DESIGN THINKING IN EDUCATION: A BIBLIOMETRIC STUDY IN INTERNATIONAL RESEARCH

DESIGN THINKING NA EDUCAÇÃO: UM ESTUDO BIBLIOMÉTRICO EM PESQUISAS INTERNACIONAIS

DESIGN THINKING EN LA EDUCACIÓN: UN ESTUDIO BIBLIOMÉTRICO EN INVESTIGACIONES INTERNACIONALES

Nadielli Maria dos Santos GALVÃO[1]
e-mail: profa.nadielligalvao@gmail.com

Henrique Nou SCHNEIDER[2]
e-mail: hns@terra.com.br

How to reference this article:

GALVÃO, N. M. dos S.; SCHNEIDER; H. N. Design Thinking in education: A bibliometric study in international research. **Revista Ibero-Americana de Estudos em Educação**, Araraquara, v. 18, n. 00, e023107, 2023. e-ISSN: 1982-5587. DOI: https://doi.org/10.21723/riaee.v18i00.17667

| **Submitted**: 30/01/2023
| **Revisions required**: 29/03/2023
| **Approved**: 07/05/2023
| **Published**: 23/11/2023

[1] Federal University of Sergipe (UFS), Itabaiana – SE – Brazil. Professor at the Department of Accounting Sciences. Member of the Study and Research Group on Information Technology in Education (GEPIED). PhD student in Education (UFS).

[2] Federal University of Sergipe (UFS), São Cristóvão – SE – Brazil. Professor at the Computing Department. Leader of the Study and Research Group on Information Technology in Education (GEPIED). PhD in Production Engineering (UFSC).

ABSTRACT: Design Thinking is a strategic proposal to generate innovation, which can even be adopted in education. However, stakeholders involved in the pedagogic process should know such proposal first. Thus, developing scientific research that shows the application of Design thinking in the educational context is crucial. The main goal of this work is to identify the profile of research about Design Thinking as a strategy for innovation in international higher education between 2013 and 2022. The year of 2022 had the highest number of publications about the subject. Five authors were responsible for publishing more than one study. Furthermore, social sciences was the field with the highest number of publications. The United States was the most productive country and, consequently, English was the prime language used. The most commonly adopted keywords were Design Thinking, Higher education, innovation and creativity. The most referenced author in the sample studied was Tim Brown.

KEYWORDS: Design Thinking. Higher Education. Innovation.

RESUMO: *O Design Thinking é uma proposta estratégica para gerar inovação, sendo possível adotá-la inclusive na educação. Porém, para isso é preciso que os envolvidos no processo pedagógico conheçam-na. Assim, buscar pesquisas científicas que apresentem a aplicação do Design Thinking no contexto educacional torna-se primordial. O objetivo deste trabalho é identificar o perfil das pesquisas sobre Design Thinking como estratégia de inovação no ensino superior no âmbito internacional entre 2013 e 2022. O ano de 2022 foi o período com maior número de publicações sobre a temática. Apenas 5 autores publicaram mais de uma pesquisa. Além disso, a área de ciências sociais foi aquela com maior quantidade de publicações. Os Estados Unidos foi o país mais profícuo e, consequentemente, o inglês foi o principal idioma. As palavras-chave mais adotadas foram Design Thinking, Higher Education, innovation e creativity. O autor mais referenciado nos textos componentes da amostra foi Tim Brown.*

PALAVRAS-CHAVE: *Design Thinking. Ensino Superior. Inovação.*

RESUMEN: *El Design Thinking es una estratégica propuesta de innovación, factible de ser adoptada inclusive en la educación. Sin embargo, para eso es necesario que los involucrados en el proceso pedagógico la conozcan. Así, buscar investigaciones científicas que presenten la implementación del Design Thinking en el contexto educativo es fundamental. El objetivo de este trabajo es identificar el perfil de las investigaciones sobre Design Thinking como estrategia de innovación en la educación superior en el marco internacional entre 2013 y 2022. El año con mayor número de publicaciones sobre la temática fue el 2022. Solamente 5 autores publicaron más de un artículo. Además, el área de ciencias sociales fue aquella con mayor cantidad de publicaciones. Los Estados Unidos fue el país más productivo y, como consecuencia, el inglés fue el idioma principal. Las palabras claves más usadas fueron Design Thinking, Higher Education, innovation e creativity. El autor más referenciado en los textos que componen la muestra fue Tim Brown.*

PALABRAS CLAVE: *Design Thinking. Educación Superior. Innovación.*

Introduction

The concept 'innovation' is associated with two terms: creation and process. Creation, as it is making something exist that did not exist or giving new use to what already existed. Process, as it comes from a set of actions and operations aiming at a result, a specific end (PLONSKI, 2017). The Oslo Manual (OECD, 2018) conceptualizes innovation as a new product or process – or a combination of both – that brings significant differences when compared to previous products or processes.

Considering the current scenario experienced in society where knowledge is seen as the raw material (CASTELLS, 2020), Masetto (2004) already warned of the need for progress in reflection on the consequences of the changes experienced in post-modernity, including in education, especially higher education. In this context, Higher Education Institutions (HEIs) must be open to interdisciplinary, collective, cooperative and integrated dialogue, in the search for solutions that respond to today's demands.

