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QUANTITATIVE APPRAISAL AND SCIENTOMETRIC EXPLORATION INTO THE DIGITIZATION OF EDUCATION

ABSTRACT

In the current conditions, the digitalization of education in almost all countries of the world has become a vital strategy for the total restructuring of traditional forms, tools, methods and technologies of education. At the same time, the issue of financial literacy is one of the priorities in education since the level of social welfare and the level of economic development of the country depend on the level of financial literacy. The article is devoted to a thorough scientometric review of scientific publications on the digitalization of financial education, highlighting key ideas, trends in developing scientific views, prospects, and opportunities for further research. The bibliometric analysis was carried out using specialized methods and tools, in particular, in-built Scopus and WoS databases tools, VosViewer software, and the Google Trends web application. Publications were extracted from the two scientometric databases, Scopus and WoS, in the time interval from 1990 to February 2024. A dynamic analysis of research articles showed their intensive growth since 2020, which is due to increased attention to digital education in the context of global transformations, the COVID-19 pandemic, and military conflicts. A transnational representation of the research was identified, with key geographic centres in the United States, the United Kingdom, and China. A country-by-country analysis confirmed the connection between researchers due to similarities in educational strategies and geographical proximity. Using the results of the constructed bibliometric map, the thematic analysis identified 4 key clusters that confirm the central role of digitalization in financial education. Within the clusters, thematic groups of scientific publications were identified (innovations in education and digital technologies, socio-economic challenges in education, leadership and competitive advantages in education, financial and economic aspects of education, etc. The analysis identified promising research areas, including strategies to improve access to educational resources during crises, studying the impact of Industry 5.0 on financial education, studying financial innovations in education, and researching inclusive digital education.

Keywords: financial education, bibliometric analysis, educational technology, e-learning, financial literacy, educational innovation, digital transformation, higher education

JEL Classification: I21, I23, O33

INTRODUCTION

Education, as an integral part of social progress, is the basis for the sustainable development of the modern economy and the achievement of social stability in society. The relevance of the topic of modern education in the context of globalization, the effects of the Covid-19 pandemic, the devastating consequences of military conflicts, etc. lies in the need to ensure access to education for all segments of the population, the balanced use of educational resources, and the maintenance of the quality of education. Digitalization of education is a tool that can help overcome these challenges. Li et al. (2023) noted that according to international and national studies, approximately 85% of universities in the world currently offer all types of educational courses and 65% claim that digitalization improves the quality of education.

In the context of modern scientific and technological progress, it is impossible to avoid the digitalization of financial education. Financial education plays a significant role in

the context of education in general. After all, understanding complex financial concepts and the ability to make important financial decisions are key to ensuring the normal life of everyone and are crucial for the country's economic development.

Of all the areas of education, the digitalization of financial education is one of the most rapidly developing. The emergence of new financial digital tools has led to new forms of learning that need to be taught and adapted.

For the effective implementation of digital learning tools, it is necessary to consider all the factors that affect the effectiveness of digital education, the level of implementation and adaptation, student motivation, and the quality of teaching. Therefore, conducting a quantitative analysis and scientometric study of digital transformation in financial education is becoming relevant and necessary to understand the future of education. Such an analysis will help identify trends, innovations, and challenges related to digital transformation and contribute to developing strategies to improve financial education's effectiveness in the digital age.

LITERATURE REVIEW

Numerous scientific publications have been published on the impact of digital technologies on education. Most research materials focus on the general aspects of the introduction of digital technologies in the educational space (Ninassi & Burrell (2023), some of which focus on the geographical and sociocultural features of the implementation of digital transformation (Díaz-García et al. (2022), Ogunleye et al. (2023)).

Given the significant number of scientific studies on numerous issues of the use of digital technologies in education, it is extremely important to have publications that implement quantitative and scientometric (bibliometric) analysis. It is these scientific materials that allow us to identify key trends in the introduction of digital tools, methods and methodologies into the educational space, as well as trends in scientific views and ideas about such digital transformation. In particular, the scientometric analysis implemented in the publications by Kharchenko (2023) and Koibichuk et al. (2023), thanks to the authors' use of special bibliometric tools (Bibliometrix and VosViewer), provided an opportunity to get acquainted with the key ideas of scientists related to the digitalization of education. The authors paid special attention to the direct correlation between the level of digitalization of education and the level of business competitiveness.

Castroa et al. (2023), Muktiarni et al. (2023) identified key thematic areas of research on the implementation of digital initiatives in the educational environment, promoting transnational and interdisciplinary exchange of knowledge and ideas.

Studies related to the bibliometric analysis of the impact of digitalization in higher education were conducted by Moghayedi et al. (2021), Muktiarni et al. (2023), and Türkistanli (2024). These research papers studied various aspects of implementing digital solutions to improve the level and quality of education. In particular, the researchers focused on two aspects: considering the effectiveness of various digital tools in times of crisis (covid-19), as well as the interdependence of the quality of digital initiatives and the level of satisfaction of the needs of the modern labour market.

In the context of the openness of economic systems and the expansion of financial and economic ties between countries, the issues of raising the level of financial education and financial literacy of the population are of particular importance. The issue of digitalization of financial education is an object of close attention of scientists and occupies a significant layer among the total number of scientific publications on the digitalization of education in general. For example, Senduk et al. (2023) conducted a bibliometric analysis of the transformation of financial education under the influence of new digital tools. Based on the analysis of a large number of scientific papers, the authors conclude that financial literacy is a strategic issue for the country's economic development. In other words, the level of financial advice of citizens determines the level of their quality of life, while the latest digital technologies, according to the authors, contribute to increasing the level of financial literacy and access to financial information.

The scientific materials in the meta-analysis related to the study of the role and development of digital literacy are also among the key ones in today's context. In particular, Sharma et al. (2023) emphasize the importance of acquiring and developing digital skills. According to scientists, digital competence is an integral part of the personal development of every citizen, which ultimately contributes to the development of the country's economy.

Equally important are studies related to the bibliometric analysis of educational inclusion. Such research is based on the identification and detailed review of digital initiatives based on the idea of providing education for all segments of the population, as well as the development of curricula to engage all stakeholders in digital learning. In particular, Li et al. (2023) and Porkuian et al. (2023) focus on the key general principles, ideas, and methods on which, according to scholars, inclusive education should be based, regardless of country or socio-cultural characteristics. Porkuian et al. (2023).

However, it is worth noting that this analysis was mostly based solely on scientific publications individually or the Scopus or WoS databases. In general, scientometric research has a number of advantages and disadvantages. One of these disadvantages is the limited data within individual scientometric and abstract databases. Muktiarni et al. (2023) and Komarova et al. (2022) emphasize the need to consider numerous aspects that, if not taken into account, can distort such research. Among these aspects, the researchers highlighted the following: the number and relevance of research materials, the time period within which the research is carried out, the use of different search queries, etc.

In general, the results of bibliometric research are relevant and important for scientists, educators, and other stakeholders in the educational process, as they help to identify key trends in the development of educational digital transformation, promote transnational and interdisciplinary dissemination of important scientifically-based ideas, strategies, methods, and methodologies in the educational space.

