TECHNOLOGIES FOR EDUCATIONAL INNOVATION: A BIBLIOMETRIC ANALYSIS OF SCIENTIFIC PRODUCTION FROM 2013 TO 2023

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ABSTRACT

This article aims to demonstrate relevant researchers, journals, and articles that deal with technologies for educational innovation, published between 2013 and 2023, in order to compose the core of a bibliographic reference on the topic in question and its bibliometric analysis. Using the ProKnow-C method with representative articles in the academic field. From this research, 25 articles were selected, including the article "Virtual laboratories for education in science, technology, and engineering: A review" by Potkonjak et al. (2016), the British Journal of Educational Technology and Computers and Education, and the researchers Anderson, T et al. Bozkurt, A & Zawacki-Richter, O and Potkonjak, V et al. The results allow researchers and practitioners to optimize their research, supported by a relevant bibliography on technologies for educational innovation.

Keywords: Proknow-C. Digital Technologies. Innovation.

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INTRODUCTION

The knowledge society recognizes that educational institutions are a fundamental part of the globalization process, where the use of information and communication technologies (ICT) improves students' attitudes towards learning (Lazar & Panisoara, 2018). The use of digital technologies has increased at all academic levels and teachers are adopting them to improve the learning experience of their students (McGovern et al., 2019). In this context, the analysis of the literature on technologies for educational innovation can be valuable to understand the innovations that the use of technologies can provide to educational environments.

Fidalgo Blanco et al., (2019) argued that educational innovation means making changes in learning/training in order to improve learning outcomes. To achieve this, educational innovation must be embraced holistically and inclusively. Businesses, students, education providers, communities and political organisations need to integrate innovation objects at all levels (Baumann et al., 2016).

As an essential step in this research, this article aims to: i. Select relevant bibliographic references related to digital technologies for university management; and ii. Perform bibliometric analyses on the articles, their respective authors and the outstanding journals in this field of study.

In order to meet the needs of this study, the process called ProKnow-C (Knowledge Development Process - Constructivist) was adopted (ENSSLIN et al., 2010a; Lacerda, 2012. This process begins with the researcher's interest in a specific theme, as well as its delimitations and restrictions intrinsic to the academic context, aiming at the construction of knowledge in the researcher. In this way, he can start scientific research with a solid and well-founded foundation. ProKnow-C also includes the use of tools and techniques for the analysis and organization of the data collected during the research. With this, it is expected to achieve accurate and reliable results, contributing to the advancement of scientific knowledge in the area in question (LACERDA; ENSSLIN; ENSSLIN, 2012)

This article is organized into 4 sections, in addition to this introduction. The next section addresses material and methods used in this research. In the third section, it is about the research process in Database and bibliometrics of theory and calculations, it is demonstrated how the concepts are related to the study, presenting the process of research in database and bibliometrics and the procedures carried out to achieve the objective of the research. The fourth section presents its results. Finally, the conclusions of the article are

presented, followed by the section of bibliographic references that were consulted and used throughout the text.

METHODS

This section deals with the methodology related to this scientific work. The systematics used in preliminary studies have the objective of verifying available files from a certain theoretical point of view of other researches already conceived, which results in the structuring and development of a review of the bibliography (MARCONI, LAKATOS, 2003).

The methods, techniques and procedures selected for this research are illustrated in Figure 1.
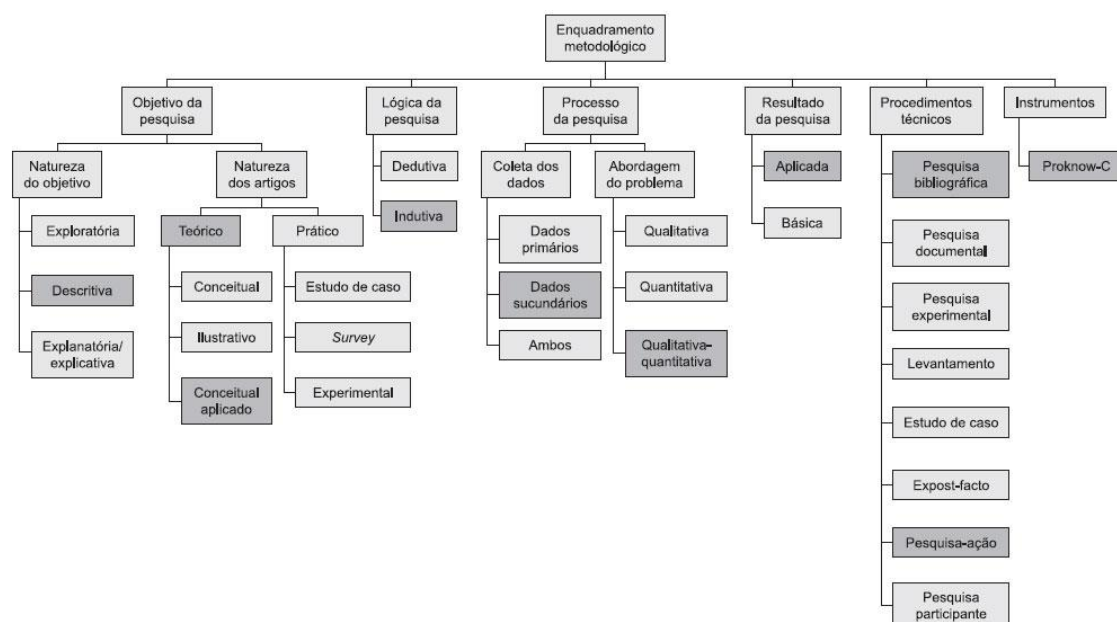

Figura 1. Enquadramento metodológico adotado pelo presente artigo. Adaptado de Tasca et al. (2010).

DATABASE SEARCH PROCESS AND BIBLIOMETRICS

The sophistication of the online information service that is in use, and the increasingly common use of electronic databases, not only serves to retrieve information, but also to perform analyses and even systematize the results and provide combinations with other information (WORMELL, 1998). The author also points out that the online search technique can be understood as a procedure of adding value, with regard to the selection and refinement procedures made based on search strategies. Bibliometric studies are used in several areas, aiming to obtain indicators related to scientific production (FERREIRA, 2010). The research already carried out on citations is numerous, increasingly, new forms

and ways of applying bibliometrics end up emerging and increasing the possibilities already known (FERREIRA, 2010).

