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Research Article

Current Research Trends on Distance Education Studies within Cyber Security Concept: Findings from A Bibliometric Analysis

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Abstract – In recent years, distance education systems which are one of the normal methods of education, have become more associated with the concept of cyber security in terms of digitalization requirements. In this context, the aim of this study is to explore the current tendencies and trends of studies involving the concepts of distance education and cyber security at the international level. In the study, researches on these concepts in the last ten years in the Web of Science database were selected and bibliometric analysis of these publications was examined in terms of many performance indicators. Since the study examines the most recent studies on the relationship between distance education and cyber security, it provides an understanding of the development process and future evolution of this field. The results reveal that distance education studies in the cyber security concept are becoming increasingly popular and should be focused more on becoming a multidisciplinary field.

Keywords – Digitalization, Distance Education, Cyber Security, Bibliometric Analysis, Web of Science

I. INTRODUCTION

With the digitalization process, many innovations are becoming a part of human life. In the digital age, more than half of the world's population has access to the active internet, and with the increase in the number of devices connected to the internet and the amount of data stored, complex systems with a combination of physical and digital components have emerged [1]. Although distance education systems, which are one of them are an alternative that is used more in the education sector thanks to its advantages such as accessibility, usability and low cost, it creates a need for cyber security in terms of the technologies it contains [2].

Recently, cyber threats encountered in complex systems such as distance education systems can be in the form of attacks that affect the usability of systems such as accessing critical infrastructures, discovering system vulnerabilities, infiltration attempts, disabling, damaging with malware, social engineering, data theft, manipulation [3]. As cyber attack approaches become more complex, the perception of cyber security is becoming more integrated with new technologies such as artificial

intelligence, internet of things, machine learning, cloud computing, data analytics, quantum cryptography, etc. [4].

Although bibliometric studies are becoming increasingly popular in every scientific field, it has seen that distance education studies within the scope of cyber security are limited. Within the scope of distance education studies, [5] aimed to provide a holistic perspective with bibliometric analysis of research examining online learning in higher education worldwide during COVID-19. [6] analyzed the research on distance education in the last two decades through 20634 studies in the WoS database according to years, keywords, countries and institutions. [7] analyzed 35 articles on COVID-19 and distance education published in the leading research journals of the field indexed in ESCI and/or SSCI indexes in the SCOPUS database during the 2020-2022 pandemic period. [8] examined the e-learning research area by conducting a bibliometric analysis of 12272 publications from the WoS database between 2015 and 2020. [9] aimed to quantitatively evaluate the research conducted and published in the field of e-learning in the university environment in the context of the pandemic crisis, starting from a comprehensive bibliometric analysis based on SCOPUS publications. [10] listed the most used keywords, most cited journals, most cited journals, most published journals, most published countries and most cited authors from 220 studies in the WoS database. [11] covered current research in e-learning from 2019-2020 in the WoS database to provide a comprehensive review of e-learning in higher education institutions during the COVID-19 pandemic. [12] analyzed important conceptual developments published in the context of e-learning in higher education during COVID-19 through data from 602 studies published in the WoS database between 2020-2021. [13] presented a conceptual analysis of the ways in which distance learning research has been addressed over a wide time period. [14] conducted an analysis of metadata such as geographical distribution of publications on e-learning from 2020 to 2022 in the SCOPUS database, authorship, keywords and impact of works, [15] examined 3148 studies on distance education in the WoS database using trend topic analysis, strategic diagram and word cloud analysis with a descriptive survey model. [16] analyzed the scholarly production on MOOCs in 1908 articles in journals indexed in WoS and SCOPUS databases.

