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Trends in Journals Indexed in the Web of Science Database about Programming Education

Özgen Korkmaz [1]
Amasya University, Engineering Faculty, Department of Computer Engineering, Amasya Turkey, Orcid: 0000-0003-4359-5692

Cavit Erdoğmuş
Suluova Şehit Hüseyin Düzenli Public Education Center, Ministry of National Education, Amasya, Turkey, Orcid: 0000-0002-6717-0528

Osman Kılıç
Suluova Şehit Yüzbaşı Alper Kalem Secondary School, Ministry of National Education, Amasya, Turkey, Orcid: 0000-0002-6347-6087

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In the literature, it is possible to come across studies on the determination of research trends in programming education. However, based on the articles published in the journals scanned by Web of Science in the literature, no studies were found in which the trends towards programming education were discussed without time limit. Considering the important contributions of the journals scanned by Web of Science to the literature, it is thought that determining the trends in these journals can make significant contributions to the literature. Therefore, in this study, it is aimed to determine the research trends in articles on programming education published in journals scanned by Web of Science. Based on the articles published in the journals indexed in the Web of Science database, the bibliometric analysis approach was used to determine the trends in programming education in the field of educational technology in the world. A data group consisting of 3234 publications in total was obtained as a result of filtering using the "Education, Educational Research" and "Document Types" filters, using the "Article", "Early Access" and "Review Article" options from the "Research Areas" preferences. The obtained data were analyzed using Vosviewer application. As a result of the analyzes, the following conclusions were reached: There has been a significant increase in both the number of articles related to programming education and the number of citations received by these articles after 2005. It has been seen that the concepts of programming, computer thinking (computational thinking?), education and computer science education are often discussed in the studies on programming education..

Introduction

It is possible to say that the programming process is a problem-solving process in general. Because this process basically covers the stages of digitizing the problem first to solve a real-life problem, determining the solution path to solve this problem in the next stage, producing an algorithm by digitizing the solution, and finally coding the algorithm. It is aimed to get more accurate and faster results through the resulting code. Yükseltürk ve Altıok (2018) state that

[1] *Correspondence: ozgenkorkmaz@gmail.com*

this process is a process that includes the relationship between hardware and software, the algorithm, the main structures of programming languages such as conditional expressions and loops. It is possible to say that the growth experienced in the programming sector in recent years has caused this sector to become a leading and strategic sector all over the world. In this context, it is possible to say that the interest in educational institutions that focus on programming education, such as computer engineering, computer programming, artificial intelligence engineering, is increasing. According to Gülbahar and Kalelioğlu (2018), having programming skills has become one of the important skills today.

With programming education, it is not only aimed to train programmers. However, in addition to this, it is aimed to develop many psychometric characteristics of students such as problem solving, computational thinking, algorithmic thinking, critical thinking (Korkmaz & Uğur Erdoğmuş, 2019). Çatlak and colleagues (2015) emphasize that students' high-level thinking abilities such as problem solving, collaborative learning, original thinking, and critical thinking can be developed through programming education. Taylor, Harlow and Forret (2010) emphasize that individuals complex math problems solving, results-oriented problem-solving skills, the development of a collaborative, systematic and emphasizes that plays an important role in the development of creative thinking skills with programming training. Taylor, Harlow, and Forret (2010) state that programming education plays an important role in the development of individuals' ability to solve complex mathematical problems and their collaborative, systematic and creative thinking skills. In the literature, it is emphasized that in order to be successful in computer programming, individuals should have high-level thinking skills such as problem solving, logical and mathematical thinking, critical thinking, and creative thinking (Korkmaz & Altun, 2014a; Fang, 2012; Korkmaz, 2012; Lau &Yuen, 2011; Wang, Geng, Jiang & Liu, 2012). According to Korkmaz (2019), it would not be wrong to say that skills such as critical thinking, problem solving and logical-mathematical thinking, computational thinking (Korkmaz, Çakır & Özden, 2017) and creative thinking are very important skills for programming education. On the other hand, it can be said that one of the ways to develop these higher-order thinking skills of individuals is to give computer programming training (Korkmaz, 2019, Erdoğmuş, Çoban, Korkmaz & Özden, 2021). In this context, it is possible that it would be wrong to perceive programming education as only a vocational education, and that it could be an alternative way to provide individuals with thinking skills throughout academic education, just like in mathematics. Considering this situation, it is possible to say that programming education cannot be limited to engineering or vocational education but should be extended to all educational processes. It is possible to find a lot of research in the literature that programming education should be reduced to younger ages whenever possible (Akçay, 2015; Berland & Wilensky, 2015; Zhang, Yang, Luan, Yang, & Chua, 2014).