Bibliometrics identifies the relationships between different variables, such as: human resources-documents, articles-periodicals, production-consumption, which present different distribution regularities, since bibliometric indicators are used to analyze productivity, and the impact of scientific research and researchers, through measurement based on the various metadata of scientific publications, as well as on the citations received, bibliometric studies and the analysis of the scientific, technological and informational production produced in all areas of human knowledge, as a qualitative and quantitative instrument. (GRÁCIO; AVILA; OLIVEIRA, 2020)

4 PROCEDURES FOR SELECTION OF THEORETICAL FRAMEWORK

The method chosen to elucidate the present research was ProKnow-C (- Knowledge Development Process - Constructivist), which is based on the methodological framework proposed by (ENSSLIN *et al*., 2010). The authors in question also report that ProKnow-C is developed through the construction of a systematic review structure of the literature on a given subject, with the proposal of developing a constructivist research. The total scenario of knowledge is essential to start the exploratory procedure of a given theme. ProKnow-C was initially designed to help researchers who do not have the built knowledge about a given topic. And who are faced with the question of where and, consequently, how to select important studies for their research theme (TASCA *et al*., 2010). Based on this initial knowledge, the process develops through a constructivist bias, leading the researcher to promote theoretical connection (STAEDELE; ENSSLIN; FORCELLINI, 2019).

That said, this study evolves according to the methodology proposed by ProKnowC, which presents a stage focused on the choice of the Bibliographic Portfolio, which seeks to find the state of the art, with regard to scientific articles on a given chosen theme. The creation of this Portfolio becomes robust due to the way of selecting the articles, these are only selected if they are really aligned with the research theme, and have a certain scientific relevance. To this end, the bibliometric analysis of the Portfolio is also idealized through pre-established parameters. The methodological framework of Proknow-C is presented in Figure 1 (ENSSLÎN et al., 2015; ENSSLIN et al., 2013; KNOFF et al., 2014; LACERDA, ENSSLIN, ENSSLIN, 2014; LACERDA, ENSSLIN, ENSSLIN, 2012; SILVA DA ROSA et al., 2012).

PRELIMINARY INVESTIGATION

On the chronology of the research

The procedures described below were carried out in October and November 2023.

About the database

To carry out the process selected for this article, the Scopus database was chosen, due to its recognition by the scientific community, as well as the JCI impact factor built from this platform. The use of a database only in bibliometric studies is commonplace, as this act allows the manipulation of metadata in a systematic and more organized way (PIÑEIROCHOUSA et al., 2020).

About Keywords

Once the sample field was defined, we started to choose the keywords that will be characterized by the first filter for the selection of articles. First, they were determined by two main research axes, namely: Axis 1 "Digital Technologies", and Axis 2 "education", the two Axes will represent the search themes. Through the definition of the research axes, the keywords that define them in English were chosen to carry out the research and the database. The chosen keywords and the search *string* are shown in chart 1, as well as the number of articles returned in each *string*.

Table 1 Keyword Combinations

Keyword Combinations			
Digital Technologies		Education	QT Scopus
"Augmented Reality"	AND	"University Education"	6
"Augmented Reality"	AND	"Distance Education"	21
"Augmented Reality"	AND	"Educational Innovation"	9
"Active methodologies"	AND	"University Education"	11
"Active methodologies"	AND	"Distance Education"	4
"Active methodologies"	AND	"Educational Innovation"	25
"Educational technology"	AND	"University Education"	26
"Educational technology"	AND	"Distance Education"	156

"Educational technology"	AND	"Educational Innovation"	61
"management"	AND	"University Education"	223
"management"	AND	"Distance Education"	476
"management"	AND	"Educational Innovation"	166
"strategy"	AND	"University Education"	234
"strategy"	AND	"Distance Education"	525
"strategy"	AND	"Educational Innovation"	218
TOTAL			2.161

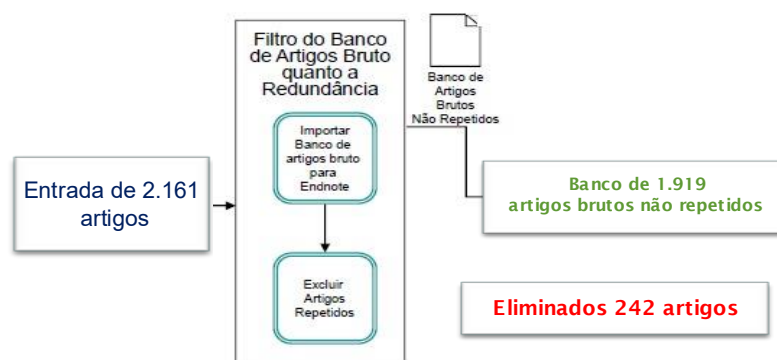Source: prepared by the authors, 2023

The research began in October 2023, presented as inclusion criteria, the fact that at least one of the above combinations appear in the title, keywords or abstract, in articles published from 2013 onwards.

SELECTION OF ARTICLES THAT WILL MAKE UP THE PORTFOLIO FOR THE RESEARCH

Based on the keywords and the database characterized by the sample field, we can begin the process of selecting the articles that will be included in the theoretical framework of the research in question. These activities took place in October and November 2023. Using the keywords defined above (as shown in Table 1) and limiting the search to articles published between 2013 and 2023 in the SCOPUS database, we obtained a total of 2,161 articles, as shown in Table 1.

To better manage these articles, they have been imported into the Mendeley app (version 1.19.8). With the help of this tool, we identified 242 articles that should be excluded from the sample. After the exclusion of these 242 articles, the reference library was left with a total of 1,919 articles up to this point in the selection process. With the remaining 1,919 articles, we proceeded to read the titles of the articles to assess their relevance to the research in question, according to figure 1.
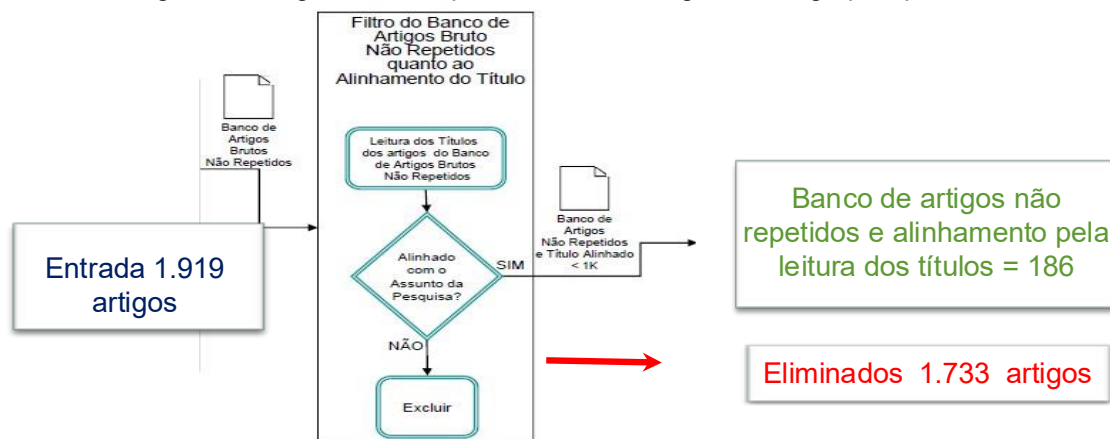
Figure 1 - Fragment of the process for selecting the bibliographic portfolio

Source: Prepared by the authors.

