Computer-Assisted Teaching in Science Education: A Bibliometric Overview

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ABSTRACT This study aims to examine the studies on computer-assisted teaching in science teaching in terms of different variables with bibliometric analysis. Scopus database was used to collect the data. The phrase "science education and computer-assisted teaching" was written in Scopus on 11_07_2023, and 1232 publications were found. Since not all data is related to computer-assisted teaching in science education, the Scopus Social Science section was selected and filtered, and 454 publications were subjected to bibliometric analysis. VOSviewer program was used for bibliometric analysis. As a result of the research, most studies on computer-assisted teaching in science education were done in 2010, most articles were preferred as document type, the most frequently used keyword was computer-assisted instruction, the country with the most publications was the United States, and the most cited publication was Leidner and Jarvenpaa (1993) and the most frequently used term is student.

Keywords: Computer-assisted teaching, Bibliometric Analysis, VOSviewer Scopus

1. INTRODUCTION

In today's information age, the increase in the knowledge produced daily and the number of students per teacher have caused many problems in the education process. However, including new technologies, which are important in developing quality education, has become mandatory (Genel, 1998; Akçay et al., 2005). New technologies have added computers to the education process as an effective communication and individual teaching tool. With the involvement of the computer in this process, the term "Computer Assisted Instruction" has emerged (Güven & Sülün, 2012). Computer-assisted instruction (CAI) involves students interacting with programmed learning materials using computers. In other words, it is a form of teaching in which students learn through computer programs, monitor their learning, and evaluate themselves (Senemoğlu, 2001; Bayturan, 2011). In another definition, the CAI method is the use of computer technology and related hardware and software in educational activities in various dimensions in line with certain goals (Delikara, 2022).

Most educators say that computer technology helps teachers provide students with effective and efficient opportunities to learn the products and processes of science (Weller, 1996). Computer-assisted instruction

actively involves individuals in learning and helps students learn at their own pace. It also offers students the opportunity to learn through simulations without destroying themselves and the laboratory and by eliminating complex problems that are too costly or impossible (Chambers & Sprecher, 1980). At the same time, most educators see student practice in teaching with computers as an important element in developing psychomotor and cognitive skills (Holman, 2000).

Science is a natural science. Understanding and interpreting the environment in which people live is the essence of knowledge and skills that trigger the idea of seeking regularity in this complex environment (Hançer et al., 2003). Many subjects in science courses have a complex, abstract, and dynamic structure. Difficulties are encountered by students in obtaining and transferring information on such subjects. In order for individuals to appeal to most sense organs, various materials such as pictures, sounds, graphics, and animations must be used individually or together. This situation is critical in understandably conveying the subjects (Kahyaoğlu, 2011;

Ergüzeloğlu & Kaplan, 2021). Computer-assisted teaching is of great importance at this point. What is intended to be taught in science education may not always be learned by experience. However, thanks to computer-assisted teaching, existing situations can be shown to individuals who can be involved in the event as if they had experienced it (Kurt, 2006).

Bibliometric analysis is an approach that uses quantitative methods to monitor, measure, monitor, and analyze scientific literature (Roemer & Borchardt, 2015). Bibliometric research is based on analyzing certain features of publications or documents and obtaining data related to the scientific side of communication (Al & Coştur, 2007; Yılmaz, 2017). In the literature, there is bibliometric research (Zeren & Kaya, 2020), which is a method that is used in many areas in many areas. When the relevant literature is examined when the bibliometric studies in the field of science education are examined, some of these studies are as follows: Yurdakul and Bozdoğan (2022) examined the bibliometric analysis of science education articles in the WoS database in their study. Özkaya (2019) examined the bibliometric analysis of scientific research published on STEM education in his study. Effendi et al. (2021) carried out a bibliometric analysis of scientific

literacy studies in the field of science education. Maryanti et al. (2022) aimed to find sustainable development goals in science education from bibliometric analysis in their study.

