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How to Calculate Bibliometric Using VOSviewer with Publish or Perish (Using Scopus Data): Science Education Keywords

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A B S T R A C T

The purpose of this study is to analyze and demonstrate step-by-step bibliometric data analysis using VOSViewer completely and systematically using article data taken from Scopus. A step-by-step analysis is provided to make first-time users easily follow how to use VOSviewers. This research makes it possible to provide easy data analysis by utilizing capture tools and providing analysis of research developments related to science education. The method used in this study is to perform bibliometric analysis to produce various types of visualizations, namely network visualization, overlay visualization, and density visualization. The analysis was carried out by the number of publications obtained related to a predetermined topic of 200 documents with the range of article publication years from 2013 - 2023. As a practical example, we evaluate the analysis of articles that discuss the keywords used for data collection, namely "Science Education". We found that VOSviewer can be used for shock results in 3 forms of visualization.

A R T I C L E   I N F O

1. INTRODUCTION

Data analysis using the bibliometric method which is displayed visually with the help of data search tools is urgently needed in today's era, where technology is growing, and human life is heavily influenced by technology. The disaster tools used in bibliometric data analysis are used to obtain research developments from various fields of science. One example of a tool that can be used as data-prone software in bibliometric data analysis is VOSviewer.

VOSviewer is a software that can be used to visualize publication data (Van Eck & Waltman, 2017). This software is very useful for researchers, librarians, and publication database managers to analyze publication data and collaboration networks. VOSViewer offers a text mining function that can be used to build and visualize correlations in article or publication excerpts (Pradhan, 2017). Publication maps can be displayed in several ways and functions, such as zooming, scrolling, and searching system mapping. Thus, articles can be mapped in more detail. VOSviewer presents and represents specific information about bibliometric chart maps. In addition, VOSviewer also provides three forms of visualization, namely network visualization, overlay visualization, and density visualization.

VOSViewer has recently been very popular in analyzing the position of research to be carried out and measuring the novelty of a study. We can display large bibliometric maps in an easy way to interpret a relationship via VOSViewer. VOSViewer has several characteristics, including being able to map various types of bibliometric analysis, supporting several major bibliographic databases, ignoring the time dimension, being limited to analysis of small to medium amounts of data, is intended for text processing functions, using layout and cluster techniques, uses visualization features expanse and density.

Many studies on VOSViewer include research discussing guidelines for using the VOSviewer application (Van Eck and Waltman, 2010), research on the stages of bibliometric data analysis with VOSviewer using google scholar indexed article data (Al Husaeni & Nandiyanto, 2022), research on bibliometric mapping with VOSviewer in agriculture (Tupan, 2016), Bibliometric analysis on chemical engineering (Nandiyanto *et al.*, 2021), and bibliometric analysis on bioenergy management using the VOSviewer application (Soegoto *et al.*, 2022). Although many have researched bibliometric data analysis using VOSviewer, only a few have conducted research that discusses how to make a bibliometric analysis using VOSViewer which is discussed in detail with several pictures of the steps accompanied by examples. Even research on research steps using Scopus data is still ongoing. not yet available.

SCOPUS is a library database that already has standards and a reputation in international journals. Journals indexed by Scopus can also have a high reputation on an international scale. Scopus itself is under the auspices of Elsevier which is one of the international scale scientific publications that has successfully indexed more than 22,000 article titles from 5,000 publishers.

Therefore, this research was conducted to be able to display bibliometric data analysis steps related to computer and personal computer research using Scopus-indexed article data and other tools such as VOSviewer and Publish or Perish. This research is expected to be used as a reference to be able to carry out big data analysis more easily by using VOSViewer with Scopus data. In addition, it is hoped that this research can also be used as a reference by first-time users because we provide a step-by-step process when using VOSviewer, Publish or Perish with the Scopus database.

2. METHOD
2.1. Preparation of Analysis Tools and Materials

In carrying out data analysis in a bibliometric way using VOSviewer, several applications must be prepared, including:

i) The VOSviewer application (**Figure 1**), this application is used as software that can visualize the analysis result data to be mapped later.

