

Cyber Security Trends in Education: A Scientometric Study

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Abstract

This paper presents a study on the quantitative analysis of global research trends in cybersecurity in education, focusing on 136 documents published between 2018 and 2022 retrieved from the Web of Science database. Various quantitative indicators were calculated and tabulated, and different graphs were plotted to understand growth patterns, citations with H-Index, country-wise contributions, affiliations, and other aspects. The study found the United States of America has the highest number of publications on cybersecurity in education research. Based on this, the authors suggest that Indian institutions should prioritize cybersecurity in education and strategize for the future with effective collaborations. The best defense strategy in cyberspace is preventive measures supported by continuous research efforts.

Keywords: Cybersecurity in Education, Internet, Management, Scientometrics.

Introduction

In today's digital age, the protection of sensitive information is of utmost importance. With the increase in cyberattacks, educational institutions must take comprehensive measures to safeguard against potential threats(1). This includes the implementation of hardware-enabled security solutions to provide a robust defense against unauthorized access. To ensure student and faculty safety, schools must first assess their vulnerabilities and identify areas of high risk (2). One such threat is the Distributed Denial of Service (DDoS) attack, which can disrupt normal operations and cause significant damage. By taking proactive steps to prevent cyberattacks, schools can safeguard against potential data breaches and maintain the integrity of their systems (3). Scientometrics is an interesting and important field of study that focuses on measuring and analyzing scholarly literature. It is a sub-field of Informetrics and deals with major research issues such as measuring the impact of research papers and academic journals, understanding scientific citations, and using such measurements in policy and management contexts (4). It is fascinating to see how data-driven analysis

can be applied to the academic world to gain insights and improve decision-making (5).

Review of Literature

The study and others provide valuable insights into the research trends of information security in the Middle East and globally (6). It highlights the importance of utilizing scientometrics to measure and analyze scientific literature and the need for collaborative efforts between countries to share knowledge and experience. The results of the study show that the majority of information security research comes from the United States and China, but Iran leads among Middle-Eastern countries and ranks 23rd globally. This study underscores the importance of international scientific collaborations and supporting research and development in the field of information security to counter security threats and vulnerabilities in information societies. The review conducted is a valuable contribution to the field of cybersecurity education for non-expert end-users (7). Their comprehensive analysis of academic publications and industry products over the past 20 years resulted in the identification of 119 tools that are categorized into five broad media

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categories. The review explores current trends, assesses the use of instructional design principles, and reviews empirical evidence of the tools' effectiveness. Their evaluation checklist is a useful resource for those developing cybersecurity educational tools. Their suggestion for a more systematic approach to the design and evaluation of such tools is an important call to action for the industry. The study presented a paper that discussed the crucial role of cyber-security in an IT education context (8). With only 30,000 qualified specialists in the US Public Sector, academic institutions have a responsibility to graduate students skilled in cyber-security to preserve US sovereignty. The paper recommends an adaptable framework called "Prepare, Defend, Act" to structure a cyber-security emphasis in a curriculum. Effective teaching methods are also discussed, and four recommendations for IT program-offering institutions are proposed. According to a recent study, the COVID-19 pandemic had a significant impact on higher education institutions (HEIs) and the way they conduct studies (9). Distance learning became the only feasible option to continue the educational process in March 2020. Cloud computing, online learning platforms, and video conferencing applications, which were previously limited in HEIs, have become the primary assets for conducting online studies. The study recommends measures to increase cyber security in e-learning conditions, including updating systems, managing security patches, implementing access policies at the

application or resource level, classifying information, and using cryptographic protocols.

Objectives

The current study aims to determine the document type of publications in addition to examining the distribution of publications by year. Finding continent countries; researching the most productive keywords; researching the most prolific writers and core journals; and researching the Web of Science Indexes; To locate a Cyber Security in Education publication by language.