However, despite the large number of studies related to the digitalization of education, certain areas remain insufficiently defined. In particular, further scientifically based quantitative and scientometric analysis is needed on the digitalization of financial education. This issue is important given that financial education and financial digital literacy are vital in the context of modern digital evolution. In addition, the digitalization of the financial world is a complex dynamic process that requires constant revision of scientific approaches, considering the complexity of such a process and constant changes in the educational space.

AIMS AND OBJECTIVES

This research aims to determine the features, directions, and level of dissemination of information on the digitalization of education and financial education, in particular, by conducting a meta-analysis of scientific publications included in the two largest scientometric databases.

The following tasks were set to achieve this goal:

- to identify scientific publications on the basis of citation and relevance, in the context of the studied topic (according to the selected search queries);
- to cluster scientific publications according to various criteria (geography of prevalence, thematic areas of research, etc.) for better orientation in the context of the research topic;
- based on the results of the meta-analysis, to outline promising areas for further research.

METHODS

The theoretical basis for the study was the scientific publications selected on the topic from two scientometric databases Scopus and WoS. The time period (from 1990 to February 2024) for which the scientific papers were selected is due to the need for a deeper study of the conceptual foundations of the digitalization of education, and development trends in different time intervals.

The following additional tools were used to implement a detailed, scientifically based bibliometric analysis of the digitalization of education (in particular, financial education):

- in-built tools for meta-analysis of Scopus and WoS databases - for graphical analysis of the number, citation and dynamics of scientific publications selected by different search queries. It is also used to build scientometric graphs of affiliation and geographical distribution of scientific publications.
- Google Trends - to track the dynamics of public interest in the digitalization of financial education, and to identify key trend peaks.
- Vos Viewer - to build scientometric maps of the geographical interaction of scientists for the implementation of research on the digitalization of education; to build thematic and evolutionary bibliomaps.

Also, in the process of quantitative evaluation and scientometric research, general scientific methods were used: analysis, synthesis, and logical generalization - in the process of outlining the conceptual framework for the digitalization of financial education, researching key ideas, the latest methods and methodologies, as well as identifying the most relevant areas that require further research.

RESULTS

The statistical analysis of the number of scientific publications and their citation level is shown in Figure 1.

The search queries were identified on the basis of relevance in the context of the studied topic of digitalization of education, with a primary focus on financial education.

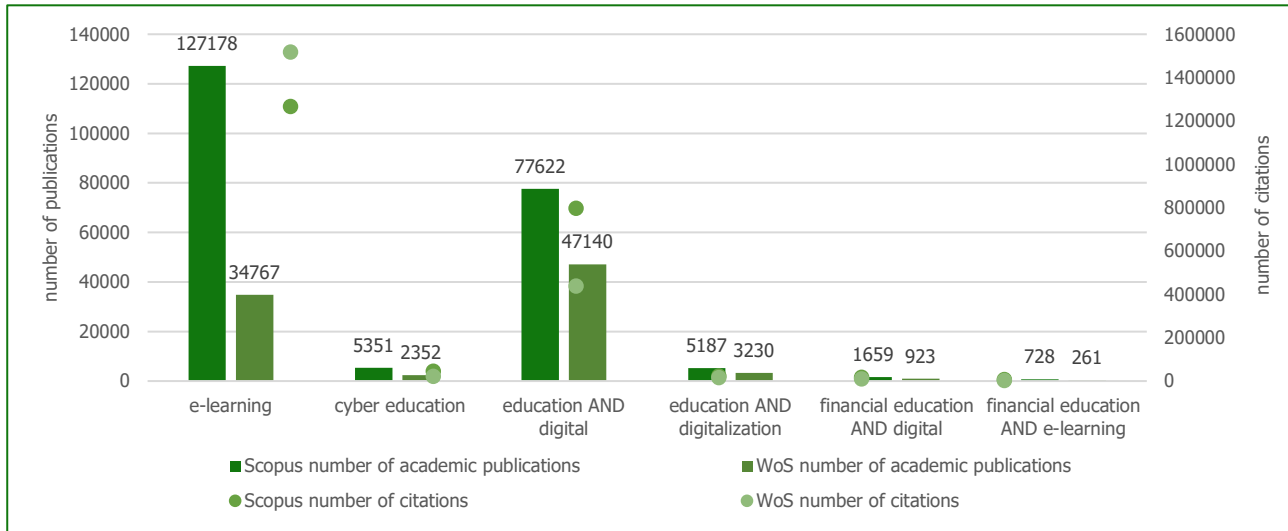


Figure 1. Statistical analysis of scientific publications.

Based on the data presented in Figure 1, it can be concluded that "e-learning" and "education AND digital technologies" are the most prominent and widely researched topics, as evidenced by both the large number of publications and citations. This indicates a strong emphasis on studying the integration of digital technologies into educational practices. In addition, "financial education and digital technologies" is emerging as a prominent area of interest, indicating a growing recognition of the importance of digital literacy in financial education. Overall, there is consistency in the trends observed between Scopus and WoS, with similar patterns in the number of publications and citations for each topic.

Figures 2 and 3 provide an overview of the dynamics of scientific publications related to the digitalization of education in the Scopus and WoS databases, in terms of selected search queries.

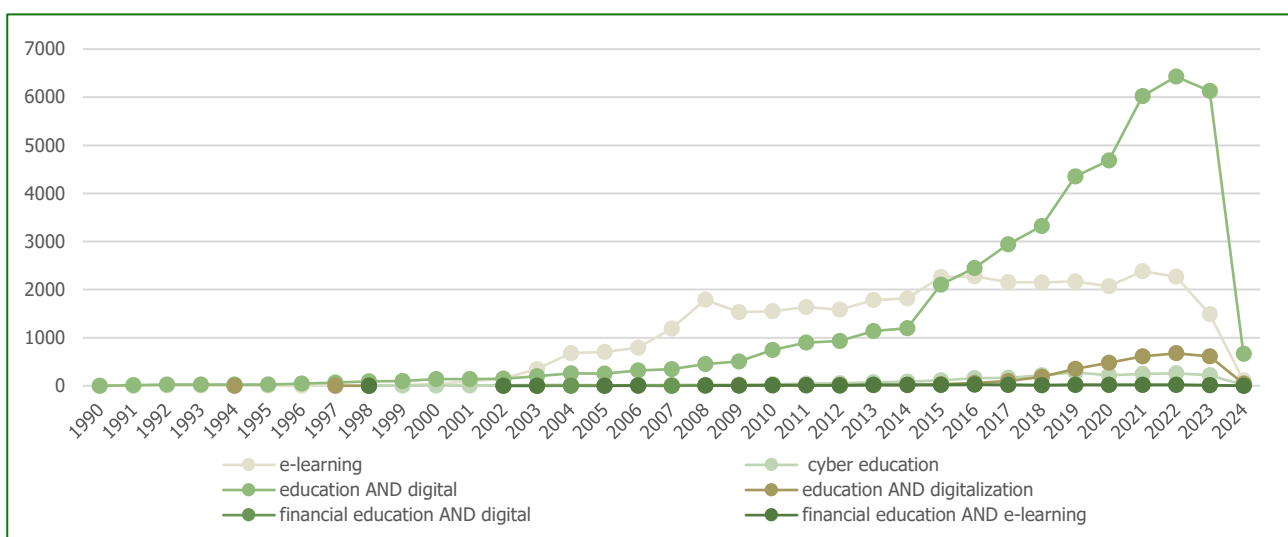


Figure 2. Dynamics of research materials in the WoS database, from 1990 to February 2024, number of articles.