Figure 1. VOSviewer application logo.

ii) Reference management applications, applications that can be used for reference management are Publish or Perish (**Figure 2**) and Mendeley (**Figure 3**). This reference management application is used to collect research data which will later be used and analyzed bibliometrically using VOSviewer. In this study, we use Publish or Perish as reference management software.

Figure 2. Publish or Perish (PoP) application logo.

Figure 3. Mendeley application logo.

iii) Number processing application (Ms.Excel), ms.Excel (**Figure 4**) is used to assist in processing search results in article data using the Publish or Perish (PoP) reference manager application.

Figure 4. Microsoft Excel application logo.

2.2. Data retrieval

The article data used in this research is research data from articles that have been published in journals that have been indexed by Scopus. In addition, the article data obtained using the Publish or Perish reference manager application must also discuss the keywords used, namely "Science Education" with a range of 2013 - 2023.

2.3. Research Data Mapping

The application used for research data mapping is VOSviewer. The search result data uses the Publish or Perish application, then is saved in *.ris and *.csv formats. After the storage process is complete, the data in *.csv format is processed in such a way using the Microsoft Excel application. Data with *.ris format is used to process data on VOSviewer. In the VOSviewer application, power will be converted into a data map that is connected to one another.

3. RESULTS AND DISCUSSION
3.1. Scopus API Key Generation

In collecting data using Scopus, the first step that must be taken before collecting data is to register the API Key on the Scopus web. The steps for registering the Scopus API Key are as follows.

i)   Open the Scopus Page

To open the Scopus page, you can use Chrome or other browser applications. The trick is to type "Scopus" in the search box (**Figure 5**) and then click "enter". Then select a web page with the address "scopus.com" (**Figure 6**). After that, the start page of the Scopus web will appear as shown in **Figure 7**.
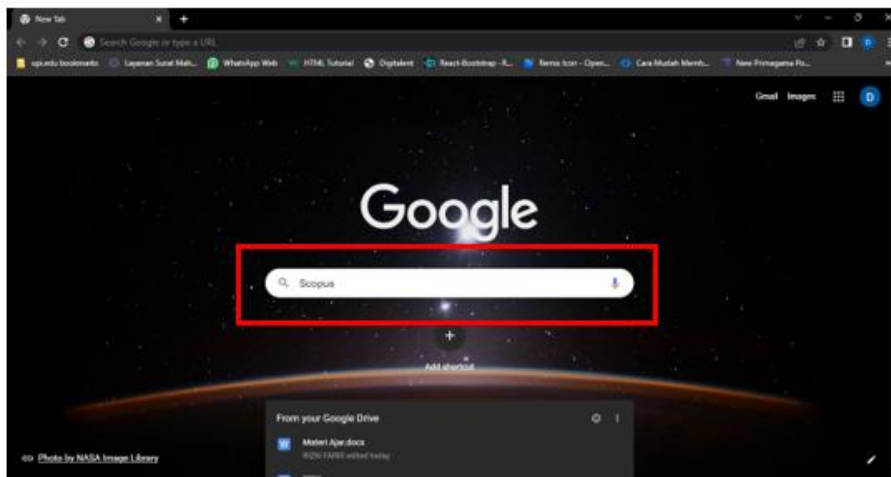
Figure 5. Scopus web search.
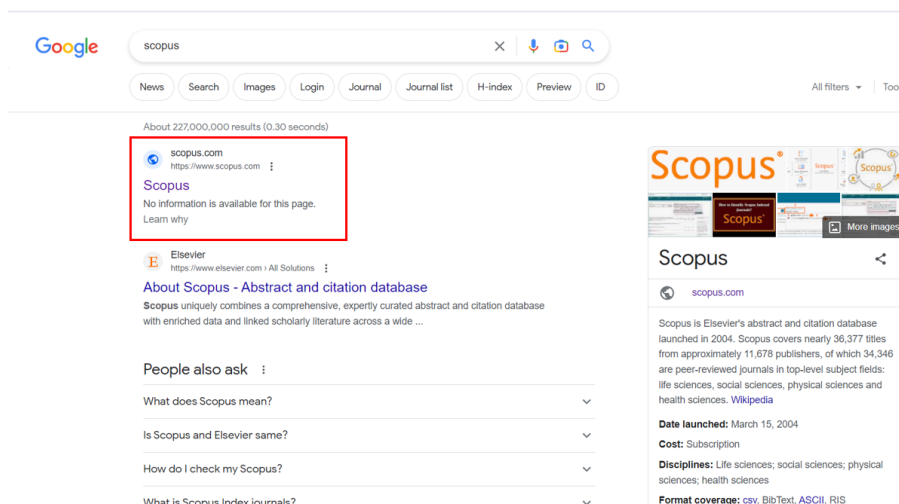
Figure 6. Scopus web address.
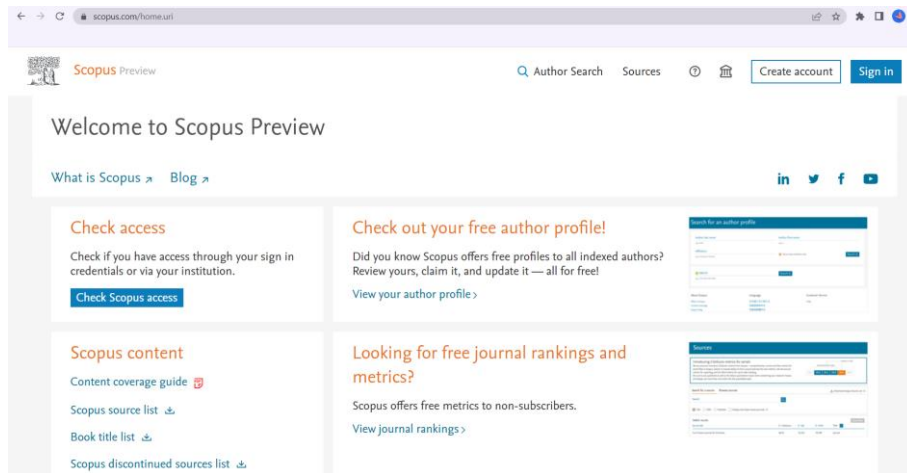
Figure 7. Scopus main page.

