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## Bibliometric Analysis of Studies Focusing on Critical Thinking in Early Childhood

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### Abstract

This study aimed to examine studies on critical thinking in early childhood through bibliometric analysis. In the research, 251 studies on the concept of "critical thinking" were selected according to the inclusion criteria and analyzed with the VOS-viewer program. In the study, co-author, co-reference, co-citation and co-word analysis of the studies on the concept of "critical thinking" was carried out according to the distribution of the ten most cited authors and publications, years, published sources and countries. According to the results of bibliometric analysis on critical thinking, it was concluded that the birthplace of the subject and the most productive country is the USA. According to the co-author analysis, it was concluded that Daniel and Gagnon were the authors who contributed the most to the subject, Lipman and Kuhn according to the result of co-citation analysis, and Dovigo and Karadağ according to the result of co-citation analysis. In addition, according to co-word analysis, the most recurring keywords in the studies were critical thinking, early childhood education, creativity, early childhood, cognitive development, teacher training, preschool. As a result of the research, it was concluded that the number of studies on critical thinking in early childhood is low and there should be an increase in studies with children as the sample.

### Key Words

Critical thinking • Early childhood education • Preschool period

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## Introduction

The only way for societies to raise individuals suitable for today's ever-changing conditions and to survive in the existing competitive order and lead the world is only possible through the reforms they carry out in their education systems. The basic understanding of these reforms should be to raise individuals who can understand the period they live in well, who are aware of the needs of society and can think differently, who have adopted lifelong learning, who have the necessary competencies to access information quickly. In fact, all these skills mentioned emphasize the need for individuals equipped with skills suitable for the 21st century (Çiftçi et al., 2021; Uçak & Erdem, 2020). In this sense, it is observed that the concept and competencies of critical thinking, which was initiated by the United States and became an issue prioritized by European countries over time, began to be more visible in research at the end of the 90s and became one of the prominent concepts of the last decade in the relevant disciplines (Güven & Bülbül, 2023; Metiri Group & NCREL, 2003; OECD, 2005; Partnership for 21st Century Skills, 2006; Voogt & Roblin, 2012).

Conceptually dating back to Socrates, the concept of "critical thinking" has been influenced by the explanations of many thinkers until today and its current meaning in the literature has emerged. However, Dewey, one of these thinkers, mentioned that the interactions of individuals with their environment affect the quality of their thoughts. Referring to the importance of experiences in learning processes, Dewey considers experiencing processes as a set of questioning actions that encourage thinking (Dewey, 1933; Tozduman-Yaralı, 2020). It is observed that this concept, which is the subject of philosophy and education disciplines, enriches its content with different definitions (Ennis, 1985; Facione, 1984; Lewis & Smith, 1993; Paul, 1989; Watson & Glaser, 1980) and is sometimes used in response to other thinking skills such as problem solving (Daniel & Auriac, 2011; Tozduman-Yaralı, 2020). In this regard, it is very important to describe the current aspects of the studies on the concept of critical thinking and to make inferences for future research.

When the current studies from Türkiye on the concept of critical thinking are examined, it is seen that they include the fields of science education (Açışlı-Çelik, 2022; Karagöz et al., 2022), philosophy of religion (Duran, 2021), language, reading and writing skills (Akça-Üşenti & Davaşlıgil, 2021; Çevirme, 2021; Kurudayıoğlu & Temur, 2021; Şahin, 2021), architecture (Acar et al., 2021), and health (Karadağ et al., 2018). Current studies in the international literature include the fields of information reliability of digital resources (Feijoo et al., 2023), academic performance in higher education (Lopez et al., 2023), art (Jiang & Alizadeh, 2023), teaching methods (Almulla, 2023; Ssemugenyi, 2023), and health (Taylor et al., 2023). Current literature in the field of early childhood focuses on what engineering practices experienced in early childhood teach children (Ramanathan et al., 2023), an intervention program to encourage children to adopt a healthy lifestyle (Jakobovich et al, 2023), cultural awareness (Adam & Byrne, 2023), play-based curriculum (Geletu, 2023), scientific thinking and scientific competencies (Carvajal-Sanchez et al., 2023; Su & Yang, 2023), STEM activities (Nikolopoulou, 2023), and independent learning behaviors (Özcan, 2022).

It is noteworthy that the studies from Türkiye in the international literature dealing with the concept of critical thinking are fewer in number compared to the general literature and are addressed in fewer related subject areas. In

this sense, it is important to evaluate the concept from a broad perspective and to identify the deficiencies in the subject areas of recurrent studies. In addition, it is foreseen that determining the key concepts with which the concept has been associated from past to present, interpreting them in the context of events, situations and views that affect the prominence of this concept, and emphasizing the focused subjects with concrete evidence will contribute to the relevant literature. In this regard, methods that enable us to analyze masses of information have become widespread since these methods classify the masses of data according to certain qualities and reveal influential researchers, studies, subject areas and keywords. Therefore, it helps researchers to discover the untouched aspects of their subject areas by alleviating the burden of literature review. The bibliometric analysis method is one of these methods (Öztürk & Kurutkan, 2020). Today, the fact that data can be stored in electronic media and accessible by everyone has led researchers to summarize the masses of data in their fields of study. Thus, it is possible to summarize a concept, subject, or keyword with the data of the last century and to guide the future. When an evaluation is made in this context, it is considered important to describe the general views of the studies on critical thinking in early childhood and to conduct content analysis. In addition, the scarcity of research on critical thinking in early childhood education has led researchers to conduct this study to fill the gap in the relevant field. Based on the importance of the subject, the questions of the research can be expressed as follows;

1. What are the ten most cited authors and their publications related to "critical thinking", and what topics are discussed in these publications?
2. What is the distribution of studies on "critical thinking" according to years?
3. What is the distribution of studies on "critical thinking" according to the sources in which they are published?
4. What is the distribution of the studies searched with the keyword "critical thinking" according to the country with the highest number of publications?
5. What is the distribution of the studies searched with the keyword "critical thinking" according to the authors who co-published?
6. What is the distribution of the studies searched with the keyword "critical thinking" according to the authors who are co-cited?
7. What is the distribution of the studies searched with the keyword "critical thinking" according to co-citation analysis?
8. What is the distribution of the studies searched with the keyword "critical thinking" according to common keywords?

