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# EDUCATION AND LEARNING IN THE WORKPLACE IN THE DIGITAL AGE: BIBLIOMETRIC AND QUALITATIVE ANALYSIS WITH RSTUDIO AND IRAMUTEQ

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## ABSTRACT

Education plays a central role in society, promoting the improvement of coexistence and continuous adaptation over the years. In the context of digital transformation, education not only requires core competencies such as interdisciplinary thinking and proficiency in information technology, but also positions itself as an integrating hub for strategic sectors such as healthcare, entrepreneurship, and the Fourth Industrial Revolution. In this scenario, the empowerment of individuals with skills aligned with sustainable development (including environmental awareness, systems thinking, innovation, and collaboration) becomes critical. Thus, a bibliometric study carried out aimed to investigate education and learning in the workplace during digital transformation. The research method used a combined, qualitative and quantitative approach. The database used was Scopus and the study had a sample of 196 articles. The evolution of scientific publications was analyzed and the most productive authors, the most cited articles and the countries with the highest number of citations were identified. In addition, a qualitative analysis was carried out exploring the five most cited publications. As a result, it was identified that the most productive authors are Germani and Papetti, leading with four publications each. Germany is the country with the most citations, with a total of 563. It is observed that the number of published studies has shown continuous growth in the last seven years, reaching 58 publications in 2023. The qualitative analysis reveals that the studies explored the digital transformation, especially in higher education, identifying key competencies for digitalization in healthcare environments, the acceptance and consequences of the 4th Industrial Revolution in the education sector. The change in the direction of research towards an entrepreneurial education was also

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noticed and, finally, the importance of the role of mathematics education in preparing students for the digitized world was also observed. In a broader panorama, advances in digital education highlight its integration with other areas, such as technology and innovation, highlighting its role in the development of a more adaptable and sustainable society.

**Keywords:** Education, Learning, Digital Transformation, Bibliometric Analysis.

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## INTRODUCTION

Education plays an important role in cultivating the improvement of coexistence in society. The adaptability of civilization in relation to learning is a fundamental characteristic that can be observed throughout history. However, with the arrival of Information and Communication Technology (ICTs), the process of learning and adapting human beings to the use of new technologies has rapidly intensified (DE MACÊDO PAULO, 2024).

Ahmad *et al.* (2022) highlight the importance of empowering individuals with skills allied to sustainable development, such as environmental awareness, systems thinking, innovation and creativity, collaboration and teamwork, among other skills.

Education, on the other hand, in a context of digital transformation, according to Pieczara (2021), will require essential skills from employees such as: interdisciplinary thinking, advanced proficiency in information technology, ability to continuous learning, and proactive involvement in solving challenges and optimizing tasks. Kipper *et al.* (2021) indicate that collaborative efforts between agents of society should focus on the creation of "learning factories", understood as environments that provide practical experiences to these professionals, preparing them in the best possible way for the demands of Industry 4.0.

The main competencies needed by these professionals include skills such as leadership, strategic vision of knowledge, self-organization, giving and receiving *feedback*, proactivity, creativity, problem-solving, interdisciplinarity, teamwork, collaborative work, among others (KIPPER *et al*., 2021).

It is also added that with the emergence of the *internet* and the way it is used, it causes significant changes in the way things are done in several areas. One of the main areas affected by this change is education and learning. Implementation approaches and institutional frameworks for learning have been employed to enable higher education to become more flexible (AHMAD *et al.,* 2022).

Moraes *et al.* (2023) carried out a study on the relationship between Industry 4.0 Technologies and Education 4.0 and indicate that there are advantages ranging from greater immersion in the content to the reduction of costs and risks. Regarding the most effective resources in promoting learning, the authors indicate augmented and virtual reality and simulation, as well as the use of *Big Data* and *Cloud Computing*, to support the teaching process.