Chiu et al. (2022) conducted a bibliometric analysis of the roles, applications, and research designs of robots in journal publications in science education from 1996 to 2020. When the literature is examined, no research has been found that provides bibliometric analysis of research tendencies in documents related to computer-assisted teaching in science education. For this reason, this study is very important for a researcher who wants to do computer-assisted teaching in the field of science education to have knowledge about research. In addition, it is very important to follow the technology of the age in science education because the education to be given to the students should be in accordance with the characteristics of the age. For this reason, the advantages of computer-assisted work in science education should be extensively researched, developments in this field should be followed by considering the importance of these benefits, and deficiencies should be eliminated as much as possible (Yumuşak & Aycan, 2002). This study provides an overview and a practical understanding of the current literature on computer-assisted teaching in science
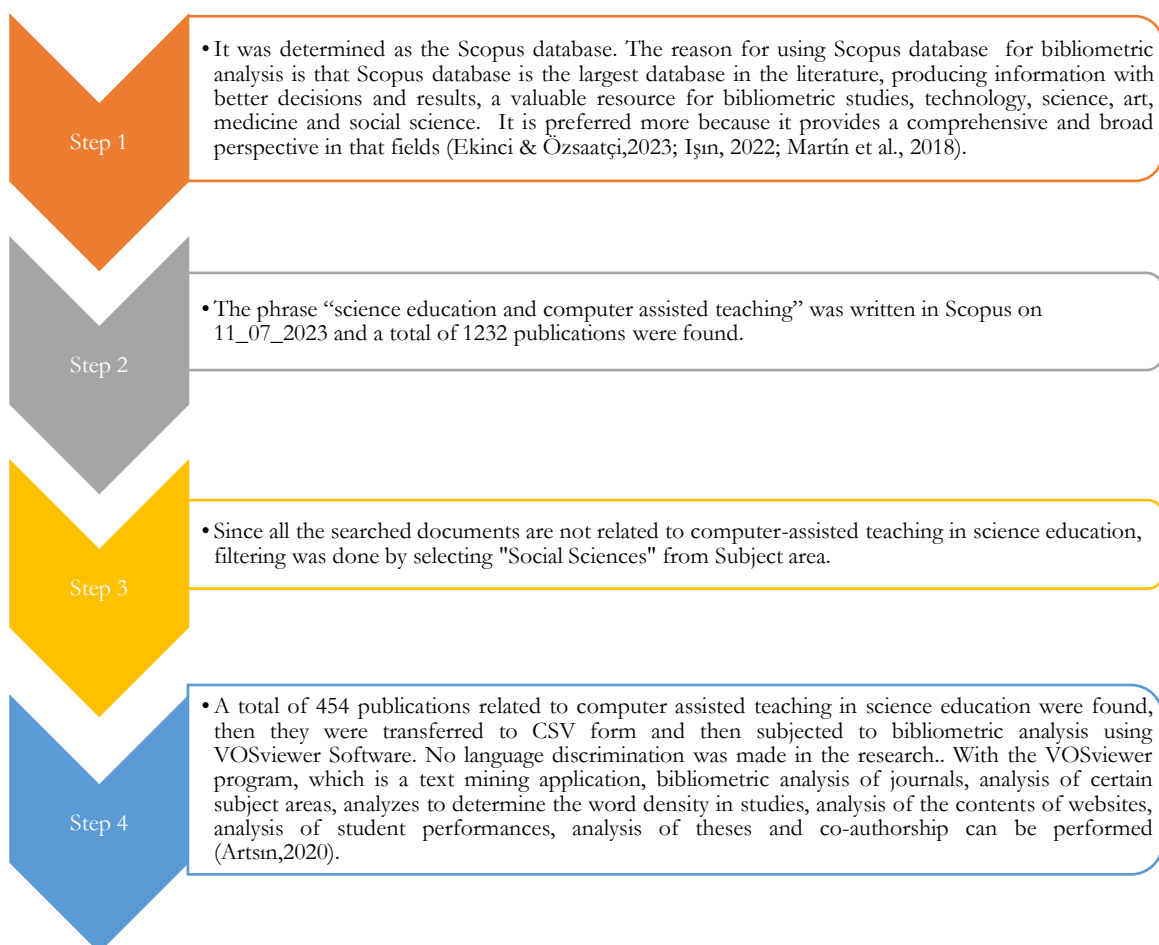