## **Conceptual Framework**

### **Critical Thinking**

The mental processes that individuals carry out by using symbols to replace the situations or events happening around them and the way they produce solutions to problems are called thinking (Batur & Özcan, 2020). Thinking,

which is a human-specific action, enables individuals to make comparisons, comprehend a situation in all its dimensions, make connections, analyze and synthesize. In the definitions of different researchers, it is described as an active, goal-oriented, organized and existential process (Kurnaz, 2013). The word critical, on the other hand, means being able to distinguish, judge and evaluate (Kaya, 1997).

Various definitions have been made to explain the concept of critical thinking, which has different dynamics. While Ernis (1989) defines the concept as the ability of individuals to think logically and deeply in decision-making processes, Watson and Glaser (1980) define it as the combination of knowledge, skills and attitudes. Another similar definition belongs to Kazancı (1989). Facione (1998) explains it as a self-controlled, goal-oriented act of evaluation. McPeck (1981) describes it as the act of thinking deeply about a subject or any information with a skeptical approach.

### **Critical Thinking in Early Childhood**

The potential for the concept of critical thinking, which is expressed as a high-level thinking ability, is acquired in the process that continues throughout a person's life. In other words, this ability, the foundations of which are laid in infancy, progresses within the framework of the developmental limitations of each period (Tozduman-Yaralı, 2020). Infants initially make sense of the world through their senses and movements, but later try to understand it through cyclical reactions. With the emergence of planned and purposeful behaviors, they are aware of their desires and can combine their existing schemas for their goals. Then, infants who can distinguish between the goal and the means learn to use means to reach their goals. These behaviors can be expressed as the basis of their ability to make predictions and inferences. Infants can comprehend the world, which they made sense of with their experiences until the age of one and a half, by thinking with representations (Avcı, 2007; Berk, 2013; Miller, 2017; Tozduman-Yaralı, 2020; Wood, 2003).

When the development of critical thinking in early childhood, when children learn to express their emotions to achieve their wishes or express what they feel is evaluated, it is seen that they lay the foundations of critical thinking by comparing justified or unfair behavioral patterns when they reach the age of four. In addition, at the age of four, children learn to realize that teasing and upsetting others for various reasons is bad behavior, and they learn conflict and problem solving to cope with peer rejection. When they reach the age of five, they learn to question stereotyped thoughts, to question justified and unfair actions, to produce solutions to possible problems, to act together with their peers in finding solutions to stereotypes and to offer suggestions with adult support. At the age of six, they can develop the ability to compare true and false beliefs within groups and to behave respectfully when asking questions about differences. When they reach the age of seven or eight, they learn to use their newly acquired reading skills to learn prejudices and stereotypes and to participate in group activities to draw attention to otherizing situations at school or in society (Bredenkamp, 2015; Tozduman-Yaralı, 2020).

Studies on critical thinking in preschool children have generally focused on cognitive development, language development and the development of social skills. In these studies, it is observed that the positive outcomes of the "philosophy with children" program as a method that develops critical thinking are addressed (Doherr, 2000; Fields, 1995; Lipman & Bierman, 1970; Williams, 1993). In addition, in Williams' (1993) experimentally designed study, it

was found that the children in the experimental group of the philosophy with children program improved their ability to produce alternative ideas for a problem, their creative reasoning, and their reading skills. In addition, Galinsky (2010) stated in his study that perspective-taking skills are a prerequisite for the development of critical thinking skills in children. It was concluded that children with healthy development in terms of perspective-taking skills can empathize by understanding the reasons for others' feelings and thoughts. However, this skill represents the affective aspect of critical thinking by forming the basis of the dimension expressed as open-mindedness by Ennis (1985). As can be seen, supporting critical thinking in children is very important for their development. Therefore, it is very valuable to evaluate the subject from different perspectives in the literature and to increase the number of studies on the subject.

### Method

In this study, studies on the concept of "critical thinking" in the Web of Science database were examined using content analysis and bibliometric analysis methods.

#### Bibliometric Analysis

Information is a cumulative structure that increases day by day. For the mass of information to be functional, the relevant documents must be accessible, controllable and measurable. All these criteria require several calculations. One of these methods is networks, i.e. bibliometric analysis. Bibliometrics is the analysis of scientific research with numerical calculations. In this method, qualitative and quantitative analyses are performed to determine the effects of researchers, groups, institutions and journals studying the subject. The results of the analyses offer an exploratory perspective to the relevant field professionals. It not only reveals the prominent research, authors, institutions and collaborations, but also gives an idea about the influence of publications on each other. It also allows researchers to base their conclusions on bibliographic data (Al et al., 2019; Krauskopf, 2018; Öztürk & Kurutkan, 2020; Zupic & Čater, 2015).

In this sense, although there are various studies in which bibliometric analysis is used in different disciplines, it is noteworthy that there are no studies in which bibliometric analysis is used on critical thinking and critical thinking in early childhood. Therefore, this study, in which the science mapping technique is used, will contribute to the field by revealing structural connections with the classifications and visuals it presents.