In this context, it is sought through a bibliometric analysis to investigate education and learning in the workplace in the digital transformation, analyzing its evolution in terms

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of publications, authors, citations, scientific production over time, *ranking* of countries regarding the production of articles related to the theme, analyzing the frequency of the terms and the relationship between them. From this, it seeks to identify research already carried out, the selection and evaluation of contributions from the main authors, through data analysis and synthesis, and the presentation of evidence on how education and learning in the workplace have been happening in the digital transformation.

Thus**,** this article is organized into four sections: section 1 presents the introduction, section 2 the methodology for bibliometric analysis, section 3 presents the results and discussions, and section 4 contains the conclusion of the research.

## METHODOLOGY

This research adopted a mixed approach, which through bibliometrics (ARIA and CUCCURULLO, 2017), analyzed the quantitative and qualitative aspects of bibliographic production (FERNANDES, 2018).

The study focuses on education and learning in the workplace in the context of digital transformation. For this, the following research questions are answered:

a. How does the evolution of scientific publications behave?
b. Who are the most productive authors?
c. What are the most cited articles?
d. What are the most cited countries?
e. What are the themes of the most cited articles?
f. What has been discussed on the topic of education and learning in the workplace in the digital transformation?

To answer the research questions, the articles were searched in the Scopus database. The curatorship is done by independent experts, who are recognized leaders in their respective fields and stand out for their quality and wide data coverage (SCOPUS, 2024). The time interval was from 2011 to 2024. The initial year (2011) was chosen because it is considered by authors as the moment of definition of the concept of Industry 4.0, coined by Kagermann *et al.* (2016).

As *strings* de busca utilizadas foram: "*education" OR "learning" AND "workplace" AND "digital transformation" OR "industry 4.0" OR "industry 5.0" OR "manufacturing of the*

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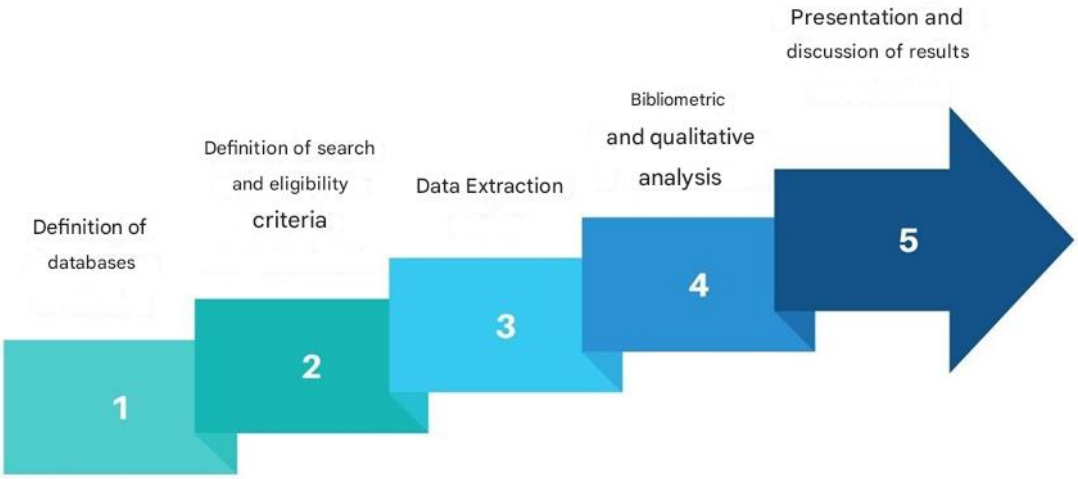
*future" OR "future manufacturing" OR "advanced manufacturing technology" OR "smart factory" OR "digitalization" OR "smart manufacturing*".

The search was limited to the fields of title, abstract or keywords, and the filter applied in the type of document to articles and review articles.

The data were analyzed using RStudio (version 3.6.0) and Iramuteq (0.8 a7) software. To assist in the quantitative bibliometric analysis, the Bibliometrix package of the RStudio software (n=196) was used, since this package provides a set of instruments for conducting quantitative research in bibliometrics and scientometrics (Aria and Cuccurullo, 2017). For the analysis in Iramuteq, the R data package (version 4.4.2) was used.