Methodology

The Web of Science databases, which are maintained by Thomson Reuters, contain the bibliographic information for the publications (Cyber Security in Education) used to collect the data for their study. The top 15 authors, nations, institutions, and keyword analysis were examples of scientometric indicators that were published in the publication. 136 records from the scientometric analysis of Cyber Security From 2018 to 2022 were used in this study (13). The Social Science Citation Index (SSCI) was used to submit the obtained data to a Web of Science database (14). bib Excel was used to analyze the data, and an Excel calculation was used to determine the outcome after tabulating the data further analysis was done using MS Excel and VOS Viewer software.

Source Data of Cyber Security in Education

The Table 1 shows the details of the source data of Cyber Security in Education research (15).

Table 1: Source Information for Educational Cybersecurity

S.No	Item Details	Description
1	Source Topic	Cyber Security in Education
2	Geographical area	Global
3	Database	Web of Science Core Collection
4	Research data	136
5	Citations	1228
6	Years	10 years (2013-2022)
7	H- Index	51
8	Language	03
9	Countries	25
10	Keywords	253

Data Analysis and Interpretations

Based on Table 2, it appears that research on Cyber Security in Education has been on the rise over the past five years. The year 2022 had the highest number of publications with 39 (28.68%), followed by 2021 with 31 (22.79%). Surprisingly, the year 2018 had the least publications with a total of 136. Interestingly(16), the survey reveals that 29 papers, or 21.32% of all articles, were published in 2020. It's fascinating to see how the number of publications changes over time in this field of research.

According to Table 3, five document types contribute to Cyber Security in Education Research at the Global level. The highest number of publications was in the form of Articles with 120 (88.24%) followed by Review Articles which had 15 (11.03%) publications (16). However, the lowest numbers of publications were found in Early Access, Proceeding Paper, and Correction, with only 5 (3.68%) publications. It is interesting to see how the document type distribution varies in this field of research.

Table 2: Year-wise distribution of publications on Cyber Security in Education

S.No	Publication Years	Records	Percentage
1	2018	17	12.50%
2	2019	20	14.71%
3	2020	29	21.32%
4	2021	31	22.79%
5	2022	39	28.68%
Total		136	100%

Table 3: Document Types wise Distributions

S.No	Document Types	Records	Percentage
1	Article	120	88.24%
2	Review Article	15	11.03%
3	Early Access	5	3.68%
4	Proceeding Paper	4	2.94%
5	Correction	1	0.74%

Table 4: The Most Prolific Authors

S.No	Authors	Records	Percentage
1	Beuran R	4	2.94%
2	Tan YS	4	2.94%
3	Choo KKR	3	2.21%
4	Baggili I	2	1.47%
5	Blazic BJ	2	1.47%
6	Blignaut RJ	2	1.47%
7	Breitinger F	2	1.47%
8	Celeda P	2	1.47%
9	Chinen K	2	1.47%
10	Delatte D	2	1.47%
11	Hatzivasilis G	2	1.47%
12	Herman GL	2	1.47%
13	Ioannidis S	2	1.47%
14	Lee H	2	1.47%
15	Li J	2	1.47%

It is impressive to see the recognition given to the top 15 prolific authors in Cyber Security in Education research as shown in the above Table 4. These authors have published 4 or more papers between 2018 and 2022. Beuran R emerged as the most productive author with the most citations, contributing 4 (2.94) articles, followed closely by Tan YS with 4 (2.94) articles. Choo KKR also made a significant contribution with 3 articles, while other authors such as Baggili I, Blazic BJ, Blignaut RJ, Breitinger F, Celeda P, Chinen K, Delatte Dare, and many others published below 2 articles. It is exciting to see how these authors are advancing research in this field.