#### Bibliometric Analysis Methods

There are basic methods used to analyze the documents obtained by examining the databases through specific keywords. These are (Zupic & Čater, 2015);

1. *Co-reference analysis*: It is to reveal how much the research affects subsequent studies through the frequency and patterns of citations.
2. *Co-citation analysis*: It is an indicator of strong relationships between co-cited authors, publications and documents. It is the measurement of the number of co-citations in any pair of documents.
3. *Co-author analysis*: It is a measure of collaboration in research. It is also an indicator of a strong social bond.

4. *Co-word analysis*: It is the creation of a conceptual structure by using the words in the title, abstract, full text and keywords of the documents. In this study, citation analysis, co-citation analysis, co-author analysis and co-word analysis, which are among the bibliometric analysis methods, were used.

### **Procedure**

In the process of analyzing the research data, firstly, the studies in the WoSCC database in September-2023, which will be evaluated within the scope of the analysis, were searched without applying any inclusion and exclusion criteria. As a result of the search, a total of 21,293 studies on "critical thinking" were found. Then, for the studies limited to "Topic", another search was conducted using the code "TS= ("critical thinking" AND "early childhood" OR "preschool" OR "pre-school" OR "kindergarten" OR "kindergarden"). Finally, a total of 251 studies were reached in line with the inclusion criteria. The inclusion criteria used in determining the studies in the research are as follows:

1. The studies should be included in the WoSCC database,
2. The studies should be related to the concept of "critical thinking",
3. The studies should not have any restrictions on year, language, citation, index or country criteria,
4. The studies should be included in the categories of articles, articles in early view, books and book chapters.

Performing a specific search using a specific keyword, that is, making a selection according to the purposeful sampling method, and determining the studies to be evaluated within the scope of the study in the context of the inclusion criteria are indicators of external validity. In addition, data and analyzes are stored electronically in order to verify the research data. In addition, all processes (code, date, etc.) for the preparation of research data are described in detail in the procedure.

### **Data Analysis**

In the study, descriptive analysis of the sources was carried out using the WoSCC database. VOS-viewer program was used for bibliometric analyses of the studies according to countries, co-authors, co-citation, co-quotation, co-word and for the creation of visual maps. In order to eliminate possible errors regarding the codes of the studies, the "tab limited file" was reviewed and the analysis of the study was carried out on the file with the .txt extension.

### **Findings**

The studies on critical thinking in early childhood in the Web of Science Core Collection (WoSCC) database were analyzed in the study. In this context, articles, articles in early view, books and book chapters on the subject were included in the study conducted by using the keyword "critical thinking". As a result of the search in the WoSCC database, 251 studies on critical thinking published between 1981 and 2023 were found. In the light of this information, the analyses were examined under two headings: descriptive and bibliometric findings.

### Descriptive Findings

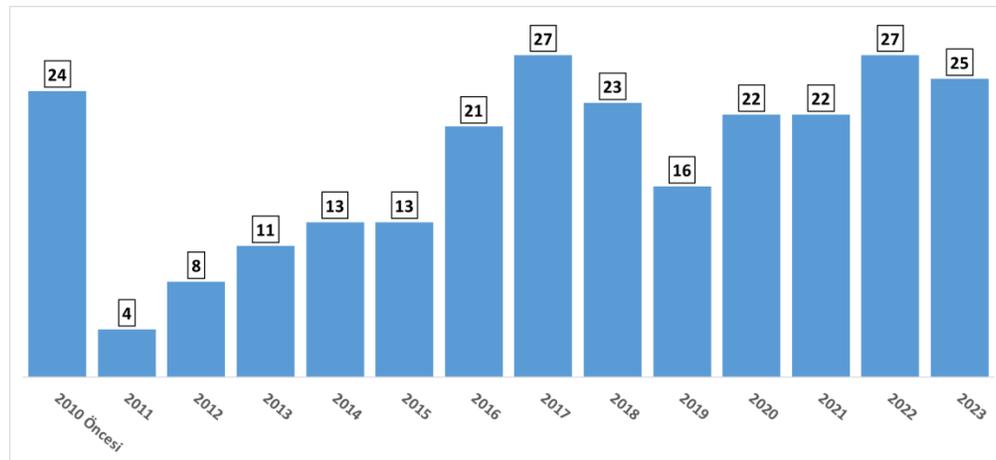
The citation information and number of citations for the top ten most cited studies on "critical thinking" in early childhood evaluated within the scope of the research are given in Table 1. In these studies, it was indicated that the effective use of digital tools will improve critical thinking in children depending on age, and that schools and museums support children's creativity and critical thinking skills in the context of Reggio Emilia approach, and technology-based education supports critical thinking. In addition, the effect of preschool teachers' critical thinking tendencies on the development of media literacy skills, the effect of computer-assisted software on problem solving and self-regulation skills of preschool teachers, information technologies in the context of the use of 21st century skills, and opinions on the Philosophy with Children training program given to preschool teachers were included in these studies (Table 1).