The methodological steps employed in the development of this bibliometric analysis were outlined as illustrated in Figure 1.

Figure 1 – Methodological steps used in this bibliometric analysis




Source: Prepared by the authors (2024).

For stage 2 (Definition of search and eligibility criteria), PRISMA (Main Items for Reporting Systematic Reviews and Meta-analyses) was used as a basis to improve the bibliometric analysis (GALVÃO, PANSANI and HARRAD, 2015). Figure 2 details step 2.

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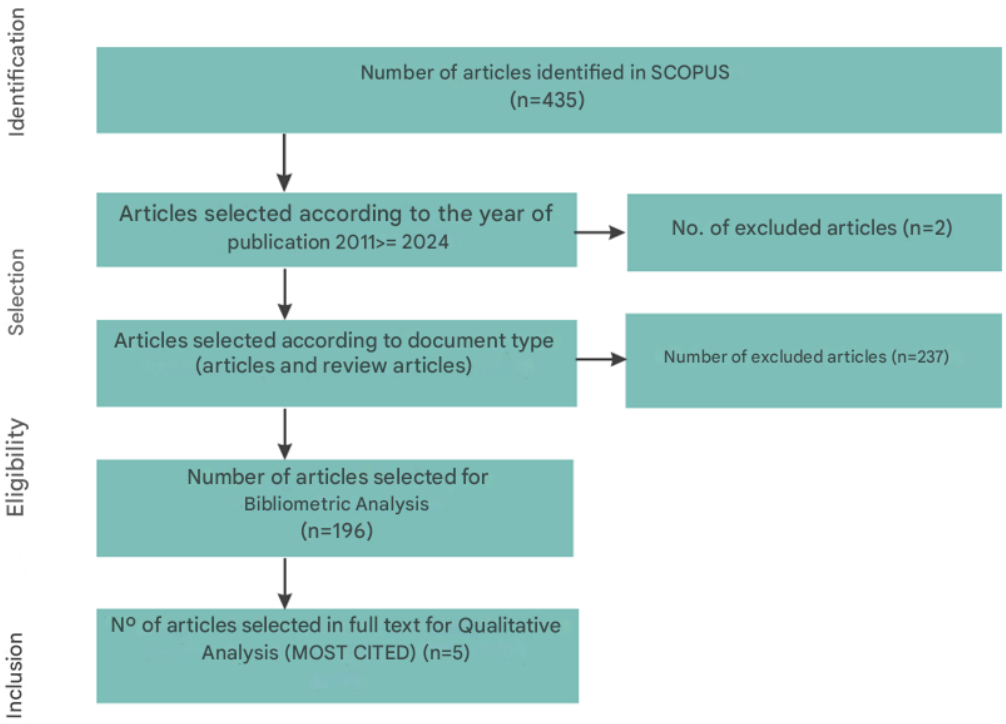
Figure 2 - Prisma methodology for defining search and eligibility criteria




Source: Prepared by the authors based on data from Scopus (2024).

As shown in Figure 2, 435 articles were found in the Scopus database (these data were collected on March 25, 2024). After selecting the articles based on the period analyzed, two articles were excluded, and based on the type of document (article or review article), another 237 articles were excluded. After the aforementioned steps, the sample increased to 196 articles eligible for the search, about 45% of the initial database. Of these, only five articles were used for qualitative analysis, due to the number of publications allowing for a more in-depth and focused analysis.

## RESULTS AND DISCUSSIONS

The results are divided into two categories: quantitative results and qualitative results, and are presented below.

### QUANTITATIVE RESULTS

The variations in publications over the years indicate a significant increase in publications in the period analyzed, as shown in Graph 1.

