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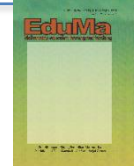
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Bibliometric Analysis: Trend of ICT and RME Researches

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abstract

Research in both ICT and RME is expanding at a breakneck pace. The growth of study in engineering can be tracked by one type of analysis known as bibliometric analysis. This analysis can be used to identify the number of scholarly publications on ICT and RME. This study is of a quantitative and descriptive nature. Researchers are interested in examining the development of ICT and RME with these research questions (RQs), there are: the growth of ICT and RME research per year, authors have had the most impact on ICT and RME research, document sources have the most impact on ICT and RME research, and topics are related to ICT and RME research? As well as the distribution pattern of publications in Scopus, which is based on research affiliations, research themes, and scientific journals. For the goals of data analysis, reduction, visualization, and mapping, Bibliometrix R-tool and BiblioShiny were utilized throughout this research. Scopus bibliometric study finds that between 1999 and 2022, there was a shift in the number of research articles that could be located in the Scopus online database associated with ICT and RME. 2020 was the year that this publication - *Journal on Education and Information Technologies* - reached its zenith. In terms of the number of documents generated, research in the field of ICT is dominated by writers from the Czech Republic and the Netherlands.

Keywords:

ICT, realistic mathematics, Bibliometric, mathematics education



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INTRODUCTION

A major instrument for educational change and reform is information and communication technology (ICT). A number of earlier studies have demonstrated that a proper application of information and communications technology (ICT) can improve the quality of education and connect it to real-life problems (Lowther et al., 2008; Weert & Tatnall, 2005). The use of information and communication technology is employed in order to improve teaching and learning, and it also identifies promising good practices in order to enable the drawing of general lessons that are of interest to many countries (Yoong & Lew, 2009, 2010). In the majority of countries, the percentage of science instructors who report using ICT is noticeably greater than the percentage of mathematics teachers who report using ICT. This finding was replicated in a number of additional studies as well .

The potential to use information and communications technology to assist students in performing better in mathematics is the impetus behind the widespread implementation of ICT in mathematics classrooms. Integration of information and communication technologies into the classroom is a promising practice due to the potentials of these technologies; yet, its effectiveness depends on a variety of circumstances (Phuong et al., 2022). A further issue with the mathematics curriculum in Indonesia is its isolation from current developments in information and communication technology (ICT). It is unfortunate that this is the case because studies have shown that information and communications technology can serve as an effective driving force in the implementation of alternative instructional strategies, such as those based on activity or those that take a more realistic approach to teaching mathematics and science (Heck, 2003; Widjaja & Heck, 2003). One of the ongoing goals of the developmental research that is being conducted is to modify the RME instructional design perspective so that it may be used to the teaching and learning of mathematics in Indonesia (Fauzan et al., 2002; Hadi & Plomp, 2001). Research in both ICT and RME is expanding at a breakneck pace. The growth of research in engineering can be tracked by one type of analysis known as bibliometric analysis. This analysis can be used to identify the number of scholarly publications on ICT and RME.

Researchers might benefit from using bibliometric analysis while doing research on bibliographic material and conducting citation analysis of each article published in scientific journals and other types of scientific literature. The type of publication, the study topic area, the place of origin of the researcher, the journal in which it was published, and the language used in the article are all examples of bibliographies that can be utilized in bibliometric analysis (Hamidah et al., 2020; Nandiyanto & Al Husaeni, 2022). A quantitative approach to analyzing the bibliographic data presented in the article is what's known as a bibliometric analysis, which you can think of as another name for. A statistical strategy is utilized in the bibliometric method, which is a technique for evaluating the body of written work. Bibliometric analysis is an approach that is regarded to be successful in producing data sets that may be exploited in the process of increasing the quality of research (Raan, 1999).

As a result of this reason, the goal of this research is to collect knowledge from earlier researchers in the field so that we can address this issue. Within the scope of this study, we will be looking into the following four research questions (RQs):

RQ1. How is the growth of ICT and RME research per year?