After this analysis, we excluded 1,733 articles that were not aligned with the research theme. Therefore, there were 186 articles to be analyzed, as shown in figure 2.

Figure 2 - Fragment of the process for selecting the bibliographic portfolio

Source: Prepared by the authors.

The 186 papers that were shown to be aligned with the research topic based on their titles were then subjected to further analysis in terms of their scientific recognition since the date of publication. To perform this analysis, we consulted all articles using the Google Scholar tool (2010 version) to check the number of citations and ordered them in descending order. Based on this information, the authors of the present research established a criterion to identify the most cited articles. This selection was made based on the generalization made by Juran (1997) in relation to the postulate of Pareto (1896), in which a small minority of the population represents most of the effect.

By contextualizing this theorem in relation to the research in question, it means that if the research chooses a minority of the most cited articles, these articles will represent the majority of the scientific recognition present in the current set of articles analyzed. Therefore, the cut-off value is defined as the selection of the most cited references until

their citations reach more than 80% of the total citations obtained by the 186 articles analyzed so far. Adding up all the citations of the 186 articles analyzed, we obtain a total of 11,177 citations. As a result, articles that have been individually cited 52 times or more represent 9,102 citations, corresponding to 81% of all citations in the 186 references selected so far. Based on this, we established the cutoff point for the approval of articles in terms of scientific recognition, identifying it as 52 citations or more. With this definition of the cut-off value, we identified 45 articles that were selected based on the number of citations, as evidenced in Figure 3.

Figure 3 - Disclosure of the cut-off value according to their citations
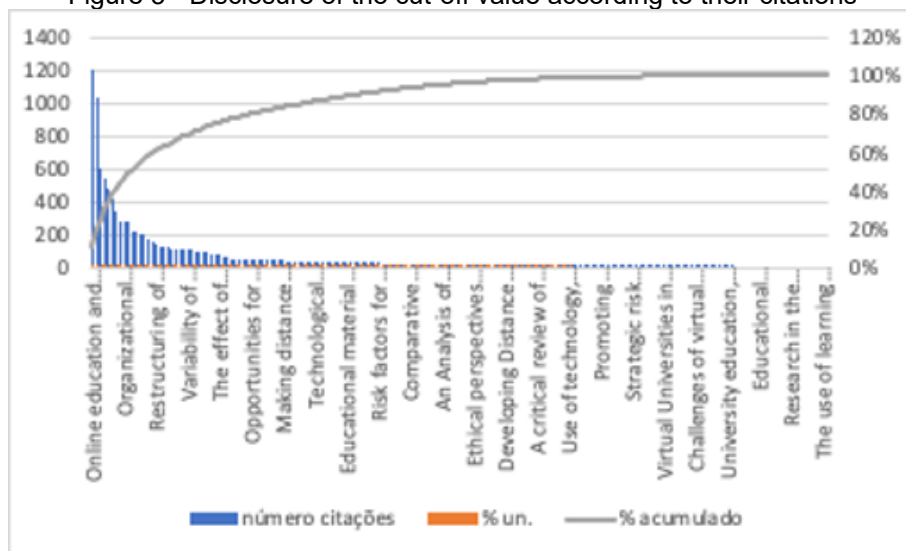
Source: Prepared by the authors.

It is worth noting that the 141 less cited articles will be submitted to an additional analysis based on other criteria, which may determine their inclusion in the final set of articles that will make up the theoretical basis of the research. After selecting the articles with the greatest scientific recognition, they were examined for the agreement of their abstracts with the focus of the research in question. Of the 45 abstracts evaluated, 22 were excluded due to lack of alignment with the research object. Therefore, there are 23 articles that meet the following criteria: i. Are in accordance with the reading of the title and abstract; ii. Have a significant number of citations; iii. They have an accessible abstract. These 23 articles, which have scientific recognition and are aligned with the research theme, were chosen to integrate the core of the theoretical basis on technologies for educational innovation.

However, an additional analysis will be carried out on the 23 selected articles, with the aim of evaluating the 141 less cited articles that can still be included in the final set of the research. For an article with few citations to be considered for inclusion in the final research, a condition was established: i. Articles published less than 2 years from the analysis, considering that they may not have had enough time to receive a large number of citations. With this condition established, of the 141 articles analyzed in the second phase, 70 of them were published in 2022 and 2023. Therefore, among the 70 articles selected for a second analysis, 2 were chosen after the evaluation of their abstracts, since congruence with the research object is a fundamental criterion to integrate the final set of articles. Following these reanalysis procedures applied to the less cited articles, we identified 2 additional articles, which were incorporated into the 23 previously selected, resulting in a total of 25 articles that make up the final set, as shown below in chart 1.