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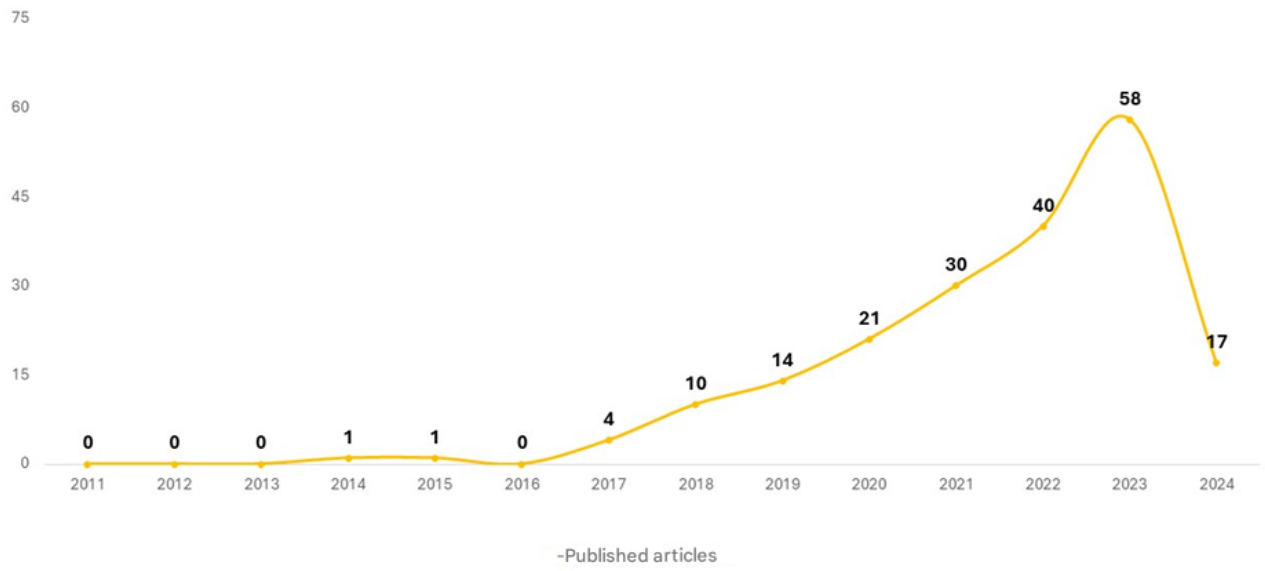
Graph 1 - Evolution of scientific publications in the Scopus database

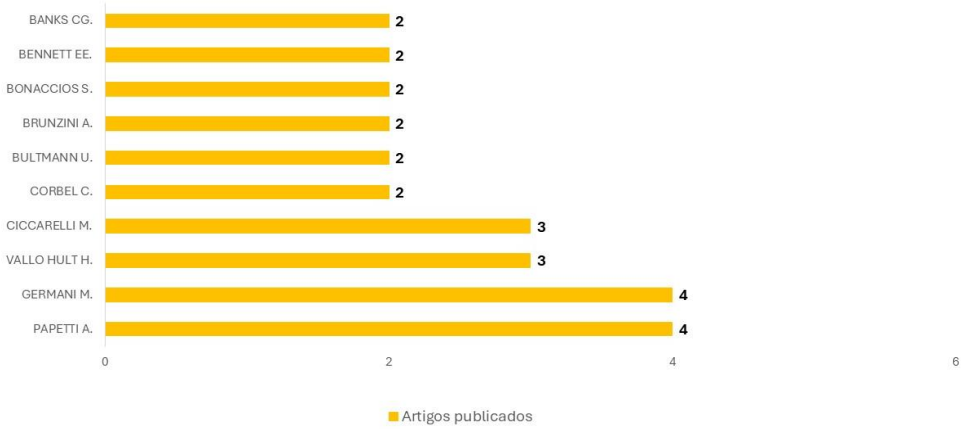



Source: Prepared by the authors (2024).

From 2011 to 2013 and 2016, there were no publications of articles, considering the filters applied and previously specified in the methodology of this article. In the years 2014 and 2015 there was only 1 publication, however, from 2017 onwards there was a continuous increase in publications, indicating the extreme relevance of the topic in the academic field and consequently for society. It should be noted that in 2024, where only 17 publications were found, this decreasing number can be understood as a reflection of the time cut in the period of data collection in the Scopus database.

