

## PAPER DETAILS

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# The New Face of Thinking in Education: Bibliometric Map of Design Thinking

## Eğitimde Düşüncenin Yeni Yüzü: Tasarım Odaklı Düşünmenin Bibliyometrik Haritası

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**Özet:** Bilgi ve teknoloji çağında, öğrencilerden eleştirel düşünme, problem çözme ve yaratıcı çözümler üretme gibi becerilerin geliştirilmesi beklenmektedir. Tasarım odaklı düşünme, eğitimde bu becerilerin geliştirilmesinde etkili bir yaklaşım olarak öne çıkmaktadır. Tasarım odaklı düşünme, empati, yaratıcılık, işbirliği ve kullanıcı odaklı çözümleri teşvik edip eğitimde öğrenci katılımını artıran bir yöntem olarak karşımıza çıkmaktadır. Eğitimcilerin eğitim-öğretim sürecinde uygulamalarına ve araştırmalarına devam edeceği bir yaklaşım olacağı düşünüldüğünden bu çalışmada tasarım odaklı düşünmenin eğitim alanındaki mevcut durumunu ve gelişim trendlerini anlamak, alandaki araştırma dinamiklerini, işbirliği ağlarını ve etki alanlarını ortaya çıkarmak amaçlanmıştır. Bu amaçla veri temelli, sayısal ve nesnel bir şekilde bütüncül bir bakış açısı sağlayan bibliyometrik analiz yöntemi kullanılmıştır. Araştırma kapsamında, 2010-2024 yılları arasında Web of Science'ta "design thinking" anahtar sözcüğü ile "Education-Educational Research" kategorisinde yayınlanan çalışmalar incelenmiştir. Eğitimde tasarım odaklı düşünme (TOD) üzerine yapılan araştırmaların 2010-2024 yılları arasındaki bibliyometrik analizi, bu alanın önemli bir çalışma konusu haline geldiğini göstermektedir. ABD ve Çin'in öncülük ettiği bu araştırmalarda yaratıcılık, yüksek öğretim ve deneyimsel öğrenme gibi temalar ön plana çıkmaktadır. Çalışmaların belirli dergilerde ve sınırlı sayıda üretken yazar tarafından yoğunlaşması, yeni araştırmacılar için fırsatlar sunmaktadır. Atıf verileri, TOD araştırmalarının eğitim uygulamaları ve sonuçları üzerindeki etkisini ve önemini vurgulamaktadır. Ayrıca araştırma bulguları tasarım odaklı düşünme üzerine yapılacak çalışmalar için yeni perspektifler ve yaklaşımlar geliştirmede, mevcut literatürü ve önceki çalışmaları daha geniş bir perspektifle incelemede fayda sağlayabilecektir.

**Anahtar Kelimeler:** Tasarım odaklı düşünme, bibliyometrik analiz, eğitim araştırmaları

**Abstract:** In the age of information and technology, students are expected to develop skills such as critical thinking, problem solving, and creative solutions. Design thinking stands out as an effective approach to develop these skills in education. Design thinking is a method that encourages empathy, creativity, collaboration, and user-oriented solutions and increases student participation in education. As educators are expected to continue applying and researching this approach, this study aims to analyze the current status and development trends of design thinking in the field of education, to reveal the research dynamics, cooperation networks, and impact areas in the field. The bibliometric analysis method was used to provide a holistic perspective in a data-based, numerical, and objective way. Within the scope of the research, the studies published in the 'Education-Educational Research' category with the keyword 'design thinking' in Web of Science between 2010-2024 were analysed. The bibliometric analysis of research on design thinking in education (DOD) between 2010 and 2024 shows that this field has become an essential subject of study. In these studies led by the USA and China, themes such as creativity, higher education, and experiential learning come to the fore. The concentration of studies in specific journals and by a limited number of prolific authors creates opportunities for new researchers. Citation data emphasise the impact and importance of TOD research on educational practices and outcomes. In addition, the findings of the research may be useful in developing new perspectives and approaches for future studies on design thinking and in examining the existing literature and previous studies from a broader perspective.

**Keywords:** Design thinking, bibliometric analysis, educational research

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## 1. Introduction

With the scientific developments in the age we live in and the technology developing accordingly, individuals are expected to develop the ability to obtain information, obtain scientific knowledge from suitable sources, know how to benefit from the information obtained, and use the information in problem-solving (İşman & Gürgün, 2008). In this respect, to develop the expected skills in individuals, it is necessary to diversify educational activities and provide an enriched educational environment for students by including innovative practices in many different fields (Simon & Tim, 2019). For this reason, studies are carried out to support different ways of thinking in the contemporary education system. Design thinking is an effective way of thinking that has recently increased in popularity (Aydemir, 2019).

Design is a process for finding practical solutions to complex problems. The design thinking (DOD) process is one of the approaches based on user-oriented, empathy-based problem-solving. Design thinking is an approach to generating new ideas and creating innovative designs for the business settings. However, it is a way of thinking that can be used in education and training activities in many disciplinary fields (Kimbell, 2011). In this respect, design thinking, which is also encountered in education-oriented academic studies is recognized as a 21st-century learning approach. (Carroll, 2015; Chesson, 2017), has been included in learning-teaching processes by educational institutions around the world (Aydemir & Çetin, 2023). Because the design thinking approach has a crucial role in acquiring 21st-century skills (Robinson et al., 2011; Thoring & Müller, 2011; Pendleton-Jullian & Brown, 2015), it is seen that concepts such as ‘design’, ‘design processes’, and ‘design thinking’ are included in the content of educational programs in many fields from pre-school to higher education (Özekin, 2006).

The importance and impact of design thinking in educational research is quite remarkable. It initially emerged to improve problem-solving skills in higher education fields such as business and engineering (Dunne & Martin, 2006). Since it effectively develops creativity, critical thinking, and problem-solving skills among students, it attracts great attention in this field. Design thinking encourages students to think innovatively and helps them adopt a user-centered approach (Razali et al., 2022). This process fosters student engagement, encourages collaboration, and cultivates empathy (Panke, 2019). It has also been observed to be effective in improving learning outcomes and curriculum development by using it in interdisciplinary contexts (Li et al., 2019). Critical charac-

teristics of design thinking include empathy, creativity, collaboration, and a focus on understanding the student’s perspective. By adopting this mindset, educators can generate innovative solutions to complex problems, encourage students to think critically, and bring a student-centered approach to teaching and learning (Gong, 2020). Due to these features, TOD, which started to spread to the K-12 level in the early 2010s, was found to increase creative confidence and collaborative problem-solving skills in secondary school students (Carroll et al., 2010). In recent years, TOD has been integrated with other educational approaches, such as STEM education and has gained a wider usage area (Henriksen et al., 2017).