However, the fact that programming processes consist of abstract operations from beginning to end causes difficulties in learning this process for early children (Korkmaz & Altun, 2014b; Gomes & Mendes 2007; Tan, Ting & Ling, 2009). Programming is perceived by students as a process that requires higher cognitive skills and therefore programming lessons are perceived as one of the most difficult subjects (Fang 2012; Tan et. al., 2009; Milne & Rowe, 2002). It is emphasized that learning programming creates a significant cognitive load on students (Garner, 2009) and because students think that computer programming is difficult to learn, they perceive programming courses as one of the most difficult courses and as a result, they fail (Korkmaz, 2013; Nilsen & Larsen, 2011; Caspersen & Kolling 2009). Significant changes have been experienced in programming environments, both in terms of technical developments in

programming processes and changing needs, as well as solving the problems faced by children at early ages in learning, and new approaches such as object-oriented programming, block programming and modular programming have begun to be adopted. It is possible to find a lot of evidence in the literature that these approaches make significant contributions to programming teaching (Baz, 2018; Sırakaya, 2018; Yünkül, Durak, Çankaya & Mısırlı, 2017; Zhang, Yang, Luan, Yang, & Chua, 2014).

In addition to the object-oriented programming, block programming and modular programming approaches in programmatic education, it is seen that educational robots are frequently used in recent days (Berland & Wilensky, 2015). As a matter of fact, in recent years, the literature has focused on the usefulness of educational robot sets in programming education (Bers, Flannery, Kazakoff & Sullivan, 2014; Chang, Lee, Chao & Cehn, 2010; Fridin, 2014). When the literature is examined, it is seen that Lego Mindstorms Robot kits, Fischertechnik robot kits, mBot-STEM Educational robot kit and Arduino robot kits stand out (Oluk & Korkmaz, 2018). In particular, educational robots were used in activities aimed at increasing the academic achievement and attitudes of students such as programming, problem solving, computational thinking, stem and logical-mathematical thinking skills (Kaya et al., 2020; Korkmaz et al., 2019; Paucar-Curasma et al., 2022; Yang et al., 2022; Marzano & Zorzi, 2022). It is thought that determining the roles of pedagogical approaches for educational robots will play an important role in making the learning process progress correctly and making the educational robot process meaningful (Tang, Tung, & Cheng, 2020). However, it is observed that educational robot studies do not focus on pedagogical approaches and theoretical frameworks, and the studies lack pedagogical approaches, and it is seen that there is a need for pedagogical approaches and theoretical perspective in educational robot studies (Xia & Zhong, 2018; Schina, Esteve-González, & Usart, 2021; Atman Uslu, Öztüre Yavuz & Koçak Usluel, 2022).

As a result, it can be said that programming education can be used in different environments and in different ways to contribute not only to professional development but also to the thinking skills of younger students. The trends in the studies conducted in this direction in the literature are important in terms of determining both the importance of programming education, the purpose of programming education and the expected benefits. In the literature, it is possible to come across studies on the determination of research trends in programming education. However, based on the articles published in the journals scanned by Web of Science in the literature, no studies were found in which the trends towards programming education were discussed without time limit. Considering the important contributions of the journals scanned by Web of Science to the literature, it is thought that determining the trends in these journals can make significant contributions to the literature. Therefore, in this study, it is aimed to determine the research trends in articles on programming education published in journals indexed by Web of Science.