Table 1

#### Ten Most Cited Publications

	Articles	Number of Citations
1	Reid Chassiakos, Y. L., Radesky, J., Christakis, D., Moreno, M. A., Cross, C., Hill, D., ... & Swanson, W. S. (2016). Children and adolescents and digital media. <i>Pediatrics</i> , 138(5).	155
2	Ulu, H., & Bař, Ö. (2020). Relationships between pre-service teachers' purpose of social network sites usage, critical thinking tendencies, and media literacy. <i>Hacettepe University Journal of Education</i> , 35(3).	132
3	Feliu-Torruella, M., Fernández-Santín, M., & Atenas, J. (2021). Building relationships between museums and schools: Reggio Emilia as a bridge to educate children about heritage. <i>Sustainability</i> , 13(7), 3713.	131
4	Yilmaz-Na, E., & Sönmez, E. (2023). Unfolding the potential of computer-assisted argument mapping practices for promoting self-regulation of learning and problem-solving skills of pre-service teachers and their relationship. <i>Computers &amp; Education</i> , 193, 104683.	121
5	Weber, A. M., & Greiff, S. (2023). ICT skills in the deployment of 21st century skills: A (cognitive) developmental perspective through early childhood. <i>Applied Sciences</i> , 13(7), 4615.	114
6	Koyuncu, E., & Demircan, H. (2022). An evaluative case study on investigating preschool teachers' views on philosophy with children. <i>Education and Science</i> , 47(210).	112
7	Weeks, M., Ooi, L. L., & Coplan, R. J. (2016). Cognitive biases and the link between shyness and social anxiety in early adolescence. <i>The Journal of Early Adolescence</i> , 36(8), 1095-1117.	109
8	Sönmez, E. (2021). Technology-enhanced CT: A systematic review. <i>Thinking Skills and Creativity</i> , 41, 100913.	106
9	Flynn, S. (2021). Convergent identities, compounded risk: Intersectionality and parenting capacity assessment for disabled children. <i>Children and Youth Services Review</i> , 129, 106185.	106
10	Oja, M. (2019). Muutused hariduselus ja ajalooõpetuse areng Eesti iseseisvuse taastamise eel 1987–91 [Abstract: Changes in educational conditions and the development of teaching in history prior to the restoration of Estonia's independence in 1987–1991]. <i>Ajalooline Ajakiri. The Estonian Historical Journal</i> , (3/4), 365-401.	106

When the number of studies on critical thinking was analyzed by years, it was concluded that more studies on the subject were conducted after 2010. While it was seen that 2017 and 2022 were the years with the highest number of studies on the subject with 27 studies, there were more than 10 publications on the subject every year and there was a significant increase in studies after 2015 (Graph 1).



**Graph 1.** Distribution chart of studies by years

Education Sciences, Thinking Skills and Creativity, European Early Childhood Education Research Journal are the most cited journals in the top ten journals on critical thinking. From Türkiye, Education and Science Journal and Hacettepe University Journal of Education are among the most cited journals on the subject (Table 2).

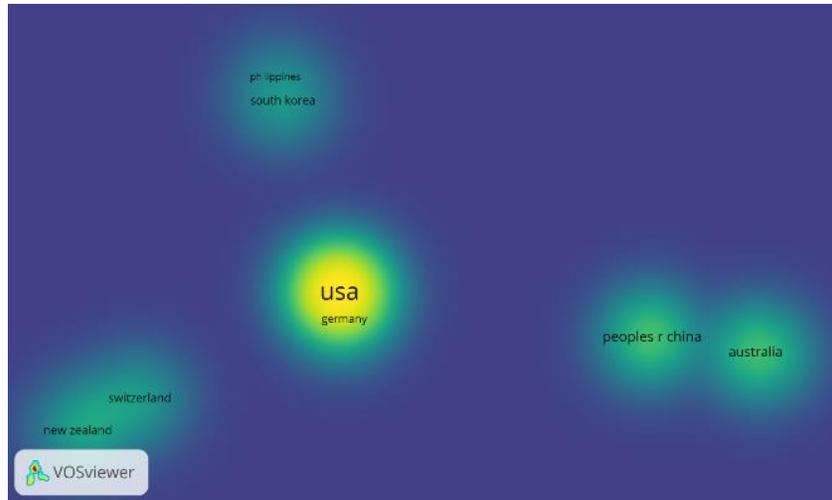
Table 2

*Distribution of Studies according to Publishing Institutions and Number of Citations*

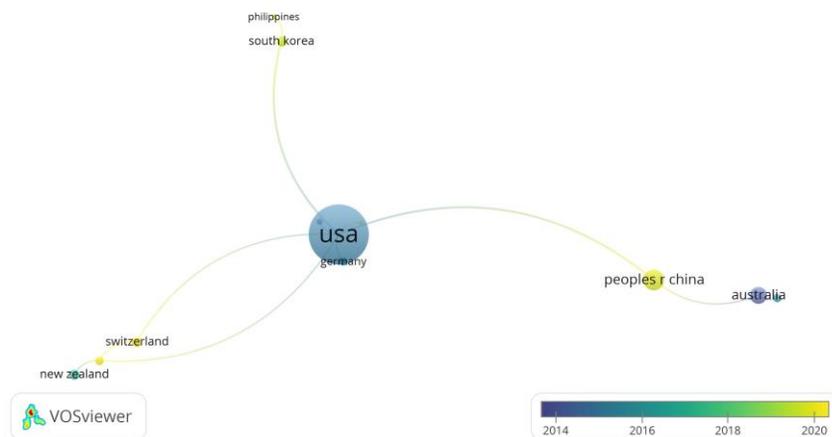
Publication Institutions	Number of Articles	Number of Citations
Education Sciences	13	660
Thinking Skills and Creativity	7	578
European Early Childhood Education Research Journal	9	460
Education and Science Journal	4	288
Computers & Education	3	239
Frontiers in Psychology	3	229
Hacettepe University Journal of Education	2	204
Early Childhood Education Journal	6	202
Philosophy for Children	4	193
Children and Youth Services Review	2	180

### Bibliometric Findings

According to the VOS-viewer analysis on critical thinking, the country with the highest number of studies is the United States of America (cc:628; tcs:9). Germany (cc:165; tcs:1), Australia (cc:141; tcs:2), People's Republic of China (cc:34; tcs:3), Switzerland (cc:14; tcs:2), South Korea (cc:13; tcs:3) and New Zealand (cc:9; tcs:1) are the countries with the highest number of citations after the USA (Figure 1). Figure 1 also shows that the countries with the highest density of citation links are the USA and Germany. When the time map according to the country was examined, it was observed that the most recent studies on critical thinking after 2020 were published in the People's Republic of China, Switzerland, South Korea and the Philippines. The oldest studies related to critical thinking in early childhood belong to the USA, Germany and Australia (Figure 2).