Additionally, Table 5 highlights the top 15 Web of Science categorized rank-wise productions (17). The most productive and top-ranked Web of Science categorized is 'Computer Science Information

Systems' with 47 records (34.56%), followed by 'Engineering Electrical Electronic' with 30 records (22.06%). Lastly, 'Telecommunications' is positioned in third rank with 22 records count, accounting for 16.18% of Web of Science Categories. We found some interesting data related to Cyber Security in Education research. According to Table 6, the majority of research outputs were found in the 'Science Citation Index Expanded (SCI-EXPANDED)' with 102 outputs (75.00%). The 'Social Sciences Citation Index (SSCI)' had 62 outputs (45.59%), and the 'Conference Proceedings Citation Index – Science (CPCI-S)' had 4 outputs (2.94%) in this research field. This information could be helpful for researchers and institutions interested in understanding the Web of Science Index wise (3 WoS Index) distribution in Cyber Security in Education research.

Table 5: Web of Science Categories of Cyber Security in Education

S.No	Web of Science Categories	Records	Percentage
1	Computer Science Information Systems	47	34.56%
2	Engineering Electrical Electronic	30	22.06%
3	Telecommunications	22	16.18%
4	Education Educational Research	15	11.03%
5	Computer Science Software Engineering	13	9.56%
6	Engineering Multidisciplinary	10	7.35%
7	Physics Applied	10	7.35%
8	Computer Science Theory Methods	9	6.62%
9	Computer Science Interdisciplinary Applications	8	5.88%
10	Chemistry Multidisciplinary	6	4.41%
11	Computer Science Hardware Architecture	6	4.41%
12	Materials Science Multidisciplinary	6	4.41%
13	Multidisciplinary Sciences	6	4.41%
14	Instruments Instrumentation	5	3.68%
15	Green Sustainable Science Technology	4	2.94%

Table 6: Web of Science Index wise distribution of Cyber Security in Education

S.No	Web of Science Index	Records	Percentage
1	Science Citation Index Expanded (SCI-EXPANDED)	102	75.00%
2	Social Sciences Citation Index (SSCI)	62	45.59%
3	Conference Proceedings Citation Index – Science (CPCI-S)	4	2.94%

Table 7: Language-wise distribution of Cyber Security in Education

S.No	Languages	Records	Percentage
1	English	134	98.53%
2	Hungarian	1	0.74%
3	Spanish	1	0.74%
Total		136	100%

Table 8: International Collaborative Research on Cyber Security in Education

S.No	Countries/Regions	Records	Percentage
1	USA	38	27.94%
2	England	16	11.77%
3	Australia	13	9.56%
4	Peoples R China	12	8.82%
5	India	8	5.88%
6	Saudi Arabia	8	5.88%
7	Spain	7	5.15%
8	Czech Republic	5	3.68%
9	France	5	3.68%
10	Italy	5	3.68%
11	Japan	5	3.68%
12	Malaysia	5	3.68%
13	Scotland	5	3.68%
14	South Africa	5	3.68%
15	Germany	4	2.94%

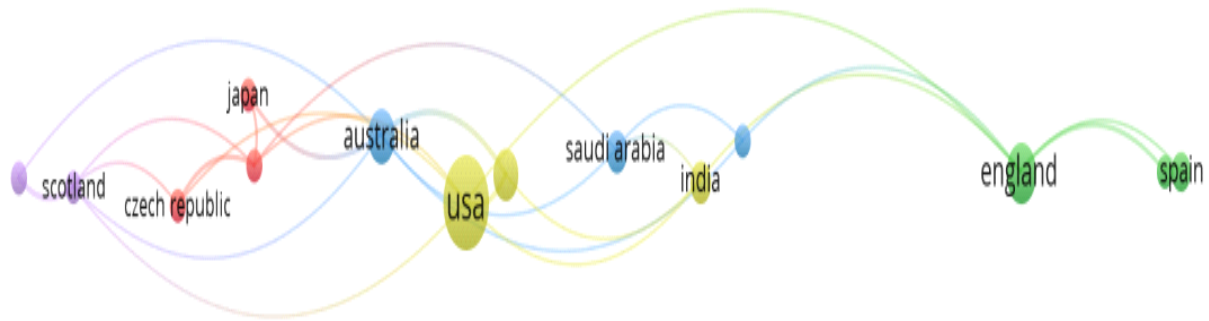


Figure 1: Countries-distributions

According to Table 7, the language-wise distribution in Cyber Security in Education research shows that English was the most commonly used language in the majority of countries. Out of the total publications, 134 (98.53%) were in English, while Hungarian and Spanish had only 1 (0.74%) publication each. This data can be useful for researchers and institutions looking to understand the language preferences in this field.