The data shown in Figure 2 indicate:

- the growing dynamics of scientific publications in the WoS database in the field of digitalization of education (search query "education and digital"), especially since 2014, which can be explained by the need to transform education in the context of the global development of digital technologies and the growing need to cover this topic in the scientific literature;
- the highest activity of scientific publications, in terms of all selected search queries, has been observed since 2019, which is due to the consequences of the COVID-19 pandemic;
- the growth of scientific literature in the categories of "e-learning" and "cyber-education" is evidence of the relevance of digital forms and education methods.

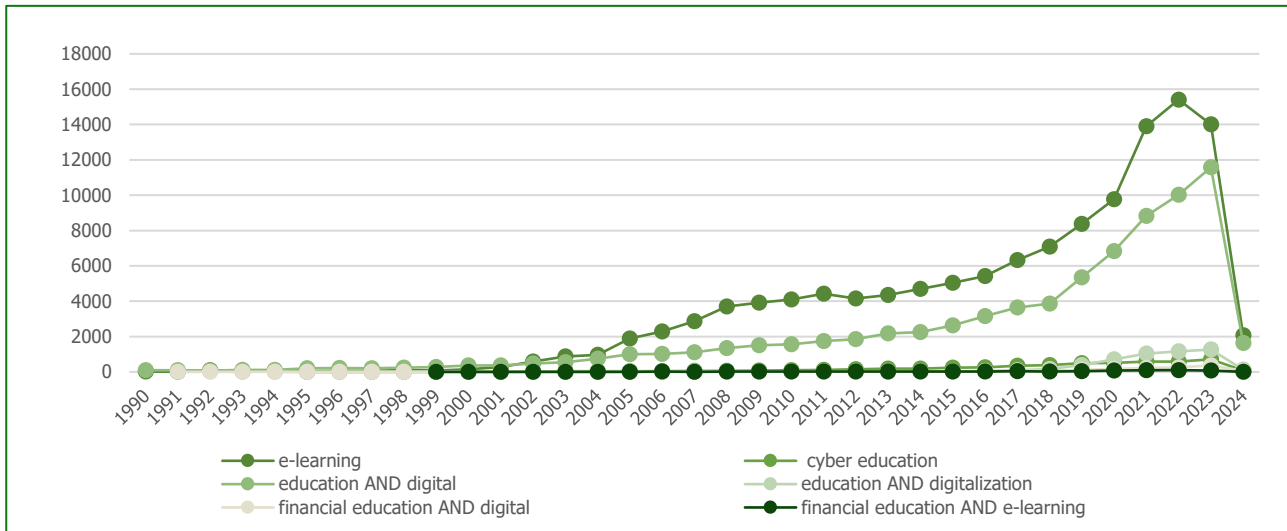


Figure 3. Dynamics of scientific publications in the Scopus database, from 1990 to February 2024, number of articles.

Figure 3 shows that since 2000, the number of scientific publications in the context of digitalization of education and financial education, in particular, in the Scopus database, has been growing exponentially. This particular period (2000-February 2024) reflects not only the active development of digital technologies in education but also the interest of the scientific community in the intricacies of such development (the emergence of new methodologies, ideas, tools, etc.). The peak of scientific publications in 2020-2024 is due to the effects of the COVID-19 pandemic, military conflicts in the territories of individual countries, and the need to adapt educational systems to new "difficult" conditions.

In general, based on the dynamics of scientific publications presented in Figures 2 and 3, as well as the analysis of these scientific publications, it can be argued that the COVID-19 pandemic has significantly changed the dynamics of research on the digitalization of education and financial education in particular. It is also the COVID-19 pandemic that has contributed to the emergence and development of new teaching methods and methodologies. Such significant changes are due to the need for the educational space to quickly adapt to changing conditions caused by quarantine restrictions. The scientific publications of this period actively study the development of online education, distance education, and the creation of online courses based on universities and other digital pedagogical methods and tools.

The small number of publications in 2024 (Figures 2 and 3) can be explained by the partial coverage of publications in January-February 2024.

Thus, the growing interest of the scientific community in the digitalization of education in general and financial education in particular points to the relevance of the topic and the need for a more thorough scientometric analysis of the selected scientific literature.

It is also essential to study the interests of not only the scientific community but also the general interest of the population in the chosen topic. Such interest can be traced using the Google Trends tool, which analyzes the frequency of Internet users' queries on the selected topic.

In general, the graphs based on predefined search queries and built using the Google Trends tool showed similar trends in the growth of general interest in the digitalization of education since 2004 with peak values in 2019 and 2020.

However, two search queries had an interesting trend (Figure 4).

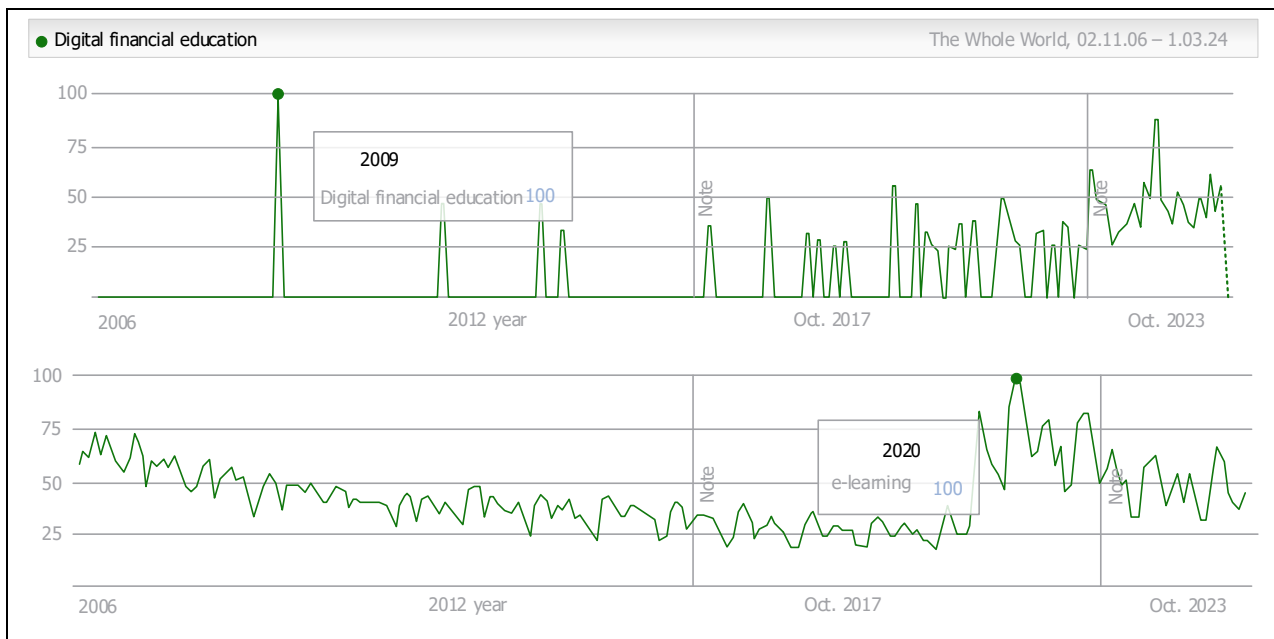


Figure 4. Google Trends results on Internet users' queries about "digital financial education" and "e-learning" in the world for 2006 - February 2024. (Source: created by the authors using the Google Trends toolkit)