Furthermore, design thinking is recognized as a valuable tool for addressing educational challenges and promoting interdisciplinary collaboration among students (Aflatoony et al., 2017). The innovative approaches of Design Thinking (DF) in education aim to improve students’ ability to blend knowledge from different fields (Goldman & Kabayadondo, 2017) and contribute to the development of empathy and emotional intelligence (Luka, 2020). It is also argued that TOD can play an important role in sustainability education in areas such as its potential to generate creative solutions (Wals & Blewitt, 2010), its adaptation to digital and blended learning environments (Tsai & Liang, 2019), and promoting diversity by increasing cultural sensitivity (Buchanan et al., 2017).

The design thinking process consists of five steps: empathize, define, ideate, prototype, and test. This process has a sequential flow, but the process can return to the beginning, be cyclical, and be repeated (Brenner, 2016). There are different applications and methods of the design thinking process. Although different applications exist, they follow similar phases. The most common design thinking model used in education is this five-stage design thinking model (Miller, 2017). According to this model, empathy refers to understanding the user and needs and identifying the problem on the spot. The definition is defined as defining, understanding, and defining the boundaries of the problem, Generating ideas, developing different ideas for the solution, prototyping, developing a rapid prototype, Testing what has been done, correcting or repeating what has been done according to the results. TOD is a process based on empathy, creativity, and innovation that enables individuals to find practical solutions to their problems. Especially in educational environments, it enables students to develop their critical thinking skills and produce creative solutions to interdisciplinary problems by involving them in active learning. The importance of this research is to understand the impact of design thinking in education from a broader perspective and to address the applicability of this approach in

different disciplines. In particular, bibliometric analysis of the literature aims to explore research trends, relationships between concepts, and international collaboration networks in this field.

In summary, design thinking offers a transformative approach in education by encouraging creativity, critical thinking and innovation among students. With the increasing adoption of this approach in educational processes, it has become an important topic in educational research. Although design thinking is generally considered to be closer to fields such as architecture and industry because it is a way of thinking that focuses on design, it is a way of thinking that provides the ability to deal with complex and specific problems that can be applied in the education process due to its nature. It is an approach consisting of a number of stages, starting from empathizing with real-life problems (Koca, 2023). Due to these features, design thinking is an approach educators will continue using effectively in the education process. Understanding the current status and development trends of design thinking in education for studies and educational practices is essential. Teacher education and educational institutions must have a supportive structure for this approach to be practical. Future research should examine the long-term effects of SDT and its application in different contexts. For this reason, this study focuses on the bibliometric analysis of research on design thinking in education from the past to the present. It has been observed that bibliometric analyses have been conducted to understand how design thinking is applied and its effects in different fields (higher education, STEM, etc.) in studies on design thinking. Dos Santos Galvão and Nou Schneider (2023) pointed out in their study that 2022 was the year with the highest number of publications on design thinking and innovation and the increasing importance of the subject. Similarly, Ghufrooni (2024) mentioned that a significant increase in design thinking research was observed in stem education. Zarate-Perez et al. (2023) also researched design thinking practices in stem education. Such studies can guide future research by helping identify trends, key researchers, and influential publications. In this context, the fact that the topic is addressed in different contexts with more research on the subject shows that the research has reached a certain maturity (Henriksen et al., 2017). Bibliometric analysis studies provide the effectiveness of the subjects that have reached a certain maturity in the literature with quantitative data on different dimensions (Van Eck & Waltman, 2014), which is essential in giving researchers an idea about new areas of study.

Some studies on design thinking in education are found when the literature is analyzed. Some of these studies

focus on connecting with a specific subject (Zarate-Perez et al., 2023), while others focus on a specific educational level (Micheli et al., 2019). However, it can be said that there is still a need for an up-to-date and comprehensive bibliometric analysis in the field. In this context, the present study aims to contribute to this gap in the literature by addressing the issue of design thinking in education with more detailed bibliometric indicators. Among the studies focusing on educational practices, this bibliometric study is considered valuable in terms of providing a holistic perspective, revealing research networks, the collaboration potential of the academic community, quality, and impact assessment, and which resources are more valuable in a data-based and objective manner from an international perspective (Ellegaard & Wallin, 2015). Thus, bibliometric indicators can reveal the development and intellectual structure of the field (Zupic & Čater, 2015). In addition, this research approach can infer gaps and potential future research directions (Chen et al., 2016).

In this research, research questions were prepared in order to reveal the trends and collaboration networks in the literature;

1. What are the general trends of the literature on design thinking in education in the context of publication trends analysis?
2. What are the general trends of the literature on design thinking in education in terms of citation analysis?
3. What are the trends of the literature on design thinking in education in the context of collaboration analysis?
4. What are the trends of the literature on design thinking in education in terms of subject analysis?

## 2. Methods

In the research, the bibliometric analysis method was preferred to reveal the bibliographic outputs of the literature on design thinking in education. This method is used to understand scientific research development and communication networks. With bibliometric analysis, descriptive analyses are performed on a scientific subject area with quantitative approaches. Thus, the characteristics of a scientific subject area can be systematically quantified. Bibliometric analysis enables researchers to identify research trends, the most compelling studies, important research areas, and researchers (Börner, 2010). Thus, it provides a holistic view of the relevant subject area (Zupic & Čater, 2015). In addition, bibliometric analysis through mapping provides in-depth analyses, highlights the sci-

entific and social structure of the field, and reveals active topics on the agenda (Deng et al., 2021).

## 2.1. Data Collection Process

In order to examine design thinking research in education, the Web of Science database was selected for accessing information on relevant publications. The systematic indexing of bibliometric data of the researches in the field was effective in this choice. When the Web of Science database was analyzed, it was seen that the first publication was in 2000. The number of publications made until 2010 was determined as 9. This period, which can be expressed as the first period, was excluded from the scope of the research. With increased publications after 2010, the field has matured and can reflect the general trend more clearly. For this reason, the period between 2010-2024 was included in the scope of the research.