Within the scope of cyber security, [17] evaluated studies on cyber security risks and listed publications according to criteria such as the most influential authors, top countries, journals, articles and funding institutions. [18] examined the topics and research methods covered in a total of 234 theses in the field of cyber security, information security and data security. [19] reviewed various threats in the cyber security framework and identified deep learning methods used to combat these threats. [20] conducted a bibliometric review on cyber threats and cyber attacks. [21] examined 2720 global publications on cyber security in the period 2001-2018 in the SCOPUS database and analyzed data on parameters such as publication growth, collaborations, citations, authorship, country-based contributions, research funding and authors. [22] examined cyber security research and compared it with other countries on a regional basis. [23] analyzed 4252 articles published in the WoS database between 1980-2021 in the context of cyber security and information security and mapped the thematic network of these fields. [24] developed a software vocabulary tree representing the connections of each security threat with possible security solutions by determining the scope of the literature on cyber attacks. [25] focused on published cyber security studies and identified the most researched keywords by analyzing 989 articles. [26] analyzed 2202 articles on digital governance and cyber security in the period 1999-2018 and identified the key areas and themes that characterize current research. [4] analyzed the global cyber security literature from the SCOPUS database published between 1998-2019 and examined the underlying trends at the global, national, institutional and individual level using bibliometric indicators. [27] conducted a bibliometric analysis of scientific studies containing selected words related to cyber security, cyber warfare in the SCOPUS database between 1999 and 2023 in order to determine the trends of scientific research in the field of cyber security and examined the geographical distribution of scientific publications.

II. MATERIALS AND METHOD

Bibliometric analysis is a statistical method used to profile the current profile of studies in various fields to determine their development in the process and their future status [28]. In addition to evaluating research performances, different criteria such as cross-sectional changes, regional comparisons and interdisciplinary collaborations can be examined as a whole with this method [29]. In this way, it is possible to evaluate studies in an integrated manner, examine their performance indicators, conceptual and thematic structures and predict the points where they will evolve.

In this context, this study aims to profile current studies on distance education within the framework of cyber security and to understand the trends. For this purpose, in the "Advanced Search" search option of the Web of Science database, "All Fields" was selected in the "Documents" section, keywords were added as (ALL=(cyber security)) AND ((ALL=(distance education)) OR (ALL=(e-learning)) OR (ALL=(online education)) OR (ALL=(digital learning)), "Publication Years" option was taken between "2014-2024" and "Document Types" option was selected as "Article". As a result of the search, a total of 896 records related to the subject were analyzed.

The categories analyzed within the scope of the study are as follows:

- Co-authorship of Author
- Co-authorship of Country
- Citation of Authors
- Citation of Organizations
- Co-Citation of Authors
- Co-Citation of Sources
- Bibliographic Coupling of Countries
- Co-occurence of All Keywords

VOSviewer 1.6.20.0 program was used to analyze the studies according to performance indicators.

III. RESULTS

The figures containing the distribution of the categorized findings are given below:

3.1 Co-authorship of Author

According to the co-authorship of author analysis, 3297 authors and a total of 2470 meet were identified in a single cluster. To identify the most connected authors, the network map was organized by selecting at least 1 document and at least 1 citation criteria and the ranking was based on the total link strength value. Accordingly, the most connected authors are Choo, K-K. R. (61), Cao, J. (54), Liu, B. (54), Hasan, M. (41), Yin, J. (38), Wang, Q. (37), Islam, S. (35), Srivastasa, G. (33), He. D. (31) and Dehghantanha, A. (27).