In particular, the search query "e-learning" peaked in 2020. And the search term "digital financial education" peaked in 2009. This can be explained by the following:

- the peak in the popularity of e-learning in 2020 is associated with the global COVID-19 pandemic and the related mass closure of educational institutions or their transition to distance learning;
- the peak of the term "digital financial education" in 2009 can be explained by the general interest in financial literacy and education after the global financial crisis of 2008. During the crisis, many people sought information and resources to understand better the basics of the financial system and how to manage their finances.

So, overall, these peaks in the popularity of the search queries "e-learning" in 2020 and "digital financial education" in 2009 show a close causal relationship between external circumstances (usually the adverse effects of economic, political, social and other crises) and the demand for digital learning and financial literacy. Circumstances such as the pandemic and the global financial crisis have led to the public interest and relevance of these topics in the respective years.

For further scientific research, it was decided to focus on scientific publications identified in the context of two scientometric databases Scopus and WoS, selected by the search term "financial education AND digital". The search term was chosen because it is more general and covers various research in the field of digital technologies in financial education. This query covers various aspects, including e-learning, cyber-education, and digitalization of financial education.

The top 10 countries by the number of publications by scholars who studied the digitalization of financial education (search query "financial education AND digital") are shown in Figure 5.

Figure 5 demonstrates:

- the national prevalence of issues related to the digitalization of financial education;
- the United States (Scopus – 328 publications), the United Kingdom (Scopus – 132 publications and WoS – 94), India (Scopus – 132 publications and WoS – 64), and China (Scopus – 128 publications and WoS – 182) are the undisputed leaders in publishing scientific materials on the topic of digitalization of financial education;
- a variety of countries (Russia, Germany, Australia, etc.) that study the development of digital technologies in financial education. Each of these countries also has a significant number of publications in both databases related to the digitalization of education in general;
- certain geographical differences in the results of the scientometric analysis. For example, although Indonesia holds a high position in the Scopus database, there are only a few publications in the WoS database with the affiliation of researchers from this country.

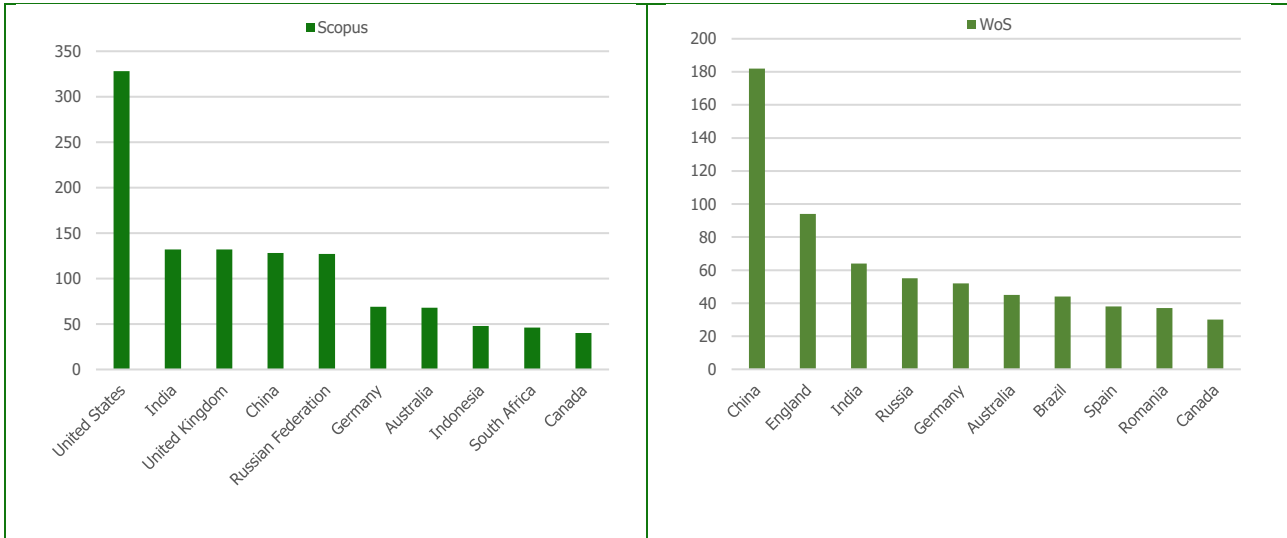


Figure 5. Scientometric Analysis of Countries Participating in Research on Digitalization of Financial Education in Scopus and WoS Data-bases.

The next stage of scientometric research on the digitalization of financial education is to study the basics of the interaction of the scientific community within certain geographical boundaries (Figure 6). Such an analysis is necessary to identify general trends and existing and potential interactions. A more detailed study of the territorial features of digital technologies in education allows us to identify promising areas relevant to certain groups of countries.