Table 8 indicates the international collaborative research on Cyber Security in Education at the Global level. Out of 85 scientific publications, the maximum

number of outputs (38, 27.94%) in USA research outputs. The other countries such as England (16, 11.77%), Australia (13, 9.56%) got the third position and then India got Fifth place (8, 5.88%) in the research field of Cyber Security in Education. Other countries are Peoples R China, Saudi Arabia, Spain, Germany, Italy, and the Czech Republic, etc. respectively. The results indicate that very few papers were published by some big countries and it shows that the collaborative countries (18). Figure 1 shows the countries distribution all over the world including USA, India, England and so on.

Table 9: Institutions Distribution of Cyber Security in Education

S.No	Affiliations	Records	Percentage
1	Japan Advanced Institute of Science Technology Jaist	4	2.94%
2	It Institut Mines-Telecom	3	2.21%
3	Institut Polytechnique De Paris	3	2.21%
4	Masaryk University Brno	3	2.21%
5	State University System of Florida	3	2.21%
6	Tsinghua University	3	2.21%
7	University of Abertay Dundee	3	2.21%
8	University of Southampton	3	2.21%
9	University of Texas At San Antonio Utsa	3	2.21%
10	University of Texas System	3	2.21%
11	Virginia Polytechnic Institute State University	3	2.21%
12	Beijing University of Technology	2	1.47%
13	City University London	2	1.47%
14	Deakin University	2	1.47%
15	Delivion Gmbh	2	1.47%

Table 10: Ranking of core Journals on Cyber Security in Education (Top 15 Journals Out of 253)

S.No	Publication Titles	Records	Percentage
1	Ieee Access	12	8.82%
2	Computers Security	9	6.62%
3	Applied Sciences Basel	6	4.41%
4	Education And Information Technologies	6	4.41%
5	Electronics	4	2.94%
6	Heliyon	3	2.21%
7	Journal Of Computer Information Systems	3	2.21%
8	Sensors	3	2.21%
9	Sustainability	3	2.21%
10	Computational Intelligence And Neuroscience	2	1.47%
11	Engineering	2	1.47%
12	Frontiers In Bioengineering And Biotechnology	2	1.47%
13	Frontiers In Psychology	2	1.47%
14	Ieee Design Test	2	1.47%
15	Ieee Internet Of Things Journal	2	1.47%

Table 9 displays the breakdown of literature outputs in the field of Cyber Security in Education, with a focus on the top 25 institutions and universities. The analysis has been limited to the most productive research papers published by distinguished scholars and faculty members. Of the institutions examined, the Japan Advanced Institute of Science Technology Jaist holds the most prominent position with 243 articles published, representing 5.31% of the total output. The second most productive institution is Imt Institut Mines Telecom, with 3 articles published, representing 2.21% of the total output. The remaining institutions and universities in the table

are ranked according to their research papers on Cyber Security in Education. This data provides valuable insights into the most productive institutions and universities in this field and can be useful for businesses and academic institutions seeking to identify potential research partners or collaborators.

It's interesting to see the detailed breakdown of core journals and their production in Table 10. According to the data, the top-ranked journal is 'Ieee Access,' which has 12 records, making up 8.82% of the total. 'Computers Security' comes in second place with 9 records, making up 6.62% of the total. The third-

ranked journal is 'Applied Sciences Basel,' with 6 records, also making up 4.41% of the total. This information provides valuable insight into the most productive and influential journals in the field.