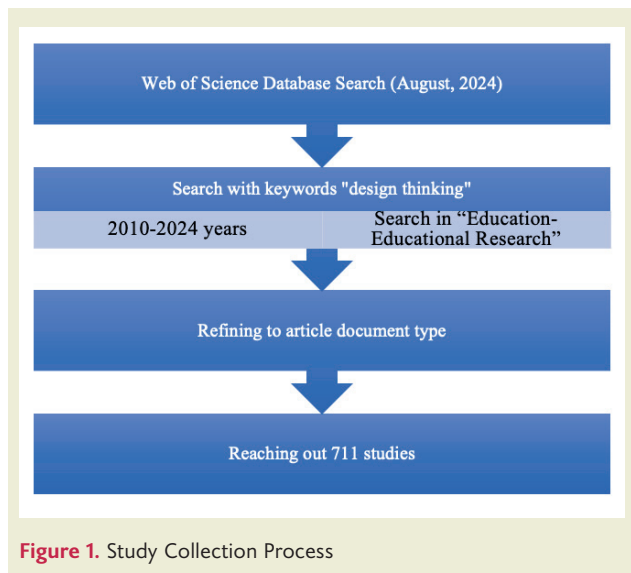


Figure 1. Study Collection Process

The concept of ‘design thinking’ was used as a keyword to access the relevant studies to be included in the research. For the bibliometric analysis of the related studies, the period of 2010-2024 was preferred. In order to focus on research in the field of education, filtering was done for the ‘Education-Educational Research’ category within the Web of Science categories. Another filtering was performed to include only full article publications in the process for the type of research. The scanning process was carried out at the end of August 2024, and the data set was obtained. ►Table 1 shows the types of studies in the educational research category.

As can be seen in ►Table 1, the number of full-text articles is 711. Here, the data set was exported by filtering and selecting 711 articles.

Table 1. Types of Publications about the design thinking within the Context of Education Education/Educational Research

Type	Frequency
Article*	711
Proceeding Paper	389
Book Chapters	99
Early Access	35
Editorial Material	21
Review Article	21
Book	4
Book Review	4
Correction	2

## 2.2. Data Analyses

Data analysis was conducted using the R bibliometrix package and VOSviewer tool. The R bibliometrics package is an open-source R software tool designed to perform comprehensive bibliometric and scientometric analysis of scientific literature (Aria & Cuccurullo, 2017). In the context of the research questions, bibliometric analyses of design thinking in education were conducted. In this context, general bibliometric information, publication trends, citation, collaboration networks and subject characteristics of the data set were analysed. Detailed analyses on publications, citations and authors were performed with the bibliometrix package using the R programming language. Scientific maps and network visualisations were created using VOSviewer software.

## 2.3. Limitations

The research review includes only the studies in the category of educational research in the WoS database. The data set consists of full-text articles only. In addition, the scope of the research is based on the years 2010-2024 in terms of time.

## 3. Findings

A Web of Science search was conducted on the subject of design thinking in education. The articles in the category of educational research between 2010-2024 constitute the data set of the bibliometric analysis study. The findings obtained through the R package and VosViewer tools are presented under the relevant headings in the context of the research questions.

### 3.1. Main Findings of the Data Set

Basic information about the literature on design thinking in education is important in terms of showing the scope of the research. The findings of the bibliomet-



ric analysis performed with the R package for the extraction of basic information are presented in ►Table 2.

**Table 2.** Eğitimde Tasarım Odaklı Düşünme konusuna yönelik veri seti hakkında temel bilgiler

Time period	2010-2024
Number of full text articles	711
Number of authors	1798
Number of single authors researchers	132
Average number of citations per article	10,28

When ►Table 2 is analysed, it is seen that the number of current full-text research on the field is 711. It is noteworthy that the number of researchers interested in the subject in the last 15 years is 1798. The number of single-author researchers was observed as 132. It is also seen that the average number of citations per article is 10,8.

### 3.2. General Trends in the Literature on Design Thinking in Education in Terms of Publication Trends

In order to examine the development and current status of articles on design thinking over time, a bibliometric analysis revealing publication trends was conducted. In this context, the distribution of publications by years, countries' contribution to producing articles in the field and the prominent researchers in the field were analysed. Thus, the publication trends of the design thinking literature are revealed through year, country and author analyses.

#### 3.2.1. Number of Publications by Years

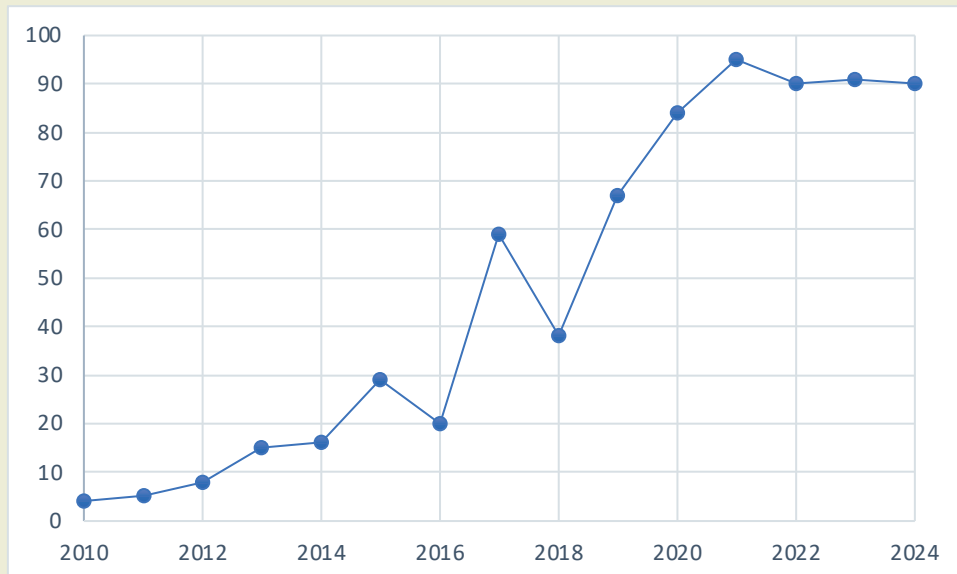
The growth rate and periodical changes of the field are observed by analysing the number of publications of research on design thinking by years. The distribution of the number of publications by years is shown in ►Figure 2.

When ►Figure 2 is analysed, it can be said that there is a general trend towards an increase in the number of publications from past to present. While there were only 4 publications in 2010, this number increased to 90 in 2024. It can be said that the most publications were made in 2021 and the number of publications in recent years has been similar to 2021.

#### 3.2.2. Most Productive Countries

Which countries stand out in terms of design thinking was analysed through the R package. ►Figure 3 shows the 10 countries with the highest production contribution through the responsible author.