RQ2. Which authors have had the most impact on ICT and RME research?

RQ3. Which document sources have the most impact on ICT and RME research?

RQ4. What topics are related to ICT and RME research?

METHODS

The objective of this bibliometric study was to carry out an analysis of the previous academic work that has been done on the topic of Information and Communications Technology (ICT) and Realistic Mathematics Education (RME). The first thing that has to be done in order to conclude a bibliometric study is to generate a comprehensive list of the publications that have the possibility of being a part of our sample. This is the first step that needs to be taken (Oermann et al., 2008). This study is of a quantitative and descriptive nature. Researchers are interested in examining the development of ICT and RME, as well as the distribution pattern of publications in Scopus, which is based on research affiliations, research themes, and scientific journals. For the goals of data analysis, reduction, visualization, and mapping, respectively, Bibliometrix R-tool and BiblioShiny were utilized throughout the course of this research. The analysis of the entire article mapping was carried out with R-Studio, which was the version of Bibliometric that was used (Aria & Cuccurullo, 2017a; Cuccurullo et al., 2016).

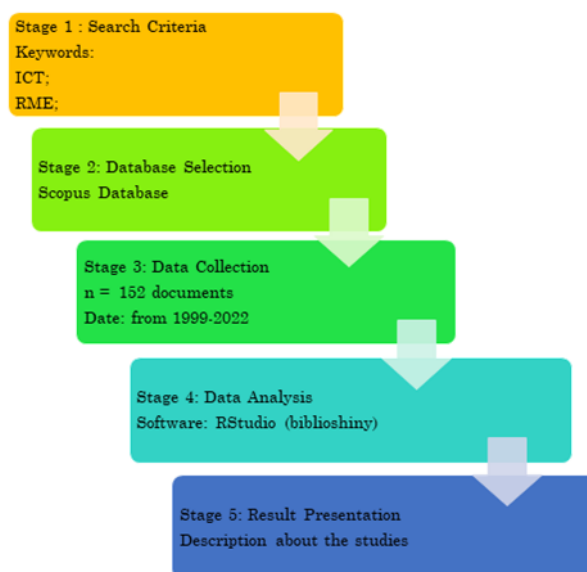


Figure 1
Stage of Bibliometric Analysis ICT and RME

Stage 1

First, this research must rely on scientific materials on ICT and RME research. This keyword has many uses. First, it makes sure the scientific literature is relevant. Second, it ensures the research stays on track. Many synonyms and initial search strings consist of three parts: the first focuses on ICT using "ICT" OR "Information and communication technologies", the second focuses on RME using "RME" OR "Realistic Mathematics Education".

Stage 2

Secondly, this study comprises a search of the scopus database, one of the most important scientific databases and the most reputable citation database in the scientific community.

Stage 3

The third, the search for the data was performed in the month of July in 2022. The search conducted on Scopus yielded a total of 152 documents derived from 104 different sources. The findings of the data search are exported in the ".csv" format which enabled their input into the bibliometric program called biblioshiny (Aria & Cuccurullo, 2017a; Cuccurullo et al., 2016), which is utilized for analysis, once the search for the data has been completed in its whole.

Stage 4

The fourth step, which followed the collecting of the data, was the evaluation of the chosen documents with the chosen stream taken into consideration just before the data synthesis. At this point, we should evaluate whether or not the study is pertinent. The primary concepts uncovered in the texts discovered are dissected in terms of their relevance on ICT and RME. For the purposes of this study, the open-source bibliometric R-package software was utilized. This software offers bibliometric capabilities. In the programming language R, Aria and Cuccurullo developed a package called R. (Aria & Cuccurullo, 2017b). It includes mathematical, statistical, and scientific mapping algorithms. Biblioshiny is a web interface application that is included in the most recent version of the bibliometric R-package (2.0 and beyond), which makes it possible for users who are not proficient in coding to conduct bibliometric analysis. BibTex, CSV, or plain text files containing data from Scopus or Web of Science can be imported into Biblioshiny. The Biblioshiny platform processes the data. Biblioshiny's CSV import was utilized in this study project so that we could import data from Scopus.