Step 1
- It was determined as the Scopus database. The reason for using Scopus database for bibliometric analysis is that Scopus database is the largest database in the literature, producing information with better decisions and results, a valuable resource for bibliometric studies, technology, science, art, medicine and social science. It is preferred more because it provides a comprehensive and broad perspective in that fields (Ekinci & Özsaatçi,2023; Işın, 2022; Martín et al., 2018).

Step 2
- The phrase "science education and computer assisted teaching" was written in Scopus on 11_07_2023 and a total of 1232 publications were found.

Step 3
- Since all the searched documents are not related to computer-assisted teaching in science education, filtering was done by selecting "Social Sciences" from Subject area.

Step 4
- A total of 454 publications related to computer assisted teaching in science education were found, then they were transferred to CSV form and then subjected to bibliometric analysis using VOSviewer Software. No language discrimination was made in the research.. With the VOSviewer program, which is a text mining application, bibliometric analysis of journals, analysis of certain subject areas, analyzes to determine the word density in studies, analysis of the contents of websites, analysis of student performances, analysis of theses and co-authorship can be performed (Artsın,2020).

Figure 1 Data collection and analysis steps

education. This research may help determine in which areas computer-assisted instruction is concentrated in science education, where it is more common, and future research trends. This analysis can provide an essential guide for the effectiveness and future development of computer-assisted teaching in science education by thoroughly evaluating the current knowledge in the field. The aim of this study is to examine the studies on computer-assisted teaching in science teaching in terms of different variables with bibliometric analysis. In line with the purpose of the research, answers to the following questions were sought.

- What is the distribution of research on computer-assisted- teaching in science education according to document type and years?
- What is the distribution of research on computer-assisted teaching in science education according to the preferred keywords?
- What is the distribution of research on computer-assisted- teaching in science education by country?
- According to the authors, what is the distribution of research on computer-assisted teaching in science education?
- What is the distribution of research on computer-assisted teaching in science education according to terms?

2. METHOD

This study used bibliometric analysis to examine the studies published on computer-assisted teaching in science education between 1973-2023. With bibliometric analysis research, a method used to determine the extent to which scientific communication tools are used, publications or documents are examined in terms of specific characteristics, and findings related to scientific communication are obtained. Thanks to the bibliometric study, It is possible to analyze data such as subject statistics, author, cited author, and cited sources and to reveal the general structure of a particular field thanks to the statistical results obtained (Bozkurt & Çetin, 2016). Especially in recent years, bibliometric analysis has become an essential part of research evaluation methods and is widely used in scientific and applied fields (Tekin et al., 2021). Bibliometric analysis was preferred in this study as the relationships between authors, journals, countries, and institutions are determined by visualization thanks to bibliometric analysis (Van Eck & Waltman, 2010). In addition, the fact that the temporal and holistic plane, which is challenging to understand due to the ever-increasing development of the literature on computer-assisted teaching in science education, will be summarized understandably under one title, which is another reason why bibliometric analysis is preferred in this study. In order to understand the literature on computer-assisted teaching in science education in detail, publications in the Scopus database were examined in this study. The following steps
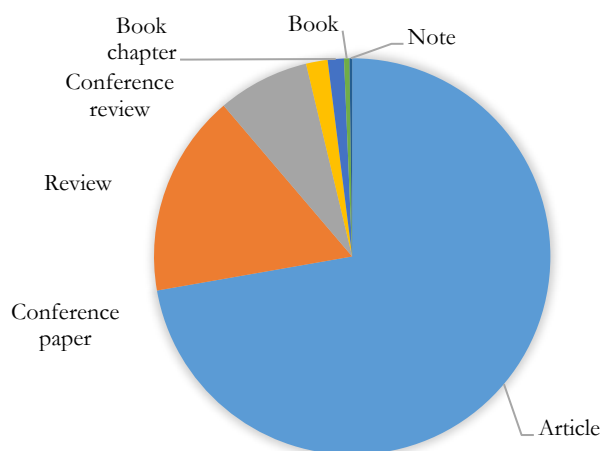