Research Question

What are the research trends in articles on programming education published in journals indexed by Web of Science?

Sub-questions

(1) What is the distribution of publications and citations of articles about programming education published in journals indexed on the Web of Science site according to the years?
(2) What are the concepts most discussed in the articles about programming education published in the journals indexed on the Web of Science site?
(3) What is the citation distribution of articles about programming education published in journals indexed on the Web of Science site according to journals?
(4) What is the citation distribution of articles about programming education published in journals indexed on the Web of Science side according to countries?

Method

Research Model

Based on the articles published in the journals indexed in the Web of Science database, the bibliometric analysis approach was used to determine the trends in programming education in the field of educational technology in the world. Bibliometric analysis; the trends in research in a particular field, the scientific size, impact and growth rate of researchers, publications, and journals, etc. It is used as an experimental tool to analyze its characteristics and to consider its intellectual status in the field (van Eck & Waltman, 2014).

Data Collection

In this study, 38894 results were obtained by entering the <“programming” + “education”> search phrase into the “All Fields” selected search field of the WoS Core Database. A data group consisting of 3234 publications in total was obtained as a result of filtering using the "Education, Educational Research" and "Document Types" filters, using the "Article", "Early Access" and "Review Article" options from the "Research Areas" preferences. Since WoS, SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI journals are easily accessible, it has been decided to search for keywords through this database.

Data Analysis

In order to access the bibliometric data of 3234 publications as text documents, the steps described in Figure 1 were applied. Each of the text documents obtained contains the author, title, source, abstract, citation information and all other information about the article (journal publication information) (Web of Science Core Collection Help, 2019).

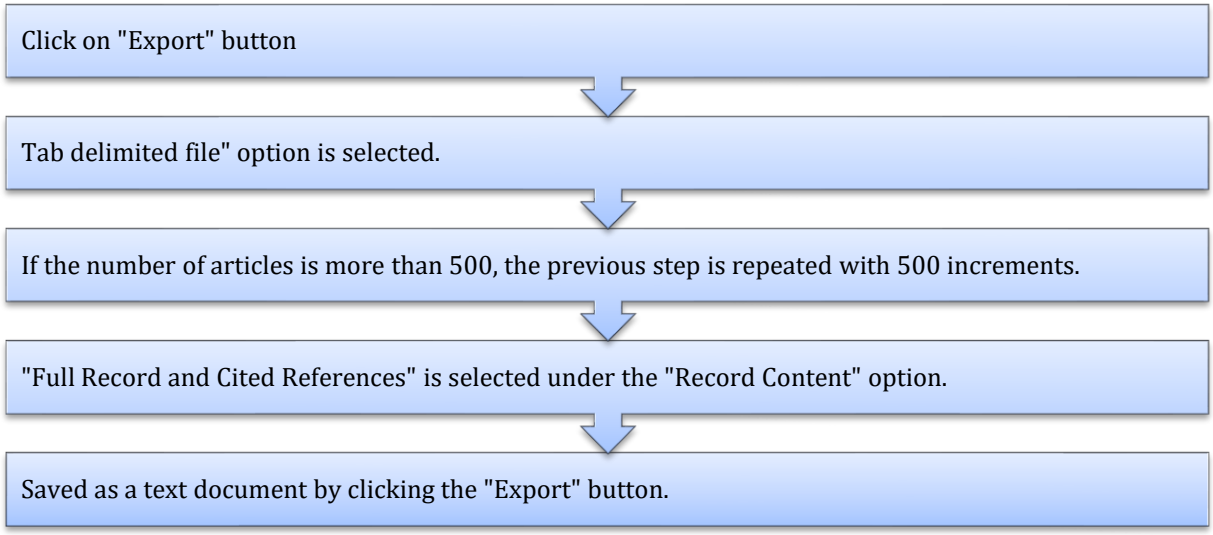

Figure 1. Web of Science bibliometric data recording process steps

The steps described in Figure 2 were applied to obtain the number of articles and the total number of citations by year.