Stage 5

Only the conclusive findings and a quantitative assessment of the research were looked into, after which the data had been processed and analyzed. The results section includes both detailed explanations of the findings as well as visual representations of those findings.

RESULT AND DISCUSSION

Table 1 displays the main information from Scopus, including the number of entries, Time period from 1999 to 19 July 2022, 104 number of Sources (Journals, Books, etc.), Documents (152), number of authors (347) found in ICT and RME research , and complete information can be seen in Figure 2 and Table 1.

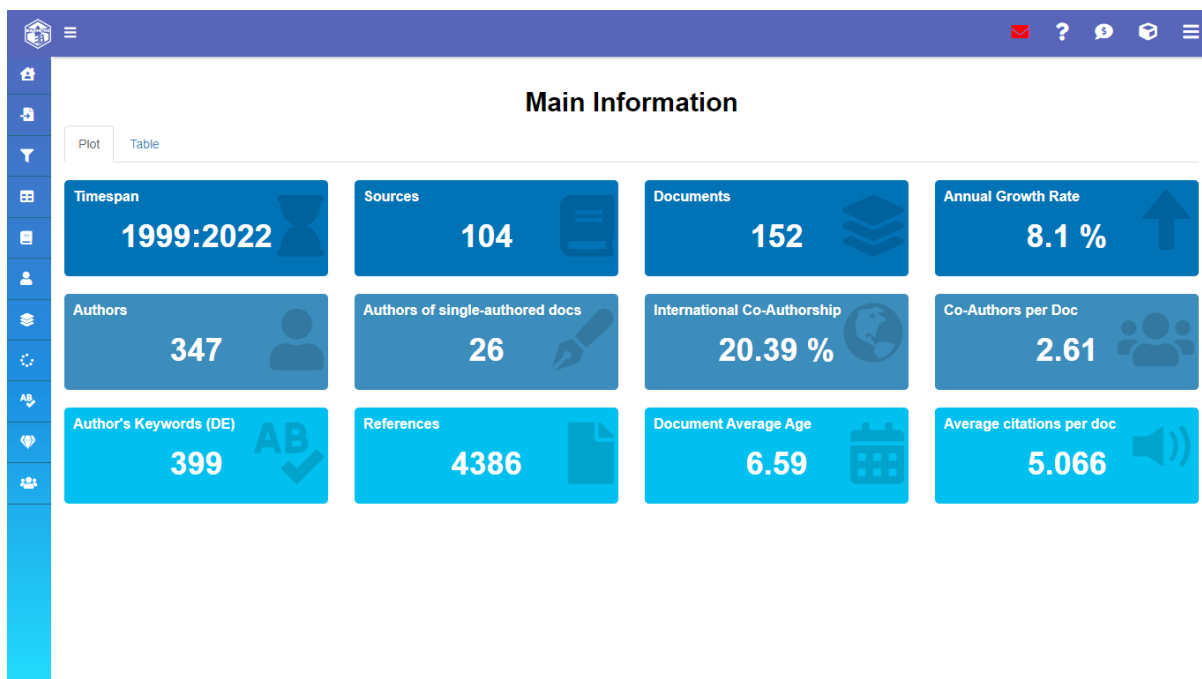


Figure 2
Main Information about ICT and RME Researches

Table 1
Main Information about ICT and RME Researches

| Main Information About Data | Document Contents | Document Types |
|--------------------------------|-------------------|--|
| Timespan | 1999:2022 | Keywords Plus (ID) 400 article 76 |
| Sources (Journals, Books, etc) | 104 | Author's Keywords (DE) 399 book 3 |
| Documents | 152 | AUTHORS book chapter 16 |
| Annual Growth Rate % | 8.1 | Authors 347 conference paper 52 |
| Document Average Age | 6.59 | Authors of single-authored docs 26 editorial 1 |
| Average citations per doc | 5.066 | AUTHORS erratum 1 |
| References | 4386 | COLLABORATION Single-authored docs 29 |
| | | Co-Authors per Doc 2.61 review 3 |
| | | International co-authorships % 20.39 |

RQ1. How is the growth of ICT and RME research per year?