Figure 2 Distribution of documents by types of publication

were followed during data collection and analysis (Figure 1).

3. RESULT AND DISCUSSION
3.1. Distribution of Documents by Types and Years

As a result of the analysis made within the scope of the research, the distribution of documents related to computer-assisted learning in science education is shown in Figure 2. According to the graph, 378 of the documents were articles (72.2%), 75 of them were Conference Paper (16.5%), 34 of them were Review (7.5%), 8 of them were Conference Review (1.8%), 6 of them Book Chapter (1.3%), 2 of them are of book (0.4%) and 1 of them are of note (2%). Bozdoğan (2020) states in his study that articles are the most preferred publication type because they provide concrete data in determining the productivity and academic activities of scientists (Bozdoğan, 2020; cited by Yurdakul & Bozdoğan, 2022). The data of scientific studies on computer-assisted learning in science education by years are given in Figure 3. When Figure 3 is examined, it is seen that the highest number of studies on computer-assisted learning in science education was done in 2010, with 33 studies. It is seen that there is a continuous fluctuation in the number of studies between 1973 and 2023. In addition, the decrease in the number of studies from 2018 to 2022 is remarkable. It can be said that the decrease in the number of studies conducted in these years is due to the pandemic. The COVID-19 epidemic, which started in December 2020, and the first death worldwide was on January 11, 2020, was declared a global epidemic (pandemic) by the World Health Organization (WHO) on March 11, 2020 (Karataş, 2020). When we look at the literature, similar studies support this finding. For example, Otluoğlu et al. (2021) stated in their study that conducting research and publishing during the pandemic period became difficult for academic mothers and that the increase in inequalities in housework and childcare caused academic inefficiency by inhibiting the productivity of academic mothers. In his
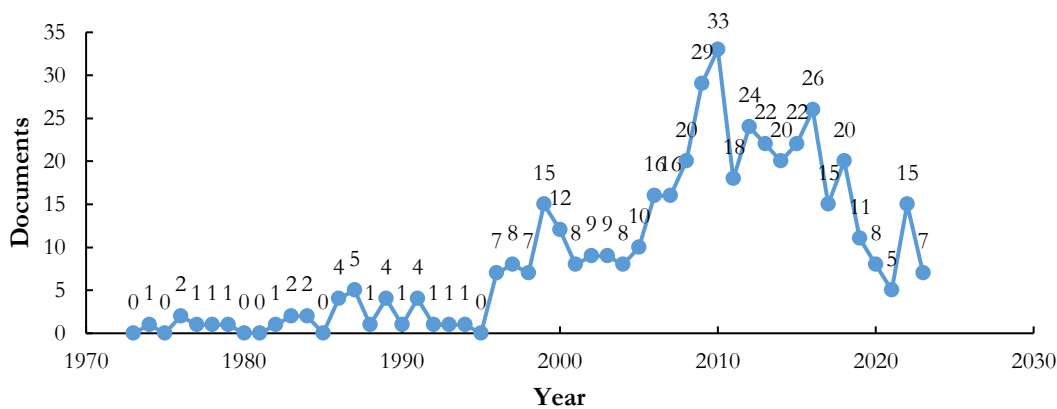
Figure 3 Distribution of documents by year of publication
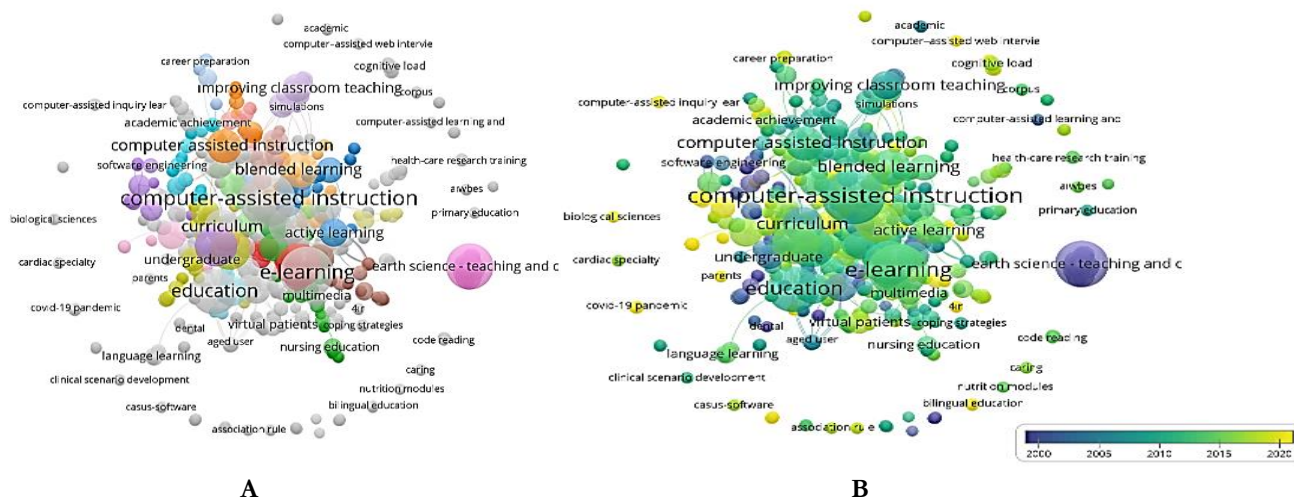