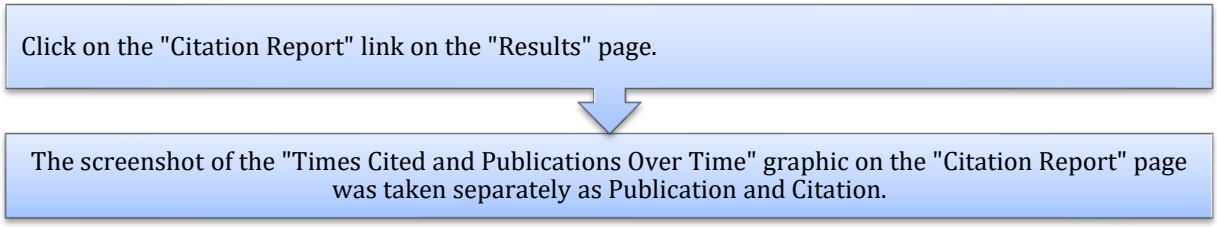

Figure 2. Process steps to obtain article numbers and citation counts

The resulting text documents are visualized by Vosviewer version 1.6.13. During this visualization.

- Distribution of articles published on keywords and citations by years
- The most used concepts with keywords
- Journal citation analysis by keyword
- Country citation analysis by keyword

Screenshots taken from the "Citation Report" page were used to show the distribution of the articles by years. In order to reach the most used concepts with keywords, the following steps were followed in the bibliometric visualization and analysis program Vosviewer application;

a) “Create” button is clicked.

b) “Create a map based on bibliographic data” is selected and “Next” button is pressed. c) In the next window, "Read data from bibliographic database files" is selected and the next step is taken.

c) The file location of the text files containing the bibliometric information of the word is specified in the field in the "Web of Science" tab, and the next page is reached by clicking the "Next" button.

d) The “Co-occurence” and “Author keywords” options are marked and the next step is taken.

e) Without changing the values given by the application, proceed with the “Next” Button.

f) The desired image has been reached by selecting the "Yes" option in the question window that appears.

After repeating the steps "a, b, c, and d" described above in order to analyze the journal citations based on keywords, the "Citation" and "Sources" options are selected from the window that appears, and the "f and g" steps described above followed sequentially. In order to analyze the country citation by keyword, the preferences in the "e" step were replaced with the "Citation" and "Countries" options, and the next steps were applied in the same way. In this way, the necessary findings were obtained.

Findings

In this section, the findings obtained as a result of the analysis of the data obtained within the scope of the research questions are included. The number of articles published and the distribution of citations by years are shown in Chart 1 (or figure?).

