

Education and Business in Conditions of Coopetition: Bibliometrics

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Type of manuscript: research paper

Abstract: *The study of the relationship between education and business is a very relevant issue when education and business are key factors in developing and uplifting the economy. Education is the foundation for creating a business since the effective activity is impossible without a strong information base. The purpose of this research is a bibliographic review of scientific publications devoted to the relationship between business and education, based on materials indexed by the Scopus, Web of Science, and Mendeley databases using the built-in functions of the Bibliometrix application and the R programming language. The logic of the research is implemented with the help of three stages: at the first stage, an analysis of literary sources related to bibliometric analysis, as well as about business and education, the interdependence of education and business, which were published in the publishing house of MDPI scientific journals with open access, was carried out. Survey and interview methods are the methodological tools of most of the analyzed publications in the open access of the MDPI database. The research is conducted in the R language, using VOSViewer tools for bibliometric analysis. Various qualitative and quantitative methods were used to analyze the relationship between education and business, such as performance analysis, scientific mapping and thematic analysis, structural equation modelling, and Z-score statistics. At the second stage, the main functions of the Bibliometrix package were studied, countries, keywords constructed a three-field plot, and the year of publication of cited references to reflect the proportion of research topics for each country and the freshness of cited articles. Source clustering through Bradford's Law was also used to identify the best journals for publishing own research and searching for the most relevant scientific information. In addition, the Hirsch and Gini indexes of the selected sample of publications were examined in detail within the second stage. The Hirsch index is a quantitative measure of productivity based on analyzing published publications and citations. The distribution of authorship is estimated using the Gini index. At the third stage, keywords were analyzed, and a table was built with the most frequently used words to decrease the number of keywords mentioned. The conducted comprehensive analysis of scientific publications confirmed the close correlation of paradigms of business and education in the conditions of coopetition in modernity.*

Keywords: bibliographic review, Bibliometrix, Bradford's Law, business, coopetition, education, Gini index, Hirsch index, three-field plot.

JEL Classification: I23, I25, L21, L26, M21.

Received: 28 September 2022

Accepted: 01 November 2022

Published: 31 December 2022

Funding: This research was funded by the Ministry of Education and Science of Ukraine and performed the results of the project «Business-Education-Science Coopetition: Institutional and Economic Models of Innovation Transfer for National Security and Sustainable Development» (№ 0122U000772).

Publisher: Sumy State University

Founder: Sumy State University

Cite as: Koibichuk, V., Samoilikova, A., & Herasymenko, V. (2022). Education and Business in Conditions of Coopetition: Bibliometrics. *Business Ethics and Leadership*, 6(4), 49-60. [http://doi.org/10.21272/bel.6\(4\).49-60.2022](http://doi.org/10.21272/bel.6(4).49-60.2022).



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Introduction

Today more than 600 active scientists and 30 business representatives are registered on the online platform for communication and effective interaction of representatives of business and the scientific community "Science and Business" (Nauka ta biznes, 2022). Education is the process and result of a person's assimilation of systematic knowledge, abilities and skills, the development of mind and feelings, the formation of a worldview and cognitive interests (Zaychenko, 2008). Business is an entrepreneurial, commercial or any other activity that does not contradict the law, and it is aimed at making a profit (Carroll, 2019).

As of November 2022, more than 120,000 articles and magazines can be found on the global network for the phrase "business and education", which indicates a close relationship between these concepts. Of course, without quality education, it is impossible to implement any business. The study of the relationship between education and business is a very relevant issue when education and business are key factors in the development and upliftment of the economy. Education is the foundation for creating a business since effective activity is impossible without a strong information base. The purpose of this research is a bibliographic review of scientific publications devoted to the relationship between business and education, based on materials indexed by the Scopus, Web of Science, and Mendeley databases using the built-in functions of the Bibliometrix application and the R programming language.

Literature Review

Many publications by world scientists confirm the relevance of the research topic. Thus, 2624,2679, and 114,193 were found in the bibliographic and abstract database Scopus (Scopus database, 2017-2022), in the Web of Science database (Web of Science database, 2017-2022), where scientific literature and patent databases are located, and in software for managing bibliographic information Mendeley (Mendeley database, 2017-2022), respectively scientific articles and magazines for the exact phrase "business and education" for the period from 2017 to 2022. MDPI, an open-access journal publisher, also publishes many articles for the search term "business and education". So, for example, in work (Zaccone et al., 2022), the authors investigated that hybrid organizations contribute to sustainable development due to their ability to develop and maintain relations with the surrounding organizational realities, their motivation to protect the natural environment and people and take care of them, teaching, spreading knowledge and ennobling the human spirit.

Bratianu et al. (2020) conducted a study on the need to change the paradigm of business education by creating a new learning environment focused on business competencies and on the new dynamics of the knowledge ecosystem. Murzyn-Kupisz & Holuj (2021) conducted interviews and analyzed the publications, documents, web pages and Facebook profiles of craftsmanship, artistic and business schools. Their activities were investigated and classified according to the main dimensions of comprehensive fashion education: art, craft, and business. The analysis provides a picture of the current situation and an overview of the specific features of sustainable fashion education in both global and Polish contexts.