A   **B**

Figure 4 Keyword map and temporal trend of computer-assisted instruction in science education

research, Erkal (2021) examined the effect of academics' absence from the workplace during the Covid 19 epidemic in terms of emotional exhaustion, decline in success, and depersonalization and stated that academics were emotionally exhausted when faced with the problem of not being able to go to work in this period.

Since the study data were obtained in July 2023, the available data are limited to that year. The fact that 2023 has not been completed can explain the low number of studies in that year.

3.2. Keyword analysis: Core content of a research

In order to determine the top 10 most used keywords out of 454 publications obtained in the search, at least 11 or more keywords were included in the analysis. The ten most used keywords out of 1066 keywords were reached (Table 1). The most used keywords are "computer-assisted instruction," followed by "e-learning", and "education - computer-assisted". The preferred keywords give important ideas about the content of the research, the sample level, and the computer-assisted teaching method used in the research. Looking at the results of the systematic search conducted in the past years, it has been seen that the software used among the keywords is less

included. This situation can be interpreted as less space being given to the software/technology used in the research conducted in the past years (Aldemir & Tatar, 2014; Battal & Caliskan, 2021).

For keyword analysis, 1066 keywords were included in the sample visualizations created with VOSviewer (Figure 4).

When the visual relationship network map in Figure 4 (A) is examined, 1066 keywords were used in studies on

Table 1 Most common keywords for computer-assisted instruction in science education

Keyword	Occurrences	Total Link Strength
Computer-assisted instruction	26	16
E-learning	24	10
Education - computer-assisted	19	0
Education	18	6
Dental education	17	10
Educational technology	15	11
Technology	14	3
Medical education	13	7
Blended learning	11	3
Curriculum	11	6

computer-assisted teaching in science education, and there are 74 interrelated clusters and 3739 links within these keywords. The circle's size shows the keywords' excess usage, the circles' colors show which keywords are used together, and the circles' lines show the keywords' relationship (Bulut & İli, 2022). The three words that stand out on the visual map are computer-assisted instruction, designated education-computer-assisted, and e-learning. According to Figure 4 (B), it is understood that there are more relatively new study subjects as it goes from blue to yellow. Accordingly, STEM, human-computer interaction, biological sciences, and the COVID-19 pandemic have been used in recent years.

3.3. Spatial distribution: Top broadcasting countries