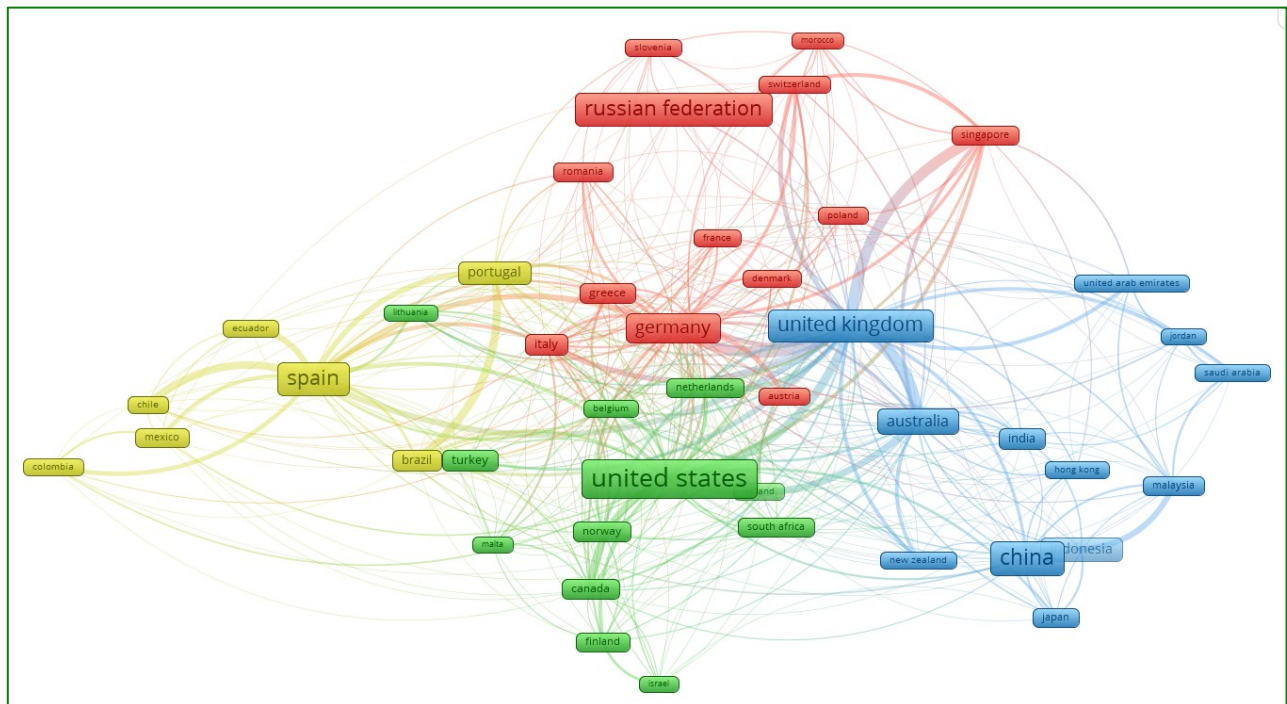


Figure 6. Geographic insights into digital financial education.

Based on the results of the spatial clustering, four clusters were identified, presented in Table 1 (researchers from each cluster have joint publications on the digitalization of education).

Table 1. Spatial clustering of research developments on the digitalization of education.

Cluster	Countries/representatives	Characteristics
1st cluster (red)	Switzerland, Slovenia, Romania, France, Greece, Poland, Singapore, Italy, Austria, Russia, etc.	In the maps of this cluster, countries facing similar challenges (e.g., modernization of education systems and development of teachers' digital competence) are identified, which are due to quite similar historical and cultural features of the development of these countries Through cooperation with other countries, researchers whose publications are related to this cluster adopt the experience of developing educational programs, exchanging educational materials, and developing new approaches to introducing digital technologies in the educational process.
2nd cluster (green)	USA, Belgium, Netherlands, Turkey, Finland, Canada, Norway, Israel, etc.	Education in the countries of this cluster is characterized by rapid technological development and the active introduction of digital tools into the pedagogical process. Scientists from these countries work together on research in the development and implementation of advanced technologies in the educational process and research on their effectiveness directly in the application process. A special role in the cooperation of these countries is played by their promotion of international mobility of students and teachers through joint exchange and internship programs.
3rd cluster (blue)	UK, China, India, New Zealand, Malaysia, Japan, Saudi Arabia, etc.	The cooperation of the countries in this cluster is mainly due to a common interest in overcoming the consequences (for education) of global economic, political, etc. crises and the effects of the COVID-19 pandemic. The scientific publications of the authors (in cooperation with these countries) aim to find common strategies for overcoming these problems, adapting and developing education systems, improving the quality of education, finding ways to invest in education development, and financing innovative programs and projects.
4th cluster (yellow)	Spain, Portugal, Colombia, Mexico, Brazil, etc.	Cooperation between scientists from the countries of this cluster is due to the similarity of cultural and linguistic environments. Due to this similarity, the countries also have similar educational systems. That is why the scientific representatives of these countries contribute to developing and adapting the latest methods of implementing digital technologies in education through such cooperation.

The scientific analysis of data on the affiliation of researchers to different academic communities allows us to assert the transnational representation of researchers and the active participation of researchers from the University of Toronto, the University of London, Harvard University, and University College London in the study of digitalization of financial education.

In addition, scientific publications were analyzed by geographical area and time (Figure 7).

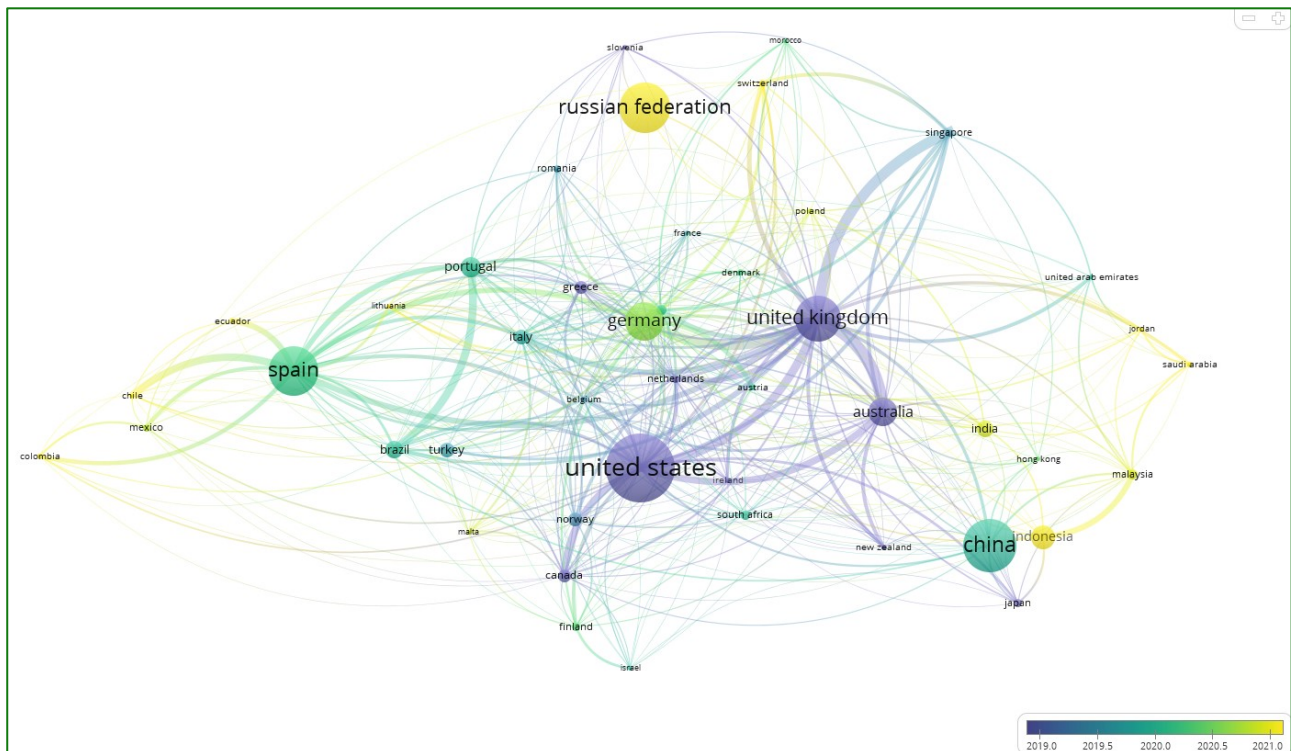


Figure 7. Spatio-temporal scientometric analysis of publications on digitalization of financial education. (Source: Created by the author with VOSviewer)

Figure 7 shows the synergistic relationship between the geographical and temporal aspects of research on the digitalization of education.