Karacsony et al. (2022) conducted a study to assess international students' cultural diversity in higher educational institutions. The study results provide an overview of students' attitudes toward study in institutions of higher education. These factors influence their studies and their expectations about studying abroad. According to the results of hypothesis testing, students believe that studying in higher education institutions is a good basis for personal development. The results also confirmed that studying in a multicultural environment can positively affect students' work ability. O'Sullivan et al. (2022) examine management education in Great Britain and how student learning has been affected by universities' substitute for online teaching during the COVID-19 pandemic. Overall, a decline in perceived learning was reported, although there were signs of stronger learning in several regions of the country.

One should note the publication of Bani-Mustafa et al. (2021), where the authors, using a system of structural equations, investigate individual influencing factors on the questionnaire data of 291 teachers (gender, academic qualification, scientific productivity, teaching experience in the relevant field of education, experience in industrial activity and professional certification) on entrepreneurial the behaviour

of teachers and the business orientation of educational institutions in Kuwait. The main result of this study is the confirmation of the hypothesis that the entrepreneurial activity of the teacher contributes to the organizational work of the educational institution.

Evaluation of the sensitivity of the unemployment rate to cyclical fluctuations of production depending on age, gender and level of education for 28 EU countries for the period from 1995 to 2019 was carried out using Okun's law in the article of Butkus et al. (2020). The authors assessed the quality and reliability of the model by least-squares dummy variables, Newey-West standard errors and the Arellano-Bond estimator. The obtained results confirmed the hypothesis put forward in the study that Okun's coefficients exert the most significant influence on men and youth during the period of negative changes in production. Gregory & Miller (2014) explored what it means for a business school to embed systems thinking and sustainability into the curriculum, looking at both the application of systems thinking to develop sustainable programs and the teaching of systems thinking to support understanding of sustainability. In this article, the development of the curriculum is considered through the prism of the viable system model of Stafford Beer on the example of the educational program of management.

One should highlight the diversity of scientific research areas where bibliometric analysis is carried out using the R programming language, VOSviewer, SciMAT and Bibliometrix packages. So the work of Muchiri et al. (2022.) contains an overview of green finance after the Paris Agreement by applying a bibliometric analysis of selected literature. The study reviewed literature from the Web of Science database for 2015-2022. Data cleaning, formatting, and analysis were performed using VOSviewer and R-studio. The study indicates the increased interest of scientists in the issue of green financing. Based on the findings, further research on green finance from an economic and financial perspective is recommended, using quantitative approaches to complement the existing literature and provide a broader vision for policymakers and regulators. Bastanchury-López & De-Pablos-Heredero (2022) provided an overview and summarized the knowledge about smart cities regarding land use. For this, a bibliometric analysis of 475 documents indexed by the Web of Science database was performed using the SciMAT and VOSviewer programs. Scientific works published between January 1, 2000, and September 8, 2022, were considered. The results of this analysis made it possible to identify the most relevant publications regarding the features of urban land use in smart cities.

Using the technique of bibliometric mapping Alex et al. (2022) analyzed the quality, quantity, and development of research on cyclone separators. A sample of 487 publications limited to the Web of Science Core Collection (WoSCC) database was used for the bibliometric analysis. Data analysis was performed using the RStudio software package (R Bibliometrix tool). The findings suggest that researchers in different parts of the world, particularly in Africa and the Middle East, should focus their research efforts on this area, given the lack of publications on this issue in these regions. The purpose of this study was to serve as a primary source for potential areas of technological research and collaboration between researchers in this and other related fields.

Methodology and Research Methods

The bibliometric analysis was carried out using powerful modern Bibliometrix software, the R programming language and the RStudio package (Aria & Cuccurullo, 2017) on a sample of the first 2,000 publications out of 2,161 (on the request "relationship between education and business") indexed by the Scopus database for the period from 2017 to 2022. Bibliometrix is a package for the R statistical programming language for quantitative research in scientometrics and bibliometrix. The R programming language is an open-source environment and ecosystem. Many powerful statistical algorithms, access to high-quality numerical procedures, and integrated data visualization tools are the strongest qualities to favour R over other languages for scientific computing. Bibliometrix is a web resource that allows to conduct a comprehensive analysis of scientific publications and can import data and convert them into R programming language codes; displays a descriptive analysis of the publication data set; selection from the global network of joint citation of works, cooperation on publications; network analysis of publications.

Publications are imported using the Biblioshiny library of the R language. It is possible to download and collect data in various formats (bibtext, xlsx, csv) from such databases as Web of Science, Scopus, Dimensions (a database of research grants that links grants with effective publications and patents), Lens (online patent and scientific literature search resource), PubMed (contains biomedical research), Cochrane Library (medical and health database). At the same time, it is possible to download and collect data in

various formats (bibtext, xlsx, csv) from such databases as Web of Science, Scopus, Dimensions (a database of research grants that links grants with effective publications and patents), Lens (online patent and scientific literature search resource), PubMed (contains biomedical research), Cochrane Library (medical and health database).

Results

Table 1 shows the main functions of the Bibliometrix package, which will be used during the bibliometric analysis in this research.