The growth rate of the resource is broken out by annual occurrence in Figure 2. The line graph illustrates the yearly progression of research into ICT and RME. Research in areas of ICT and RME has increased at an annual growth rate of 8.1 percent. If you use the Scopus online database, the accompanying figure will show you how ICT and RME research has evolved from 1999 to 2022. The findings of classroom experimental research (Heck, 2003) revealed that students achieved amazing progress in their learning of RME and ICT. This was one of the aspects that contributed to the successful attempt to increase the average growth rate of this RME and ICT research.

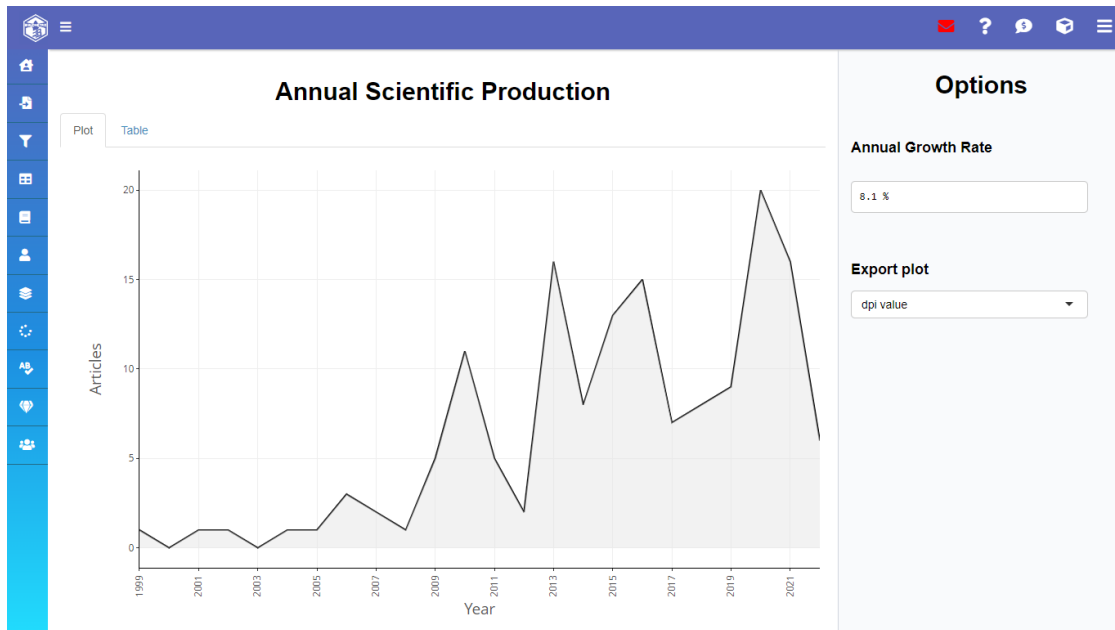


Figure 3
Annual Scientific Production about ICT and RME Researches

Table 2
Annual Scientific Production about ICT and RME Researches

| Year | Articles | Year | Articles |
|------|----------|------|----------|
| 1999 | 1 | 2011 | 5 |
| 2000 | 0 | 2012 | 2 |
| 2001 | 1 | 2013 | 16 |
| 2002 | 1 | 2014 | 8 |
| 2003 | 0 | 2015 | 13 |
| 2004 | 1 | 2016 | 15 |
| 2005 | 1 | 2017 | 7 |
| 2006 | 3 | 2018 | 8 |
| 2007 | 2 | 2019 | 9 |
| 2008 | 1 | 2020 | 20 |
| 2009 | 5 | 2021 | 16 |
| 2010 | 11 | 2022 | 6 |