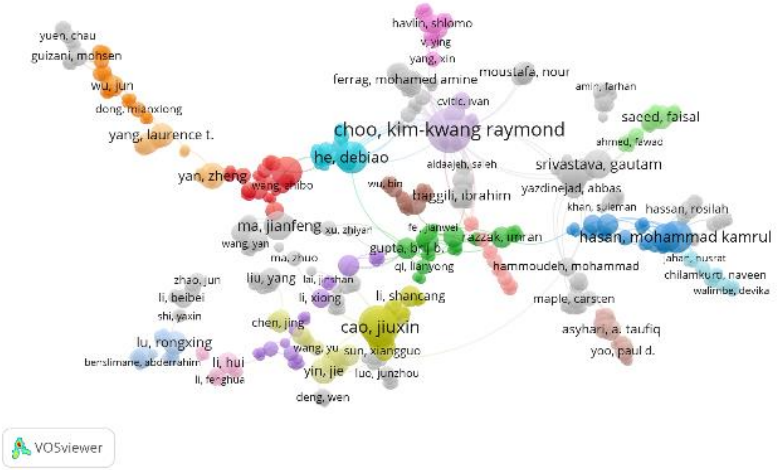

Figure 1. Co-authorship of Author

3.2 Co-authorship of Country

According to the co-authorship of country analysis, 90 countries and a total of 80 meet were identified in a single cluster. To identify the most connected countries, the network map was organized by selecting at least 1 document and at least 1 citation criteria and the ranking was based on the total link strength value. Accordingly, the most connected countries are China (241), US (178), UK (163), Saudi Arabia (123), India (112), Pakistan (110), Australia (102), Canada (89), Malaysia (64) and Germany (62).

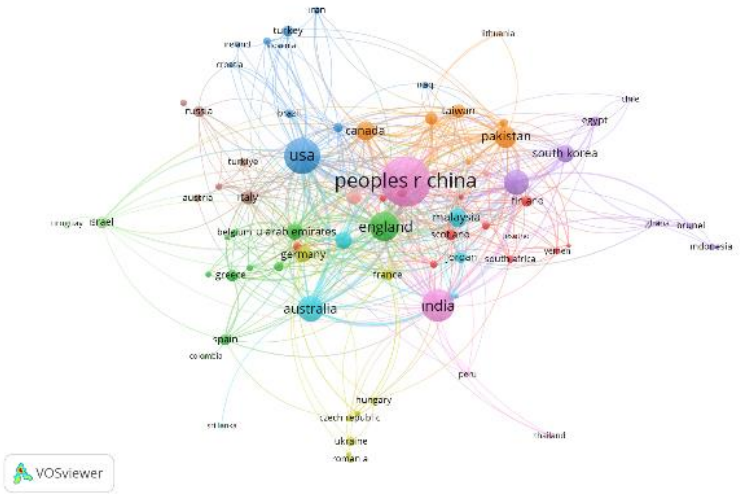

Figure 2. Co-authorship of Country

3.3 Citation of Authors

According to the citation of authors analysis, 3297 authors and a total of 2470 meet were identified in a single cluster. To identify the most cited authors, the network map was organized by selecting at least 1 document and at least 1 citation criteria and the ranking was based on the total link strength value. Accordingly, the most cited authors are Choo, K-K. R. (56), Karimipour, H. (43), Dehghantanha, A. (41), Parizi, R. M. (41), Chen, G. (37), Dong, Z. Y. (37), Ferraq, M. A. (37), Musleh, A. S. (36), Friha, O. (36) and Hailes, S. (35).

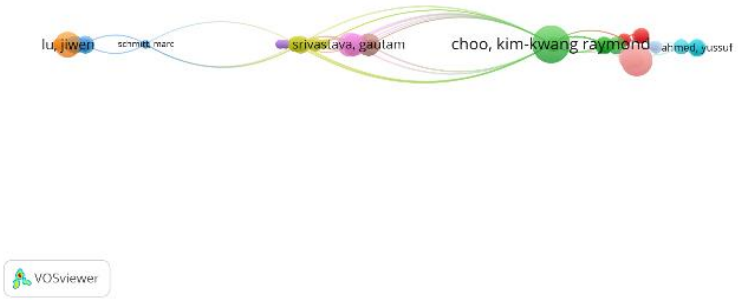

Figure 3. Citation of Authors

3.4 Citation of Organizations

According to the citation of organizations analysis, 1429 organizations and a total of 1106 meet were identified in a single cluster. To identify the most cited organizations, the network map was organized by selecting at least 1 document and at least 1 citation criteria and the ranking was based on the total link strength value. Accordingly, the most cited organizations are Texas San Antonio University (42), Kennesaw State University (38), New South Wales University (37), Guelph University (35), Edith Cowan University (29), Brandon University (27), Calgary University (26), Badji Mokhtar Annaba University (25), University College London (23) and Guelma University (23).