Therefore, it is crucial to know strategies that can be adopted as a way of promoting innovation throughout the pedagogical process. Thus, the proposal arises that agents linked to higher education become familiar with Design Thinking (DT), as a strategy for searching for innovative solutions, in a creative way, focusing on people's needs, based above all on empathy (PAIVA; ZANCHETTA; LONDOÑO, 2020), being a topic of multidisciplinary interest (ARAGÃO *et al.,* 2021).

However, to adopt DT as an innovation strategy in the educational context, those involved in the pedagogical process must know how it can be used. In higher education, this attitude is essential, as society expects HEIs to train proactive, creative individuals capable of working for the community (JOHANN *et al.,* 2020). To this end, it is relevant to visit scientific research that addresses this topic, as a way of understanding how others have used DT and, thus, understanding how it can be applied in our own context.

Given the relevance of knowing how DT has been adopted in the academic environment, especially through research, it is essential to carry out a survey of the profile of scientific works on the topic. Thus, the research question is: What is the profile of international scientific research on Design Thinking as an innovation strategy in higher education published between 2013 and 2022? In this sense, the objective of the study is to identify the profile of research on Design Thinking as an innovation strategy in higher education internationally between 2013 and 2022 (last 10 years, considering the period in which the research was carried out).

Through this study, it will be possible for those interested in the subject, applied to the educational context, to have an overview of what has been published on the topic, as well as the main characteristics of the studies carried out, thus facilitating the search for reliable scientific literature. Additionally, the work has the distinction of carrying out a survey of the literature on DT in higher education specifically, while other studies carried out bibliometric research without focusing on education, covering all areas in which DT can be applied, or focused on in other educational aspects not necessarily specific to innovation in higher education.

Design Thinking: Main aspects

The Bauhaus school, founded in 1919 in Germany, proposed a way of creating objects and spaces combining engineering production techniques with the people-centered vision of artisans. However, due to Nazi persecution the school stopped operating in 1933 (ALT, 2017). However, it cannot be denied that it brought the pillar of what we know today as *Design Thinking*, having become popular with David Kelley, founder of the innovation and *design company* Ideo (CÔRTES JÚNIOR *et al.*, 2020).

DT can be defined as an analytical and creative process, which takes as a starting point the perspective of end users, aiming to offer effective and alternative solutions, experimenting, modeling, creating prototypes, collecting comments and redesigning processes (ARIAS-FLORES; JÁDAN- GUERRERO; GÓMES-LUNA, 2019). Regarding him, Brown (2010) highlighted that *designers thinking* start by decomposing complex problems to understand them better and then put the excerpts together to create complete ideas.

Morais and Fonseca (2022) highlighted that the basis of DT is empathy, collaboration and experimentation. When talking about empathy, Brown (2010) highlighted that it is necessary to develop a connection with people, especially with those who will be the end users of the product/service/process that we are creating and/or transforming. It's trying to see the world through that individual's eyes.

DT is also collaborative. Regarding this, Vianna *et al.* (2012) highlighted that collaborative work between multidisciplinary teams is essential for DT as it provides diverse perspectives that allow for varied interpretations of problems and, thus, as a corollary, the creation of innovative solutions. Finally, experimentation is also one of the most striking points of DT since, as pointed out by Silva *et al.* (2016), it is through this characteristic that prototypes

are modeled and developed that are shared with end users in order to validate and refine the product/service/process.

To carry out the DT, it is important to follow some steps, which do not need to be carried out one after the other in a rigid manner, as it is possible to perform more than one step at the same time and revisit them. Brown (2010) initially brought three stages: inspiration, where the problem or opportunity that motivates the search for a solution is raised; ideation, which refers to the process of generating, developing and testing ideas; and implementation, which would be the path that goes from the design studio to the market, that is, the final development of the solution found.

Educa Digital (2014) brought an adaptation of the DT stages to the educational context (since it was initially created for the corporate and business sector), recommending five stages: Discovery, Interpretation, Ideation, Experimentation and Evolution. In discovery, there is an initial understanding of the challenge or problem to be solved, identifying opportunities; in interpretation, the results of the immersion carried out in the first stage are consolidated, transforming the data into inputs for the next phase, which is ideation, where ideas are generated to solve the challenge. In turn, the fourth stage is experimentation, in which prototypes are created for testing that will ultimately move on to the evolution stage, which is the final application of the product/service/process created/developed.

Through its stages, DT can promote relevant transformations in the pedagogical process. In the formulation of innovative curricula (PUSCA; NORTHWOOKD, 2018); as an active teaching methodology, aiming to stimulate creativity among students (ÇEVIKER-ÇINAR; MURA; DEMIRBAĞ-KAPLAN, 2017; LATORRE-COSCULLUELA *et al.,* 2020); to foster new skills and abilities among students, seeking to enable them to practice professionally in line with new market demands (REVANO; GARCIA, 2020); for teaching in a multidisciplinary way (SILVA *et al*., 2019), aiming to train teachers (GLEASON; CHERREZ, 2021). DT can also be used together with other active methodologies such as, for example, Problem-Based Learning (PBL) (QUEIROZ-NETO; FARIAS; CHAGAS, 2021).