Based on the data presented in Table 11 and the accompanying picture, we can see the frequency of Research Areas in Cyber Security in Education research. It's interesting to note that the research has been taken up in various Research Areas. The most frequently used Research Area is "Computer Science," which has been used 64 times by Cyber Security in Education research scientists during the study period. "Engineering" is the second most frequently used area, being used 42 times. The third most frequently used area is "Telecommunications," which was used 22 times. These results provide valuable insights into the diverse areas of research

being pursued in the field of Cyber Security in Education.

The data presented in Table 12 shows that the research productivity in Global Cyber Security in Education has steadily increased during the study period, with the maximum number of scientific papers being published in 2022. The highest number of research articles (39, 4.46%) were published in that year, with 124 citation articles, 127 times cited, and 6 H-index. The year 2021 also saw a significant number of articles (31, 8.58%) with 258 citations, 266 times cited, and 9 H-index. The growth rate has been consistently rising, except for 2019, with the least number of papers (17, 28.88%) being published before 2018. These findings demonstrate the increasing importance of Cyber Security in Education research and the growing global interest in this field.

Table 11: Research Areas on Cyber Security in Education

S.No	Research Areas	Records	Percentage
1	Computer Science	64	47.06%
2	Engineering	42	30.88%
3	Telecommunications	22	16.18%
4	Education Educational Research	17	12.50%
5	Physics	10	7.35%
6	Science Technology Other Topics	10	7.35%
7	Chemistry	9	6.62%
8	Materials Science	6	4.41%
9	Business Economics	5	3.68%
10	Instruments Instrumentation	5	3.68%
11	Psychology	4	2.94%
12	Social Sciences Other Topics	4	2.94%
13	Communication	3	2.21%
14	Environmental Sciences Ecology	3	2.21%
15	Public Environmental Occupational Health	3	2.21%

Table 12: Comparative growth of Global output with Cited Article and H-index

S.No	Year	Publications	Citation	Times Cited	H-Index	Percentage
1	2018	17	463	474	11	28.88%
2	2019	20	650	655	14	32.75%
3	2020	29	733	737	11	25.41%
4	2021	31	258	266	9	8.58%
5	2022	39	124	127	6	4.46%
Total		136	2228	2259	51	100%

Table 13: Highly Productive Keywords on Cyber Security in Education (Top 15 out of 253)

S.No	Keywords	Records
1	Security	19
2	Challenges	13
3	Internet	12
4	Education	11
5	Model	9
6	Management	8
7	Awareness	8
8	Attacks	6
9	Privacy	6
10	Impact	6
11	Trust	6
12	Things	6
13	Systems	6
14	Cybersecurity	6
15	Behavior	6