Only 27 articles had been published on the subject of ICT and RME between the years of 1999 and 2010, however that number more than doubled to 125 publications between 2011 and 2022. When compared to the total of 16 articles published in 2013, the number of publications declined by 8 in 2014. However, this trend continued, and the number of publications fell by another 7 in 2017. According to a review, the number of articles published in the field of ICT and RME research peaked in the year 2020 with 20. As a direct consequence of this, the number of publications that deal with ICT and RME that are published in the Scopus database has decreased.

RQ2. Which authors have had the most impact on ICT and RME research?

H-index, m-index, e-index and i10-index are used to measure an author's influence on the academic community. The number of times a researcher's academic work is mentioned is often used to gauge an author's influence (also known as citation metric). This citation metric is then utilized to assess a researcher's impact and output. The h-index is the most commonly used author statistic that incorporates citation metrics (Bhardwaj et al., 2017). The findings of this study will allow us to show the influence of authors and authors based on the number of articles that they have generated.

The leading ICT and RME authors are included in Table 1, along with their total number of citations and the number of articles they have contributed to the respective fields. It is interesting to note that there is a substantial gap between the two scores (by documents and citations). This means that the author who has the most documents on ICT and RME might not also have the most citations, and vice versa. For instance, Novotná produced six publications in the field of information and communications technology, while RME, which was ranked number one in terms of documents, only had a total of four citations (not in the top 10 in terms of citations). In the opposite way, it was noted that De Witte in 2014 received a total of 55 citations (ranked 1 in terms of citations), but they only produced one ICT and RME document. This indicates that although they are highly cited, they only publish a single document (not included in the top 10 in terms of documents).

In terms of documents, the top 10 ICT and RME authors are dominated by authors from the Czech Republic. Meanwhile, in the top 10 rankings, every country holds one spot, and none of them are particularly dominant in terms of the number of citations received by their ICT and RME writers. A author from the Netherlands, De Witte is known for being the author of the works that have received the most citations.

Study of (De Witte & Rogge, 2014) used data from the 2011 TIMSS (Trend in International Mathematics and Science Study) to create a Mahalanobis-matched control group comprising students, teachers, schools, and regions that were all similar in some way. The findings suggest that accounting for or not taking into account these factors can significantly vary the anticipated impact of ICT.

Different from (De Witte & Rogge, 2014), (Trouche & Drijvers, 2010) have personal perspective that benefits and drawbacks of integrating handheld technology into our daily lives. It's important, in their opinion, to raise awareness about how kids' use of technology impacts their mathematical thinking in subtle and nuanced ways. Mathematical education that incorporates technology can be made more effective by studying instrumentation theory and orchestration.

Table 3

Top 10 Authors Name Based on frequency and Citations in ICT and RME publications

| Authors | Articles | Authors | Doi | Total Citations |
|-------------|----------|----------------------------|-------------------------------|-----------------|
| Novotná J | 6 | (De Witte & Rogge, 2014) | 10.1016/j.compedu.2014.02.012 | 55 |
| Zaranis N | 6 | (Trouche & Drijvers, 2010) | 10.1007/s11858-010-0269-2 | 50 |
| Purwanto SE | 5 | (Pade-Khene et al., 2011) | 10.1080/02681102.2011.568222 | 46 |
| Fan L | 4 | (Agyei & Voogt, 2011) | 10.1007/s10639-010-9141-9 | 40 |

| Authors | Articles | Authors | Doi | Total Citations |
|-------------------------|----------|-------------------------|----------------------------------|-----------------|
| Jančařík A | 4 | (Ottestad, 2010) | 10.1111/j.1365-2729.2010.00376.x | 25 |
| Albano G | 2 | (González et al., 2014) | 10.1145/2669711.2669903 | 25 |
| Baya'a N | 2 | (Mailizar & Fan, 2020) | 10.29333/ejmste/110352 | 21 |
| Campbell C | 2 | (Barana et al., 2017) | 10.1109/COMPSAC.2017.44 | 21 |
| Chionidou-Moskofoglou M | 2 | (Chen & Wu, 2020) | 10.1016/j.compedu.2019.103740 | 19 |
| Daher W | 2 | (Petrova et al., 2018) | - | 19 |

RQ3. Which document sources have the most impact on ICT and RME research?