**Figure 1.** Density map of the countries with the highest number of publications



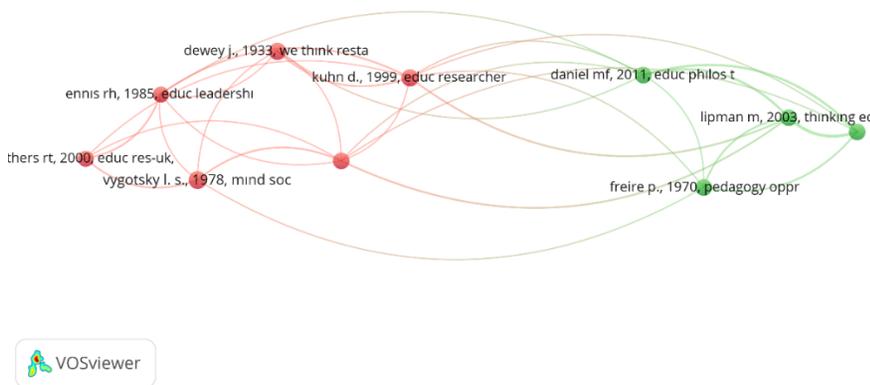
**Figure 2.** Time map according to the country of publication

When the author link analysis on critical thinking was examined, it was seen that Marie-France Daniel and Mathieu Gagnon were the authors who contributed the most to the subject (Figure 3). The authors published three studies on the subject together and had a total of 10 citations (f:3; cc:10; tcs:3) (Daniel et al., 2012; Daniel & Gagnon, 2011; Daniel et al., 2017). Philip Balcaen (f:3; cc:5; tcs:0) and Mohamed Ridha Ben-Maad (f:3; cc:4; tcs:0) are the most influential authors on the subject, although they do not have co-authorship with any author.



**Figure 3.** Visual mapping of author link analysis (co-author analysis)

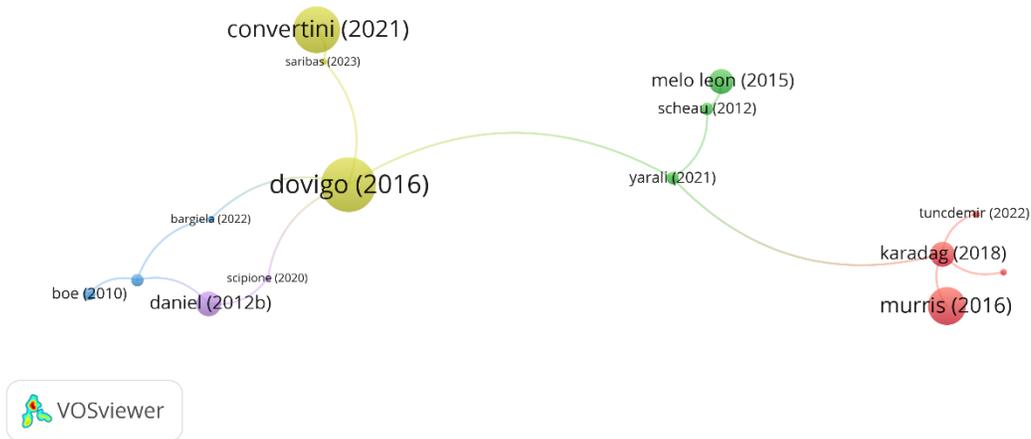
According to the results of the co-reference analysis regarding critical thinking in the Web of Science Core Collection (WoSCC) database, it was observed that two interrelated clusters were formed. Since the studies of the authors in the red and green clusters in the figure express the connection between the publications cited by the same publication, total connection strength (tcs) in the studies is important in co-citation analysis. As a result of the co-reference analysis, the author with the highest connection strength in the red cluster (cc:8; tcs:11) is Kuhn's (1999) study "A developmental model of critical thinking". It is followed by Ennis' (cc:8; tcs:8) "A logical basis for measuring critical thinking skills", Vygotsky's (cc:11; tcs:7) "Mind in society: Development of higher psychological processes", Dewey's (cc:9; tcs:6) "How we think: A restatement of the relation of reflective thinking to the educative process", Pithers' (cc:6; tcs:6) "Critical thinking in education: A review". In the green cluster, the study titled "Thinking in education" by Lipman (2003) has the highest connection strength (cc:7; tcs:14). It is followed by Daniel's (cc:7; tcs:11) "Philosophy, critical thinking and philosophy for children" and Freire's (cc:7; tcs:7) "Pedagogy of the oppressed" (Figure 4).



**Figure 4.** Co-reference analysis

According to the results of the citation analysis of the studies on critical thinking in the WoSCC database, it was seen that five different colored groups were formed depending on the relationship between the cited authors. The size of the circles varies according to the number of citations and connection strength. It was determined that the most frequently cited publications and the authors whose works have the highest connection strength are the studies

of Dovigo (cc:15; tcs:4) and Karadağ (cc:5; tcs:4). On the other hand, although Convertini's study (cc:12; tcs:1) has a high number of citations, its low connection strength does not produce a meaningful result for co-citation analysis (Figure 5).