Table 1. Main Functions of the Bibliometrix Package

Software-assisted workflow steps	Bibliometrix function	Description
Downloading and converting data	• Convert2df()	• Creates a bibliographic data frame
Data analysis Descriptive bibliometric analysis	• biblioAnalysis () • Summary () and plot () • citations () • localCitations () • dominance () • Hindex () • lotka ()	• Returns an object of the bibliometrix class • Summarize the main results of the bibliometric analysis • Identifies the most cited references or authors • Identifies the most cited local authors • Calculates author dominance rating • Measures the productivity and citation impact of a scholar • Estimates Lotka's law coefficients for scientific productivity
Data analysis Excerpt of the term	• termExtraction ()	• Selects terms from text fields (theses, titles, author keywords, etc.) of the bibliographic collection
Data analysis Two-way networks	• cocMatrix ()	• Computes a two-way network
Data analysis Normalization	• couplingSimilarity ()	• Calculates the Jacquard or Salton similarity coefficient among the manuscripts of the communication network
Data analysis Data reduction	External functions from other R packages	Other R packages suggested for bibliometric analysis: • factominer: for PCA and MCA • cmdscale: for MDS • cluster: for clustering
Data analysis Similarity matrix (square network matrix)	• biblioNetwork ()	• Calculates the most frequently used connecting networks
Data visualization Mapping	External functions from other R packages	Other R packages suggested for mapping: • igraph for social network • ggplot2 for 2D maps • cluster for dendrogram

Source: Compiled by the authors

Figure 1 characterizes the three-pole graph (Sankey diagram) by country, keyword, and publication year of cited references. It was created to reflect the proportion of research topics on the relationship between education and business for each country and the recency of cited articles.

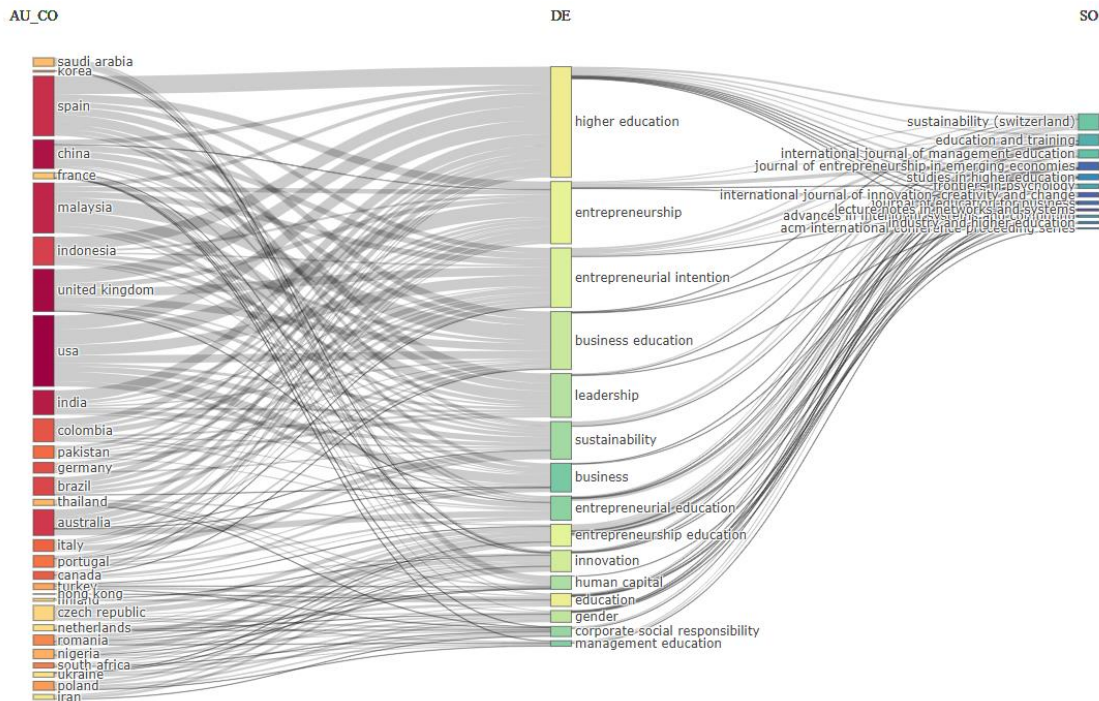


Figure 1. Three-Field Plot

Sources: Compiled by the authors using RStudio

Figure 2 shows the top 30 sources by the number of studies published in them on the relationship between education and business.