Table 1 Bibliographic Portfolio Articles

**	Autor	Titulo	Ano
1	Potkonjak, V et al. (2016)	Virtual laboratories for education in science, technology, and engineering: A review	2016
2	Stošić, L (2015)	The importance of educational technology in teaching	2015
3	Martin, F et al. (2020)	A systematic review of research on online teaching and learning from 2009 to 2018	2020
4	Zhu, C & Engels, N (2014)	Organizational culture and instructional innovations in higher education: Perceptions and reactions of teachers and students	2014
5	He, W et al. (2014)	Online is education for the 21st century	2014
6	Bond, M et al. (2019)	Revisiting five decades of educational technology research: A content and authorship analysis of the British Journal of Educational Technology	2019
7	O'Brien, K et al. (2013)	You say you want a revolution? Transforming education and capacity building in response to global change	2013
8	Davis, N et al. (2013)	Restructuring of educational systems in the digital age from a co-evolutionary perspective	2013
9	Jelfs, A & Richardson, J T E (2013)	The use of digital technologies across the adult life span in distance education	2013
10	Delen, E & Liew, J (2016)	The use of interactive environments to promote self-regulation in online learning: A literature review	2016
11	Barroso-Osuna, J et al. (2019)	Difficulties in the incorporation of augmented reality in university education: Visions from the experts	2019
12	Anderson, T et al. (2020)	A critical look at educational technology from a distance education perspective	2020
13	Badia, A et al. (2013)	Teachers' perceptions of factors affecting the educational use of ICT in technology-rich classrooms	2013
14	Backfisch, I et al. (2021)	Variability of teachers' technology integration in the classroom: A matter of utility!	2021
15	Rojas-Sánchez, M A et al. (2023)	Systematic literature review and bibliometric analysis on virtual reality and education	2023
16	Ramírez-Montoya, D.M.-S. et al. (2020)	Systematic review of mixed methods in the framework of educational innovation	2020
17	Moreno-Guerrero, A.-J. et al. (2020)	Educational innovation in higher education: Use of role playing and educational video in future teachers' training	2020
18	Rahman, H (2014)	The role of ICT in open and distance education	2014
19	Abad-Segura, E et al. (2020)	Sustainability of educational technologies: An approach to augmented reality research	2020
20	Eldokhny, A A & Drwish, A M (2021)	Effectiveness of Augmented Reality in Online Distance Learning at the Time of the COVID-19 Pandemic	2021
21	Ahmed, M U et al. (2018)	Factors influencing the adoption of e-learning in an open and distance learning institution of Pakistan	2018
22	Carlisle, R M et al. (2017)	Educational Technology and Distance Supervision in Counselor Education	2017
23	Díaz, M J S et al. (2021)	Flipped classroom in the context of higher education: Learning, satisfaction and interaction	2021
24	Bozkurt, A & Zawacki-Richter, O (2021)	Trends and Patterns in Distance Education (2014–2019): A Synthesis of Scholarly Publications and a Visualization of the Intellectual Landscape	2021
25	Okoye, K et al. (2023)	Impact of digital technologies upon teaching and learning in higher education in Latin America: an outlook on the reach, barriers, and bottlenecks	2023

Source: Prepared by the authors

BIBLIOMETRIC ANALYSIS OF THE PORTFOLIO OF ARTICLES FOR THE THEORETICAL FRAMEWORK IN QUESTION

During the review of the abstracts of these 25 articles, all of them demonstrated that they were in agreement with the alignment with the research in question. As a final step, the articles were read in full, with the purpose of evaluating their adherence to the research theme. Figure 4 outlines the reanalysis process, showing the number of articles that advanced in each stage of the selection.

Figure 4 - Bibliographic portfolio selection process
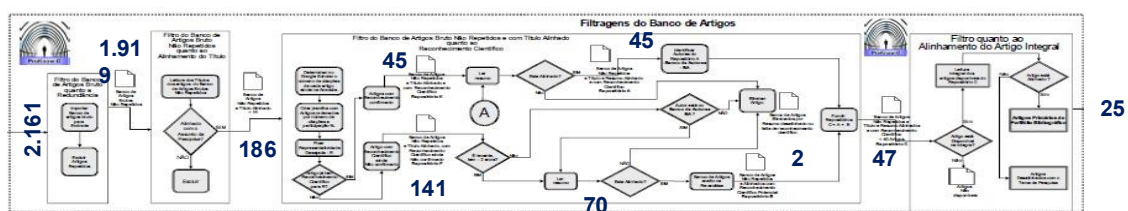
Source: Prepared by the authors.

Figure 4 provides a graphical representation of the procedures performed and the quantities corresponding to the final stages involved in the formation of the definitive set of 25 articles, organized in descending order by number of citations, as shown in Chart 2.

Table 2. Articles that form the portfolio of articles to compose the theoretical framework on technologies for educational innovation.

**	Autor	Titulo	Ano	Citações
1	Potkonjak, V et al. (2016)	Virtual laboratories for education in science, technology, and engineering: A review	2016	1029
2	Stošić, L (2015)	The importance of educational technology in teaching	2015	540
3	Martin, F et al. (2020)	A systematic review of research on online teaching and learning from 2009 to 2018	2020	418
4	Zhu, C & Engels, N (2014)	Organizational culture and instructional innovations in higher education: Perceptions and reactions of teachers and students	2014	283
5	He, W et al. (2014)	Online is education for the 21st century	2014	282
6	Bond, M et al. (2019)	Revisiting five decades of educational technology research: A content and authorship analysis of the British Journal of Educational Technology	2019	204
7	O'Brien, K et al. (2013)	You say you want a revolution? Transforming education and capacity building in response to global change	2013	182
8	Davis, N et al. (2013)	Restructuring of educational systems in the digital age from a co-evolutionary perspective	2013	140
9	Jelfs, A & Richardson, J T E (2013)	The use of digital technologies across the adult life span in distance education	2013	126
10	Delen, E & Liew, J (2016)	The use of interactive environments to promote self-regulation in online learning: A literature review	2016	124
11	Barroso-Osuna, J et al. (2019)	Difficulties in the incorporation of augmented reality in university education: Visions from the experts	2019	122
12	Anderson, T et al. (2020)	A critical look at educational technology from a distance education perspective	2020	117
13	Badia, A et al. (2013)	Teachers' perceptions of factors affecting the educational use of ICT in technology-rich classrooms	2013	114
14	Backfisch, I et al. (2021)	Variability of teachers' technology integration in the classroom: A matter of utility!	2021	108
15	Rojas-Sánchez, M A et al. (2023)	Systematic literature review and bibliometric analysis on virtual reality and education	2023	107
16	Ramírez-Montoya, D.M.-S. et al. (2020)	Systematic review of mixed methods in the framework of educational innovation	2020	97
17	Moreno-Guerrero, A.-J. et al. (2020)	Educational innovation in higher education: Use of role playing and educational video in future teachers' training	2020	93
18	Rahman, H (2014)	The role of ICT in open and distance education	2014	87
19	Abad-Segura, E et al. (2020)	Sustainability of educational technologies: An approach to augmented reality research	2020	77
20	Eldokhny, A A & Drwish, A M (2021)	Effectiveness of Augmented Reality in Online Distance Learning at the Time of the COVID-19 Pandemic	2021	66
21	Ahmed, M U et al. (2018)	Factors influencing the adoption of e-learning in an open and distance learning institution of Pakistan	2018	58
22	Carlisle, R M et al. (2017)	Educational Technology and Distance Supervision in Counselor Education	2017	52
23	Díaz, M J S et al. (2021)	Flipped classroom in the context of higher education: Learning, satisfaction and interaction	2021	52
24	Bozkurt, A & Zawacki-Richter, O (2021)	Trends and Patterns in Distance Education (2014–2019): A Synthesis of Scholarly Publications and a Visualization of the Intellectual Landscape	2021	49
25	Okoye, K et al. (2023)	Impact of digital technologies upon teaching and learning in higher education in Latin America: an outlook on the reach, barriers, and bottlenecks	2023	31

Source: Prepared by the authors.