When ►Figure 3 is analysed, it is observed that the broadcast frequencies vary between 13 and 205. The findings show that the USA ( $f=205$ ) is by far the leader in the field of design thinking in education. China ( $f=88$ ) and Australia ( $f=60$ ) follow the USA in terms of production. It is especially noteworthy that the countries where English language is spoken (USA, Australia, Canada, England) are at the top of the list. In terms of continental distribution, 234 articles were published in North America (USA and Canada), 124 in Asia (China, Singapore and South Korea), 58 in Europe (UK, Spain and Germany), 60 in



**Figure 2.** Distribution of Number of Articles by Year

Oceania (Australia) and 20 in South America (Brazil).

### 3.2.3. Most Published Authors

Bibliometric analysis was carried out with the R package to determine the authors who published the most in the field of design thinking in education. ►Figure 4 shows the number of publications of the 10 authors who produced the most articles in the field.

As can be seen in ►Figure 4, the most productive authors in the field of design thinking are Chai (f=20), Koh (f=14) and Hong (f=13). It can be said that these authors lead the field in terms of the number of publications. It is seen that the other authors in the list are close to each other

and have relatively low number of publications. Considering the general number of studies, this situation indicates that the field has a large number of researchers.

### 3.2.4. Journals with the Most Publications

Bibliometric analysis was carried out with the R package to determine the journals with the highest number of publications in the field of design thinking in education. ►Table 3 shows the number of publications of the 10 prominent journals in the field.

As can be seen in ►Table 3, the journals with the highest number of publications in the field of design thinking are International Journal of Technology and Design

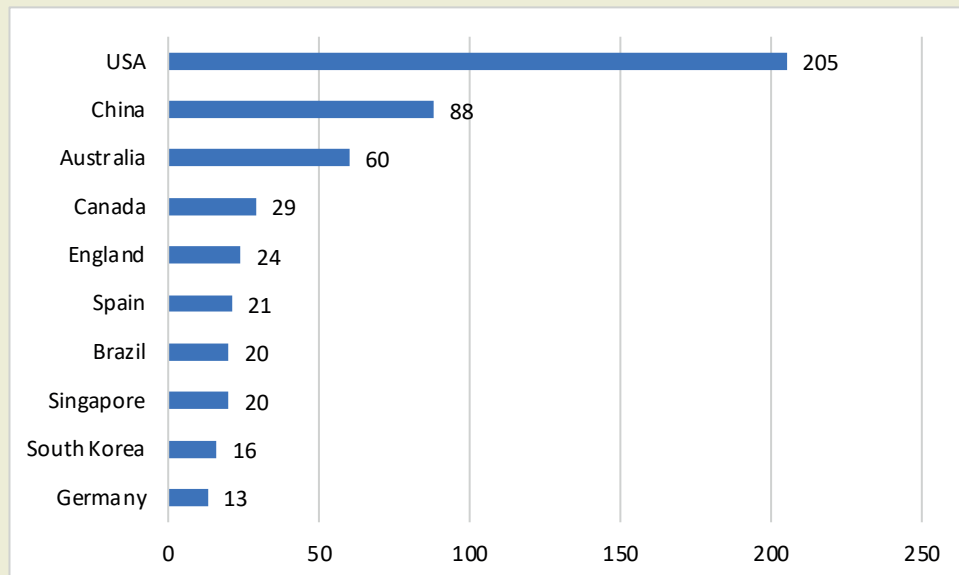


Figure 3. Top Producing Countries by Corresponding Author

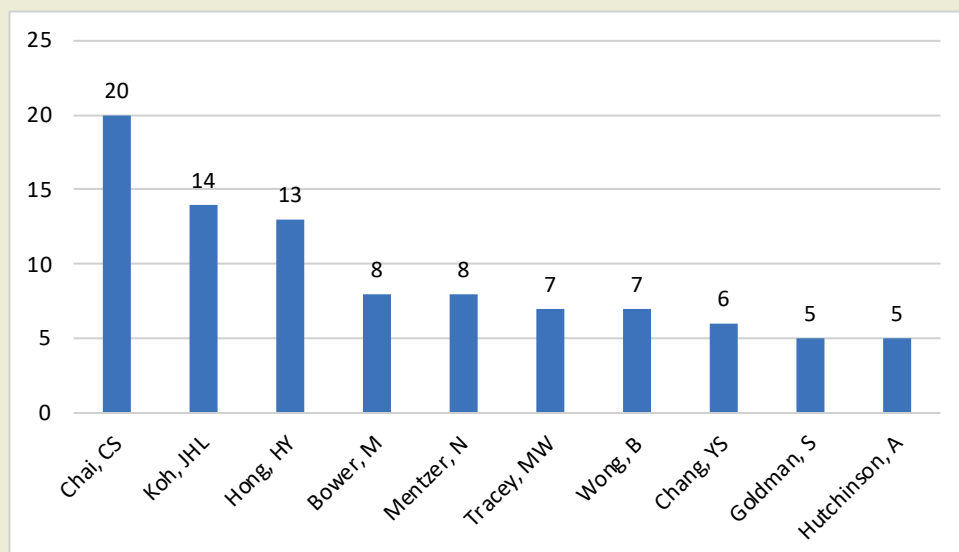


Figure 4. Authors with the Most Article Publications

Education (f=55) and Thinking Skills and Creativity (f=42). It can be said that these journals are frequently preferred in the field in terms of the number of publications. Among the other journals included in the list, International Journal of Art & Design Education (f=28) and Education Sciences (f=20) also draw attention. In general, it can be said that the journals included in the list are directly related to the field of design thinking and this close relationship has gained continuity.

### 3.3. General Trends of the Literature on Design Thinking in Education in the Context of Citation Analysis

Citation analysis was performed by bibliometric analysis method for the articles published in the field of design thinking in education. It may be important to include citation analysis to reveal effective studies in the field and to observe the intellectual identity of the field. In the citation analysis in the research, the most cited articles and the citation averages of these articles according to years are focused on. Analysing the most cited articles aims to reveal the articles that shape the field of design thinking in education. By examining the averages of the citations of these prominent articles according to years, it can be observed how these researches affect the field depending on time. Seeing the continuity and timeliness of the researches can make the citation analysis more meaningful. Because with the annual citation averages, the change in the importance of the researches over time, their permanent impact levels and the researches that attract attention can be observed.

#### 3.3.1. Most Cited Articles and Citation Averages by Year

The articles published in the field of design thinking in education were analysed according to the number of citations they received. ► **Table 4** shows the most cited articles and their annual citation averages.

Table 4 shows that Razzouk's (2012) study has by far the highest number of citations with 471 citations. Carroll (2010) and Glen (2014) articles rank second and third with 142 and 140 citations, respectively. The oldest article in the list is Carroll (2010) and the newest article is Lu (2023). Looking at the changes in citations over time in ► **Table 4**, it is seen that the total number of citations of articles published between 2010-2015 is generally higher.