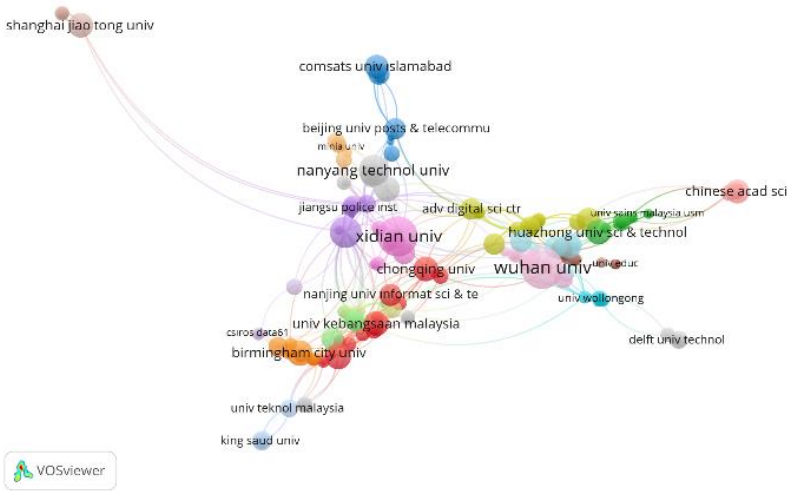

Figure 4. Citation of Organizations

3.5 Co-citation of Authors

According to the co-citation of authors analysis, 27301 cited authors and a total of 1063 meet were identified in a single cluster. To identify the most co-cited authors, the network map was organized by selecting at least 5 citation criteria and the ranking was based on the total link strength value. Accordingly, the most co-cited authors are; Liu, Y. (1249), Ferraq, M. (1183), Sarker, I. (890), Moustafa, N. (880), Tao, F. (830), Wang, Y. (682), Zhang, Y. (678), Javed, A. (673), Wang, W. (672) and Li, J. (653).

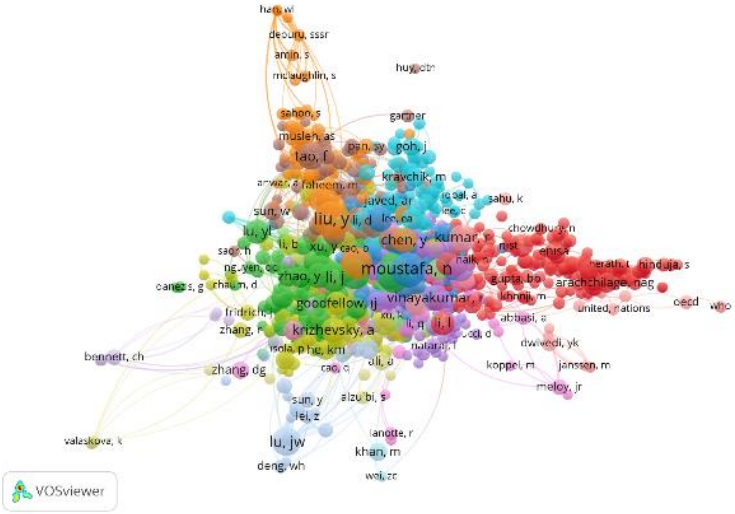

Figure 5. Co-citation of Authors

3.6 Co-Citation of Sources

According to the co-citation of sources analysis, 17376 sources and a total of 1009 meet were identified in a single cluster. To identify the most co-cited sources, the network map was organized by selecting at least 5 citation criteria and the ranking was based on the total link strength value. Accordingly, the most co-cited sources are IEEE Access (57170), IEEE Internet Things (28138), Arxiv (27501), Lect Notes Comput Sc (24548), IEEE Commun Surv Tut (21884), Comput Secur (20740), IEEE T Ind Inform (20578), Future Gener Comp Sy (15553), IEEE T Inf Foren Sec (15184) and Sensors-Basel (14803).