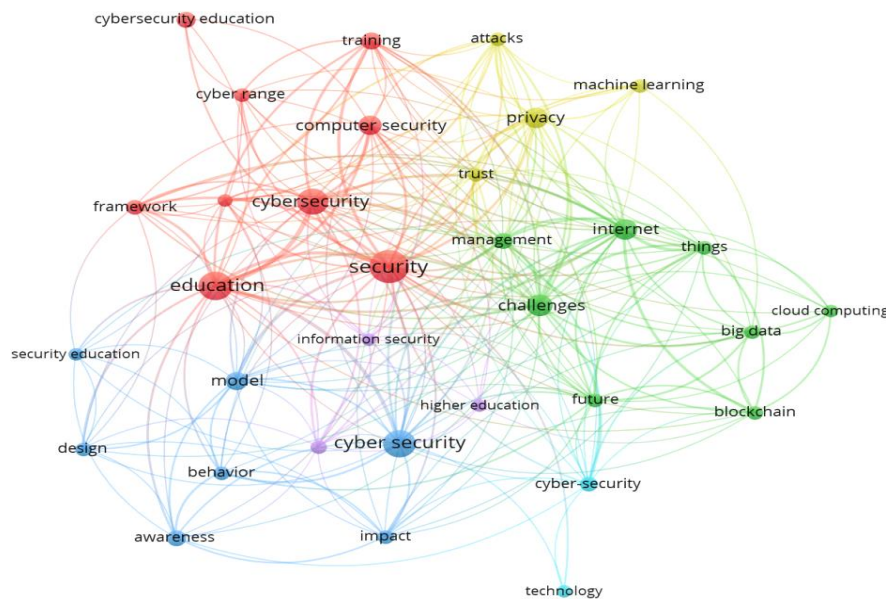


Figure 2: Keywords Analysis on Cyber Security in Education

Based on the data presented in Table 13 and the picture above Figure 2, it is clear that Cyber Security in Education research scientists have focused heavily on the word "Security," using it 19 times throughout the study period. This is followed by "Challenges," which was used 13 times, and "Internet," which was used 12 times. These findings highlight the central role that security plays in this field of study and the challenges that researchers face when trying to address it. It also demonstrates the importance of the

Internet in the context of Cyber Security in Education research.

Results

After analyzing the research on Cyber Security in Education from 2018 to 2022, it can be concluded that a Scientometric study is an effective way to evaluate scientific publications in any area of study (10). This research produced a total of 136 publications, with the year 2022 having the most publications at 39 (28.68%). The document types

were distributed globally and contributed significantly to Cyber Security in Education research, with 5 types including Article, Review Article, Early Access, Proceeding Paper, and Correction. Article was the highest type of publication with 120 (88.24%) being published, with some authors publishing 4 or more papers during 2018-2022 (11). The most productive author was Beuran R, who contributed 4 (2.94) articles with the highest number of citations. 'Computer Science Information Systems' was the most productive and top-ranked Web of Science, with 47 records (34.56%). The majority of the outputs (102, 75.00%) were in 'Science Citation Index Expanded (SCI-EXPANDED)'. It is also worth mentioning that English was the most preferred language for research publications in most countries. Furthermore, after conducting an extensive analysis of Cyber Security in Education research spanning from 2018 to 2022, it is evident that the vast majority of the publications were written in English. Specifically, out of the 136 papers analyzed, a staggering 134 (98.53%) were in English, highlighting the language's dominance in this field of study. The research was conducted on a global level, with the United States having the highest number of outputs at 38 (27.94%). This indicates the significant role the US plays in advancing the field of Cyber Security in Education (12).

To further explore the topic, we narrowed our focus to the top most productive research papers from 25 institutions published by notable scholars and faculty members in the Cyber Security in Education Department. The top-ranked journal was 'Ieee Access,' with 12 records (8.82%) (Table 8). This showcases the journal's prominence in publishing high-quality research in this field. It is worth noting that the research was conducted in the field of Computer Science, which was used 64 times by Cyber Security in Education research scientists (Table 5). This highlights the interdisciplinary nature of the field and how it intersects with other areas of study. In terms of publication dates, the most research articles, 39 (4.46%), were published globally in 2022 (Table 2). Additionally, these publications received 124 citation articles and were cited 127 times, indicating their importance and impact in the field. The H-index for these articles was 6, further emphasizing their significance. Lastly,

throughout the research, the word "Security" was frequently used, appearing 19 times. This highlights the central role that security plays in Cyber Security in Education research and how it is a critical aspect that cannot be overlooked.

Discussion and Conclusion

The research on Cyber Security in Education from 2018 to 2022 revealed that a Scientometric study is an effective method for evaluating scientific publications. The study produced 136 publications, with 2022 having the most (28.68%). The most productive type of publication was Article, with 120 publications (88.24%). The most productive author was Beuran R, who contributed 4 articles with the highest number of citations. The majority of the outputs were in English, with 134 out of 136 papers being in English. The United States had the highest number of outputs at 38 (27.94%), indicating its significant role in advancing the field. The top-ranked journal was 'Ieee Access', with 12 records (8.82%). The research was conducted in Computer Science, highlighting its interdisciplinary nature. The most research articles were published globally in 2022, with 124 citation articles and 127 citations.

Abbreviation

Nil

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Author's Contributions

All authors are equally contributed.

Conflict of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

Ethics Approval

Not applicable

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