According to the findings, 78 countries have published documents on computer-assisted teaching in science education. Keywords used at least seven times or more were included in the analysis to determine the 10 countries with the most publications out of 454 publications obtained as a result of the search from the Scopus database, and ten countries were reached (Table 2). Table 2 shows that these countries play an essential role in computer-assisted teaching in science education and contribute significantly to research in this field.

Developed countries are aware that every success in education is vital for their societies' future development and competitiveness. For this reason, they attach great importance to science education and focus on constantly developing and updating science teaching programs (Topaloğlu & Kıyıcı, 2015). Looking at the visual in Figure 3, it can be seen that the countries with the most publications on computer-assisted teaching in science education are "The United States", "The United Kingdom", "Australia" and "Canada", respectively. This shows that the USA is the leader in computer-assisted teaching in science education compared to other countries. Many similar studies support this situation (Demir & Selvi, 2018; Demir & Çelik, 2020; Gapsalamov et al., 2020; Yurdakul & Bozdoğan, 2022). As emphasized in the study of Demir and Çelik (2020), the USA plays a key role and

Table 2 Countries with the most publications on computer-assisted teaching in science education

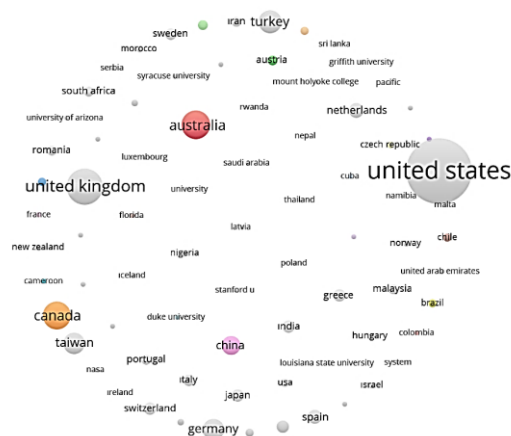| Country	Documents	Citations
United States	161	2891
United Kingdom	50	857
Australia	31	700
Canada	29	881
Turkey	20	489
Germany	17	578
Taiwan	17	424
China	14	75
Netherlands	9	324
Spain	8	128

Figure 5 The nexus of citation among the countries

serves as a bridge in the development of scientific relations and communication internationally.

Seventy-eight countries were included in the sample visualizations created with VOSviewer for country analysis (Figure 5).

3.4. Author Citation analysis: Most Cited documents and number of citations

Among the 454 publications obtained in the search, the top 10 documents with the highest citations from 441 authors are seen (Table 3).

The most cited documents are Leidner and Jarvenpaa (1993), with 192 citations; with 177 citations Harder (2010), 167 citations Woltering et al. (2009), with 166 citations, Moraros et al. (2015). Leidner and Jarvenpaa (1993), which has the most citations with 177 citations; in their study titled "The information age confronts education: Case studies on electronic classrooms", examined the use and results of computer-based instructional technology in the context of postgraduate business education and compared the use of computer-based instructional methods to traditional methods and computer-based methods that do

Table 3 Most cited documents for computer assisted instruction in science education