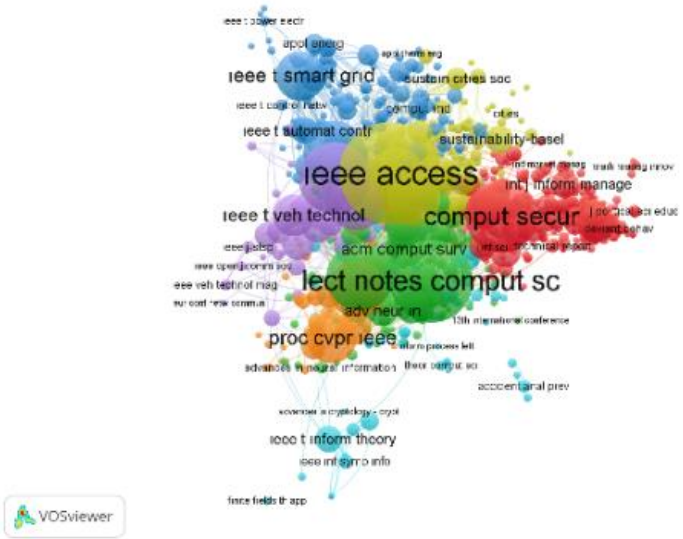

Figure 6. Co-Citation of Sources

3.7 Bibliographic Coupling of Countries

According to the bibliographic coupling of countries analysis, 90 countries and a total of 80 meet were identified in a single cluster. To identify the most coupled countries, the network map was organized by selecting at least 1 document and at least 1 citation criteria and the ranking was based on the total link strength value. Accordingly, the most coupled countries are China (21134), US (17276), Australia (12710), India (11339), Saudi Arabia (8656), Canada (8314), Pakistan (7977), UK (17542), UAE (7479) and Germany (5692).

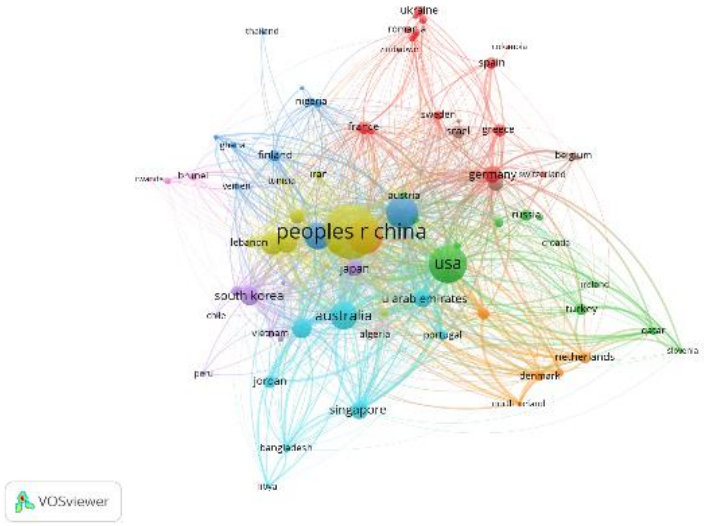

Figure 7. Bibliographic Coupling of Countries

3.8 Co-occurence of All Keywords

According to the co-occurence of all keywords analysis, 3259 keywords and a total of 554 meet were identified in a single cluster. To identify the most used keywords, the network map was organized by selecting at least 2 keywords and the ranking was based on the total link strength value. Accordingly, the most used keywords are; security (475), machine learning (434), deep learning (312), cybersecurity (280), cyber security (221), blockchain (189), internet of things (182), training (181), feature extraction (176) and data models (170).