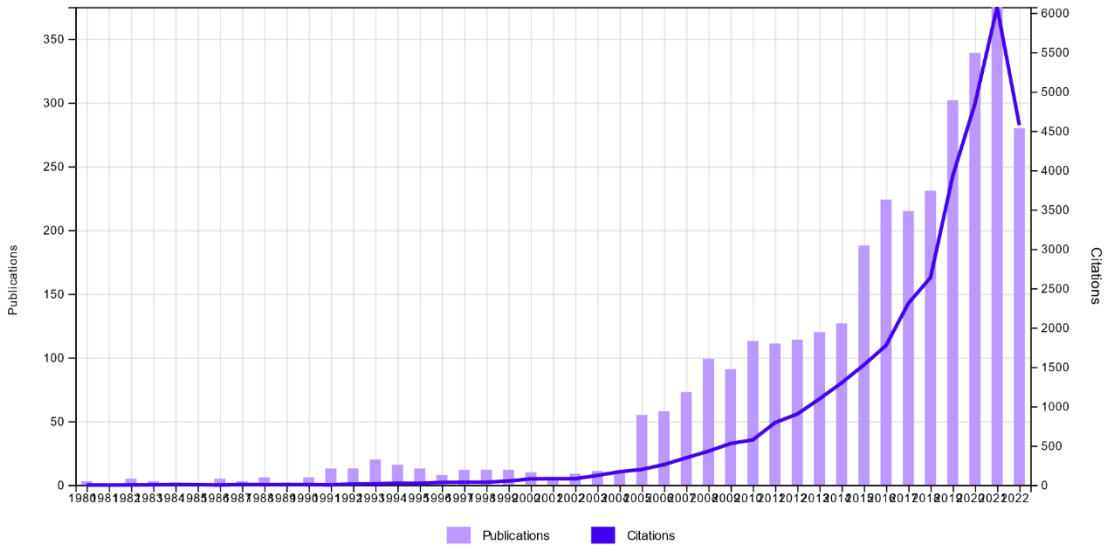

Chart 1 Number of articles published and number of citations by years

Chart 1 shows that while the number of articles and citations showed a horizontal trend between 1980 and 2005, they show an increasing trend after 2005. Likewise, the number of citations is directly proportional to the number of articles.

Most Used Concepts

Vosviewer Co-occurrence analysis was used to obtain a map of the most used concepts with the help of text-based data obtained from the WoS system. During this analysis, "Author Keywords" was chosen. The minimum number of occurrences of a keyword was set to 25. The number of keywords to be selected is given as 40 by the program. The concept map created by the Vosviewer program is given in Figure 3.