Bibliometric analysis of the selected articles

From the bibliometric analysis of the selected articles, 3 aspects were evaluated: i. Scientific recognition for the number of citations; ii. Number of articles per journal; iii. Number of articles per author. For this aspect, researcher Zawacki-Richter, O (2021) had two of his articles selected for the final portfolio. The other authors had only one of their articles selected.

Regarding the number of indexes per journal, the *Journal* Computers and Education stands out for having three indexes present in the sample, the journals British Journal of Educational Technology, Education and Information Technologies and Sustainability, also stand out for having more than one article in the bibliographic portfolio, as shown in Figure 5.

Figure 5. Number of articles per journal.

Número de Artigos por Periódicos

Source: Authors.

Figure 6. Number of citations.

Citações de autores
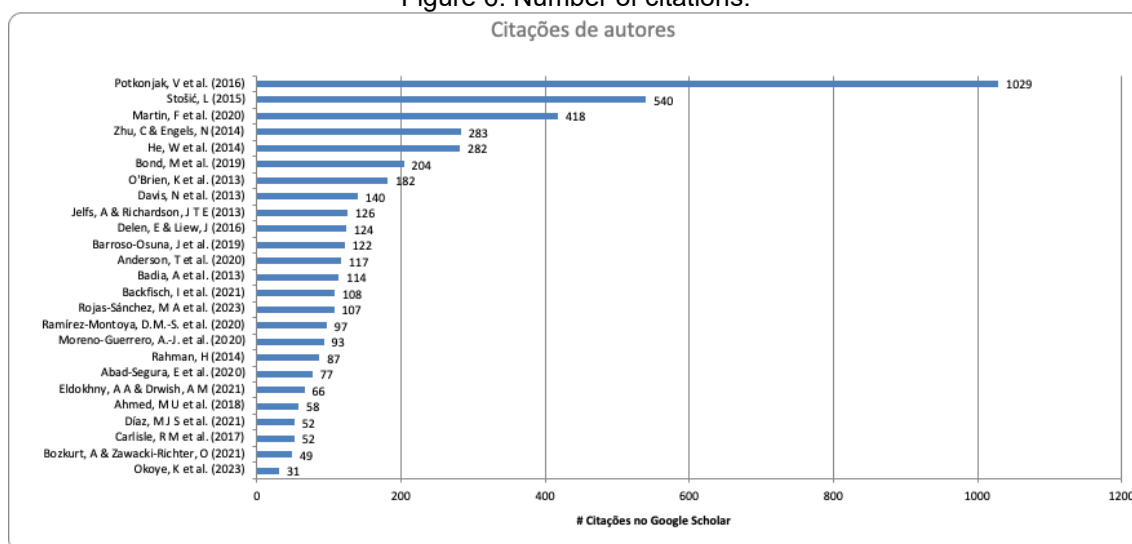
Source: Authors.

Some keywords stood out in the portfolio, among those that appear the most are *Distance education,* mentioned in eleven articles, *Higher education* present in eight articles, and the last highlight is *Educational technology*, which appears in seven articles. The other keywords can be seen in Figure 7:

Figure 7. Main Keywords.

Source: Authors.

4.3.2 Bibliometric analysis of the references of the articles in the bibliographic portfolio

In order to identify the authors, articles and journals that stand out in the context of the research in question, 1,221 references cited by the 25 articles that make up the final portfolio were cataloged.

The dissemination of articles by journal in which it is indexed, in accordance with Figure 9. It should be noted that the Figure presents the ten most representative journals.
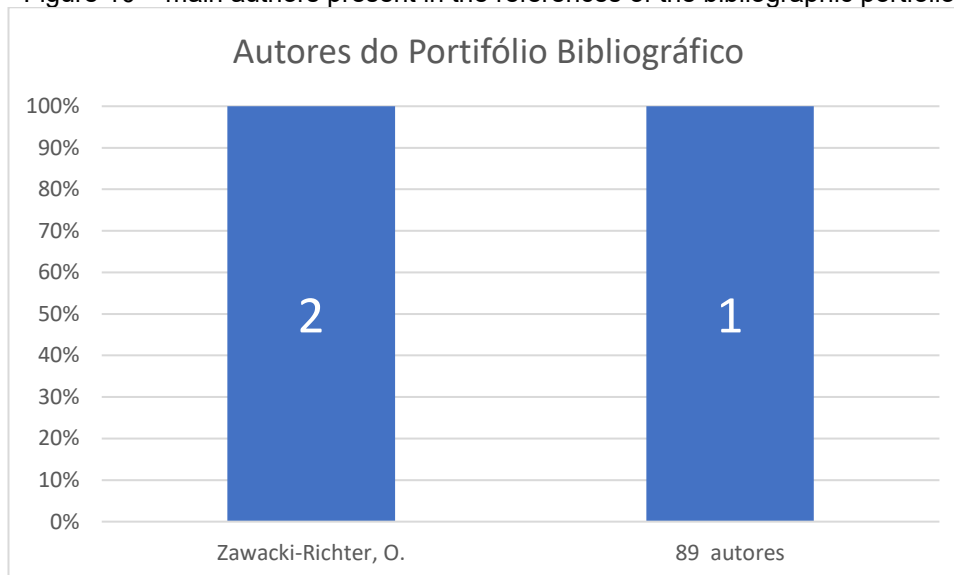
Figure 9 - Distribution of reference articles in the bibliographic portfolio by journal
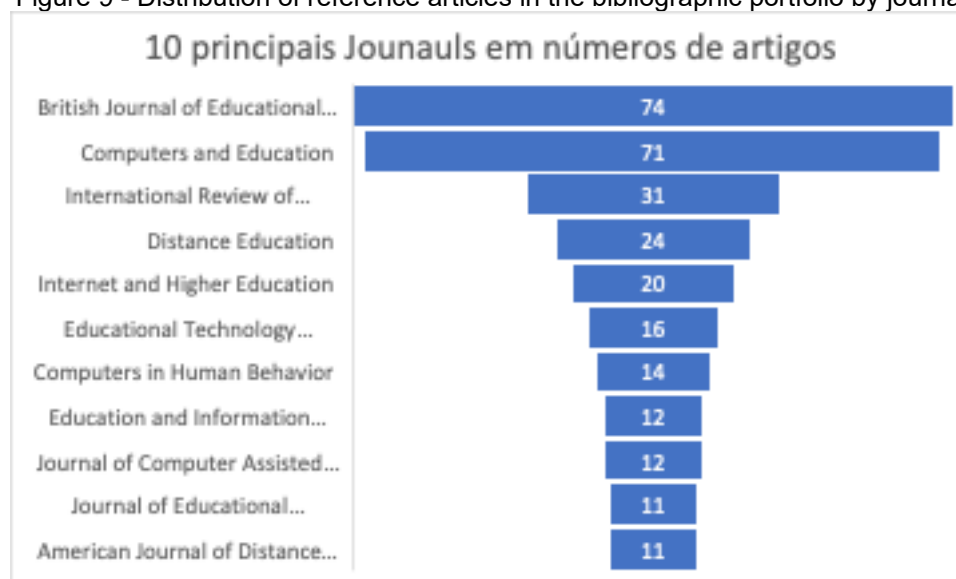
Source: Authors.