When the annual average number of citations is analysed, as seen in ► **Table 4**, Lu (2023) has the highest rate with 47.5 citations per year, although it is a fairly new publication. This shows the timeliness and effectiveness of the study. It can be said that it has a rapid impact by reflect-

ing the current trends in the field. Razzouk's (2012) article ranks second with 36.23 citations per year. This shows that although it is a relatively old publication, Razzouk (2012)'s article maintains its influence. It can be said that this article has become a basic source in the field. Henriksen (2017) and Kuo (2019) articles are also noteworthy regarding the number of annual citations.

### 3.4. Trends in the Literature on Design Thinking in Education in the Context of Collaboration Analysis

Collaboration analysis was applied within the scope of bibliometric analysis study for the field of design thinking in education. Thus, it aimed to understand the field's development and reveal its social structure. In this context, author, institutional, and cross-country collaboration were analysed. While author collaboration shows how knowledge production and sharing occurs, inter-institutional collaboration shows interdisciplinary interactions. Cross-country collaboration, on the other hand, reflects knowledge transfer on a global scale and intercultural interaction.

Within the scope of bibliometric analysis, VosViewer tool

**Table 3.** Most Published Journals

Journals	F	Impact Factor
International Journal of Technology and Design Education	55	2.0
Thinking Skills and Creativity	42	3.5
International Journal of Art & Design Education	28	1.1
Education Sciences	20	2.5
Applying Design Thinking to The Measurement of Experiential Learning	18	3.3
Taking Design Thinking to School	17	0.8
Etr&D-Educational Technology Research and Development	16	4.8
Interaction Design And Architectures	15	1.9
Education and Information Technologies	14	6.0
Frontiers in Education	13	2.2

**Table 4.** Top 10 Most Cited Articles and Citation Averages by Year

Article	Reference	Annual Average Citation
Razzouk (2012)	471	36,23
Carroll (2010)	142	9,47
Glen (2014)	140	12,73
Tsai (2012)	135	10,38
Henriksen (2017)	117	14,62
Wrigley (2017)	108	13,50
Lu (2023)	95	47,50
English (2015)	91	9,10
Kuo (2019)	89	14,83
Koh (2017)	86	10,75



was used to analyse collaboration networks. For visualisation, the ‘overlay visualisation’ representation was chosen. The size of the nodes in the visualisation shows the effectiveness in the field. The network change from the past to the present is examined by colouring according to years. Cold and dark colours represent the past, while warm and light colours represent new studies.

### 3.4.1. Author Cooperation Networks

The pair ‘co-authorship’ and ‘author’ was selected for the analysis. ►Figure 5 shows the author collaboration network and publication times for the field of design thinking in education.

As shown in ►Figure 5, the authors named Chai, Koh, and Ling are at the center of the network. It shows that these authors have a high level of influence in the field and attach importance to cooperation. It is also seen that Tsai comes closest to the effectiveness of these authors.

The authors at the center of the network are connected with many other authors. It is seen that these authors have a broad collaboration network. Wong has a strong relationship with the authors in the center. It can also be said that a small sub-group is formed around Lin on the right side of the network.

When ►Figure 5 is analysed, it is seen that most authors are in blue-green tones. This indicates that the studies were concentrated in 2016-2020. The fact that authors such as Chung, Guang-Han, and Chen on the right side of the network are in light colors shows that they have recently contributed to the field and have risen in this field. It is also noticeable that Wu and Dandan are somewhat isolated from the main network. This indicates

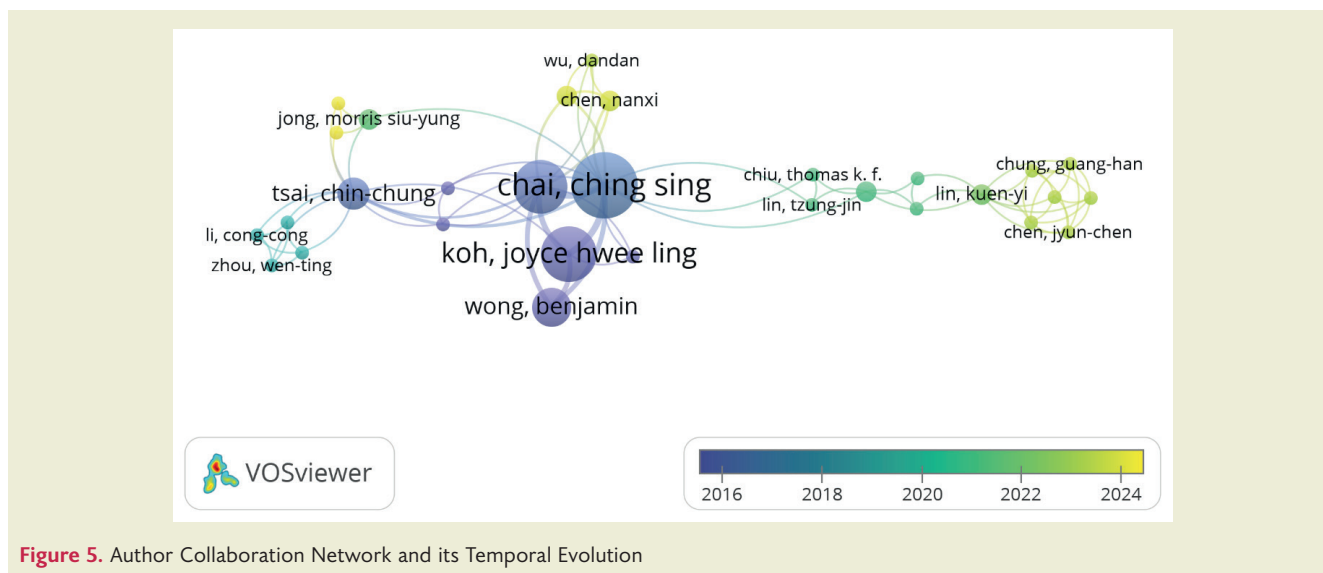
that they may be working on a specific sub-topic.

### 3.4.2. Institutional Collaboration Networks

For the bibliometric analysis of the field of design thinking in education, an inter-institutional collaboration network analysis was conducted. For this analysis, ‘co-authorship’ and ‘organisation’ binary was chosen. This analysis shows which organisations work together, which organisations are pioneers in the field and the patterns of collaboration between organisations. ►Figure 6 shows the inter-organisational collaboration and its temporal evolution.