The leading sources of research on ICT and RME have most impact are detailed in Table 3, which ranks the sources according to the number of documents relating to ICT and RME that they cite. Using the most comprehensive and extensive bibliographic database available over a three-year period, the SJR calculates the prestige or influence of scientific journals. The citation window used is wide enough to include all journals in the database and dynamic enough to track the evolution of scientific journals (González-Pereira et al, 2010). In terms of the total number of documents, the top five sources are as follows: Journal on Education and Information Technologies (SJR 2021 = 1.06), the Journal on Eurasia Journal of Mathematics, Science and Technology Education (SJR 2021 = 0.57), the New Icmi Study Series (SJR 2019 = 1.5), the ACM International Conference Proceeding Series (SJR 2021 = 0.23), and the Australian Educational Computing (SJR 2021 = 0.12).

Table 4.
Top 10 Resources Based on Impact in ICT and RME Publications

| Element | H_Index |
|--|---------|
| Education and Information Technologies | 6 |
| Eurasia Journal Of Mathematics, Science and Technology Education | 3 |
| New ICMI Study Series | 3 |
| ACM International Conference Proceeding Series | 2 |
| Australian Educational Computing | 2 |
| Australian Journal of Teacher Education | 2 |
| Computers and Education | 2 |
| International Journal of Research in Education And Science | 2 |
| Journal of Physics: Conference Series | 2 |
| Mathematics Education Research Journal | 2 |

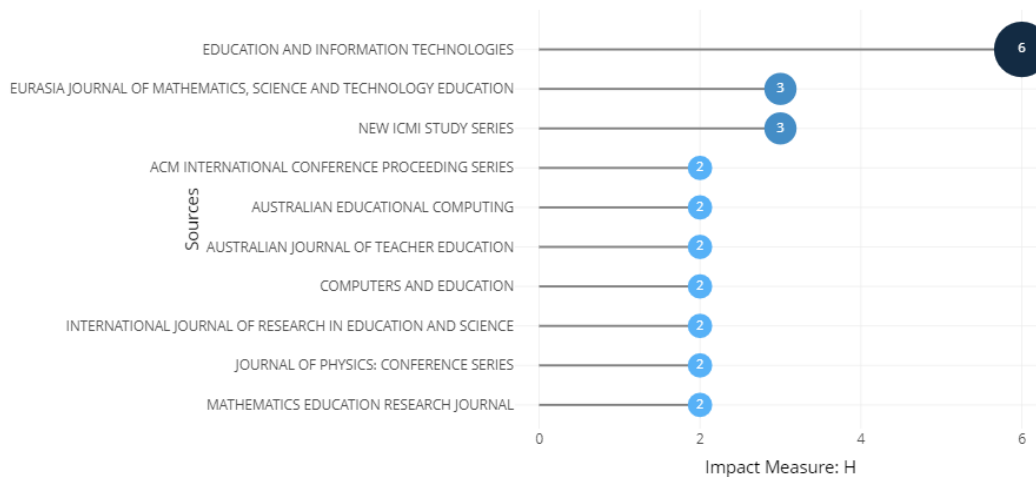


Figure 4.
Top 10 Resources Based on Impact in ICT and RME Publications

RQ4. What topics are related to ICT and RME research?