Graph 2 shows the 10 authors who produced the most within the analyzed period.

Graph 2 – Publications by authors (2011 - 2024) most productive authors




Source: Prepared by the authors (2024).

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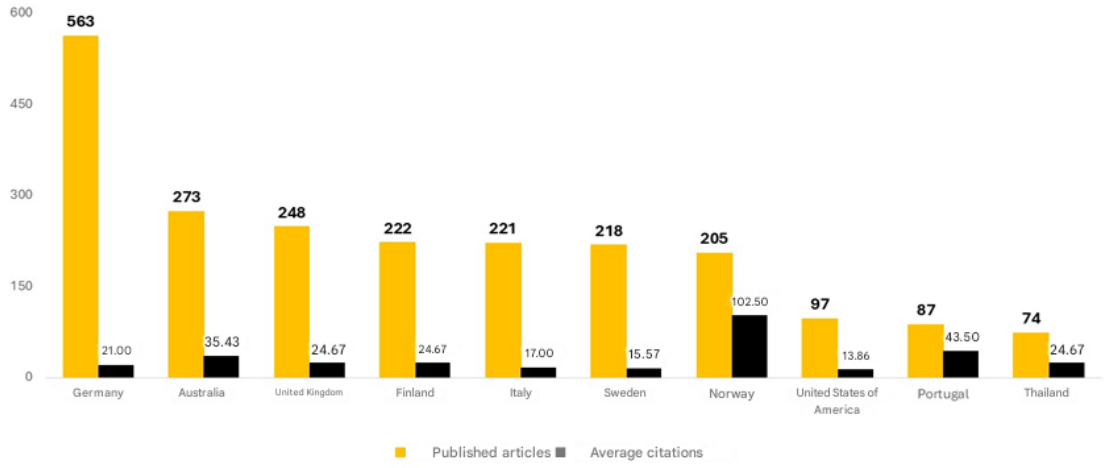
Authors Germani and Papetti lead with four publications, followed by Vallo Hult and Ciccarelli M, who have three publications. Theother authors have two publications each.

The articles by Germani *et al.* (2022) explore digital manufacturing systems that can contribute to social sustainability, the other focuses on improving the well-being of workers and the performance of companies. This involves assessing the work environment, identifying problems, and implementing positive changes. The goal is to create a healthy and productive environment for employees, which in turn benefits the company as a whole. Finally, the latest article by Germani (2022), presents a multi-sensor platform to monitor the stress of workers in smart manufacturing environments. It's remarkable how education and learning often fall on the sidelines of discussions, but exploring this topic can reveal valuable *insights* for progress.

Ciccarelli (2023), on the other hand, addresses posture recognition in the manufacturing environment using deep learning networks. He proposes the SPECTRE model, which is sensor-independent and based on convolutional networks to classify postures in the workplace. It also investigates the acceptance of wearable technologies by employees in the workplace.

The following analysis concerns the ten most relevant sources on the topic addressed in this study. Figure 5 shows the representation of each of the journals. The results of the *ranking* of citations by countries are presented in Graph 3. It is possible to observe the number of publications, as well as the average number of citations of the ten countries that published the most in the period analyzed.

Graph 3 – 10 most cited countries considering the period from 2011 to 2024




Source: Prepared by the authors (2024).

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Germany leads with a total of 563 citations, but with an average citation (21.00) below other countries such as Norway (102.5) and Australia (35.43). Australia follows in second place with 273 total citations, followed by the United Kingdom, Finland, Italy, Sweden and Norway (248, 222, 221, 218 and 205, respectively). The United States of America, Portugal, and Thailand have fewer than 100 citations and an average citation ranging from 13.86 to 43.5. It is interesting to note the differences in average citations, which may indicate the relative influence of these countries in different contexts, with Norway, for example, despite having a lower total citations than Germany, has the highest average citations, suggesting that your citations may have a greater impact per publication.