**Figure 5.** Co-citation analysis

When the studies conducted in the context of critical thinking in early childhood were analyzed, it was seen that five different colored clusters were formed. The formation of nodes between these clusters reveals the most frequently repeated words together in studies. Clusters of the same color represent words repeated together in similar studies. According to the analysis results, the most frequently repeated words are critical thinking (f:64; tcs:51), creativity (f:13; tcs:18), creative thinking (f:7; tcs:12), young children (f:5; tcs:3), preschoolers (f:5; tcs:1) in the blue cluster; teacher training (f:10; tcs:6), higher education (f:7; tcs:4), e-learning (f:6; tcs:4) in the red cluster; preschool (f:9; tcs:7), philosophy for children (f:6; tcs:6) in the purple cluster; the words early education (f:21; tcs:13), assessment (f:5; tcs:1), kindergarten (f:5; tcs:4) in the green cluster; early childhood education (f:19; tcs:12), education (f:5; tcs:4) in the yellow cluster, cognitive development (f:7; tcs:11), reasoning (f:5; tcs:7) in the orange cluster (Figure 6). According to the results of co-word analysis by year, it was determined that the words creativity, teacher training, young children, early childhood education, reasoning, and preschoolers are frequently repeated words in recent studies (Figure 7).

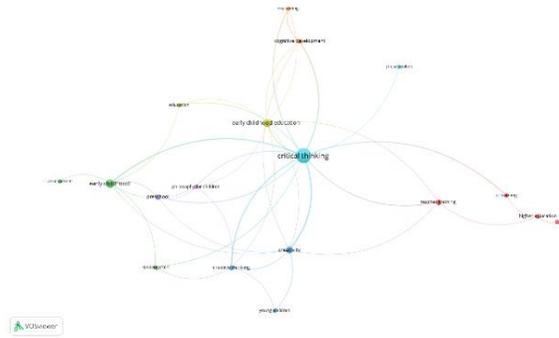


Figure 6. Co-word analysis

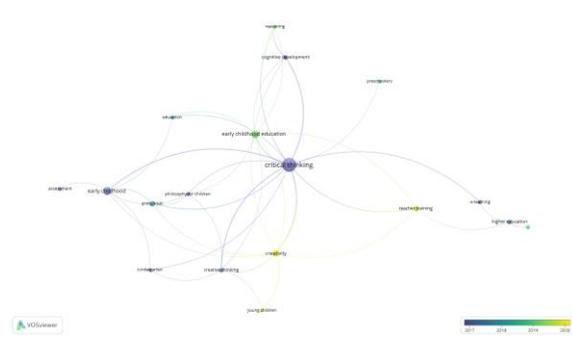


Figure 7. Co-word time map

### Discussion and Conclusion

Bibliometrics is an effective method that analyzes data such as the titles, authors, citation numbers, keywords and country of publication of scientific publications prepared on a specified subject, and determines the most productive author, author collaborations, and the most productive country or institution on the subject. Another prominent feature of bibliometrics is that it enables the identification of prominent topics, developing aspects of the research field, and untouched study areas related to the subject in line with the criteria determined for the field of study. It also provides information about the development process of the subject by revealing its conceptual infrastructure, intellectual and social aspects (Gupta, 2021). In this study, based on the features of bibliometrics, the bibliometric analysis method was preferred to determine how the concept of "critical thinking" is addressed in early childhood studies because it is an effective method in revealing issues that have not yet been studied in the field.

In the study, firstly, the citation information of the top ten most cited studies is included. When these studies are examined, it is seen that in the most cited study on critical thinking in early childhood, Reid Chassiakos et al. (2016) emphasize digital media as a tool that blends traditional intellectual attitude with contemporary knowledge. The study highlights the role of carefully selected contents for the balanced and controlled use of digital media in supporting the development of critical thinking skills in children. The second most cited study on the subject is the study by Ulu and Baş (2020), in which they aimed to determine the relationship between the purposes of use of social networking sites by teacher candidates and their critical thinking tendencies and media literacy skills. This study and similar studies describe that media literacy has a significant impact on building knowledge, gaining different perspectives, and understanding how information represents reality, which is shown as determinants of critical thinking (Hobbs, 2010). In social media tools, there is a relationship between visual images and cultural images. For this purpose, media literacy is an important variable for individuals to gain a critical perspective on differences and to improve themselves in the social context (Knochel, 2013; Quitadamo, 2002). Another study with the highest number of citations emphasizes the role of the Reggio Emilia approach in supporting critical thinking (Feliu-Torruella et al., 2021). The study indicated that learning activities in schools that plan for children to be intertwined with museums support critical thinking and creativity skills in children. For this purpose, the study emphasizes the need to build a bridge between museums and schools for children so that children can analyze the

strengths and weaknesses of the program. When the other most cited studies were examined, it was seen that the studies frequently focused on teacher candidates. In these studies, it was concluded that computer-assisted argument mapping applications contributed to the development of preschool teacher candidates' learning and problem-solving skills (Yılmaz-Na & Sönmez, 2023). It is also stated that the software developed for this purpose helps teacher candidates to answer the critical questions asked to them in the sessions they attend and their active participation in the process helps to support their critical thinking. In the study, it was reported that such software is effective in deciding the most appropriate solution to a problem (Freeley & Steinberg, 2013). It is also emphasized that it is an effective tool that allows existing knowledge and experiences to be blended with new knowledge (Pecore, 2013). As a result, it seems that such tools brought by digitalization are effective in the acquisition of critical thinking today. When the most cited studies on the concept of critical thinking were examined, it was seen that the number of studies covering the early childhood period was limited. The participants of the studies were mostly determined as teacher candidates or it was determined that theoretical information about the conceptual framework of critical thinking was given in the studies (Koyuncu & Demircan, 2022; Sönmez, 2021; Weber & Greiff, 2023). In their study, Koyuncu and Demircan (2022) discussed Philosophy with Children, which is a prominent approach in the literature on critical thinking. In the experimental study conducted with pre-school teacher candidates, teachers stated that the philosophy-based sessions they would organize in their classrooms could be used in pre-school education and that it was a practice that could positively affect the development of children. As a result, it was seen that critical thinking was generally associated with digitalization and technology-based studies in the most cited studies. Therefore, it is thought that the reason why these studies are the most cited is because critical thinking is a current concept and the number of studies in education increases with the advancement of technology. In addition, when the most cited studies were examined, it was seen that the studies were published after 2016. This result is similar to the distribution of studies on critical thinking by the years.