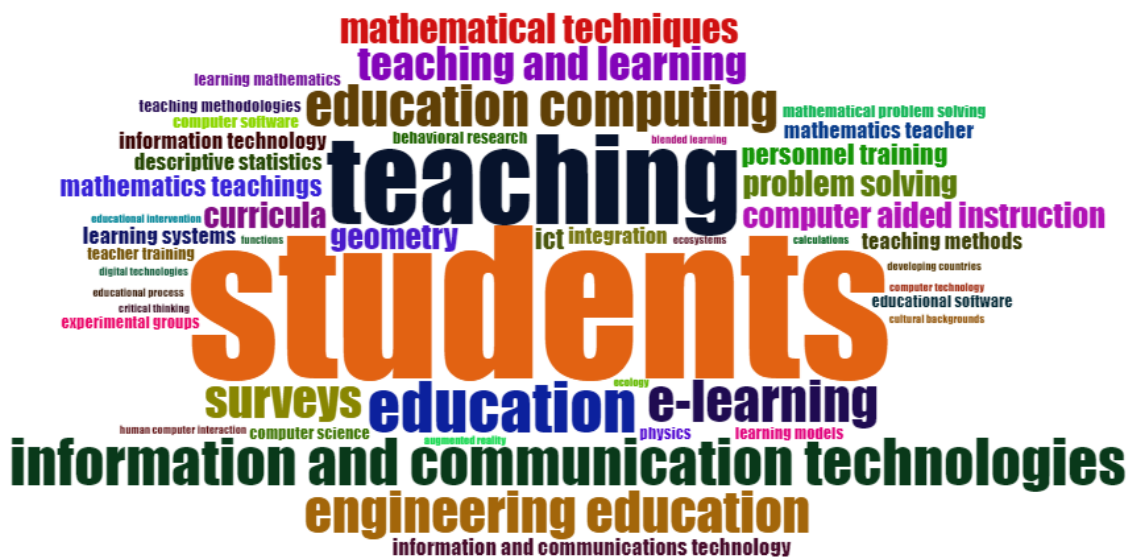


Figure 5
Wordcloud in ICT and RME publications

Word Cloud was generated using the 'Biblioshiny App' of the R version 4.1.2 program. In the graphic parameters, plus has been selected. The primary benefit of selecting the keyword plus is that it provides insight into the most important subjects and research trends in ICT and RME. The maximum number of keywords plus allowed is 50. Image-wise, a circle is definitive. Assigning a random dark color as the text color. The values for ellipticity and padding are 0.65 and 1. Figure 5 depicts a visualization of the 50 most frequently occurring keywords in addition to mathematics education, which is highly visible to students at the next level, where the words teaching, education, information and communication technologies, e-learning, education computing, engineering education, surveys, and teaching and learning are also displayed.

CONCLUSION AND IMPLICATION

Conclusion

According to the findings of this bibliometric study, it was discovered that between the years 1999 and 2022, there was a shift in the number of research articles that could be located in the Scopus online database that were associated with ICT and RME. The year 2020 was the year that this publication on ICT and RME reached its zenith, which is also the year that it reached its full potential. The publication outcomes are dominated by journal volumes that are part of conference series. In terms of the quantity of documents generated, research in the fields of ICT and RME is dominated by writers from the Czech Republic. Despite the fact that their work is built on quotations that are utilized extensively, writers from the Netherlands lead the pack far ahead of other writers. The leading sources of research on ICT and RME have most impact is Journal on Education and Information Technologies (SJR 2021 = 1.06). In terms of trends that arise based on keywords plus words, mathematics education and student are two words that frequently appear from ICT and RME. The current study provides a complete view of ICT and RME from a respected database, however it has limitations. First, picking articles and data sets is difficult in bibliometrics. Scopus has the most studies, but it may miss crucial ones. Future analyses will use Google Scholar and Web of Science multisource searches. VOSviewer must be used to analyze the data.

Implication

Research in ICT and RME has become a worldwide trend that is expanding in terms of membership and geographic scope. Cultural and educational distinctions exist amongst countries across the globe, and many publications emanate from these regions. A trend in mathematics education and students has been discovered, and we believe that further research into ICT and RME should focus on these two terms.

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