When ►Figure 6 is analysed, it is seen that there are several main clusters on the network. It can be said that the networks are predominantly regional. North American, Australian, and Asian universities are seen on the network. Stanford University, Purdue University, and National Taiwan Normal University are at the center of the inter-institutional cooperation network. According to these central network nodes, these universities cooperate more frequently and have strong connections with different institutions.

According to ►Figure 6, these three universities (Stanford et al.) are more active in the field of design thinking in education. When analysed through the colorings, Arizona State University and Stanford University appear in darker blue. It can be said that these institutions have done earlier studies in the field. Institutions such as National Taiwan Normal University and Purdue University are visualized in more yellow tones. It can be said that more recent publications in the field represent these institutions.



As a result, the field has attracted more attention, and the number of publications has increased in recent years. The central location of Stanford University shows that this institution plays a pioneering and linking role in the field. Purdue University and National Taiwan Normal University are essential connection points.

### 3.4.3. Inter-Country Co-operation

A bibliometric analysis was conducted for cross-country collaboration in the field of design thinking in education. ‘co-authorship’ and “country” binary was selected for the analysis. The analysis was based on countries

with at least 5 publications and the average publication year was colour coded with ‘overlay visualisation’. ►Figure 7 shows the cross-country collaboration network in the field of design thinking in education.

Figure 7 shows that the USA has the most significant node and is at the center of the network. This shows that the USA is the country that publishes and co-operates the most in the field. It is also evident that Australia, Taiwan, and China are essential actors in the network.

When the patterns of cooperation are analysed, it is seen that the USA has a connection with almost all countries

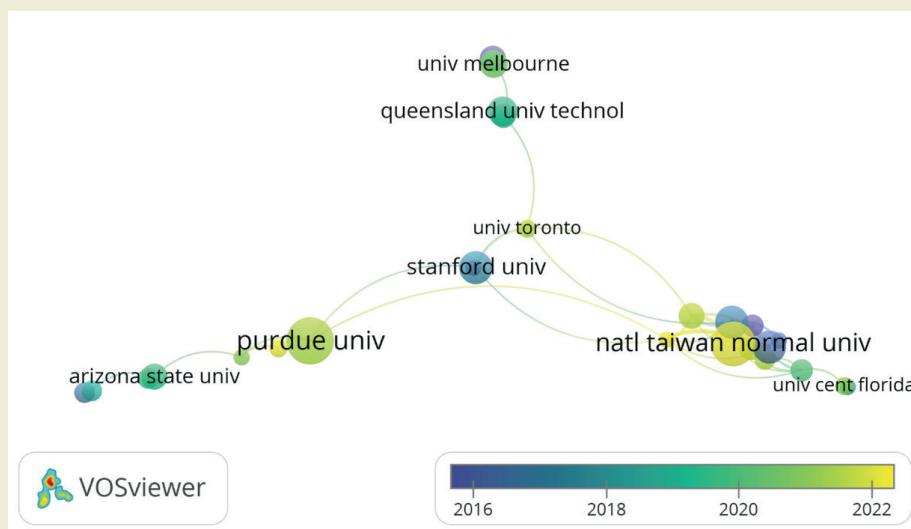


Figure 6. Inter-institutional Cooperation Network and its Temporal Evolution

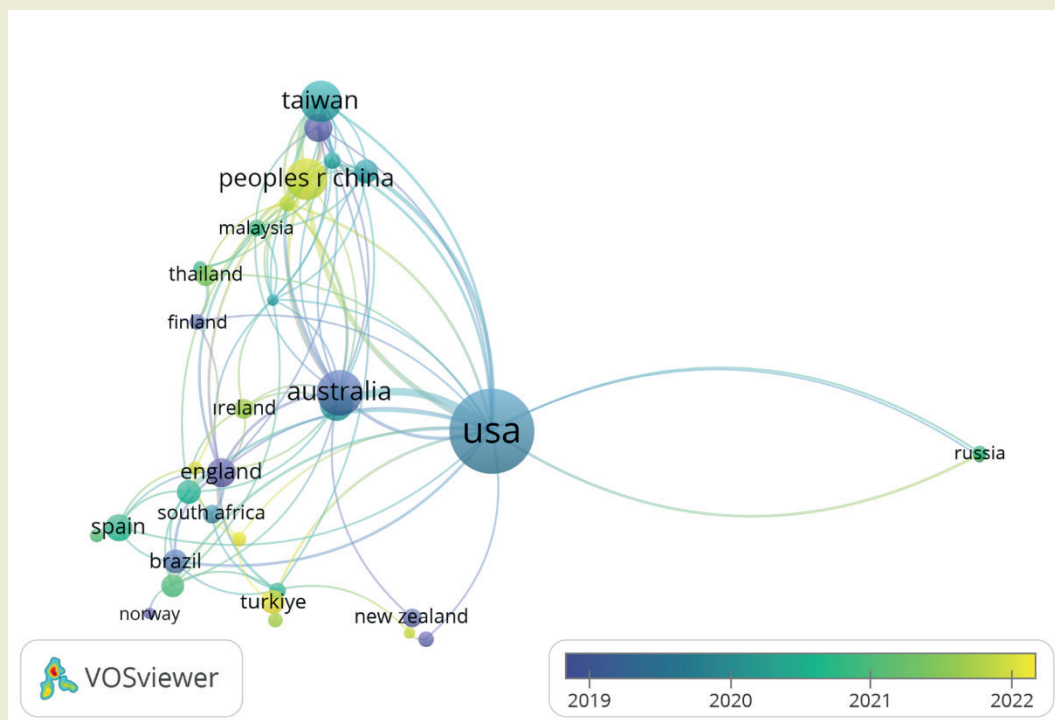


Figure 7. Global Co-operation Network and its Temporal Evolution

and attaches importance to cooperation. It can be said that the ties among Asian countries (China, Taiwan, Malaysia, Thailand) are pretty strong. Focusing on the colors on the network, it is seen that countries such as Spain, Brazil, and Turkey are in lighter green-yellow tones. It can be said that these countries have started to contribute to the field more recently. It can be said that research in these countries will potentially increase.

When the cooperation network is analysed regionally in ► **Figure 7**, it is seen that there is a triple network structure: North America (USA), Asia-Pacific (Australia, Taiwan, China), and Europe. Brazil from South America and South Africa from Africa are also noteworthy. Russia, on the other hand, has a connection only with the USA. This shows that Russia is isolated in design thinking in education. On the other hand, according to its geographical location, New Zealand's active presence in the global co-operation network is noteworthy.