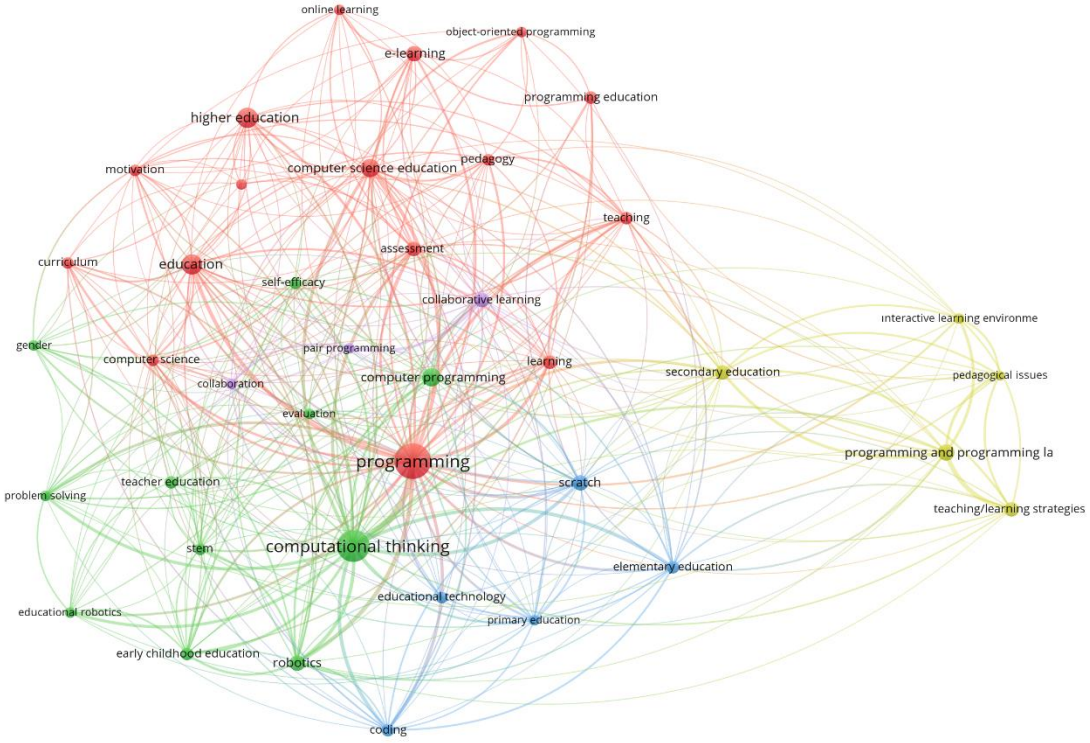

Figure 3 Most used concepts map

As seen in Figure 3, the number of concepts included in the articles published with the key phrase was found to be 40. These concepts have formed 5 separate clusters among themselves, and the 1st cluster consists of 16 concepts, the 2nd cluster consists of 11 concepts, the 3rd cluster consists of 5 concepts, the 4th cluster consists of 5 concepts and the last cluster consists of 3 concepts. The most mentioned concept is "programming" (f=298), the second concept is "computational thinking" (f=233), the third concept is "higher education" (f=100), the fourth concept "education" (f=98), and the last concept was "computer science education" (f=85). Accordingly, it can be said that the concepts of programming, computational thinking, education, and computer science education are frequently discussed in studies on programming education, and concepts such as pedagogical issues, stem, problem solving, educational robots, motivation, are less frequently discussed. On the other hand, it can be said that the researches are mostly done at the higher education level, and the studies conducted at the pre-school, primary school and teacher training levels are very few.

Citation Map in the Context of the Journal

Vosviewer Citation analysis was used to obtain the most citation maps with the help of text-based data obtained from the WoS system. “Sources” was selected during this analysis. The minimum number of documents of a source is set to 15. The minimum number of citations of a source has been changed to 15. Thanks to the determined values, a total of 35 journals were reached. The journal-citation map created by the Vosviewer program is given in Figure 4.