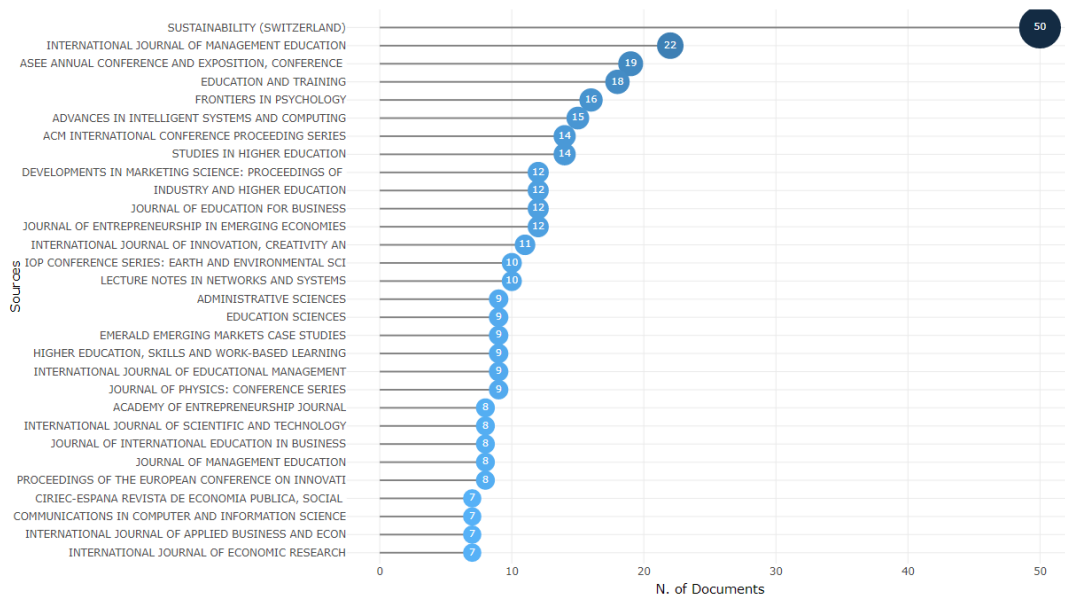


Figure 2. Top 30 Most Significant Journals by the Number of Published Materials in Terms of the Correlation of the Concepts of Education and Business

Sources: Compiled by the authors using RStudio and Bibliometrix software

It is advisable to use Bradford's law of dispersion to identify the best journals both for publishing one's research and searching for the most relevant scientific information in terms of institutional and economic models of transfer of innovations in education and business in conditions of competition (Bates & Maack, 2015) (Table 2).

Table 2. Source Clustering through Bradford's Law

SOURCE	Rank	Frequency	Cumulative Frequency	Zone
SUSTAINABILITY (SWITZERLAND)	1	50	50	Zone 1
INTERNATIONAL JOURNAL OF MANAGEMENT EDUCATION	2	22	72	Zone 1
ASEE ANNUAL CONFERENCE AND EXPOSITION, CONFERENCE PROCEEDINGS	3	19	91	Zone 1
EDUCATION AND TRAINING	4	18	109	Zone 1
FRONTIERS IN PSYCHOLOGY	5	16	125	Zone 1
ADVANCES IN INTELLIGENT SYSTEMS AND COMPUTING	6	15	140	Zone 1
ACM INTERNATIONAL CONFERENCE PROCEEDINGS SERIES	7	14	154	Zone 1
STUDIES IN HIGHER EDUCATION	8	14	168	Zone 1
DEVELOPMENTS IN MARKETING SCIENCE: PROCEEDINGS OF THE ACADEMY OF MARKETING SCIENCE	9	12	180	Zone 1
INDUSTRY AND HIGHER EDUCATION	10	12	192	Zone 1
JOURNAL OF EDUCATION FOR BUSINESS	11	12	204	Zone 1
JOURNAL OF ENTREPRENEURSHIP IN EMERGING ECONOMIES	12	12	216	Zone 1
INTERNATIONAL JOURNAL OF INNOVATION, CREATIVITY AND CHANGE	13	11	227	Zone 1
IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE	14	10	237	Zone 1
LECTURE NOTES IN NETWORKS AND SYSTEMS	15	10	247	Zone 1
ADMINISTRATIVE SCIENCES	16	9	256	Zone 1
EDUCATION SCIENCES	17	9	265	Zone 1
EMERALD EMERGING MARKETS CASE STUDIES	18	9	274	Zone 1
HIGHER EDUCATION, SKILLS AND WORK-BASED LEARNING	19	9	283	Zone 1
INTERNATIONAL JOURNAL OF EDUCATIONAL MANAGEMENT	20	9	292	Zone 1
JOURNAL OF PHYSICS: CONFERENCE SERIES	21	9	301	Zone 1
ACADEMY OF ENTREPRENEURSHIP JOURNAL	22	8	309	Zone 1
INTERNATIONAL JOURNAL OF SCIENTIFIC AND TECHNOLOGY RESEARCH	23	8	317	Zone 1
JOURNAL OF INTERNATIONAL EDUCATION IN BUSINESS	24	8	325	Zone 1
JOURNAL OF MANAGEMENT EDUCATION	25	8	333	Zone 1
PROCEEDINGS OF THE EUROPEAN CONFERENCE ON INNOVATION AND ENTREPRENEURSHIP, ECIE	26	8	341	Zone 1
CIRIEC-ESPANA REVISTA DE ECONOMIA PUBLICA, SOCIAL Y COOPERATIVA	27	7	348	Zone 1
COMMUNICATIONS IN COMPUTER AND INFORMATION SCIENCE	28	7	355	Zone 1
INTERNATIONAL JOURNAL OF APPLIED BUSINESS AND ECONOMIC RESEARCH	29	7	362	Zone 1
INTERNATIONAL JOURNAL OF ECONOMIC RESEARCH	30	7	369	Zone 1
INTERNATIONAL JOURNAL OF SUPPLY CHAIN MANAGEMENT	31	7	376	Zone 1
IOP CONFERENCE SERIES: MATERIALS SCIENCE AND ENGINEERING	32	7	383	Zone 1
JOURNAL OF APPLIED RESEARCH IN HIGHER EDUCATION	33	7	390	Zone 1
JOURNAL OF ASIAN FINANCE, ECONOMICS AND BUSINESS	34	7	397	Zone 1
JOURNAL OF BUSINESS ETHICS	35	7	404	Zone 1
JOURNAL OF MANAGEMENT DEVELOPMENT	36	7	411	Zone 1
PROBLEMS AND PERSPECTIVES IN MANAGEMENT	37	7	418	Zone 1
SPRINGER PROCEEDINGS IN BUSINESS AND ECONOMICS	38	7	425	Zone 1
ACADEMY OF MANAGEMENT LEARNING AND EDUCATION	39	6	431	Zone 1
E3S WEB OF CONFERENCES	40	6	437	Zone 1
ECONOMIC RESEARCH-EKONOMSKA ISTRAZIVANJA	41	6	443	Zone 1
HIGHER EDUCATION	42	6	449	Zone 1
INTERNATIONAL JOURNAL OF ENTREPRENEURIAL BEHAVIOR AND RESEARCH	43	6	455	Zone 1
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	44	6	461	Zone 1
INTERNATIONAL JOURNAL OF GENDER AND ENTREPRENEURSHIP	45	6	467	Zone 1
JOURNAL OF ENTREPRENEURSHIP EDUCATION	46	6	473	Zone 1
JOURNAL OF SMALL BUSINESS AND ENTREPRENEURSHIP	47	6	479	Zone 1
LECTURE NOTES IN COMPUTER SCIENCE (INCLUDING SUBSERIES LECTURE NOTES IN ARTIFICIAL INTELLIGENCE AND LECTURE NOTES IN BIOINFORMATICS)	48	6	485	Zone 1
FORMACION UNIVERSITARIA	49	5	490	Zone 1
HELION	50	5	495	Zone 1