When the studies on critical thinking are analyzed by years, it is observed that there is a significant increase in studies after 2015 compared to previous years. The reason for this increase may be that critical thinking is now shown among the 21st century skills that individuals should have (Partnership for 21st Century Learning, 2015). According to the statement of the World Economic Forum, as of 2016, problem solving and critical thinking skills are among the basic qualities that employers pay attention to and that individuals should have. It is also stated that by 2025, the share of having certain skills in determining the competence of individuals is 40%. The most prominent of these skills are analytical thinking, innovation, active learning and learning strategies, complex problem solving, critical thinking and analysis, creativity, originality, leadership, use of technology, stress resilience and adaptability (WEF, 2020). It can be seen that the characteristics that individuals are expected to develop are basically related to critical thinking skills and tendencies. In this sense, the acquisition of critical thinking at an early age will enable the development of globally qualified individuals. For this purpose, although it is still unclear when and how critical thinking should be taught as a developable skill, Lipman et al. (1980) are among the first to advocate that children should be taught critical thinking from an early age. It is important for children to acquire critical thinking skills at an early age in order to explain and shape how they think. Similarly, Galinsky (2010) emphasizes the importance of

critical thinking by listing critical thinking among the seven life skills that every child needs. Therefore, studies should focus on practices aimed at developing critical thinking starting from early childhood.

When the journals with the highest number of publications on critical thinking are examined in the study, it is seen that Education Sciences, Thinking Skills and Creativity, European Early Childhood Education Research Journal are the journals that stand out with the highest number of citations on critical thinking. In Türkiye, The Journal of Education and Science and Hacettepe University Journal of Education are among the most cited journals on the subject. As can be understood from the journals, critical thinking is associated with education in terms of purpose and scope. The existence of a specific journal related to the subject area indicates that the subject is original and attracts attention.

When the high number of studies on critical thinking was examined on a country basis, it was seen that the country where the subject was born and the country with the highest number of citations was the USA. The most current studies on the subject were published in the People's Republic of China and Switzerland. The studies of Matthew Lipman, an American philosopher and founder of Philosophy for Children (P4C), have shed light on many studies conducted with preschool children on critical thinking. In addition, the studies of American philosophers and scientists Ennis, Dewey and Kuhn, who form the theoretical basis of critical thinking, explain the USA's prominence in the research. Kaplan (2017) revealed that the most studies on critical thinking approach were conducted in the USA, which supports the results of this study. The main reason why the USA is at the forefront in this regard is that important steps have been taken towards critical thinking practices in the country since the 1940s. In addition to the Delphi panel held by the American Philosophical Association in 1987, which defined the scope of critical thinking, the importance given to the development of critical thinking as an educational goal in the "A Nation at Risk", "Participation in Learning", "Higher Education and the Revitalization of America" reports published since the 1980s (Kraak, 2018) can be shown as the reason why the USA stands out in the research. When the author connection analysis on the subject was examined, it was concluded that Marie-France Daniel and Mathieu Gagnon were the authors who contributed the most to the subject. In the studies the authors conducted together, it was discussed whether it is possible to develop an abstract concept such as critical thinking in five-year-old children through an interactive and dialogue-based perspective (Daniel et al., 2012), the extent to which the implementation period of the Philosophy for Children Program in the preschool period contributed to children's cognitive development was evaluated (Daniel & Gagnon, 2011), and the effect of a dialogue-based philosophical practice carried out with kindergarten and primary school children on children was analyzed (Daniel et al., 2017). As a result of the studies, it was emphasized that critical thinking can be acquired at an early age and that effective methods should be developed for this. Philip L. Balcaen and Mohamed Ridha Ben Maad were determined as the most influential authors with their studies on critical thinking, although they do not have a co-authorship bond. Balcaen and Hirtz (2007) trained 36 teachers from kindergarten to 12th grade in order to support critical thinking and the effective use of information communication technology and discussed the results in their study. In his study, Ben Maad (2020) pointed out that raising awareness of different languages in kindergartens is a practice that improves children's cognitive capacities and contributes to their critical thinking processes. As a result of the co-author analysis conducted in the study, it was seen that different methods were used to teach critical thinking in pre-schools since it is an abstract concept. In the

studies, it was determined that dialogue-based practices were more effective in developing critical thinking in children. For this reason, authors with a co-authorship network reveal in their studies that critical thinking can be taught to young children through different methods. In addition, when the studies of authors who do not have a co-authorship network were analyzed, it was determined that shaping their studies within the framework of current issues was effective in coming to the fore with the number of citations. It is thought that the evaluation of technology and multiculturalism, which have an impact on every field at the global level, in the context of critical thinking is effective in the prominence of these studies.