ii)   Login Scopus Account

After successfully logging into the Scopus web, the next step is to log in to the Scopus account that was created by entering the registered email (**Figure 8**).
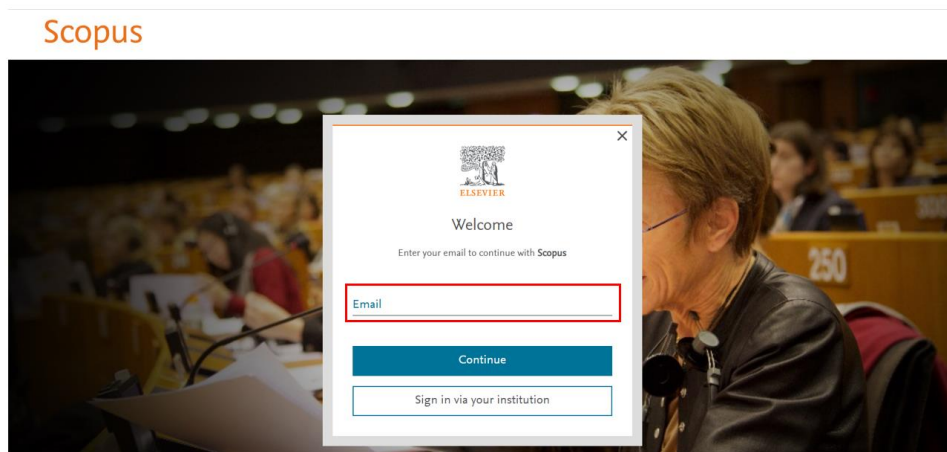

Figure 8. Login to Scopus Account.