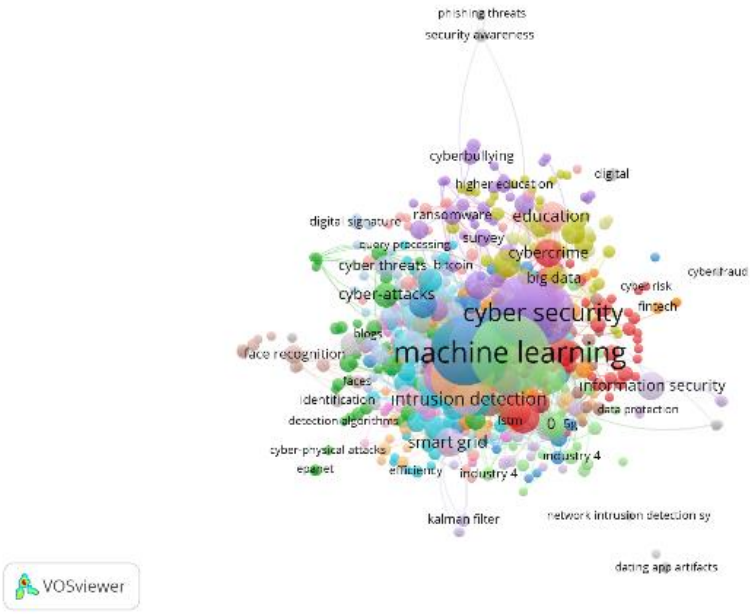

Figure 8. Co-occurence of All Keywords

IV. DISCUSSION AND CONCLUSION

Cyber security is a field that can have global consequences with its effects [30]. In the literature, it is seen that in recent years cyber security research has become more focused and has become a multidisciplinary field. At this point, one of the issues that cyber security studies have focused on has been distance education systems that contain many technological structures [14].

In this study, in order to explore the global dynamics in the field of distance education within the scope of cyber security and to understand the general trend, 896 relevant studies were used by analyzing the articles from 2014-2024 in the Web of Science database. The findings were analyzed in 8 categories: Co-authorship of Author, Co-authorship of Country, Citation of Authors, Citation of Organizations, Co-Citation of Authors, Co-Citation of Sources, Bibliographic Coupling of Countries and Co-occurence of All Keywords.

According to the findings; the most linked (Choo, K-K. R. (61), Cao, J. (54), Liu, B. (54), Hasan, M. (41), Yin, J. (38)), most cited (Choo, K-K. R. (56), Karimipour, H. (43), Dehghantanha, A. (41), Parizi, R. M. (41), Chen, G. (37)) and the most co-cited authors (Liu, Y. (1249), Ferraq, M. (1183), Sarker, I. (890), Moustafa, N. (880), Tao, F. (830)) were predominantly from China. Similarly, in the ranking of the most connected countries (China (241), United States (178), United Kingdom (163), Saudi Arabia (123), India (112)) and the most coupled countries (China (21134), US (17276), Australia (12710), India (11339), Saudi Arabia (8656)) China was the leader, followed by the United States, and the United Kingdom and India were on the list in both categories. In the ranking of the most cited organizations (Texas San Antonio University (42), Kennesaw State University (38), New South Wales University (37), Guelph University (35), Edith Cowan University (29)), it has seen that universities in the United States stood out. It is possible to say that IEEE-based sources (IEEE Access (57170), IEEE Internet Things (28138), Arxiv (27501), Lect Notes Comput Sc (24548), IEEE Commun Surv Tut (21884)) are used more in the list of most co-cited sources. Finally, in the category of the most used keywords, it was found that the concept of cyber security was associated with artificial intelligence-based methodologies (security (475), machine learning (434), deep learning (312), cybersecurity (280), cyber security (221)).

In conclusion, considering that new technologies closely affect human life it has believed that distance education-based studies in the concept of cyber security will be useful in understanding the dynamics of the field and predicting the points where it will evolve in the future. As distance education systems incorporate new technologies and expand their area of use, it is quite likely that the number of studies associated with cyber security will increase and include more multidisciplinary relationships in the future.

LIMITATIONS AND FUTURE WORK

One of the limitations of the study is that it was conducted on a specific discipline, in a single format, in a specific time period and on a dataset with few parameters. It has thought that future studies on a multidisciplinary subject, in more than one format, in a wider time interval and in a form containing many more parameters may contribute more to the literature.

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