In particular, Eltanskaya et al. (2024) identify a direct correlation between the level of education and the correctness of digital transactions. The researchers emphasize that the number of correctly performed financial transactions, as well as the level of efficiency and security of such transactions, directly depends on the level of financial education.

The study by Shvahr et al. (2021) is interesting in terms of information dissemination. The researchers study the impact of social media on financial literacy. The authors emphasize that financial advertising, as well as financial advice on social media, contributes to improving financial literacy in society.

Within the red cluster, an additional grouping of articles was made to facilitate understanding of the key ideas of scientists and trends in their development. In our opinion, such grouping will also make it easier to navigate through many scientific materials in the context of the topic under study.

Group 1: digital transformation and innovation in financial education:

In particular, this group of articles is devoted to the study of the effectiveness of the introduction of the latest digital tools, methods and methodologies of education and their role in shaping the modern digital economy. Also, scientists assign a key place to financial education in the formation of human capital Ponomarenko et al. (2021).

The relationship between the dynamics of mastering digital financial technologies, the level of financial literacy and

Dobrowolski et al. (2023), through an in-depth correlation analysis, noted the importance of acquiring financial knowledge in higher education institutions. Scientists emphasize that it is in such institutions that there is a likelihood of obtaining more thorough financial knowledge and practical skills, precisely because of the availability of a wide range of digital tools.

During 2014-2022, the term "Industry 4.0" was used quite often in the scientific publications of this group. The relationship between the key concepts of "Industry 4.0" and "financial education" is based on the fact that the production process now involves the introduction of a number of digital technologies, which in turn requires a fairly high level of financial education and financial literacy. That is why educational institutions are faced with the task of developing curricula and methods in accordance with the needs of the modern labour market, which is becoming increasingly digitalized. The development of financial knowledge, with the obligatory mastery of digital technologies, increases the level of competitiveness of an individual citizen in the modern labour market (Tortorella et al., 2020).

The study by Vachalek et al. (2017) is interesting from the point of view of scientific novelty. The researchers substantiate the concept of a "digital twin" in the manufacturing sector as one of the key concepts in the theory of Industry 4.0.

Chituc (2021) offers variations on strategies for introducing digital technologies into the educational space. The researcher emphasizes the need to develop the latest digital tools to improve the efficiency of 4.0 educational environments.

Another important study is Nikolova et al. (2023). The undoubted scientific value of this study is the results of a survey conducted by the authors to determine the readiness of universities to implement inclusive digital financial education in the era of Industry 4.0.

Group 2: the role of education in sustainable development and achieving the sustainable development goals

In the scientific publications of this cluster, special attention is paid to the relationship between sustainable development and the effective use of digital technologies in education.

In particular, Artyukhov et al. (2021) and Leonov et al. (2021) explore the role of universities in sustainable development. These studies emphasize the importance of cooperation between universities and enterprises to ensure the sustainable development of a country or region. The main role of universities is to provide high-quality education, primarily financial education, based on the identified business demand to ensure the achievement of sustainable development goals within the country.

Also worth highlighting is the study by Gupta et al. (2020). The authors present the concept of the Digital Resilience Matrix, a research tool aimed at studying digital resilience. The concept is based on the idea of assessing the impact of digital initiatives on sustainable development. The researchers also provide recommendations on possible strategic and tactical actions, depending on the level of impact.

Burinskienė and Sergente (2022) explore the relationship between digitalization and sustainable development based on a scorecard. The article provides valuable insights into how the implementation of effective digitalization measures in financial education can be a driver of sustainable development efforts.

In addition, Onopriienko et al. (2023) comprehensively explore the inclusion of financial education in synergy with the achievement of Sustainable Development Goal 4 (SDG4). The authors emphasize the importance of ensuring that financial

education is accessible to all segments of the population, regardless of their gender or age, to promote the well-being of the population and further sustainable economic development of the country.

Group 3: leadership and competitive advantage in education:

A separate group of articles (Pozovna et al. (2023), Onopriienko et al. (2023), Sanko (2023), Habenko et al. (2023), Hara (2023), Melnyk et al. (2023), Orzagaliyeva et al. (2023)) is devoted to leadership in education, in particular through innovative digital teaching methods.

In particular, Vasylieva & Kasyanenko (2013) and Kuzior et al. (2023) assess the country's innovation and competitive potential, in particular in the context of digitalization of education and sustainable development. The researchers consider the country's future development through the prism of competitiveness and the level of educational digitalization of universities.

Group 4: financial and economic aspects of education:

Group 4 (e.g., Djalilov et al. (2015), Vorontsova et al. (2021), Bilan et al. (2019), Kuzior et al. (2022)) combines research on financial and economic aspects of education.

For example, Djalilov et al. (2015) investigated the impact of financial aspects on the quality of education and its accessibility. Vorontsova et al. (2021) examined the effects of financial aspects of managing an educational institution, highlighting ideas on the effectiveness of implementing paid financial educational services. Bilan et al. (2019) investigate the relationship between financial resources and the quality of educational services.

The scientific publications identified within the second (green) cluster are related to the study of specific instruments, the latest methods used in the initial process, their advantages and disadvantages, etc. In other words, the overall research Scientific publications belonging to the second (green) cluster within the topic of digitalization of financial education focus on the tools and methods used in the educational process (in particular, the use of technology and information resources to improve the educational process).

The keywords that characterize the research in this cluster, such as "3D printing" and "additive manufacturing", indicate the use of the latest technologies both in the learning process (creation of educational materials or individual physical objects to be used in learning) and directly as a result of learning (i.e., 3D objects can be the result of the educational process).

At the same time, the keywords "access to information" and "databases" indicate the interest of scientists in using various digital technologies to increase the level of access to information.

It should be noted that researchers in the context of this cluster pay considerable attention to distance education. Most researchers agree that distance education is currently one of the key means of ensuring access to information, flexibility and adaptability of educational programs, and effective organization of the learning process at a distance. In general, most scholars agree that distance education is as effective as offline education, but requires the use of additional innovative digital tools and teaching methods.

For example, Appolloni et al. (2021) argue that distance education, in addition to a number of advantages, has a set of limitations due to a number of technical, social, and psychological challenges. Access to various financial data through distance education is studied by Huxhold et al. (2020). The results show the importance of ensuring access to the Internet for all segments of the population, especially older people who may face challenges in the digital sphere Ohla and Joda (2020). Researchers also pay considerable attention to studying the role of teachers in the context of the digitalization of education. In particular, Kalimullina et al. (2021) proved that digital transformations not only lead to changes in teaching methods and tools but also require teachers to acquire new skills and competencies. Researchers generally agree that distance learning promotes individualized learning, allowing all participants in the educational process to work at their own pace.