Figure 10 shows the authors with the greatest relevance and are mentioned in the bibliographic portfolio. It should also be noted that authors who obtained less than one citation in BP will not be shown.
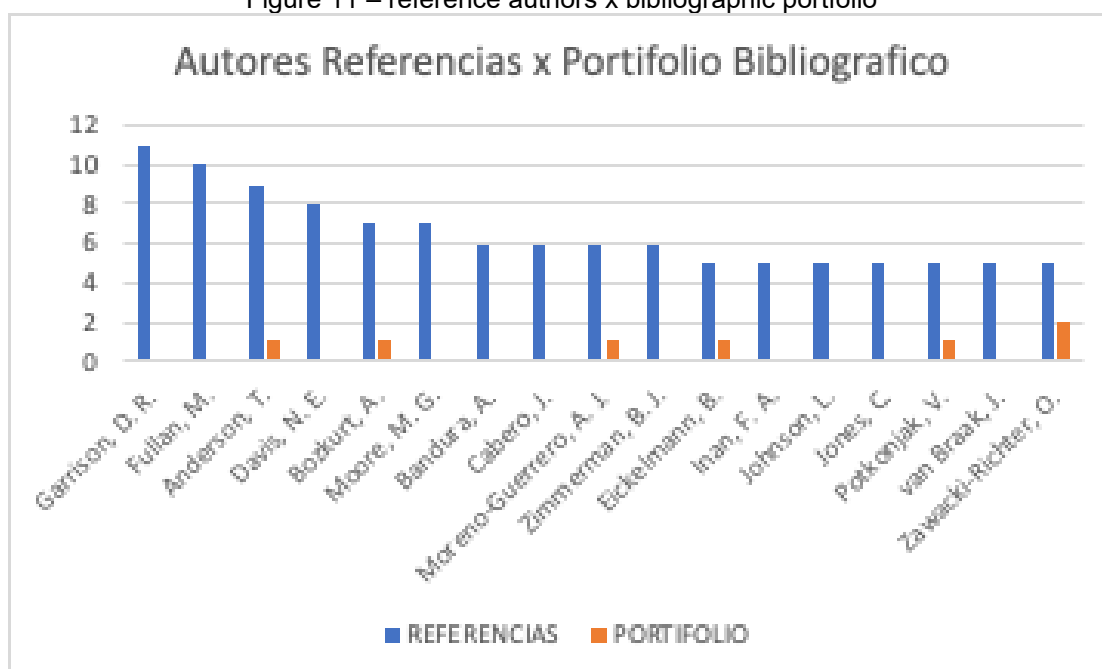
Figure 10 – main authors present in the references of the bibliographic portfolio
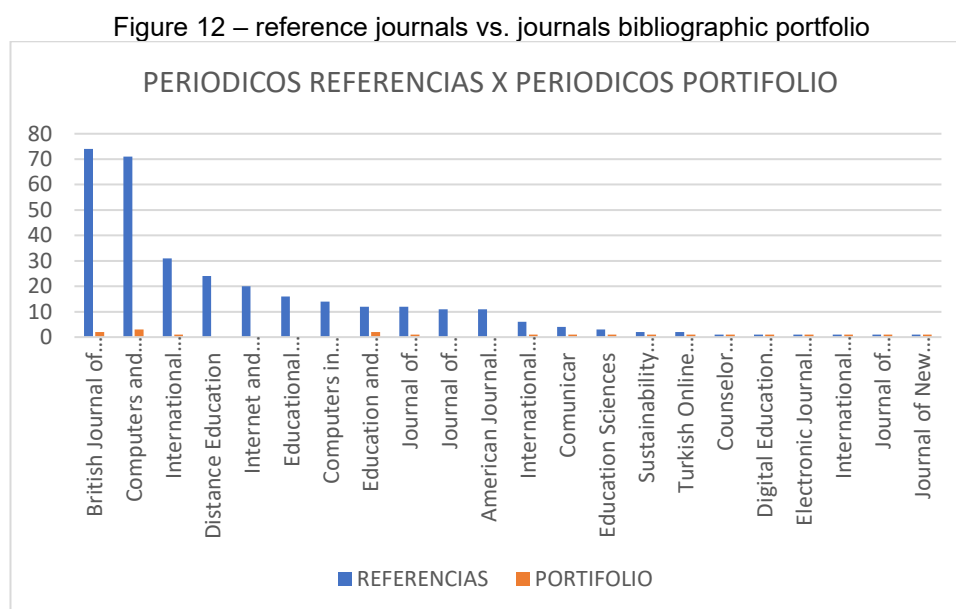

Source: Authors.

Figure 11 shows that the authors with the greatest relevance are mentioned in the references and in the bibliographic portfolio.

Figure 11 – reference authors x bibliographic portfolio

Source: Authors.

Figure 12 shows the most relevant journals mentioned in the references and in the bibliographic portfolio.