### 3.5. Trends in the Literature on Design Thinking in Education in the Context of Subject Analysis

Bibliometric analysis was conducted for the keywords preferred by the authors in the field of design thinking in education. The keywords mentioned at least 10 times in the studies were taken as basis. 'co-occurrence' and "author keywords" pair was selected for the analysis.

Here, 'network visulation' was used for visualisation.

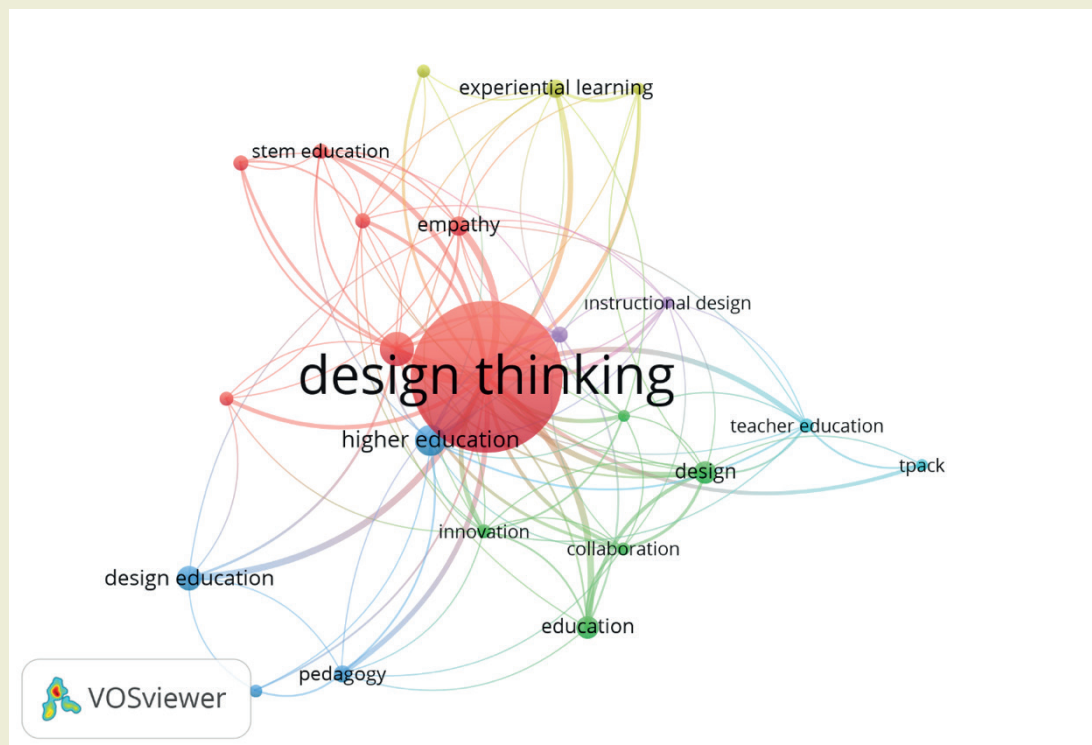
#### 3.5.1. Keyword Analysis

Figure 8 shows the co-use analysis of the keywords used in the field of design thinking in education. This analysis is valuable in terms of showing how design thinking is used in the field of education and with which concepts it is associated.

Figure 8 shows that the keyword 'design thinking' is placed at the center of the network. This is understandable since it is the central theme of the research. In order to see which dimensions of design thinking are addressed in education, the prominent keywords, among other related keywords, were analysed. It can be said that the observed keywords reflect the research trends in the field.

One of the keywords with a solid connection to the network is 'higher education.' This shows that design thinking research is frequently conducted in higher education. In this context, it can be said that research on how to integrate students into creative processes is carried out. Another prominent keyword is 'design education.' This shows that the design of education is emphasised in design thinking. The design of education can play an essential role in acquiring creative and critical thinking skills.

According to ► **Figure 8**, concepts such as empathy, col-



**Figure 8.** Relationship of the Most Used Keywords

laboration, experience, and innovation are the essential elements of design thinking. ‘Empathy’ is an important concept representing the student-oriented design thinking approach. Again, it is seen that the word ‘collaboration,’ which is one of the essential components of design thinking, is included in the network. Because collaborating with group work and joint projects is effectively preferred in this field, other prominent words can be listed as ‘innovation,’ ‘experiential learning,’ and ‘instructional design.’ In addition, when ►Figure 8 is examined, it is seen that the concepts of ‘TPACK,’ which includes the combination of technology, pedagogy, and content knowledge, ‘teacher education’ for the education of teachers, and ‘pedagogy,’ which is directly related to teaching methods and techniques, also have connections on the network, although not as strong as other words.

## 4. Discussions

This research focuses on the bibliometric analysis of design thinking among academic studies in education. In light of the findings, design thinking is essential for 21st-century educational goals and is increasingly the subject of research worldwide (Çeviker-Çınar, 2018). When the findings are analysed, it is seen that the increase in the number of publications accelerated between 2015 and 2020. This shows that the interest in the subject has increased even more after 2015. It can be said that emerged as a critical research topic that has reached a certain maturity in the field of education, especially with the research conducted in the last ten years. It can be said that the increase accelerated, especially between 2020-2024, and reached an important position in educational research. This can be explained by adopting the constructivist approach in education and training processes, the active role of the student in this process, and the importance given to learning experiences by doing and experiencing in recent years (Aydemir & Çetin, 2023). It can be said that the popularity of design thinking has increased significantly over time. Again, the number of similar studies in recent years may indicate that the field has become an established research area. In this case, new sub-research topics for the subject area may also have an impact. It can be thought that this subject will maintain its effectiveness in the coming years with new application areas and methodological developments (Sürmelioglu & Seferoğlu, 2023).

The USA is the pioneer and leader in the field of TOD in educational research and directs the development of the field in a global context. This can be explained by the importance given to this issue by the institutions and companies involved in universities and educational pro-

cesses in the USA and the fact that the origins of TOD are based on design firms (e.g., IDEO) and universities (such as Stanford d.school) in the USA (Brown, 2008; Kelley & Kelley, 2013). Indeed, the Hasso Plattner Institute (d.school) at Stanford is one of the essential and pioneering institutions in implementing design thinking (Dam & Siang, 2018). Likewise, David Kelley and Tim Brown, founders of IDEO, a design firm established in California with offices in the USA, the UK, and China, have also been instrumental in popularising TOD (Nasir et al., 2022). These organizations and companies have been influential in the US and are pioneers. The leadership of the USA can also be associated with the openness of education systems to innovative approaches and the importance given to STEM education (Henriksen et al., 2017). However, the dominance of English in academic publications is reflected in the field with other countries included in the list.