When the co-reference results related to critical thinking were analyzed, it was concluded that there were two clusters that interacted with each other. The prominent authors in these clusters are [Lipman \(2003\)](#) and [Kuhn \(1999\)](#). In his study, which is cited as the most cited source in different studies, [Kuhn \(1999\)](#) emphasized the difficulties that preschool children experience in gaining and maintaining awareness of the sources of the information they have. In this study, it was concluded that four-year-old children were able to observe the reasons concretely and could easily answer questions about a claim. For example, when a 4-year-old child sees a picture of a zebra, he/she can prove it because zebras have stripes that make them different from other animals. In this respect, [Kuhn \(1999\)](#) laid the foundation for critical thinking in early childhood with this study. [Lipman \(2003\)](#) is another author whose study is frequently used in the literature. In his study, [Lipman \(2003\)](#) stated that critical thinking skills are needed to lay the foundations of philosophical thinking in children. According to Lipman, children identify the possible causes of a problem through critical thinking, form hypotheses and search for possible solutions. Thus, philosophical studies enable children to think more and reflect on their views. Therefore, conducting philosophical inquiries helps children develop critical thinking skills by enabling them to listen to others, evaluate others' views, become aware of their own thinking processes and organize their own thoughts ([Trickey & Topping, 2004](#)). It is thought that the reason why Kuhn stands out in the co-reference analysis is that he brought a different model for teaching and evaluating critical thinking to the field. According to Kuhn, skills and tendencies should be acquired together in critical thinking. Both his contribution to the literature and his combination of critical thinking with early childhood are among the reasons why he stands out in this study. It is very important that Kuhn also addresses critical thinking in early childhood by taking into account developmental periods. The reason why Lipman's study stands out in this study is that it combines philosophy with critical thinking and aims to teach it to children. At this point, Lipman introduced a new method to the field of teaching philosophy, which is a set of abstract concepts, to preschool children. In this method, it is proven that stories guide children's philosophical questioning. Therefore, these authors have come to the forefront of studies of critical thinking in early childhood.

[Dovigo \(2016\)](#) and [Karadağ and Demirtaş \(2018\)](#) are the prominent authors in the citation analysis of studies on critical thinking. In his study, [Dovigo \(2016\)](#) stated that providing a discussion environment in early childhood has an important role in developing cooperation and critical thinking skills if teachers lead the process and actively participate. In their study, [Karadağ and Demirtaş \(2018\)](#) emphasized the importance of using P4C as a method that develops critical thinking skills in children. In this study, it was also stated that the use of texts such as stories as a tool to develop children's questioning is a versatile practice that supports language and reading skills. Dovigo's study is important because it guides the studies on critical thinking in education. In this study, Dovigo stated that, as in

other education levels, the development of critical thinking in primary and pre-school periods is possible if a discussion environment can be created. As can be seen, as a result of the citation analysis, it is accepted that inquiry and dialogue-based practices draw attention in studies dealing with critical thinking in early childhood and that interaction with children plays an important role in the acquisition of critical thinking. As a result, it is thought that the studies citing these studies as sources also use similar methods in the acquisition of critical thinking and address similar aspects of critical thinking.

When the common word analysis of the studies conducted in the context of critical thinking in early childhood was examined, it was found that the most frequently repeated words were critical thinking, creativity, creative thinking, young children, preschoolers in the blue cluster, teacher training, e-learning, higher education in the red cluster, philosophy for children, preschool in the purple cluster, early education, assessment, kindergarten in the green cluster, early childhood education, education in the yellow cluster, and cognitive development, reasoning in the orange cluster. When the studies were examined, it was stated that digital learning-based applications can provide a learning environment that supports creativity and critical thinking skills, knowledge transfer, acquisition of digital experience skills and skills to develop a positive attitude towards learning, and deep learning in children aged 3-6 years (Behnamnia et al., 2020a). In another study, Behnamnia et al. (2020b) found that digital game-based learning supports preschool children's creativity and critical thinking skills, and that such practices help children develop motivation and positive attitudes towards learning. In addition, it was emphasized in the studies that the development of critical thinking skills in teacher education improves their reflective thinking skills, and that gaining critical thinking in education should become a goal (Gomez-Gomez & Botero-Bedoya, 2020). In other studies where critical thinking was discussed together, the importance of e-learning in education was emphasized. In these studies, it was indicated that e-learning environments develop cooperative behaviors in children and support critical thinking skills. In addition, these studies emphasized the importance of e-learning environments in helping children take individual responsibility and make their own decisions (Camuñas et al., 2012). In another remarkable article on critical thinking, the level of understanding of implicit messages in stories by children from preschool to third grade was compared. It was determined that preschool children were able to understand explicit information and find implicit messages in the story, but as the age increased, children were able to develop systematic thinking and logical reasoning (Szabo & Brakas, 2020). Based on the keywords related to critical thinking, studies emphasize that different teaching methods are necessary depending on the development of technology today. Innovative learning tools that have entered our lives have an effective role in the development of critical thinking in individuals at all levels of education, starting from the pre-school period. The predictive effect of digital tools or software on critical thinking, which is generally mentioned in the findings of the studies, confirms this view. It was also determined that critical thinking skills in the preschool period were mostly related to skills such as cooperation, problem solving and motivation. These skills are thought to be an important factor in helping individuals take responsibility for their learning today. Considering all these, it was concluded that critical thinking in early childhood is a much deeper issue than discussed in the literature.

In this study, the reflections of the studies concerning critical thinking on early childhood were discussed. The relevant literature was examined from a broad perspective and the findings were tried to be explained within the

framework of prominent publications. In this regard, it was seen that critical thinking is an important concept in early childhood years, but there is a limited number of studies on the subject. It is thought that enriching the sample diversity to explain the subject comprehensively will make a significant contribution to the field.

#### **Limitations and Recommendations**

In this study, studies on the concept of "critical thinking" in the WoSCC database were analyzed. In future studies, conducting the analysis together with other databases will enable the concept to be analyzed from a broader perspective. In this study, WoSCC was chosen as it provides a reliable data source in bibliometric analysis. In future studies, it is recommended to focus on the areas that have not been studied in early childhood to contribute to the field. In this way, it is thought that the range of studies on critical thinking in early childhood can be expanded and the concept can be analyzed from a broader perspective.

#### **Ethic**

The research does not require ethics committee approval.

#### **Conflict of interest**

The authors declare that there are no conflicts of interest.

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