It is important to highlight that the use of DT in the pedagogical process requires a change in the attitude of the entire educational body, considering that new practices are now being thought of in groups (JOHANN *et al.,* 2020). However, for teams to be able to apply this approach as a way of generating innovation in their pedagogical processes, it is important to know experiences of using DT, how it was applied and what results were achieved.

Previous studies

In research carried out on December 14, 2022, three bibliometric studies have already been carried out on *Design Thinking*[3]. It is noteworthy that only one study carried out in the national context was viewed (ARAGÃO *et al*., 2021). The articles were published between 2018 and 2022, that is, the topic presents itself as a recent subject, with room for new investigations. The search platforms used were *Web of Science* and/or Scopus

The data collected referred mainly to the year of publication, type of documents, most productive countries, most adopted language, areas of knowledge, most cited articles, most referenced authors, authors with the greatest number of publications, main journals and conferences, keywords most adopted key.

It is noteworthy that the present work expands the literature on the subject as it focuses on higher education, considering that other bibliometrics highlighted broader aspects of DT without specifying areas (ARAGÃO *et al.,* 2022), or worked *on* other educational aspects, such as entrepreneurial education in Johann *et al*. (2020).

Research methodology

To achieve the objective of the study of identifying the profile of research on Design Thinking as an innovation strategy in higher education at the international level between 2013 and 2022, bibliometric research was carried out which allows measuring the contribution of scientific knowledge to a given area starting from of the analysis of the publications carried out (SOARES *et al*., 2016), and, according to Uehara *et al*. (2017, p. 1544) "[...] a rich instrument with regard to the foundation of knowledge and scientific dissemination".

To this end, Scopus was adopted as a database, which is a multidisciplinary platform, indexing different types of scientific works, being considered the broadest in terms of bibliographic references, guaranteeing peer-reviewed studies (OLIVEIRA, 2017). The search *string* _ adopted was: ' *design thinking* ' AND *'higher education'* AND ' *innovation* '.

The research covered a period of 10 years (2013 to 2022), which is common in other bibliometrics (JOHANN *et al*., 2020), with 2022 being the final year, considering that the data collection took place on the 11th of January 2023 and the year 2022 would be the year in which

[3]Research carried out on the CAPES periodical platform with the string : 'Design Thinking ' AND ' bibliometric ' (in any field) returned 18 studies. The filter was carried out for articles published in peer-reviewed journals, totaling 14 articles. Finally, by reading the abstract, 3 works were chosen that were in fact aligned with the theme of the present study, checking whether they, in their search strings , used the term 'design thinking '.

the editions of the periodicals would already be complete. Thus, the platform returned a total of 85 studies.

Filters were carried out within Scopus so that only articles and conference papers, published in journals and conference proceedings, in the final stage of publication, were reported. After these filters, the final sample of the study included 67 surveys. Furthermore, some questions arose that guided the work and served to answer the general research question, as highlighted in table 1.

Table 1 - Guiding questions

Question	Data collected
What is the period with the highest number of publications on the Scopus platform according to the established search patterns?	Year of publication
What are the most cited articles indexed on the Scopus platform, according to established search standards?	Number of citations per article
Which areas of knowledge have the highest number of studies published on the Scopus platform, according to the established search patterns?	Knowledge area of published articles
Which journals are indexed in Scopus with the largest number of publications on *design thinking* as an innovation strategy in higher education, according to established search patterns?	Articles by periodical
Which conferences, indexed in Scopus, have the largest number of publications on *design thinking* as an innovation strategy in higher education according to the established search patterns?	Articles by conferences
Who are the most useful authors on *design thinking* as an innovation strategy in higher education according to established search patterns?	Articles by author
Which countries have the highest number of publications on *design thinking* as an innovation strategy in higher education?	Articles by country
Which languages have the highest number of publications on *design thinking* as an innovation strategy in higher education, according to established search patterns?	Articles by language
What are the keywords most used by authors to describe their work on *design thinking* as an innovation strategy in higher education, according to established search patterns, and how do the connection networks between them reveal specific lines of research on the topic?	[1] Article keywords; [2] Connections between keywords;
Which authors are most used in the references of the articles included in the study sample?	Authors referenced in articles

Source: Prepared by the authors

The data from the Scopus database itself was exported into a CSV format file for analysis in the *software* VOSViewer, which allows the creation of *clusters*, which enable the understanding of elements such as co-authorship networks and keyword networks

(BHANDARI, 2022). Furthermore, the data was tabulated in Excel for a better visualization of frequency.

Results

The first question that guided the data analysis was: **What is the period with the highest number of publications on the Scopus platform according to the established search patterns ?**. It was noticed that, considering the sample of 67 articles collected for this study, the year 2022 was the year with the highest number of publications on *Design Thinking* and innovation in higher education, with 17 articles, followed by 2019, with 16 works. It is noteworthy that the fact that the year 2022 proved to be significant denotes that the topic remains relevant, showing that there is still room for new investigations on the subject that can expand the existing literature. It should be added that the majority of research in the sample were articles published in journals (42, while 25 were articles from event annals).

