011	Journal of Science Education and Technology	9	0.82
Exploring Seventh-Grade Students' and Pre-Service Science Teachers' Misconceptions in Astronomical Concepts	Korur, F.	2015	Eurasia Journal of Mathematics Science and Technology Education	8	1.14
Embedding Analogical Reasoning into 5E Learning Model: A Study of the Solar System	Devecioglu-Kaymakci, Y.	2016	Eurasia Journal of Mathematics Science and Technology Education	6	1.00

N.C.: Number of Citations

It was determined that 25 articles from Turkey, indexed in the Web of Science database on astronomy in the Education/Educational Research category, received 89 citations in total and the average number of citations per publication was 3.56. It is seen that the most cited article from Turkey in the Education/Educational Research category is Kanlı U.'s article titled "A Study on Identifying the Misconceptions of Pre-service and In-service Teachers about Basic Astronomy Concepts" published in the Eurasia Journal of Mathematics Science and Technology Education. A total of 17 citations were made to the article published in 2014, and the annual citation average is 2.13.

The keyword network of articles from Turkey published on astronomy in the Education/Educational Research category was also looked. It was determined that a total of

83 different keywords were used in the articles. The scientific network map of the keywords is presented in Figure 5.

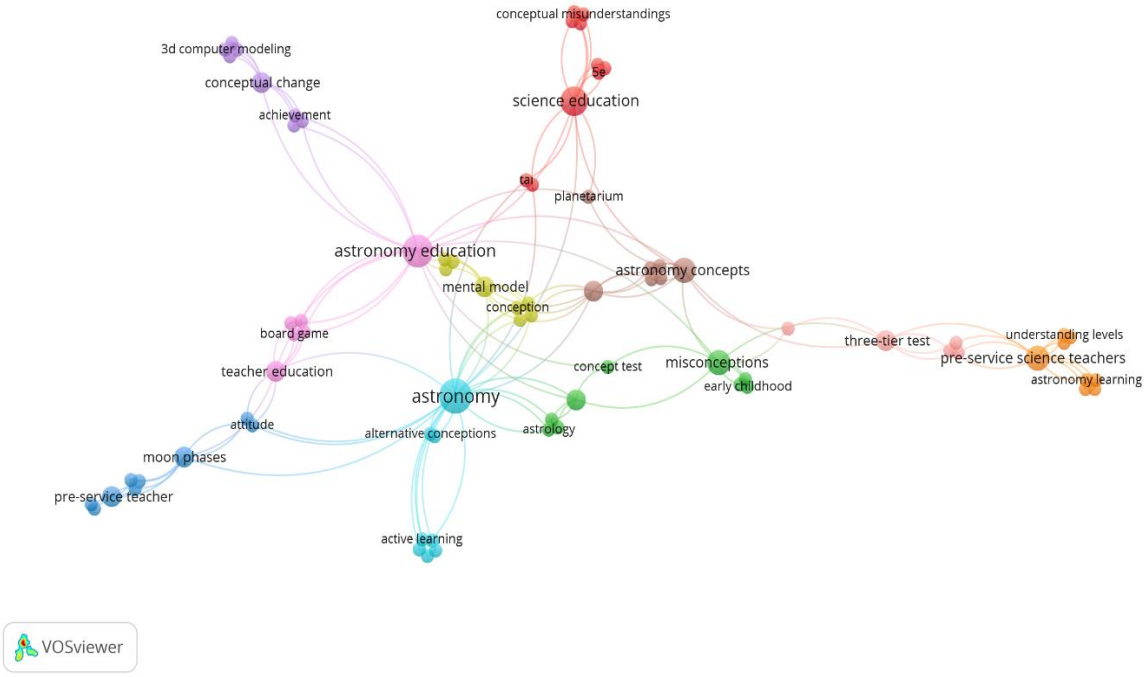

Figure 5. Keywords network of articles from Turkey

It is seen that the most frequently used keywords in articles from Turkey are "astronomy" (6), "science teacher candidates" (5) and "astronomy education" (5). The other keywords used are; "science education" and "teacher candidates" (4), "astronomy concepts" and "misconceptions" (3), and "teacher education", "conceptual change", "phases of the moon" "mental model" and "three-tier test" (2), respectively.

4. Discussion and Conclusion

Within the scope of the study, it was seen that a total of 284 articles were published between 1975 and 2020 on astronomy in the Education/Educational Research category of Web of Science database. It is noteworthy that about four-fifths of these articles were published in the last ten years. There has been a great increase in the number of articles on astronomy both in the world and in Turkey in the last ten years. This situation is in parallel with the increase in astronomy education activities given in schools and various out-of-school institutions such as planetariums (Berryhill & Slater, 2017; Doğru, Güzeller & Satar, 2019). When the international literature is examined totally, it is seen that the studies on astronomy education started long ago, and in the national literature, these studies were published after the 2010s and increased cumulatively (Table 2 and Table 9). In this context, it can be said that the number of national studies and the number of researchers who publish are more limited than the international literature (Table 7 and Table 12). This situation may also affect the number of citations of national articles (Mandapur, Govanakoppa & Rajgoli, 2011; Wildgaard, 2015).