Document	Documents	Citations
leidner ; jarvenpaa s.l. (1993)	1	192
harder b.n.(2010)	1	177
woltering v.; herrler a.; spitzer k.; spreckelsen c.(2009)	1	167
moraros j.; ıslam a.; yu s.; banow r.; schindelka b.(2015)	1	166
raggi v.l.; chronis a.m.(2006)	1	161
shih m.; feng j.; tsai c.-c.(2008)	1	155
fidan m.; tuncel m.(2019)	1	152
zary n.; johnson g.; boberg j.; fors u.g.h.(2006)	1	135
cook d.a.; levinson a.j.; garside s.(2010)	1	132
çepni s.; taş e.; köse s. (2006)	1	121

not require the practical use of students. Indicated that it offered an advantage. The fact that this research was conducted many years ago can also indicate that it has more citations. Notably, the work of Fidan and Tuncel (2019) is among the documents with the highest number of citations, with 152 citations. Although the study was conducted in 2019, this highly cited study is likely due to its high quality.

3.5. Term analysis of computer-assisted instruction in science education: Most used terms

In order to determine the top 10 most used terms out of 10881 terms obtained in the search, at least 62 or more used terms were included in the analysis. Sixteen terms met the relevant threshold. A fitness score was calculated for each of the 16 terms. Accordingly, the most relevant terms were selected. For this, 60% of the most relevant terms were selected, and ten were reached (Table 4).

When the analysis results were examined, the most used term was "student". It was concluded that terms such as "study", "education", "learning", and "science" are used more frequently than other terms. This situation is because science education studies are primarily experimental, and students are preferred as the sample group. When the literature is examined, there are similar studies supporting this situation (Sözbilir et al., 2015; Özcan & Çalışkan, 2020; Kara, 2021). As a matter of fact, in support of this finding, Lin et al. (2018) examined the research trends in science education with content analysis in their study named "Research trends in science education from 2013 to 2017: A systematic content analysis of publications in selected journals". They stated that subjects such as learning, education programs, and educational technologies are the subjects that they focus more on.

Table 4 Most common terms for computer-assisted instruction in science education

Term	Occurrences	Relevance Score
Student	315	26.157
Study	242	14.275
Education	225	0.9829
Learning	194	0.7876
Science	190	0.7622
Computer	188	0.7343
Course	160	0.9839
Technology	154	0.5416
Teaching	151	0.6323
Instruction	117	0.532

4. CONCLUSION

This study aims to examine the studies on computer-assisted teaching in science teaching in terms of different variables using bibliometric analysis. When the literature is examined, no research has been found that provides bibliometric analysis of research trends in documents related to computer-assisted teaching in science teaching. Therefore, this study is the first study in this field. By

thoroughly evaluating the current knowledge in the field, this type of research can help determine in which areas computer-assisted instruction in science education is concentrated, more widespread, and future research trends. This creates a unique field for new studies on the subject. This study provides an overview and an effective understanding of the current literature on computer-assisted teaching in science education. It also provides interesting information on the development of the area. This study's results are important for the future development of computer-assisted instruction in science education. Although the research is a study on computer-assisted teaching in particular, it is generally related to science education as a research area. Therefore, it explains how the subject can be handled in related disciplines. The prominent results of the research are as follows: 72.2% of 454 publications on computer-assisted teaching in science education are articles; most studies were done in 2010. The most frequently used keywords were computer-assisted education, education-computer-assisted, and e-learning. The countries that published the most on the subject were the United States, England, and Australia. The most cited document is Leidner &. Jarvenpaa (1993) with 192 citations. The most used term on the subject was "student".

This research aims to reveal the priority issues in this field and the relationships between studies. From this point of view, science education research will fill the literature gaps and allow the opportunity to follow new trends closely. In addition, considering the macro data presented in this study, more detailed bibliometric studies can be conducted in different fields of education. Bibliometric studies are important for researchers to follow closely the studies and developments in that field. The research will also include a method applicable to different fields of science. For this reason, it gives direction to new research about the method to be followed, and it can be recommended to conduct bibliometric research in another discipline

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