Sources: Built by the authors using RStudio and Bibliometrix software

One of the formulations of Bradford's law is that if the journals of a certain field are divided into three zones (groups) by the number of articles in such a way that each zone contains one-third of all articles by the number of publications in them, then the number of journals in each group will be proportionally determined according to formula:

$$1:n:n^2 \quad (1)$$

where n is the number of journals in the group.

With the help of such logic (1) and the Bradford multiplier bm , it is possible to determine the optimal number of journals that a researcher needs to analyze in the direction of his activity (Bates & Maack, 2015). That is, if, for example, the researcher knows information about the activities of five main journals in his field of research, which together published 12 articles that were of interest to the researcher. To find the other 12 new articles, the researcher needs to review twice as many journals, that is, the Bradford multiplier $bm = 10/5 = 2$. Therefore, to find the next 12 new articles, the researcher needs to analyze bm times more journals. Having analyzed 5, 10, 20, ..., 60, ... journals, the researcher realizes that he does not need further analysis; he has identified the top relevant journals for his field of research. Different researchers have their primary base of core journals and have different Bradford multipliers and define their core areas for publication.

The next index, with the help of which the analysis of publications was carried out, is the Hirsch index. The Hirsch index, or h-index, is a scientometric indicator proposed in 2005 by the American physicist Jorge Hirsch from the University of San Diego, California. The Hirsch index is a quantitative characteristic of the productivity of a scientist, a group of scientists, a scientific organization, or a country, based on the number of publications and the number of citations of these publications. A scientist with index h has published h articles, each of which has been cited at least h times. So, if a given researcher has published 100 articles, each of which has only one reference, his h-index is equal to 1. The same will be the h-index of a researcher who has published one article that has been cited 100 times.

The Hirsch index was designed to obtain a more adequate assessment of a researcher's scientific productivity than simple characteristics such as the total number of publications or the total number of citations can provide. The index works well only when comparing scientists working in the same field of research, because the traditions associated with citations differ in different fields of science (for example, in biology and medicine the h-index is much higher than in physics). Normally, the h-index of a physicist is approximately equal to the length of his scientific career in years, while for an outstanding physicist it is twice as high.

The Hirsch index can be calculated using both free public online scientometric databases (e.g., Google Scholar) and paid subscription databases (e.g., Scopus or ISI Web of Science), but paid databases often also provide the h-index scientists in free access. It should be noted that the Hirsch index calculated for the same person using different databases will be different – like other scientometric characteristics, it depends on the area of coverage of the selected database. In addition, the Hirsch index can be calculated with and without self-citation; it is assumed that dropping authors' references to their own articles produces more objective results (Rozrakhunok).

The result of the Hirsch index analysis is presented in Figure 3.