## QUALITATIVE RESULTS

The sample for the qualitative analysis is formed by the five most cited articles during the analyzed period, in the order presented in Table 1.

Table 1 - Most cited authors

| Authors | Number of citations |
|---|---|
| Bond *et al*. (2018) | 269 |
| Konttila *et al*. (2019) | 176 |
| Oke e Fernandes (2020) | 165 |
| Ratten e Usmanij (2021) | 163 |
| Gravemeijer *et al*. (2017) | 161 |

Source: Prepared by the authors (2024).

The most cited article, authored by Bond *et al.* (2018), explores the digital transformation in German higher education. It investigates the use of digital media by students and teachers. Although the main focus is not specifically on education, it does address relevant issues related to technology in the academic context.

The second most cited article is by the authors Kontilla *et al.* (2019) and aimed to identify the key areas of competence for digitalization in healthcare environments, describe the competencies of healthcare professionals in these areas, and identify factors related to their competence.

The third most cited article was by Oke and Fernandes (2020), where the acceptance and consequences of the 4th Industrial Revolution in the educational sector are explored. Some survey results highlight that the education sector, especially in Africa, is unprepared for the 4th Industrial Revolution, there is a symbiotic relationship between the education sector and technological innovations. According to the authors, the 4th Industrial

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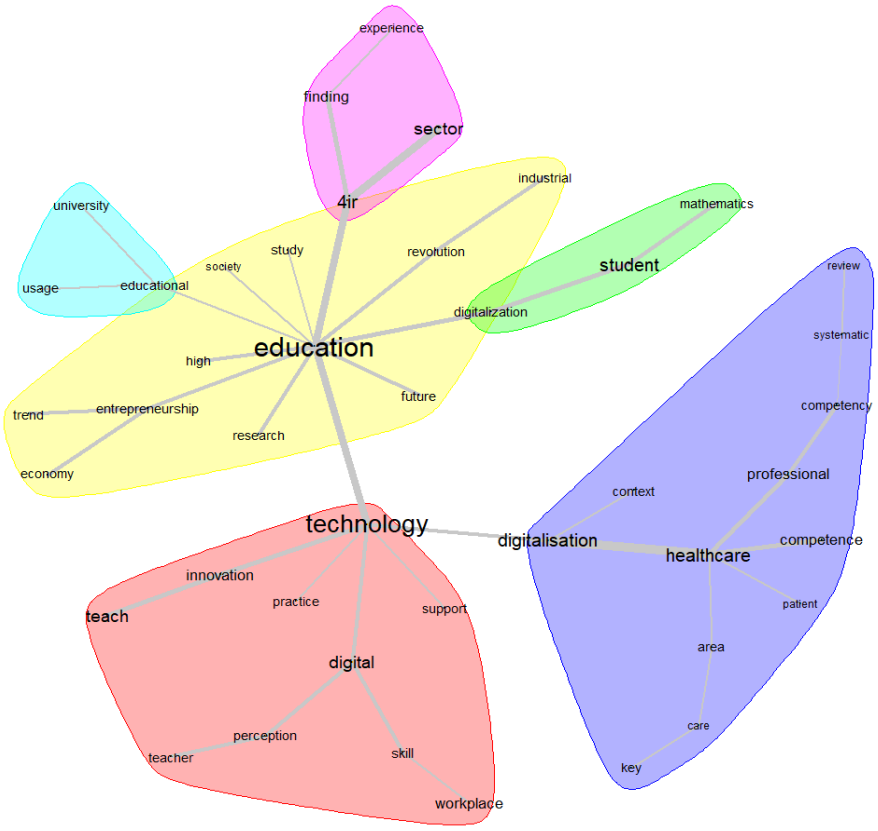
Revolution can facilitate the learning experience of students and transform the work environment. The study emphasized that the education sector can take advantage of the innovations of the Industrial Revolution through research and teaching, but this requires significant improvements in curricula and investments.