The second question was: **What are the most cited articles indexed on the Scopus platform, according to established search standards?**. Checking among the 67 texts in the sample, it was found that the 5 works with the highest number of citations are those presented in table 1. This result is significant as it is interesting for researchers with curiosity in the subject to read such works so that base their research on studies seen as relevant by the academic community.

Table 1 – Most cited articles

Author(s) and year	Title	Number of citations
Pusca and Northwood (2018)	Design thinking and its application to problem solving	32
McLaughlan and Lodge (2019)	Facilitating epistemic fluency through design thinking: a strategy for the broader application of studio pedagogy within higher education	24
Leonard, Fitzgerald and Riordan (2016)	Using evaluation as a design thinking tool for curriculum innovation in professional developmental higher education	16
Revano and Garcia (2020)	Manufacturing Design Thinkers in Higher Education Institutions: The Use of Design Thinking Curriculum in the Education Landscape	14
Çeviker-Çınar, Mura and Demirbağ -Kaplan (2017)	Design Thinking: A New Road Map In Business Education	14

Source: Survey data (2023)

These articles highlight different ways of applying DT to generate innovation in higher education, highlighting its multiple possibilities, from the creation of new curriculum models (LEONARD; FITZGERALD; RIORDAN, 2016), innovative pedagogies, new assessment methods and teaching spaces (PUSCA; NORTHWOOD, 2018). Studies also highlight that the adoption of DT can provide the training of professionals capable of generating innovation in areas such as technologies (REVANO; GARCIA, 2020) and in the business area (ÇEVIKER-ÇINAR; MURA; DEMIRBAĞ-KAPLAN, 2017). Furthermore, they point out the role of DT in improving the development of epistemic fluency as a way of preparing new graduates to face complex problems.

The third question raised was: **Which areas of knowledge have the largest number of studies published on the Scopus platform, according to the established search patterns?**. In the study by Aragão *et al*. (2018), the areas of knowledge on the Scopus platform with the largest number of publications on DT and innovation were agriculture (22%), arts and humanities (17%) and biological sciences (14%). In turn, in the study by Johann, Nunes, Santos and Silva (2020), the area of education and educational research stood out (48.59%).

In the present work, considering the *string* search and filters carried out, the largest number of publications was in the area of social sciences (36%), followed by engineering (19%) and computer science (14%). It is noteworthy that social sciences cover, according to the Encyclopedia Britannica, branches that deal with human behavior in its social and cultural aspects. This result, although different from previous studies, is interesting, because considering that DT has the human being as its central focus, the study by the sciences that analyze human behavior is aligned with the principle of DT.

Next, we asked: **Which journals, indexed in Scopus, have the largest number of publications on *design thinking as an innovation strategy in higher education according to the* established search patterns ?**. In the present work, 37 journals were found with research on the topic, but only 3 had more than 1 publication. Regarding the question: **Which conferences, indexed in Scopus, have the largest number of publications on *design thinking as an innovation strategy in higher education according to the* established search patterns ?,** we found 22 conferences with published articles, according to the search patterns. However, only 2 had more than one work on the topic.

These results show that research on DT and innovation in higher education are not concentrated in a restricted group of journals or scientific dissemination events, which may

require dedication from those interested in the area in the search for scientific work. Table 2 outlines these findings.

Table 2 – Journals and Conferences with the largest number of articles

Periodicals	
Title	**Amount**
Sustainability Switzerland	3
Techtrends	3
Higher Education Research And Development	2
Conferences	
Title	**Amount**
Proceedings Of The 21st International Conference On Engineering And Product Design Education Towards A New Innovation Lands cape E And Pde 2019	3
IEEE Global Engineering Education Conference Educon	2

Source**:** Survey data (2023)

We also asked: **Who are the most useful authors on *design thinking* as an innovation strategy in higher education?**. We saw a tendency for authors to publish only 1 article on the topic, while only 5 authors published 2 works (Caballero, E.; Gonzalez- Almaguer, C.; Zubieta; C.; Saavedra, VA), in co-authorship. Therefore, it is understood that it is not a tendency for researchers to publish a large number of articles on the subject, with a diversity of authors who contributed to the formation of literature on the subject, which is in line with the results of works such as those by John *et al*. (2020), Aragão *et al*. (2021) and Bhandari (2022).

Another question asked in this study was: **Which countries have the highest number of publications on *Design Thinking as an innovation strategy in higher education according to* established search patterns?**. It is noteworthy that the United States was the country with the largest number of publications, totaling 16, followed by Australia with 7 works, which is similar to the results found by Johann *et al*. (2020) and Bhandari (2022). This finding denotes that research on the topic indexed in Scopus (which allows greater international visibility) is still concentrated in countries considered developed.

This result is also explained by the fact that countries considered developed are those that invest the most in innovation. In a survey carried out by WIPO (2022), the United States occupies 2nd place in the ranking and Australia in 25th place. On the other hand, Brazil occupies 54th position. Considering that DT is a mental model for generating innovation, it was expected that countries that invest more in creating innovative solutions would present more research on the subject.