Figure 12 – reference journals vs. journals bibliographic portfolio

By crossing the information, in Figure 13, it is possible to identify it by means of a two-dimensional graph. These are defined in order to identify the main studies developed, according to academic relevance. As well as the articles that cover the two axes of research explained here, in order to prioritize them in future research.

Figure 13 – characterization of the articles

Figura 13

Legenda:
- Qualitative inquiry and research design: Choosing among five traditions
- Mind in society: The development of higher psychological processes
- Visualizing data using t-SNE
- A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research
- Users of the world
- Social cognitive theory: An agentic perspective
- Digital Immigrants Part 1
- Guidelines for performing systematic literature reviews in software engineering
- A survey of augmented reality
- Visible learning: A synthesis of over 800 meta-analyses relating to achievement

Source: Authors.

The classification of the articles according to academic relevance can be seen in Figure 13, where two measurement attributes were crossed:

a) Number of citations of the article in Google Scholar

b) Number of citations by authors with articles in the set of references that made up the bibliographic portfolio.

A horizontal and a vertical line were drawn dividing the image into four quadrants, which accommodates the combinations between the number of citations in the article and the number of citations of the author with the highest citations in the references. The most significant quadrant is the upper right that signals the featured article written by a featured author.

CONCLUSIONS

In view of the general objective initially proposed for the study, which consists of the construction of a theoretical framework through bibliometric analysis to assist future studies on technologies for educational innovation, it is possible to ensure that this study was successful. Since, a collection of important bibliographic references for the erudition of

technologies aimed at educational innovation were selected, in addition to bibliometric analyses.

Checking the graphs generated in this study to analyze the indexations in the journals, there are two that stand out both in the portfolio and in the references, compared to the others, the British *Journal of Educational Technology and Computers and Education*. With regard to the authors of the bibliographic portfolio, the highlight is Zawacki-Richter (2021), who is the author of two articles present in the bibliographic portfolio. Making it evident that they are exponents of research with regard to the theme under analysis.

The article presented here suggests a validated framework of scientific theory, in order to serve as a basis for future studies and research aligned with the theme explained here. This article also provides opportunities for other bibliographic analyses.

Regarding the limitations of this study, which occur through the perception of the researchers, it is also possible to highlight the time frame and the database chosen to carry out the study.

For future research, it is suggested to carry out the other steps of the ProKnow-C method, especially the systemic analysis, which aims to explain research opportunities in the selected field, based on the content analysis of the selected articles. These research opportunities are useful to accelerate new doctoral theses and other research related to the topic.

That said, the results of this study contribute to a better understanding of technologies for educational innovation. These results can be used for future research. In addition to this point, the bibliographic portfolio obtained here can deepen the discussion on the subject as well as contribute to new research in the area.

REFERENCES

1. Abad-Segura, E., González-Zamar, M.-D., Infante-Moro, J. C., & Ruipérez García, G. (2020). Sustainability of educational technologies: An approach to augmented reality research. *Sustainability, 12*(10), Article 4091. https://doi.org/10.3390/su12104091

2. Ahmed, M. U., Hussain, S., & Farid, S. (2018). Factors influencing the adoption of e-learning in an open and distance learning institution of Pakistan. *Electronic Journal of e-Learning, 16*(2), 148–158.

3. Anderson, T., & Rivera Vargas, P. (2020). A critical look at educational technology from a distance education perspective. *Digital Education Review, (37)*, 208–229. https://doi.org/10.1344/der.2020.37.208-229

4. Backfisch, I., Lachner, A., Stürmer, K., & Scheiter, K. (2021). Variability of teachers' technology integration in the classroom: A matter of utility! *Computers & Education, 166*, Article 104159. https://doi.org/10.1016/j.compedu.2021.104159

5. Badia Garganté, A., Meneses, J., & Sigalés Conde, C. (2013). Teachers' perceptions of factors affecting the educational use of ICT in technology-rich classrooms. *Electronic Journal of Research in Educational Psychology, 11*(3), 787–808. https://doi.org/10.14204/ejrep.31.13053

6. Baumann, T., Manthey, S., & Terkowsky, C. (2016). Education and innovation management: A contradiction? How to manage educational projects if innovation is crucial for success and innovation management is mostly unknown. *Procedia-Social and Behavioral Sciences, 226*, 243–251. https://doi.org/10.1016/j.sbspro.2016.06.185

7. Bond, M., Zawacki-Richter, O., & Nichols, M. (2019). Revisiting five decades of educational technology research: A content and authorship analysis of the British Journal of Educational Technology. *British Journal of Educational Technology, 50*(1), 12–63. https://doi.org/10.1111/bjet.12730

8. Bortoluzzi, S. C., Ensslin, S. R., & Ensslin, L. (2011). Multicriteria performance evaluation as a support to business management: Application in a service company. *Gestão & Produção, 18*(3), 633–650. https://doi.org/10.1590/S0104-530X2011000300013

9. Bozkurt, A., & Zawacki-Richter, O. (2021). Trends and patterns in distance education (2014–2019): A synthesis of scholarly publications and a visualization of the intellectual landscape. *International Review of Research in Open and Distributed Learning, 22*(2), 19–45. https://doi.org/10.19173/irrodl.v22i2.5381

10. Carlisle, R. M., Jordan, S. S., & Jonkman, J. N. (2017). Educational technology and distance supervision in counselor education. *Counselor Education and Supervision, 56*(1), 33–49. https://doi.org/10.1002/ceas.12056

11. Davis, N., Eickelmann, B., & Zaka, P. (2013). Restructuring of educational systems in the digital age from a co-evolutionary perspective. *Journal of Computer Assisted Learning, 29*(5), 438–450. https://doi.org/10.1111/jcal.12032

12. Delen, E., & Liew, J. (2016). The use of interactive environments to promote self-regulation in online learning: A literature review. *European Journal of Contemporary Education, 15*(1), 24–33. https://doi.org/10.13187/ejced.2016.15.24

13. Eduardo Tasca, J., Ensslin, L., Ensslin, S. R., & Alves, M. B. M. (2010). An approach for selecting a theoretical framework for the evaluation of training programs. *Journal of European Industrial Training, 34*(7), 631–655. https://doi.org/10.1108/03090591011070761

14. Eldokhny, A. A., & Drwish, A. M. (2021). Effectiveness of augmented reality in online distance learning at the time of the COVID-19 pandemic. *International Journal of Emerging Technologies in Learning, 16*(9), 198–218. https://doi.org/10.3991/ijet.v16i09.17895

15. Ensslin, L., Ensslin, S. R., & Lacerda, R. T. O. (2010). *ProKnow-C, Knowledge Development Process–Constructivist: Technical process with patent pending registration with the INPI*. [Publisher not specified].