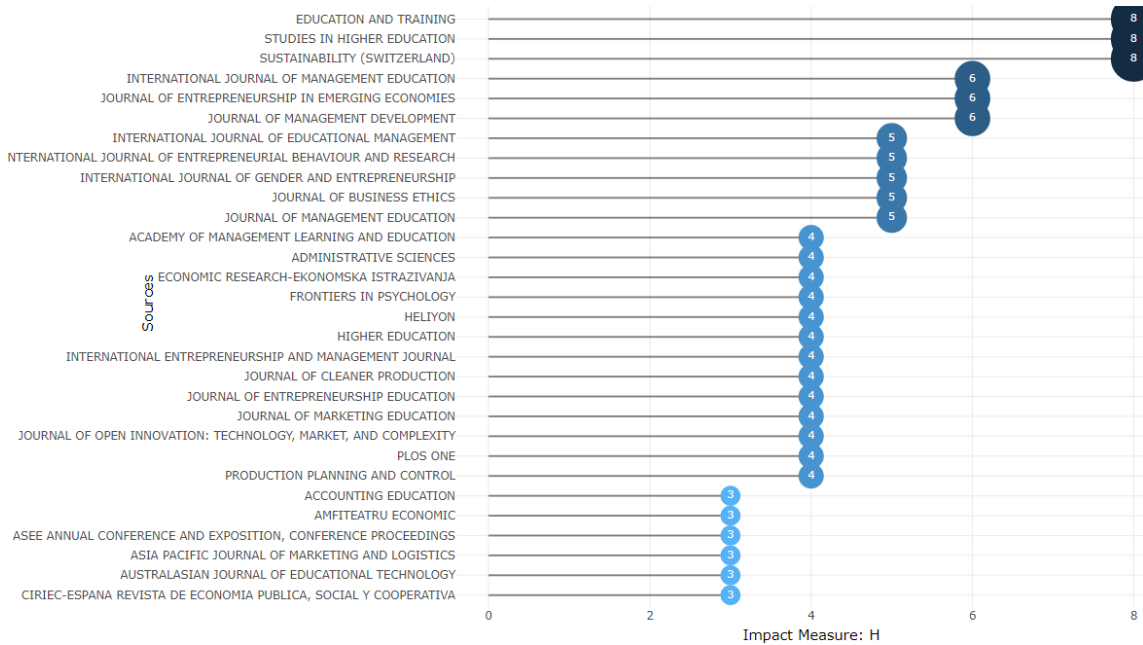


Figure 3. Source Local Impact According to the Hirsch Index

Sources: Compiled by the authors using RStudio and Bibliometrix software

Another index used for analysis is the Gini index. The Gini index is a widely used measure of economic inequality that measures the distribution of authorship. This index is usually used to measure economic inequality, but in bibliometric analysis, it measures the distribution of a particular resource among a certain population. The coefficient ranges from 0 to 1, where 0 means complete equality among individuals in the sample and 1 means complete inequality or 1 person owns all resources within the sample cohort. Thus, a smaller Gini index indicates a more even distribution of resources among individuals, and a larger Gini index indicates a less even distribution of resources among individuals (Hart & Perlis, 2021).

The result of the Gini index analysis is presented in Figure 4.

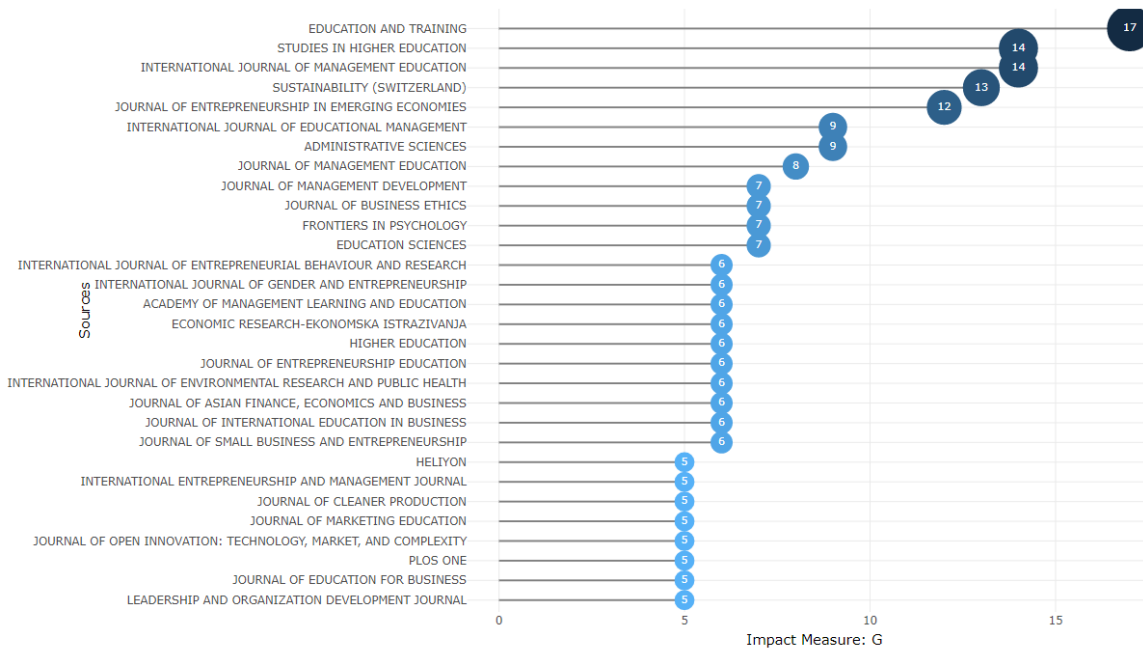


Figure 4. Source Local Impact According to the Gini Index

Sources: Compiled by the authors using RStudio and Bibliometrix software

Figure 5 shows the total citations of these journals.