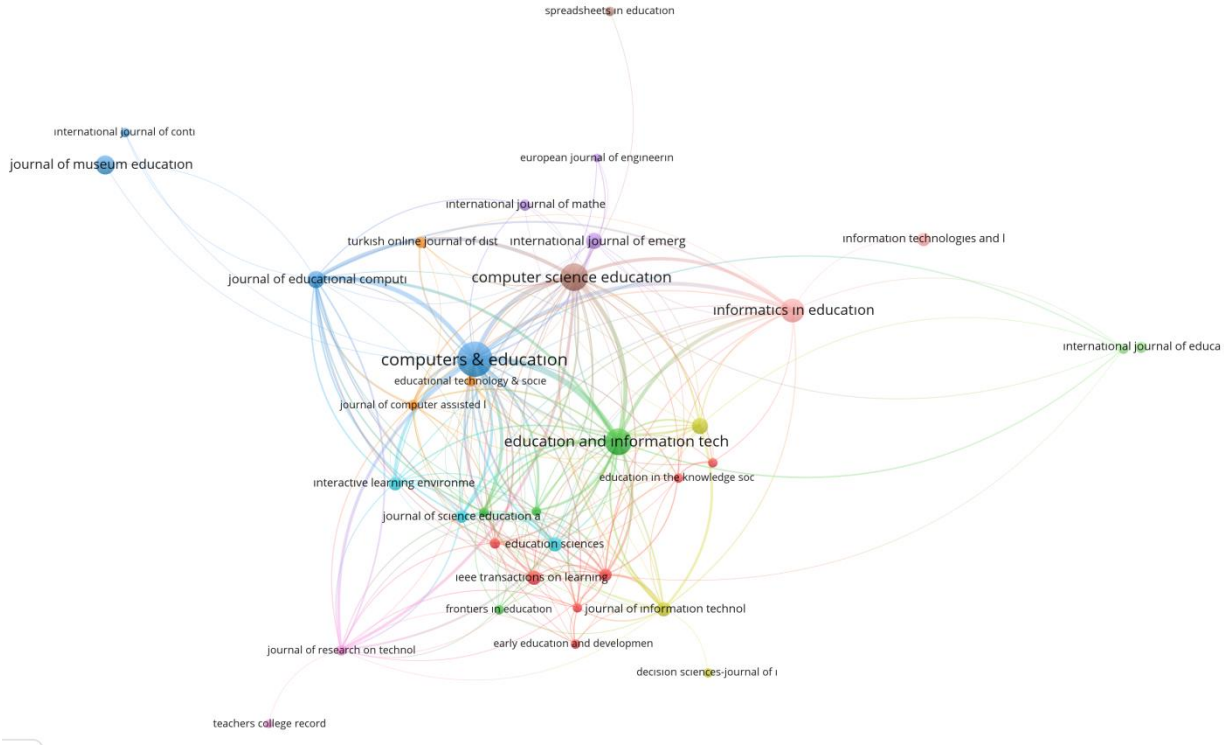

Figure 4 Citation map between journals

In Figure 4, it is seen that there is an intense citation relationship between journals. The ranking of the top 5 journals according to the number of citations among the journals: Computers & Education (222 articles, 6896 citations), Computer Science Education (133 articles, 2062 citations), Education and Information Technologies (127 articles, 1089 citations), Informatics in Education (101 articles), 756 citations), IEEE Transactions on Learning Technologies (40 articles, 665 citations). When we look at the journals published in this field in Turkey, the Turkish Online Journal of Educational Technology is among the 44 journals in this field with 25 articles and 80 citations. According to these data, it can be said that Computers & Education, Computer Science Education, Education and Information Technologies, Informatics in Education, IEEE Transactions on Learning Technologies journals are the most cited sources.

Citation Map in Context of Country

Vosviewer Citation analysis was used to obtain the citation map in the context of the country with the help of text-based data obtained from the WoS system. “Countries” was selected during this analysis. The minimum number of documents of a country is set at 15. The minimum number of citations of a country has been changed to 15. As a result of the determined values,

a total of 38 countries were reached. The country-citation map created by the Vosviewer program is given in Figure 5.