A review of scientific publications in this cluster has identified several digital methods and tools that are generally recognized by scholars as contributing to the effectiveness and interest in financial literacy:

- online courses, websites, MOOCs (massive open online courses), social networks - these digital tools provide access to financial information for a wide range of stakeholders and may additionally include other interactive digital learning tools (methods) (video tutorials, webinars, exercises, games, the ability to display large amounts of financial data using infographics, etc.);

- mobile applications - these digital tools ensure the adaptability of the educational process to different and accessible data, thanks to the widespread use of gadgets among the majority of the population;
- simulations and virtual experiments - belong to a number of empirical digital tools that allow to model real financial situations and develop specific actions in the context of developed scenarios;
- gamification is a tool that aims to turn the process of learning financial information into a game by using various game elements to motivate and engage students.

Equally important is **the third (blue) cluster**, which is related to the effects of the COVID-19 pandemic and other global crises that have led to the replacement or reformatting of traditional teaching methods.

The largest number of publications within this cluster relates to the study of the consequences of the COVID-19 pandemic for the education sector and, in particular, financial education. The research of this cluster is closely intertwined with the research of the previous one in the context of the transition to distance education under quarantine restrictions. The key goal of the research in this cluster is to find possible ways to overcome and adapt to the consequences of the pandemic.

The transition to forced online learning is studied by Watermeyer et al. (2021). The researchers identify the advantages and disadvantages of this transition. Among the key advantages are the ability to ensure the safety of students and educators, flexibility and accessibility of learning, as well as increased access to information resources through online platforms. The disadvantages are a decrease in interpersonal communication, a decrease in the level of control over the learning process, etc.

The advantages and disadvantages of the transformed educational process due to the pandemic are discussed in the studies by García-Morales et al. (2021) and Rapanta et al. The key problem of education during a pandemic is the need to adapt students to the new conditions. The authors note that not all participants in the educational process were ready for distance learning and the need to master the latest digital methods and tools. Moreover, some participants failed to adapt to the new conditions, which had a negative impact on the overall level of digital literacy of the public.

On the other hand, the impact of the pandemic on learning was studied by Barnes (2020), Bygstad et al. (2022), and Javaid et al. (2020). The researchers considered the new requirements for digital technologies in times of crisis (flexibility, accessibility, transition to remote or virtual mode, etc.) The authors emphasize that the transition to online learning has increased the need to develop additional methods to ensure data security in the digital space. Some studies in this cluster were devoted to considering strategies for adapting the educational process in educational institutions in the context of the COVID-19 pandemic.

Scientific articles related to **the fourth (yellow) cluster** focus on the introduction of digitalization of financial education, taking into account the gender, demographic, and socio-cultural characteristics of citizens. In particular, researchers study the relationship between these factors and the readiness and ability to use and perceive digital technologies.

In particular, Kanungo & Gupta (2021) explore the importance of digitalizing financial education and the need to pay close attention to financial inclusion. The researchers emphasize that increasing the level of accessibility of financial education for all segments of the population contributes to increasing the level of access to financial services, thereby increasing the level of financial literacy of society and its well-being.

The development of new tactical and strategic actions to reduce gender and demographic inequalities in financial knowledge through various digital tools is the subject of research by Vasile et al. (2021) and Boiko et al. (2023).

An analysis of the scientific publications in this cluster allowed us to identify several general conclusions shared by most scholars:

- the issue of raising the level of financial education and financial literacy of society should be resolved at the national and global levels;
- acquisition of new digital skills is an unconditional factor in the personal development of a person and increasing the digital literacy of society as a whole;
- demographic, gender and socio-cultural characteristics must be taken into account when introducing the latest digital tools and developing curricula;
- ensuring the availability of learning resources for all segments of the population is of paramount importance;
- special attention should be paid to the gender dimensions of access to digital financial education and the development of curricula that take into account the needs of both genders (Nguyen et al. (2023)).

Also, in the context of each cluster, scientific publications were analyzed and singled out on the basis of the highest citations. This made it possible to outline several generally accepted conclusions among such publications:

1. Rapid digital transformation – contributes to more effective acquisition of knowledge. In particular, through the use of digital tools and teaching methods (webinars, interactive games, artificial intelligence, mobile applications, etc.), students not only enthusiastically oppose new knowledge (as in traditional, offline learning), but also acquire new digital education skills.
2. The emergence of online courses and digital platforms contributes to the prevalence of the conceptual foundations of financial education among a wide range of people of different demographic groups, thereby preventing their digital and educational isolation. In general, the issue of ensuring the availability of financial education for different segments of the population is extremely important in the context of the study of the digitalization of financial education.

Prospects for Further Research

The results of the bibliometric analysis of the digitalization of education have made it possible to outline several promising areas for further research:

1. First, the scientific community is interested in finding effective tools to ensure access to educational resources in times of crisis, such as military conflicts or mass pandemics. In particular, most scholars, despite the fact that there is already a considerable arsenal of such tools, still emphasize the need to develop new and find more effective (performance indicators - time, quality, cost) tools and technologies for distance learning, the use of virtual and augmented reality, etc.

Studies that help to understand the importance of introducing digital technologies in education, especially in times of crisis (e.g., military conflicts), emphasize the need for their effective use to ensure stability and possible future development.

In the context of this area of research, it is worth paying attention not only to studies related to overcoming the challenges posed by the pandemic but also to newer studies related to the challenges to education caused by the consequences of military conflicts.

Prominent examples of such studies are those conducted by Shkolnik et al. (2022), Porkuyan et al. (2023), Spivakovsky et al. (2023), Prokopchuk et al. (2022), and Barvinok and Pudlo (2023). These scholars focus on the possibility of overcoming the consequences of the military conflict in Ukraine. Using the example of Ukrainian universities, the authors analyze the challenges that educational institutions have faced since February 2022 and highlight the key role of digitalization of education in overcoming these challenges.

In the context of studying the issue of digitalization of financial education in times of crisis, it is worth paying attention to the study by Shkolnyk et al. (2022). In this study, the authors analyze the impact of financial digitalization on Ukraine's economic security during the war.

These publications are a valuable source of information for researchers, educators, and other stakeholders in the educational process who seek to adapt the educational process to difficult crisis conditions. They are also a starting point for further research in this area.

2. Secondly, an important aspect is to study the impact of the Industry 5.0 concept on financial education, in particular the use of artificial intelligence, robotics, and mobile applications in the educational process.

The following interesting conclusions are worth noting regarding this research topic, which should form the basis for further research:

- the concept of "Industry 5.0" involves the use of the latest interactive digital tools and methods that should provide greater flexibility, adaptability and accessibility of financial education in the world (Gagnidze (2023), Pacher et al. (2023), Shanahan & Organ (2022));
- thanks to the use of artificial intelligence, it is possible to develop curricula based on the needs and characteristics (gender, demographic, socio-cultural) of each student (Carayannis & Morawska-Jancelewicz (2022), Pinto et al. (2023));
- the use of augmented reality (AR) and virtual reality (VR) involves the development of new or improvement of existing educational resources and materials (by supplementing them with 3D models, etc.) (Alvarez-Aros & Bernal-Torres (2021)).