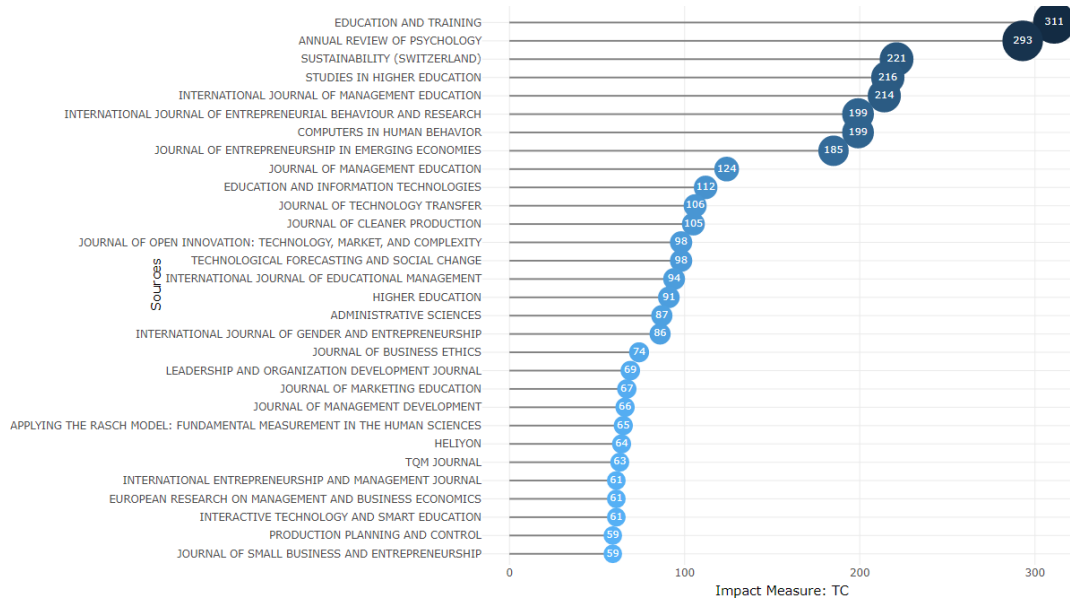


Figure 5. The Total Number of Citations of the Top 30 Journals about the Relationship Between Education and Business
 Sources: Compiled by the authors using RStudio and Bibliometrix software

Figure 6 shows the list of the most cited countries in which the authors indicated their affiliations.

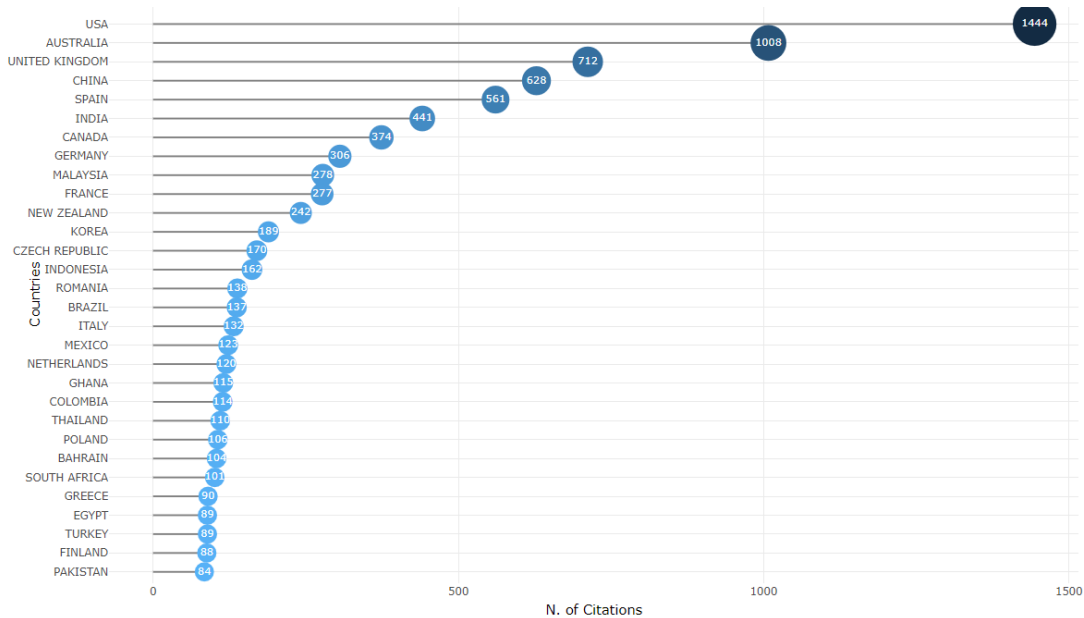


Figure 6. Top 30 Most Cited Countries by Research Topic

Sources: Compiled by the authors using RStudio and Bibliometrix software

In addition, the analysis of keywords (Figure 7) by frequency of use in 2000 publications clearly shows the relevance of articles to the search request on the topic “business and education”.