China's second place in the list may result from a competitive education policy effort on creativity and design thinking in recent years. Studies have been conducted in Australia on integrating TOD into the K-12 curriculum (Anderson et al., 2014). The active role of Taiwan and China in this field reflects their interest in innovative educational approaches and technology-oriented educational policies (Koh et al., 2015). In addition, the critical design firm (IDEO), established in the USA and has offices in China, can also be considered to impact this issue. The fact that European countries (UK, Spain, Germany) are in the middle of the list and no other European country has entered the list indicates that this continent can do more work in the field. The strong ties between Asian countries emphasise the importance of regional cooperation and information sharing. This can be explained by cultural affinity and common educational goals. For example, Singapore's efforts to integrate TOD into its education system have influenced other countries in the region (Lim et al., 2018). Design thinking has influenced researchers worldwide and pushed them to produce publications. In the future, research will be expected to increase in countries with fewer studies. Publications in different geographical locations will contribute to the development of the field in the context of establishing cooperation. The fact that countries such as Spain, Brazil, and Turkey are seen as newer participants shows that TOD continues to spread globally. The potential for increased research in these countries may offer new insights into how TOD can be applied in different cultural and educational contexts (Aflatoony et al., 2018). Again, based on this, the field maintains its continuity and is an active research topic. The authors' names show that the field has an international dimension, and contributions are made from different countries.



In the light of all these, it can be said that the field of design thinking in education is guided by a few pioneering researchers, but at the same time, it has a wide research audience, so it can be thought that the research in this field is examined more in-depth and from different angles. Because by its nature, the design process is a process that develops with the cooperation of individuals with different perspectives and different skills (Johaneson & Perjons, 2021). The field will have more impact on educational approaches with future research. As a result, ►Table 4 shows the effects of practical studies in the field of design thinking in terms of citation. While Razzouk's (2012) article appears to be one of the cornerstones of the field, new studies such as Lu's (2023) are rapidly making an impact. This shows that the field of design thinking is an active and emerging research area. The inter-author collaboration network shows various sub-groups with a centralized solid structure. This suggests that the field is organized around leading researchers but also works on various unique sub-topics. Working with researchers from different disciplinary fields is essential for the innovative and comprehensive solution process of the TOD process (Toker & Çakiroğlu, 2023). It can be said that the field has developed with the participation of new researchers. In addition, looking at the authors' names, it can be said that Asian names are more active in the field in terms of cooperation.

The central role of the USA shows that it is a pioneer in the development of the field, the strong participation of the Asia-Pacific region shows the importance this region attaches to educational research, and the relatively dispersed but connected structure of European countries on the network shows that they are strong in global connections as well as within the continent. Finally, according to the network structure in ►Figure 7, there are strong ties between English-speaking countries. This is an advantage of using a common language in establishing cooperation.

It is seen that the keywords observed in the network structure presented in ►Figure 8 can be clustered under specific themes. These clusters can be explained as design thinking (1), education and pedagogy (2), and learning approaches (3). This cluster emphasizes empathy, creativity, problem-solving, innovation, and collaboration. In the cluster of education and pedagogy, concepts such as higher education, teacher education, instructional design, and pedagogy come to the fore. The researches focuses on higher education and teacher education and gives instructional design importance. In the cluster of learning approaches, it can be said that concepts such as experiential learning, STEM education, and TPACK are discussed. Experience, technology integration, and

interdisciplinary learning are emphasized in executing learning processes in the studies. As a result, it can be said that the concept of design thinking in education has strong connections with educational and learning approaches. In addition, in educational sciences, SDT is considered an approach to teaching-learning processes (Aydemir & Çetin, 2023). As a learning-teaching approach, SDL is a product development process using different methods, techniques, and materials (Sürmelioglu & Erden, 2021). With this analysis, it can be said that solid concepts for using design thinking in learning environments have been put forward. The increase in the number of studies in the field, together with the observed concepts, may lead to design thinking gaining more importance in education. However, there are some difficulties encountered in the effective use of design thinking approach in learning environments. Designing learning environments and processes with the design thinking approach is time-consuming (Koh et al., 2015). For teachers to design and carry out teaching processes through this approach, they may also need training on applying it (Razzouk & Shute, 2012). Efficient results may not be obtained in environments where group work cannot be carried out effectively (Noweski et al., 2012). Design thinking also differs from traditional approaches in terms of evaluation. Using alternative evaluation methods can also be challenging for researchers and educators (Aflatoony & Wakkary, 2015). In this respect, future studies must provide educators with various application examples, evaluation methods, and instructional designs.

A bibliometric analysis of design thinking research in education from 2010 to 2024 reveals that TOD is an essential area of research, with significant contributions from the USA and China. The main themes include creativity, higher education, and experiential learning. Research is concentrated in specific journals and conducted by a few prolific authors, indicating opportunities for further contributions from new researchers. The citation data underline the impact and importance of this research on educational practice and outcomes. This approach helps students develop 21st-century skills and prepares them to solve real-world problems. However, teachers need to receive appropriate training to implement TOD effectively, and educational institutions need to be restructured to support this approach. In this new configuration, integrating design thinking with technology is an opportunity to offer new perspectives in the field of education (Lugmayr et al., 2020). For example, integrating artificial intelligence technologies into TOD processes can accelerate creative problem-solving and innovation. AI-supported design tools can help students solve more complex problems. Similarly, intelligent classrooms and learning



environments can enable students to apply design thinking more effectively. For this, learning environments can be enriched with the Internet of Things in the long term. Future research should examine the long-term effects of TOD and how it can be best applied at different educational levels and cultural contexts.

## Research Ethics

Not applicable.

## Author Contributions

Conceptualization: [Zeynep Avinç Kara, Türkan Karakuş Yılmaz], Methodology: [Türkan Karakuş Yılmaz, Abdulkadir Kara], Formal Analysis: [Abdulkadir Kara], Investigation: [Zeynep Avinç Kara, Abdulkadir Kara], Resources : [Zeynep Avinç Kara], Data Curation: [Zeynep Avinç Kara, Abdulkadir Kara], Writing - Original Draft Preparation: [Zeynep Avinç Kara], Writing - Review & Editing: [Zeynep Avinç Kara, Türkan Karakuş Yılmaz], Visualization: [Zeynep Avinç Kara, Abdulkadir

Kara], Supervision: [Türkan Karakuş Yılmaz], Project Administration: [Zeynep Avinç Kara], Funding Acquisition: [Zeynep Avinç Kara]

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