3. A promising area of research on the digitalization of financial education is the study of financial innovations in education. The development and effective implementation of new technologies to improve financial literacy and financial management

is an important area for the future development of the education sector as a whole. An example is the research on the use of blockchain technologies to ensure the security and transparency of financial transactions, as well as the introduction of innovative financial instruments and services into curricula.

The basis for such studies may be existing ones. For example, the role of fintech innovations was studied by Apostu et al. (2023) and Locatelli & Tanda (2021). The researchers, in particular, examined the impact of mobile applications and gaming approaches on financial literacy and personal budget management.

Studies (Babkin et al. (2018), Gromovs & Lammi (2017)) consider the possibilities of using blockchain to create secure and transparent financial systems. The emphasis is on students' understanding of the latest financial instruments and their adoption.

4. Some promising areas for further research in the field of digitalization of financial education:

- Inclusive Digital Education (Ensuring Access To Financial Education For Different Groups Of People, Including Marginalized Groups And People With Disabilities (For Example, Learning New Professions By People Affected By Military Conflicts)).
- Training And Retraining Of Educators In The Event Of The Emergence Of New Digital Tools, The Latest Digital Teaching Methods, Etc.
- These promising areas of research can contribute to deepening knowledge and understanding of digital financial education, ultimately supporting efforts to improve financial literacy and well-being worldwide.

DISCUSSION

Comparing this study with the existing ones, we can note some key differences and innovations in the approach used in this study.

In particular, in the context of this study, for a more detailed review of scientific publications in the context of the topic under study, publications selected from the two largest scientometric databases Scopus and WoS were used, and additional analytical tools such as Google Trends were used to study the dynamics of public interest in the topic under study. It is the use of publications from the two largest scientometric databases and additional tools to analyze the prevalence of digitalization of education in the scientific space that distinguishes this study from the studies of Muktiarni et al. (2023) and Senduk et al.

Compared to the works of Moghayedi et al. (2021) and Muktiarni et al. (2023), which explore technological trends in the educational process, this study focuses on the importance of digitalization of financial education and financial literacy.

The implemented study differs conceptually from Koibichuk et al. (2023) in that it focuses exclusively on the quantitative evaluation of scientific ideas related to the digitalization of financial education and on the identification of promising areas of research. At the same time, Koibichuk et al. (2023), in the context of the implemented bibliometric study, focus on a comparative analysis of the effectiveness of specific digital platforms in higher education.

In the context of this study, the decisive role was devoted to the digitalization of financial education. This is a critical difference from the publications of Diaz-García et al. (2022) and Turkistanli (2024), who studied digital trends in higher education and vocational training. However, the key findings of Diaz-García et al. (2022) and Turkistanli (2024) have become the basis for identifying priority research areas in the context of this study.

Thus, the implemented research is a significant contribution to understanding the relationship between financial education and digital evolution. The key emphasis on the findings of the most relevant scientific works identified in the context of the review allowed us to become the basis for further research in the context of the topic under study.

CONCLUSIONS

The article was devoted to a comprehensive quantitative assessment and scientometric review of the scientific literature on the digitalization of financial education.

The first stage of the bibliometric analysis consisted of a comprehensive study of the dynamics of scientific publications in the context of the studied topic. The results of the dynamic analysis of scientific literature from the Scopus and WoS

databases from 1990 to February 2024 demonstrated an increase in scientific interest in the digitalization of education, especially since 2000.

The peak of research activity was observed in the period 2019-2023, which is associated with a growing awareness of the importance of digital transformation in education. It is determined that the COVID-19 pandemic has played a vital role in the growth of research dynamics. After all, quarantine restrictions have emphasized the key role of digital teaching methods in the modern educational space.

An analysis of the dynamics of search queries using Google Trends tools confirmed a similarly growing dynamics of public interest in the digitalization of financial education, especially after the pandemic and the 2008 global financial crisis.

The bibliometric analysis of publications by territory reflected the global representation of research on the digitalization of financial education. The United States, the United Kingdom, India, and China were identified as leaders in this area.

The bibliometric analysis of the digitalization of financial education was based on the analysis of 1659 scientific articles selected by relevance and citation.

The analysis of key terms and publications in the first (red) cluster shows a significant interest in the use of digital technologies in the educational process, as well as in aspects of sustainable development, engineering education, and financial literacy. Other clusters generally consider different aspects of the importance of the development and use of digital technologies in the modern educational process.

Promising areas for further research have been identified, such as expanding access to educational resources in times of crisis, studying the impact of Industry 5.0 on financial education, studying financial innovations in education, researching inclusive digital education, etc.

ADDITIONAL INFORMATION

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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КІЛЬКІСНА ОЦІНКА ТА НАУКОМЕТРИЧНІ ДОСЛІДЖЕННЯ ДИДЖИТАЛІЗАЦІЇ ОСВІТИ

У сучасних умовах диджиталізація освіти майже в усіх країнах світу стала життєво необхідною стратегією тотальної перебудови традиційних форм, інструментів, методів і технологій навчання. При цьому питання фінансової освіченості є одним із пріоритетних в освіті, адже від рівня фінансової грамотності залежать рівень суспільного добробуту населення та рівень економічного розвитку країни. Стаття присвячена ретельному наукометричному оглядові нау-

кових публікацій про диджиталізацію фінансової освіти з виокремленням ключових ідей, тенденцій розвитку наукових поглядів, перспектив та можливостей подальших досліджень. Бібліометричний аналіз проводився з використанням спеціалізованих методів та інструментів, зокрема вбудованих інструментів аналізу баз даних Scopus та WoS, програмного забезпечення VosViewer, та вебдодатка Google Trends. Публікації були виокремлені з двох наукометричних баз даних Scopus та WoS у розрізі часового інтервалу з 1990 по лютий 2024 року. Динамічний аналіз дослідницьких статей показав інтенсивне зростання їх кількості з 2020 року, що пов'язано з підвищеною увагою до цифрової освіти в умовах глобальних трансформацій, пандемії Covid-19, воєнних конфліктів. Було визначено транснаціональну репрезентацію досліджень із ключовими географічними центрами США, Великобританії та Китаю. Аналіз у розрізі країн підтвердив зв'язок між дослідниками через схожість освітніх стратегій та за рахунок географічної близькості. Використовуючи результати побудованої бібліометричної карти, тематичний аналіз виявив 4 ключові кластери, що підтверджують центральну роль диджиталізації у фінансовій освіті. У межах кластерів визначено тематичні групи наукових публікацій (інновації в освіті та цифрових технологіях, соціально-економічні виклики в освіті, лідерство та конкурентні переваги в освіті, фінансово-економічні аспекти освіти тощо) для покращення розуміння та навігації в межах цієї сфери. За результатами аналізу визначено перспективні напрями досліджень, серед яких стратегії покращення доступу до освітніх ресурсів під час криз, вивчення впливу Індустрії 5.0 на фінансову освіту, вивчення фінансових інновацій в освіті, дослідження інклюзивної цифрової освіти.

Ключові слова: фінансова освіта, бібліометричний аналіз, освітні технології, електронне навчання, фінансова грамотність, освітні інновації, цифрова трансформація, вища освіта

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