16. Ferreira, A. G. C. (2010). Bibliometrics in the evaluation of scientific journals. *DataGramaZero, 11*(3), Article A05.

17. Fidalgo-Blanco, Á., Sein-Echaluce, M. L., & García-Peñalvo, F. J. (2019). Método para diseñar buenas prácticas de innovación educativa docente: Percepción del profesorado. [Publisher not specified].

18. Grácio, M. C. C., Ávila, D. M., & Oliveira, E. F. T. de. (2020). *Topics of bibliometrics for university libraries* (1st ed.). Cultura Acadêmica.

19. He, W., Xu, G., & Kruck, S. E. (2014). Online IS education for the 21st century. *Journal of Information Systems Education, 25*(2), 101–106.

20. Jelfs, A., & Richardson, J. T. E. (2013). The use of digital technologies across the adult life span in distance education. *British Journal of Educational Technology, 44*(2), 338–351. https://doi.org/10.1111/j.1467-8535.2012.01308.x

21. Juran, J. M. (1992). *Quality from the design*. Pioneira.

22. Lacerda, R. T. de O., Ensslin, L., & Ensslin, S. R. (2012). A bibliometric analysis of the literature on strategy and performance evaluation. *Gestão & Produção, 19*(1), 59–78. https://doi.org/10.1590/S0104-530X2012000100005

23. Lazar, I., & Panisoara, I. O. (2018). Understanding the role of modern technologies in education: A scoping review protocol. *Psychreg Journal of Psychology, 2*(2), 74–86.

24. Lazar, S. (2015). The importance of educational technology in teaching. *International Journal of Cognitive Research in Science, Engineering and Education, 3*(1), 111–114. https://doi.org/10.5937/IJCRSEE1501111S

25. Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. *Computers & Education, 159*, Article 104009. https://doi.org/10.1016/j.compedu.2020.104009

26. McGovern, A., Elmore, K. L., Gagne, D. J., Haupt, S. E., Karstens, C. D., Lagerquist, R., Smith, T., & Williams, J. K. (2019). Making the black box more transparent: Understanding the physical implications of machine learning. *Bulletin of the American Meteorological Society, 100*(11), 2175–2199. https://doi.org/10.1175/BAMS-D-18-0195.1

27. Marconi, M., & Lakatos, E. (2003). *Fundamentals of scientific methodology*. Atlas.

28. Moreno-Guerrero, A.-J., Gómez-García, G., López-Belmonte, J., & Rodríguez-Jiménez, C. (2020). Educational innovation in higher education: Use of role playing and educational video in future teachers' training. *Sustainability, 12*(6), Article 2558. https://doi.org/10.3390/su12062558

29. O'Brien, K., Pelling, M., Patwardhan, A., Hallegatte, S., Maskrey, A., Oki, T., Oswald-Spring, U., Wilbanks, T., & Yanda, P. Z. (2013). You say you want a revolution? Transforming education and capacity building in response to global change. *Environmental Science & Policy, 28*, 48–59. https://doi.org/10.1016/j.envsci.2012.11.011

30. Okoye, K., Rodriguez-Tort, J. A., Escamilla, J., & Hosseini, S. (2023). Impact of digital technologies upon teaching and learning in higher education in Latin America: An outlook on the reach, barriers, and bottlenecks. *Education and Information Technologies, 28*(2), 2291–2360. https://doi.org/10.1007/s10639-022-11214-1

31. Osuna, J. B., Gutiérrez-Castillo, J. J., Llorente-Cejudo, M. C., & Ortiz, R. V. (2019). Difficulties in the incorporation of augmented reality in university education: Visions from the experts. *Journal of New Approaches in Educational Research, 8*(2), 126–141. https://doi.org/10.7821/naer.2019.7.429

32. Pareto, V. (1897). *Cours d'Economie Politique*. Rouge and Cie.

33. Piñeiro-Chousa, J., López-Cabarcos, M. Á., Romero-Castro, N., & Pérez-Pico, A. M. (2020). Innovation, entrepreneurship and knowledge in the business scientific field: Mapping the research front. *Journal of Business Research, 115*, 475–485. https://doi.org/10.1016/j.jbusres.2020.04.045

34. Potkonjak, V., Gardner, M., Callaghan, V., Mattila, P., Guetl, C., Petrović, V. M., & Jovanović, K. (2016). Virtual laboratories for education in science, technology, and engineering: A review. *Computers & Education, 95*, 309–327. https://doi.org/10.1016/j.compedu.2016.02.002

35. Rahman, H. (2014). The role of ICT in open and distance education. *Turkish Online Journal of Distance Education, 15*(4), 162–169. https://doi.org/10.17718/tojde.52666

36. Ramírez-Montoya, M.-S., & Lugo-Ocando, J. (2020). Systematic review of mixed methods in the framework of educational innovation. *Comunicar, 28*(65), 9–20. https://doi.org/10.3916/C65-2020-01

37. Rojas-Sánchez, M. A., Palos-Sánchez, P. R., & Folgado-Fernández, J. A. (2023). Systematic literature review and bibliometric analysis on virtual reality and education. *Education and Information Technologies, 28*(1), 155–192. https://doi.org/10.1007/s10639-022-11167-5

38. Staedele, A. E., Ensslin, S. R., & Forcellini, F. A. (2019). Knowledge building about performance evaluation in lean production: An investigation on international scientific research. *Journal of Manufacturing Technology Management, 30*(5), 798–820. https://doi.org/10.1108/JMTM-02-2018-0055

39. Silva da Rosa, F., Ensslin, S. R., Ensslin, L., & Lunkes, R. J. (2012). Environmental disclosure management: A constructivist case. *Management Decision, 50*(6), 1117–1136. https://doi.org/10.1108/00251741211238372

40. Sosa Díaz, M. J., Guerra Antequera, J., & Cerezo Pizarro, M. (2021). Flipped classroom in the context of higher education: Learning, satisfaction and interaction. *Education Sciences, 11*(8), Article 416. https://doi.org/10.3390/educsci11080416

41. Zhu, C., & Engels, N. (2014). Organizational culture and instructional innovations in higher education: Perceptions and reactions of teachers and students. *Educational Management Administration & Leadership, 42*(1), 136–158. https://doi.org/10.1177/1741143213499253