The fourth most cited article was written by Ratten and Usmanij (2021). The authors discuss entrepreneurship education and propose a shift in the direction of research in this area, the authors explore how entrepreneurial education can adapt to changes in society and technology.

Finally, the fifth most cited article was written by Gravemeijer *et al.* (2017), examined the role of mathematics education in preparing students, especially with the rise of technology and digitalization. The authors question what mathematical proficiency means in today's world and how content and pedagogy should be adjusted to prepare students for mathematical reasoning and 21st-century skills.

The correlation analysis of the most cited terms in the articles was performed with the aid of the Iramuteq software and is presented in Figure 3.

Figure 3 - Correlation analysis of the terms




Source: Iramuteq (2024).

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The concept map organizes and relates core ideas on the themes of education, technology, and digitalization, with subdivisions that connect topics related to these core concepts.

The term "*education*" is in the center of the graph and interconnects several areas, suggesting that education is the integrating pillar between technology, digitalization, sectors (such as health), and preparing students for the future.

Technology appears as a vector of innovation, connecting directly to teaching, teaching practice, and the development of digital skills. A significant cluster is related to the application of digitalization in healthcare. Words such as "*competence*", "*professional*" and "*context*" indicate that digitalized education aims to train professionals with specific skills for this sector.

This map portrays digital transformation as a cross-cutting axis that unites education, technology, and practices in specific sectors, such as health and industry. There is an emphasis on preparing skills for the future, especially in line with the demands of the Fourth Industrial Revolution. The concepts of innovation and teaching practice are interconnected, which suggests that the role of educators is essential in the dissemination of technologies.

Another analysis obtained through Iramuteq is the one presented in Figure 4, representing the frequency and relevance of the terms in the dataset. The larger words indicate greater importance or presence in the context analyzed.

Figure 4 - Cloud of Most Relevant Words


Source: Iramuteq (2024).

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The central term indicates that the main theme of the content is education, reflecting the integration with other concepts, such as technology, digitalization, and specific sectors. The term *healthcare* highlights the application of digitalization and technology in the healthcare sector, to form professional skills. Finally, the term *4ir* (*Fourth Industrial Revolution*) indicates an alignment of education with the demands of the Fourth Industrial Revolution, integrating automation, artificial intelligence, and digitalization.

## FINAL CONSIDERATIONS

Education plays a crucial role in improving coexistence in society, and adaptability to learning is a striking characteristic of human evolution. With the emergence of the *internet*, its application has significantly transformed several areas, especially education and learning processes, causing profound changes in the way we teach and learn (AHMAD *et al.*, 2022).

In view of this, the research proposed, through a bibliometric analysis, to investigate education and learning in the work environment in the digital transformation, analyzing the evolution of the theme in terms of the number of publications and citations and what the most cited authors say, aiming to understand what these works are about and what has been discussed about the theme of education and learning in the work environment in the digital transformation.

In the results found, an evolution of scientific publications is observed, but it is important to emphasize that the field is still open in terms of awareness about the importance of education and learning in the context of digital transformation, as presented by Hokason (2022), in his study where he addressed changes forced by the pandemic, including the increase in online education and learning.

It can be seen that the number of published studies has shown continuous growth in the last seven years, reaching 58 publications in 2023. This evolution shows that there is continued interest and a need to explore this ever-changing field.

Regarding the topics addressed in the analyzed studies, the absence of an approach directly linked to education and learning in the workplace is noticeable, since the topics studied involve: the digital transformation in German higher education, as presented by Bond *et al.* (2018), where the study investigated the use of digital media by students and teachers; identify the key areas of competence for digitalization in healthcare settings, as

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well as describe the competencies of healthcare professionals in these areas and identify which are the factors that are related to their competence (KONTILLA *et al.,* 2020).

Oke and Fernandes (2020) explored the acceptance and consequences of the 4th Industrial Revolution in the education sector, showing that there is a symbiotic relationship between the education sector and technological innovations and that the education sector can harness the innovations of the Industrial Revolution through research and teaching, but this requires significant improvements in curricula and investments.