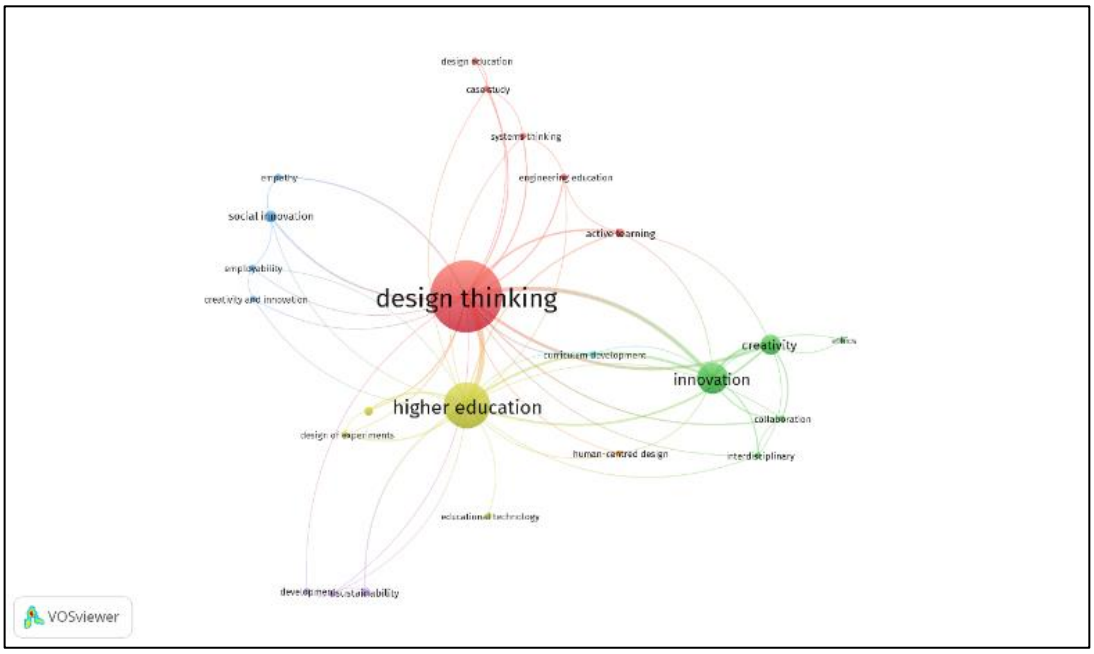
Along the same lines, we checked: **Which languages have the highest number of publications on *design thinking as an innovation strategy in higher education, according to* established search patterns ?**. As a result, we found 3 languages with published texts, namely: English, Portuguese and Spanish, with English being the one with the highest number of publications (64). This result was also found by Johann *et al*. (2020), being considered expected, given that English has been adopted as the main language of scientific dissemination (CINTRA; SILVA; FURNIVAL, 2020).

Next, we sought the answer to the question: **What are the keywords most used by authors to describe their work on *design thinking* as an innovation strategy in higher education, according to established search patterns, and how the connection networks between them reveal specific lines of research on the topic?**. We found 235 keywords included by the authors. The most adopted were *Design Thinking* (36), *Higher Education* (21), *innovation* (14), *creativity* (8). Through the analysis of networks between keywords, VosViewer reported 7 *clusters* (figure 1), with the previously mentioned keywords proving to be central in all *clusters*.

In the current study, the first *cluster* (in red) had the terms *active learning, case study, design education, engineering education, systems thinking*, with the term *design thinking being* central to this *cluster*. The second (in green) had the terms *collaboration, creativity* (central term)*, ethics, innovation* (central term) It is *interdisciplinary*. The third (in blue) presented the terms *empathy, social innovation, employability, creativity and innovation*.

The fourth *cluster* (yellow) indicated the terms *design of experiments, educational innovation, educational technology, higher education* (central term). The fifth *cluster* (in lilac) presented the terms *design, development and sustainability.* The last two *clusters* had only one term in correlation with the central words in the network.

Figure 1 - Keyword networks



Source: Survey data (2023)

It is still possible to infer that there are 3 strongest thematic lines (red, green and blue *clusters*, respectively) that denote 3 lines of research. The first focused on case studies, linked to engineering teaching, active learning and information systems. The second, which brings studies that focus on attitudes linked to the execution of DT, such as creativity, innovation, ethics, collaboration, also demonstrating the interdisciplinarity of the strategy. And finally, the third line, which focuses on the social scope of DT: empathy, social innovation, employability, all of this with innovation and creativity.

Finally, we sought to verify: **Which authors were most used in the references of the articles included in the study sample?**. It was found that the most referenced authors in the 67 works in the sample were those presented in table 2, which highlights some relevant comments about each of them.