Because of high interest of students in astronomy subjects (Ertaş Kılıç & Keleş, 2017) and mutual interaction of astronomy subjects with other science subjects (Taşcan & Ünal, 2015), it can be stated that the increasing importance has been embodied in recent researches. However, due to the lack of a special journal for astronomy education, it has been observed that the articles shifted to science education or physics education journals. It has been determined that the main articles on astronomy education were published in important journals in science education such as the International Journal of Science Education, while the articles from Turkey were mostly published in the Journal of Baltic Science Education or the Turkish Eurasia Journal of Mathematics Science and Technology Education, which is originated from Turkey. In the literature, it is seen in bibliometric studies on different subjects in science education that Turkish authors prefer the same journals scanned in Web of Science database (Bozdoğan A. E., 2020a; Bozdoğan A. E., 2020b; Doğru, Güzeller & Çelik, 2019).

It has been determined that the most effective country in which publications on astronomy is the USA, and Turkey is in the second place in the list with 25 articles. This suggests that Turkey has focused on astronomy education in recent years and is one of the leading countries. Within the bibliometric studies conducted in different sub-fields of education, it can be said that similar results have been obtained (Bozdoğan K., 2020; Gülmez, Özteke & Gümüş, 2021, Julia et al. 2020; Olpak & Arican, 2021; Sönmez, 2020; Şeref & Karagöz, 2019). For example, in the study of Evren Yapıcıoğlu (2021), in which she examined the bibliometric features of the articles published in the field of socioscientific issues, Turkey ranks second after the USA in the ranking of the countries with the highest number of publications. In the light of these indicators, it can be claimed that Turkey's studies in the field of education are increasing in the international arena and that it is one of the leading countries. Parallel to this, articles on astronomy education also show their numerical advantage. With the emphasis on astronomy issues in the Science Curriculum (MEB, 2018), it can be stated that studies in this field may increase even more.

It is known that the dominant language of publication at the international level is English (Olpak & Arican, 2021). In the Web of Science database, where the search was made, there are mainly English-language journals. The high number of publications in countries with English as a native language such as the USA also contributes to the situation. Journals publishing in Turkish could not enter the indexes scanned in the Web of Science database, and some of the journals originating in Turkey were excluded from these indexes in recent years (Olpak & Arican, 2021). As González-Alcaide, Valderrama-Zurián, and Aleixandre-Benavent (2012) emphasized, the high number of journals that only accept articles written in English in the journals included in the indexes scanned in the Web of Science database affects the number of indexed articles published mainly by non-English speaking countries. This situation also shows itself in review studies in the field of education (Bozdoğan A. E., 2020a; Bozdoğan K., 2020; Evren Yapıcıoğlu, 2021; Sönmez, 2020; Yavuz, Kayalı, & Tutal, 2021).

When the articles from Turkey in the journals indexed in the Web of Science database published on astronomy are examined, it can be said that there is no dominant institution or author. Many different universities have taken place in the literature with a maximum of 2-3 articles. It is thought that this may be due to the lack of formation of various working groups focused on certain issues in Turkey. When looked at the publications of other countries, it is seen that different working groups in certain universities can be more productive in publishing (González-Alcaide, Valderrama-Zurián & Aleixandre-Benavent, 2012). It is thought that both the visibility and prestige of Turkey in the international arena will increase if such working groups are formed and work together in Turkey. Another reason why articles

have spread to institutions and authors may be a language problem. This distribution seen in the sources written in English can be reviewed with a bibliometric study to be carried out in TR Index.

When the citations made in the articles published in the journals indexed in the Web of Science database on astronomy in Turkey and in the world are examined, it is seen that there is a similarity. In this context, it has been determined that the most cited authors are Vosniadou S., Plummer J.D., Trumper, R. and Trundle K., respectively. It reveals that these authors are pioneers in the field. Doğru, Güzeller and Satar's (2019) bibliometric study in the field of astronomy education similarly states that Vosniadou S. is the author with the highest citation explosion value.

It is revealed that the citation average of the articles published around the world on astronomy is approximately 4 times higher than the citation average of the articles originating from Turkey. It can be said that the more publication of articles from Turkey in recent years has contributed to this situation. However, there were differences in the keyword networks of the articles published on this subject. In this context, it has been seen that the most frequently used keywords in the articles published around the world are astronomy, astronomy education and science education, respectively. When the keywords in the articles originating from Turkey were examined, it was determined that the most frequently used ones were astronomy, science teacher candidates and astronomy education. This result shows that more frequent studies are conducted with pre-service teachers in researches conducted in Turkey. It can be said that the reason for this may be because researchers working at universities can reach pre-service teachers more easily, or it may be due to the concern of providing better education to future generations on astronomy.

5. Suggestions

In the study, the articles in the category of Education/Educational Research related to astronomy in the WoS database were examined, and this study can also be carried out again in the same database, with the different types of resources, such as books, conference proceedings, etc. Moreover, similar studies can be carried out in different internationally respected databases such as SCOPUS, ERIC, H. W. Wilson. In addition, bibliometric studies can be conducted at the national level in DergiPark and TR-Dizin, which are the most important databases of Turkey. Similar to this study, international and national postgraduate theses about astronomy education can also be examined. In addition, citation analyzes can also be made within the scope of articles, theses, books, conference proceedings etc. to be examined. Thus, the trends can be revealed in a broader perspective related to the astronomy education.

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