Other authors such as Ratten and Usmanij (2020), have discussed entrepreneurship education and propose a change in the direction of research in this area; and Gravemeijer *et al.* (2017), examined the role of mathematics education in preparing students, especially with the rise of technology and digitalization.

Finally, as a suggestion for future studies, it is suggested to increase the database, as well as expand the *search string*. Broadening the search to include synonyms, related terms, and variations can enrich the results and cover a wider range of relevant information.

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## REFERENCES

1. Ahmad, I., et al. (2022). MOOC 5.0: A roadmap to the future of learning. Sustainability (Switzerland), 74(18).

2. Aria, M., & Cuccurullo, C. (2017). A brief introduction to bibliometrix. Journal of Informetrics, 11(4), 959-975.

3. Bond, M., et al. (2018). Digital transformation in German higher education: Student and teacher perceptions and usage of digital media. International Journal of Educational Technology in Higher Education, 15(1), 1-20.

4. Ciccarelli, M., et al. (2022). A novel approach to use marker-less mixed reality applications with in-motion systems. In International Joint Conference on Mechanics, Design Engineering & Advanced Manufacturing (pp. 1401-1412). Cham: Springer International Publishing.

5. Ciccarelli, M., et al. (2023). SPECTRE: A deep learning network for posture recognition in manufacturing. Journal of Intelligent Manufacturing, 34(8), 3469-3481.

6. De Macêdo Paulo, E., et al. (2024). Desenvolvendo habilidades do século XXI com TDIC. Aracê - Direitos Humanos em Revista, 6(3), 5340-5354.

7. Fernandes, A. M., et al. (2018). Metodologia de pesquisa de dissertações sobre inovação: Análise bibliométrica. Desafio Online, 6(1).

8. Galvão, T. F., Pansani, T. S. A., & Harrad, D. (2015). Principais itens para relatar revisões sistemáticas e meta-análises: A recomendação PRISMA. Epidemiologia e Serviços de Saúde, 24, 335-342.

9. Germaní, et al. (2022). Human work sustainability tool. Journal of Manufacturing Systems, 62, 76-86.

10. Gravemeijer, K., et al. (2017). What mathematics education may prepare students for the society of the future? International Journal of Science and Mathematics Education, 15, 105-123.

11. Hokanson, B. (2022). New approaches on education technologies: A global perspective for digital transformation. Journal of Educational Technology and Online Learning, 5(4), 775-780.

12. Kagermann, H., et al. (2016). Industrie 4.0 in a global context: Strategies for cooperating with international partners. Munich: ACATECH.

13. Kipper, L. M., et al. (2021). Scientific mapping to identify competencies required by Industry 4.0. Technology in Society, 64, 101454.

14. Konttila, J., et al. (2019). Healthcare professionals' competence in digitalisation: A systematic review. Journal of Clinical Nursing, 28(5-6), 745-761.

Revista ARACÊ
ISSN: 2358-2472

15. Moraes, E. B., et al. (2023). Integration of Industry 4.0 technologies with Education 4.0: Advantages for improvements in learning. Interactive Technology and Smart Education, 20(2), 271-287.

16. Oke, A., & Fernandes, F. A. P. (2020). Innovations in teaching and learning: Exploring the perceptions of the education sector on the 4th industrial revolution (4IR). Journal of Open Innovation: Technology, Market, and Complexity, 6(2), 31.

17. Pieczara, M. (2021). Perspectives on the design of creative workplaces in Industry 4.0: A new theme in architects' education. International Journal of Design Education, 15(2).

18. Ratten, V., & Usmanij, P. (2021). Entrepreneurship education: Time for a change in research direction? The International Journal of Management Education, 19(1), 100367.

19. Scopus (Ed.). (2024). Why choose Scopus? Available at: https://www.elsevier.com/solutions/scopus/why-choose-scopus. Accessed on: March 25, 2024.