Table 2 - Most referenced authors in the sample

Author	Biographical summary[4]
Tim Brown	Author of works such as: *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation* as well as articles and texts on the topic. He is co-president of IDEO, working at the institution since 1987.
Roger Martin	Strategic business consultant, author of books such as *Creating Great Choices, Getting Beyond Better* and *Playing to Win*. Selected several times as one of the 50 most influential business thinkers in the world.
Richard Buchanan	Professor in the Department of Design and Innovation at Weatherhead School of Management. Author of several articles and books, his main works being: *Discovering Design: Explorations in Design Studies, The Idea of Design* and *Pluralism in Theory and Practice.*
Nigel Cross	Professor Emeritus at The Open University Milton Keynes, author of several articles and books as *Engineering Design Methods: Strategies for Product Design, Design Thinking: Understanding How Designers Think and Work* and *Designerly Ways of Knowing.*
Christoph Meinel	Administrative and scientific director of *Hasso Plattner Institute for Digital Engineering gGmbH* (HPI) and was founding dean of *Digital Engineering*, Professor at the University of Potsdam. Co-author of several articles that address DT in education.
Kees Dorst	Professor of transdisciplinary innovation at the TD School at the University of Technology Sydney. Author of several construction about *design* as *Understanding Design, Design Expertise, Frame Innovation, Designing for the Common Good,* and *Notes on Design – How Creative Practice Work.*
Dear Wrigley	Professor of Design Innovation at the Faculty of Engineering, Architecture and Information Technology at the University of Queensland. Author of several books as *Design Innovation and Integration, Design Innovation for Health* and *Medicine Affected: Emotionally Engaging Customers in the Digital Age*, is also co-author of several articles about *design* and *design thinking.*
Jeanne Liedtka	Darden Professor Graduate School of Business at the University of Virginia, researcher on the use of DT in the transformation of innovators. Author of several works such as *Experiencing Design: The Innovator's JourneyDesigning for the Greater Good: Innovation in the Social Sector; The Catalyst: How You Can Lead Extraordinary Growth Designing for Growth: A Design Thinking Tool Kit for ManagersThe Designing for Growth Field Book: A Step-by-Step Guide; The Physics of Business Growth: Mindsets, System and Process; and Solving Business Problems With Design Thinking: 10 Stories of What Works*.
David Dunne	Professor at Gustavson School of Business, research into how designers apply in-depth user research to solve critical problems in society and business. Teaches design, strategy and marketing to students and executives. He has published several research studies in journals such as *Harvard Business Review* and *Academy of Management Learning & Education*. Many of his works were co-authored with Roger Martin.
Larry Leifer	Professor Emeritus at Stanford University. Design thinking researcher focused on engineering, aiming to equip design groups to understand, support and improve their practices. His main lines of research include: design team research methodology, global team dynamics, innovation leadership, interaction design, design for well-being and adaptive mechatronic systems.

Source: Survey data (2023)

[4]Available on the websites of the researchers' linking institutions.

In this sense, it is essential that researchers interested in *Design Thinking* are aware of the profile of the aforementioned authors, read their works to appropriate the concepts of DT, considering that they bring the basic aspects to understanding the methodology and seek to support their studies in the concepts they developed. It is also evident that the author Tim Brown was also highlighted in the works of Johann *et al*. (2020) and Bhandari (2022), reinforcing the relevance of the aforementioned researcher's writings for the thematic area under discussion in this study.

Conclusion

The question that guided this research was What is the profile of international scientific research on Design Thinking as an innovation strategy in higher education published between 2013 and 2022?. After analyzing the collected data, it was concluded that the profile of research that addresses DT as an innovation strategy in higher education, published in the international context, in the aforementioned period, is formed by studies mostly published in 2022. The country with the largest number of publications was the United States and, consequently, English was the main language of research.

The authors who published the most articles (considering the sample parameters) were Caballero, Gonzalez-Almaguer, Leite, Saavedra and Silva. The sample research with the highest number of citations was Design thinking and its application to problem solving. The most used keywords were Design Thinking (36), Higher Education (21), innovation (14), creativity (8), and they indicated the existence of 3 main lines of research. It is noteworthy that the area of knowledge with the largest number of publications was social sciences. Additionally, the author most referenced by the studies in the sample was Tim Brown. Therefore, it is recommended that new researchers, or those interested in the topic, pay attention to the results raised in this study, looking for references of authors, periods, places of publication of articles, aiming to learn more about DT and thus apply them in their context.

Despite its contribution, the present work has as a limitation the fact that only one database was selected. Despite this being comprehensive, it would be possible to find relevant research in other bases, and the analysis was restricted to aspects more linked to the general profile of the research, without delving into the content of the studies, a limitation that is related to the bibliometric perspective. Thus, as a suggestion for future research, it is recommended to adopt the Systematic Literature Review, aiming to understand more qualitative aspects of the

work, such as objectives, adopted phases of the DT, sample of studies, forms of application, among other aspects more linked to the content of the works.

REFERENCES

ALT, L. **O que é Design Thinking?** 2017. Available at: https://mamtra.com.br/wp-content/uploads/2017/08/Coaching-e-Thinking-Desing.pdf. Access: 12 Dec. 2022.

ARAGÃO, E. M. *et al*. Inovação e Contribuição do Design Thinking: Mapeamento Bibliométrico sobre a Produção Acadêmica nas Bases Scopus e Web Science. **Revista Gestão em Análise**, v.10, n.3, p. 191-203, 2021. Available at: https://periodicos.unichristus.edu.br/gestao/article/view/3939. Access: 17 Oct. 2022.