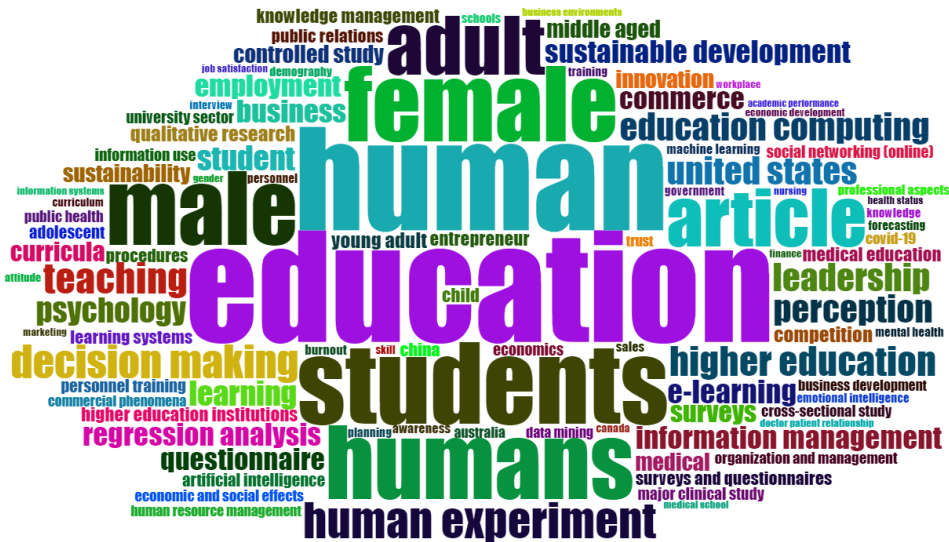


Figure 7. A Cloud of the 100 Most Used Keywords by Research Topic

Sources: Compiled by the authors

The frequency of use of keywords is shown in Table 3. The most frequently used words are education, human, students, female, male, and humans.

Table 3. Frequency of Use of 100 Keywords

Terms	Frequency	Terms	Frequency	Terms	Frequency
education	164	learning	36	qualitative research	23
human	152	student	36	young adult	23
students	119	e-learning	35	child	21
female	111	business	34	entrepreneur	21
humans	108	information management	34	higher education institutions	21
male	108	regression analysis	34	knowledge management	21
adult	87	sustainable development	34	medical education	21
article	85	commerce	33	China	20
engineering education	76	employment	33	learning systems	20
human experiment	53	questionnaire	33	procedures	20
decision making	49	surveys	31	public relations	20
teaching	46	curricula	29	surveys and questionnaires	20
higher education	44	controlled study	26	adolescent	19
education computing	41	innovation	26	artificial intelligence	19
leadership	41	medical	26	personnel training	19
perception	41	middle aged	26	economics	18
united states	41	sustainability	26	information use	18
psychology	37	competition	23	major clinical study	18
social networking (online)	18	professional aspects	15	interview	13
university sector	18	sales	15	skill	13
covid-19	17	demography	14	business environments	12
cross-sectional study	17	mental health	14	doctor patient relationship	12
economic and social effects	17	emotional intelligence	14	economic development	12
organization and management	17	personnel	14	finance	12
public health	17	planning	14	gender	12
Australia	16	schools	14	health status	12
business development	16	training	14	nursing	12
commercial phenomena	16	forecasting	14	job satisfaction	12
data mining	16	government	14	marketing	12
human resource management	16	knowledge	14	medical school	12
trust	16	attitude	13	information systems	12
awareness	15	Canada	13	workplace	12
machine learning	15	curriculum	13	academic performance	11

Sources: Built by the authors using RStudio and Bibliometrix software

Conclusions

In this research, a bibliographic review of articles and magazines related to business and education was made using the built-in functions of the Bibliometrix application. In the research process, statistics from the bibliographic and reference database Scopus, scientific literature from the Web of Science database, and software for managing bibliographic information Mendeley were used. The analysis in work is carried out in the following logical sequence: at the first stage, an analysis of literary sources related to bibliometric analysis, as well as business and education topics, and their interdependence on each other, which were published in the MDPI publishing house of scientific journals with open access, was carried out. The methodological tools of most of the research are survey and interview methods, and the research is conducted in the R language, VOSViewer tools for bibliometric analysis and for the analysis of education and business, various qualitative and quantitative methods were used, such as performance analysis, scientific mapping and thematic analysis, structural equation modeling, Z-score statistics, etc.

At the second stage, the main functions of the Bibliometrix package were studied, such as `Convert2df()`, `biblioAnalysis()`, `Summary()` and `plot()`, `citations()`, `localCitations()`, `dominance()`, `Hindex()`, `lotka()`, `termExtraction()`. With the help of these and other built-in functions of the Bibliometrix library, a three-field plot (three-field graph) was built by countries, keywords and the year of publication of the most cited references, the top 30 journals by the number of publications in them, a cluster analysis of articles was carried out using Bradford's law, a local distribution of authors' contributions to writing articles according to the Gini index was built, and global distribution according to the Hirsch index was determined. At the third stage, an analysis of keywords was made, and a table was built with the most frequently used words in order of decreasing number of mentions of the word. A comprehensive and comprehensive bibliometric analysis confirmed the high level of correlation between the concepts of quality education and highly efficient business.

Author Contributions: Conceptualization: Vitaliia Koibichuk, Valeriia Herasymenko and Anastasiia Samoilikova; methodology: Vitaliia Koibichuk, Valeriia Herasymenko; software: Vitaliia Koibichuk; validation: Vitaliia Koibichuk, Valeriia Herasymenko and Anastasiia Samoilikova; formal analysis: Valeriia Herasymenko; investigation: Vitaliia Koibichuk, Valeriia Herasymenko and Anastasiia Samoilikova; resources: Valeriia Herasymenko; data curation: Vitaliia Koibichuk, Valeriia Herasymenko; writing-original draft preparation: Vitaliia Koibichuk, Valeriia Herasymenko and Anastasiia Samoilikova; writing-review and editing: Vitaliia Koibichuk, Anastasiia Samoilikova; visualization: Valeriia Herasymenko; supervision: Vitaliia Koibichuk, Anastasiia Samoilikova; project administration: Anastasiia Samoilikova; funding acquisition: Anastasiia Samoilikova.

Conflicts of Interest: Authors declare no conflict of interest.

Data Availability Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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