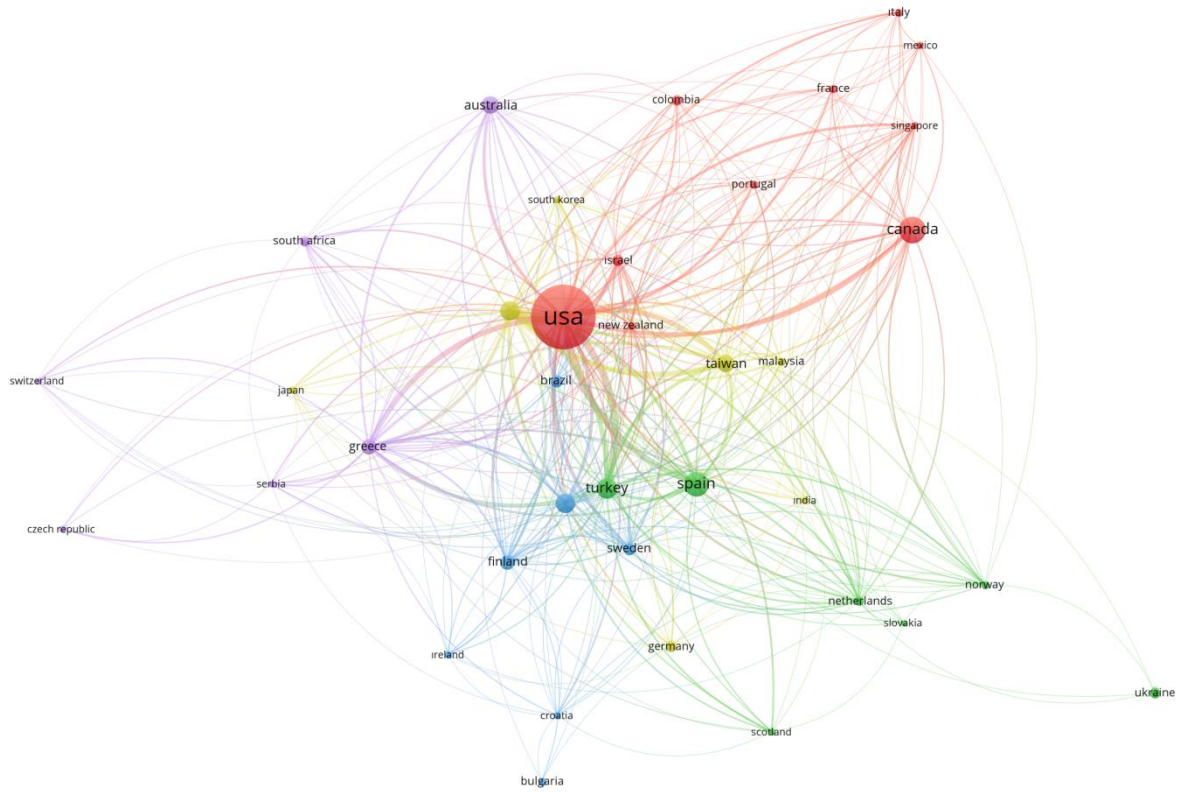

Figure 5 Citation map between countries

As a result of Vosviewer cross-country citation analysis, a citation map was created among 38 countries. Ranking of the top 5 countries by number of citations: USA (1343 articles, 17583 citations), Taiwan (104 articles, 2388 citations), Spain (199 articles, 1728 citations), Canada (231 articles, 1560 citations), China (133 articles, 1401 citations) citation). Considering the number of publications and citations from Turkey in this field, it has been included in a total of 138 articles and 1081 citations. According to these data, it can be said that the USA, Taiwan, Spain, Canada and China are the countries with the most citation exchange.

Discussion and Conclusion

After 2005, there has been a significant increase in both the number of articles on programming education and the number of citations received by these articles. Especially in the last five years, there has been a significant increase in both the articles and the number of citations related to programming education. This situation can be interpreted as programming education has started to attract significant attention in recent years. As a matter of fact, in a study conducted by Saygıner and Tüzün (2017), it was concluded that the importance given to programming education by countries increased after 2010 and that there is a tendency in many countries to provide these trainings at an early age. In the research conducted by Korkmaz and Uğur Erdoğmuş (2019), in which the tendencies towards the theses in Turkey were examined, it was emphasized that the interest in programming education was increasing. In the systematic

analysis of the articles published between 2010 and 2015 by Kim and Lee (2016) to determine the trends in programming and Science, Technology, Engineering, Art and Mathematics (STEAM) education research, it was emphasized that the research on programming and STEAM education is in an upward trend. Similarly, in a study conducted by Becker and Quille (2019) to determine the trends in the papers presented at the SIGCSE technical symposium in the last 50 years, it was emphasized that research on programming education showed an upward trend in recent years. As a result, it can be said that this result reached within the scope of this research is also consistent with the literature.

It has been determined that in studies on programming education, the concepts of programming, computational thinking, education, and computer science education are frequently discussed, and other than these concepts, concepts such as pedagogical issues, stem, problem solving, educational robots, motivation, are less discussed. The fact that programming education is widely considered within the scope of vocational education and that it is used very limitedly to improve the thinking skills of students at early ages may have resulted in this result. On the other hand, it has been determined that these researches are mostly done at the higher education level, and the studies conducted at the pre-school, primary school and teacher training levels are very few. When the trends towards the theses made in Turkey by Korkmaz and Uğur Erdoğmuş (2019) are examined, it is concluded that the theses are concentrated at the secondary school and university level. As a result, it can be suggested that necessary steps should be taken to extend programming education not only within the scope of vocational education, but also to all education levels in order to improve students' computational thinking skills.

When examined in the context of journals that accept articles on programming education, it has been determined that Computers & Education, Computer Science Education, Education and Information Technologies, Informatics in Education, IEEE Transactions on Learning Technologies journals are the most cited sources. Considering that these journals accept articles on computer science education and educational technology, are indexed in SCI and SSCI indexes and have very high impact factors, it can be said that this result is normal.

In addition, as a result of the research, it has been determined that there are studies on programming education in 38 countries in the world. Turkey is among these 38 countries, but the USA, Taiwan, Spain, Canada and China are the countries with the most citation exchange. When the trends towards the theses made in Turkey by Korkmaz and Uğur Erdoğmuş (2019) are examined, it is concluded that only 4.4% of the theses made between 2008-2018 are related to programming education, but this trend is low in Turkey. On the other hand, the fact that the countries where the programming sector is the largest in the world economically are also the same countries and the annual share of the USA in this sector exceeds one trillion dollars (Akın, 2021), which may have led to the fact that there are more studies on programming education in these countries. In this context, it can be suggested that steps should be taken quickly to expand programming education to all education levels in order to improve students' computational thinking skills, increase interest in this sector, and train good programmers in order to ensure that Turkey can get a sufficient share from this sector.

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