ARIAS-FLORES, H.; JADÁN-GUERRERO, J.; GÓMEZ-LUNA, L. Innovación educativa en el aula mediante Design Thinking y Game Thinking. **Hamut'ay**, v. 6, n. 1, p. 82-95, 2019. Available at: https://revistas.uap.edu.pe/ojs/index.php/HAMUT/article/view/1576. Access: 12 Oct. 2022.

BHANDARI, A. Design Thinking: from Bibliometric Analysis to Content Analysis, Current Research Trends, and Future Research Directions. **Journal of the Knowledge Economy**, p. 1-56, 2022. Available at: https://link.springer.com/article/10.1007/s13132-022-00920-3. Access: 12 Oct. 2022.

BROWN, T. **Design thinking**: uma metodologia poderosa para decretar o fim das velhas ideias. Rio de Janeiro: Elsevier, 2010.

CASTELLS; M. **A Sociedade em Rede**. Tradução: Roneide Venancio Majer. 22. ed. São Paulo: Paz e Terra, 2020.

ÇEVIKER-ÇINAR, G.; MURA, M.; DEMIRBAĞ-KAPLAN, M. Design Thinking: A New Road Map In Business Education. **The Design Journal**, v. 20, n. 1, p. 977-987, 2017. Available at: https://www.tandfonline.com/doi/abs/10.1080/14606925.2017.1353042. Access: 18 Sept. 2022.

CINTRA, P. R.; SILVA, M. D. P.; FURNIVAL, A. C. Uso do inglês como estratégia de internacionalização da produção científica em Ciências Sociais Aplicadas: estudo de caso na SciELO Brasil. **Em Questão**, Porto Alegre, v. 26, n. 1, p. 17–41, 2020. Disponível: https://seer.ufrgs.br/EmQuestao/article/view/88528. Access: 18 Sept. 2022.

CÔRTES JÚNIOR, J. C. *et al*. Design Thinking na Reestruturação do Sistema de Avaliação de Disciplina em um Curso de Medicina. **Revista brasileira de educação médica**, v. 44, n. 4, p. 1-4, 2020. Available at: https://www.scielo.br/j/rbem/a/vLTSrqXczd9tcst6k8wjKcR/?lang=pt. Access: 12 Oct. 2022.

EDUCA DIGITAL. Design Thinking para Educadores. **Educa Digital**, 2014. Available at: https://educadigital.org.br/dteducadores/#oque. Access: 21 Oct. 2022.

GLEASON, B.; CHERREZ, N. J. Design Thinking Approach to Global Collaboration and Empowered Learning: Virtual Exchange as Innovation in a Teacher Education Course. **TechTrends: Linking Research and Practice to Improve Learning**, v. 65, n. 3, p. 348-358, 2021. Available at: https://link.springer.com/article/10.1007/s11528-020-00573-6. Access: 12 Sept. 2022.

JOHANN, D. A. *et al*. Mapping of scientific production on design thinking as a tool for entrepreneurship education: a bibliometric study of a decade. **World Journal of Entrepreneurship, Management and Sustainable Development**, v. 16, n. 4, p. 271-285, 2020. Available at: https://www.emerald.com/insight/content/doi/10.1108/WJEMSD-05-2019-0028/full/html. Access: 10 Sept. 2022.

LATORRE-COSCULLUELA, C. *et al*. Design Thinking: creatividad y pensamiento crítico en la universidad. **Revista Electrónica de Investigación Educativa**, v. 22, e28, 2020. Available at: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1607-40412020000100128. Access: 17 Aug. 2022.

LEONARD, S. N.; FITZGERALD, R. N.; RIORDAN, G. Using developmental evaluation as a design thinking tool for curriculum innovation in professional higher education, **Higher Education Research & Development**, v. 35, n. 2, p. 309-321, 2016 Available at: https://www.tandfonline.com/doi/full/10.1080/07294360.2015.1087386. Access: 17 Sept. 2022.

MASETTO, M. Inovação na Educação Superior. **Interface - Comunicação, saúde, educação**, v. 8, n. 14, p. 197-202, 2004. Available at: https://www.scielo.br/j/icse/a/7Jg4FDgrP6k4GRPCHMX5s5c/?lang=pt. Access: 12 Aug. 2022.

MCLAUGHLAN, R.; LODGE, J. M. Facilitating epistemic fluency through design thinking: a strategy for the broader application of studio pedagogy within higher education. **Teaching in Higher Education**, v. 24, n. 1, p. 81-97, 2019. Available at: https://www.tandfonline.com/doi/full/10.1080/13562517.2018.1461621. Access: 12 aug. 2022.

MORAIS, R. S.; FONSECA, L. R. The use of Design Thinking in the development of digital games for the teaching of chemistry in basic education. **Revista Tempos e Espaços em Educação**, v. 15, n. 34, p. e17778, 12 set. 2022. Available at: https://periodicos.ufs.br/revtee/article/view/17778. Access: 17 Oct. 2022.

OECD. **Oslo Manual**. 2018. Available at: https://read.oecd-ilibrary.org/science-and-technology/oslo-manual-2018_9789264304604-en#page4. Access: 12 Dec. 2022.

OLIVEIRA, J. WOS e SCOPUS: Os grandes aliados de todo pesquisador. **Grupo Comunicar**, 2017. Available at: hhttps://www.grupocomunicar.com/wp/escola-de-autores/wos-e-scopus-os-grandes-aliados-de-todo-pesquisador/. Access: 17 Oct. 2022.

PAIVA, E. D.; ZANCHETTA, M. S.; LONDOÑO, C. Inovando no pensar e no agir científico: o método de Design Thinking para a enfermagem. **Escola Anna Nery**, v. 24, n. 4,

p. 1-6, 2020. Available at: https://www.scielo.br/scielo.php?script=sci_arttext&pid=S1414-81452020000400601&tlng=pt. Access: 12 Jan. 2022.

PLONSKI, G. A. Inovação em transformação. **Estudos avançados**, v. 31, n. 90, p. 7-21, 2017. Available at: https://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-40142017000200007&lng=pt&tlng=pt. Access: 17 Aug. 2022.

PUSCA, D.; NORTHWOOD, D. Design thinking and its application to problem solving. **Global Journal of Engineering Education**, v. 20, n. 1, p. 48-53, 2018. Available at: http://www.wiete.com.au/journals/GJEE/Publish/vol20no1/06-Pusca-D.pdf. Access: 12 Oct. 2022.

QUEIROZ-NETO, J. P.; FARIAS, M. S. F.; CHAGAS; E. L. T. Project Based Learning e Design Thinking em um projeto de intercâmbio. **Revista Ibero-Americana de Estudos em Educação**, Araraquara, v. 16, n. 3, p. 1791-1806, jul./set. 2021. Available at: https://periodicos.fclar.unesp.br/iberoamericana/article/view/14557. Access: 12 Oct. 2022.

REVANO; T. F.; GARCIA; M. B. Manufacturing Design Thinkers in Higher Education Institutions: The Use of Design Thinking Curriculum in the Education Landscape. *In*: INTERNATIONAL CONFERENCE ON HUMANOID, NANOTECHNOLOGY, INFORMATION TECHNOLOGY, COMMUNICATION AND CONTROL, ENVIRONMENT AND MANAGEMENT, 12., 2020. **Anais** [...]. IEEE PELS, 2020. Available at: https://www.researchgate.net/publication/350089850_Manufacturing_Design_Thinkers_in_Higher_Education_Institutions_The_Use_of_Design_Thinking_Curriculum_in_the_Education_Landscape. Access: 12 Aug. 2022.

SILVA, A. *et al*. How education background affects design outcome: teaching product development to mechanical engineers, industrial designers and managers. **European Journal of Engineering Education**, v. 44, n. 4, p. 545-569, 2019. Available at: https://www.tandfonline.com/doi/full/10.1080/03043797.2018.1465029. Access: 17 Aug. 2022.

SILVA, A. M. *et al*. Aplicação do Design Thinking em um Problema Educacional: Um Relato de Experiência. *In*: WORKSHOP DE INFORMÁTICA NA ESCOLA, 22., 2016, Uberlândia. **Anais** [...]. Porto Alegre: Sociedade Brasileira de Computação, 2016.

SOARES, P. B. *et al*. Análise bibliométrica da produção científica brasileira sobre Tecnologia de Construção e Edificações na base de dados Web of Science. **Ambiente Construído**, v.16, n. 1, p. 175-185, 2016. Available at: https://www.scielo.br/j/ac/a/7CmZ3n8FT8R5g93DkW5kzMJ/?lang=pt. Access: 12 Oct. 2022.

UEHARA, F. M. *et al*. O uso de objetos de aprendizagem no ensino fundamental: um estudo bibliométrico. **Revista Ibero-Americana de Estudos em Educação**, Araraquara, v. 12, n. esp. 2, p. 1539–1553, 2017. Available at: https://periodicos.fclar.unesp.br/iberoamericana/article/view/10308/6700. Access: 17 Oct. 2022.

VIANNA, M. *et al*. **Design thinking**: inovação em negócios. Rio de Janeiro: MJV Press, 2012.

WIPO. Resumo Executivo Índice Global de Inovação 2022. **Portal da Industria**, 2022. Available at: https://www.portaldaindustria.com.br/publicacoes/2022/9/resumo-executivo-indice-global-de-inovacao-2022/. Access: 01 Apr. 2023.

CRediT Author Statement

Acknowledgments: Federal University of Sergipe.
Financing: Not applicable.
Conflicts of interest: There are no conflicts of interest.
Ethical approval: Not applicable, as this is not research involving human beings.
Availability of data and material: Not applicable as this is literature review research available on a scientific basis.
Author contributions: Nadielli Maria dos Santos Galvão (PhD student) - construction of the research problem, survey of literature to compose the sections, collection and analysis of research data and writing of the text. Henrique Nou Schneider (Doctoral advisor) - participated in this research at all stages, guiding the writing process, carrying out the necessary interventions and reviewing the text.

Processing and editing: Editora Ibero-Americana de Educação.
Review, formatting, standardization, and translation.