iii) Enter the Scopus API Page

After successfully logging in, a display will appear as shown in **Figure 9**. Then the next step that must be taken is to click "Scopus API" which is on the Scopus page.
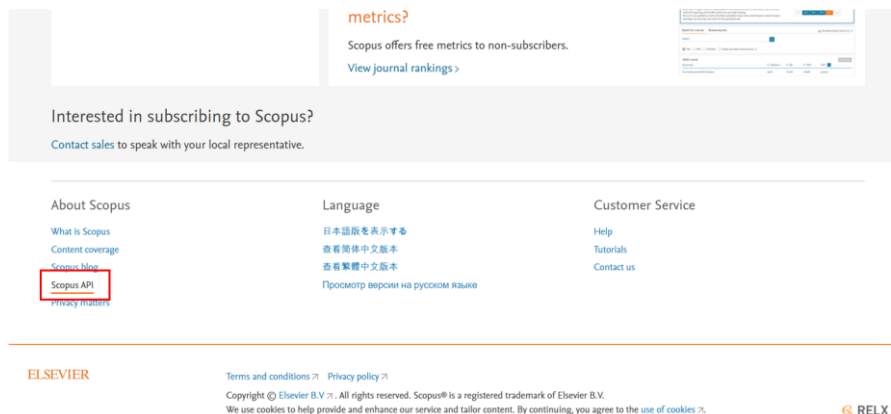

Figure 9. Click Scopus API on Scopus page.

iv) After that, select the My API Key menu (**Figure 10**).
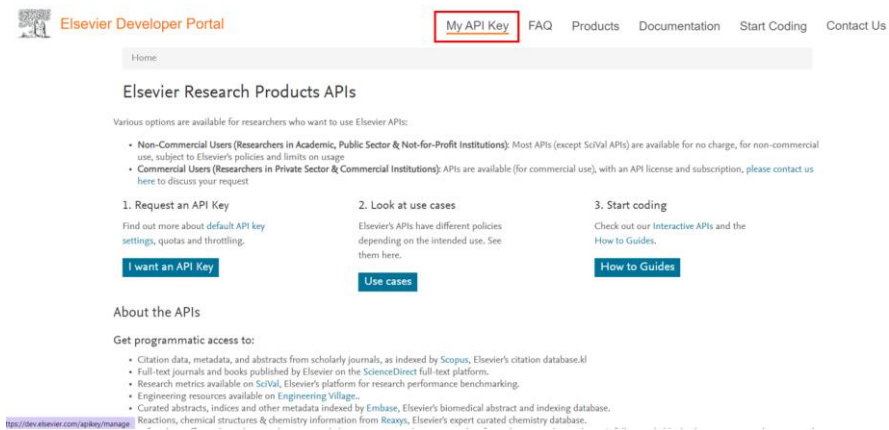
Figure 10. Click My API Key Menu.

v) Copy of registered API Key (**Figure 11**).
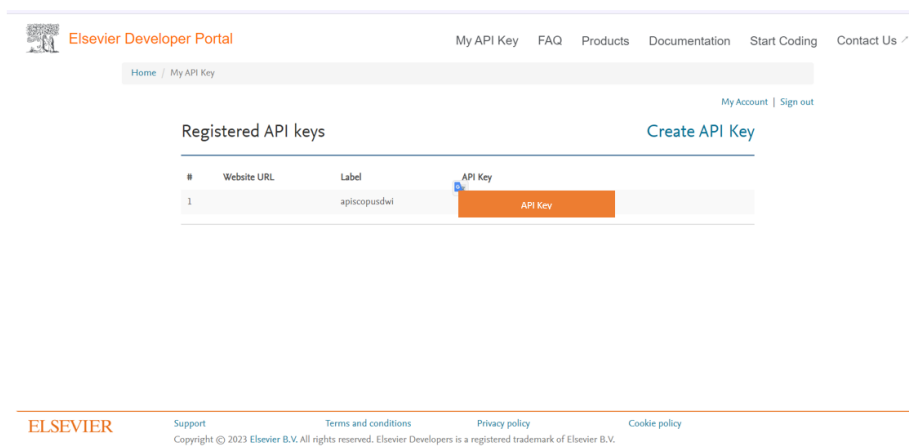
Figure 11. Copy API Key.

vi) If the API Key has not appeared, then you can create a new API by selecting the "Create API Key" menu (**Figure 12**).
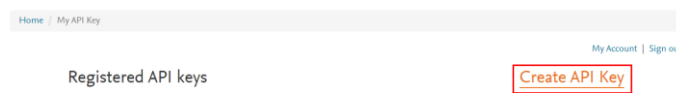

Figure 12. Create API Key.

vii) After that, fill in the "API Label" data with the desired API label, for website URLs you can fill it in or leave it blank (**Figure 13**).
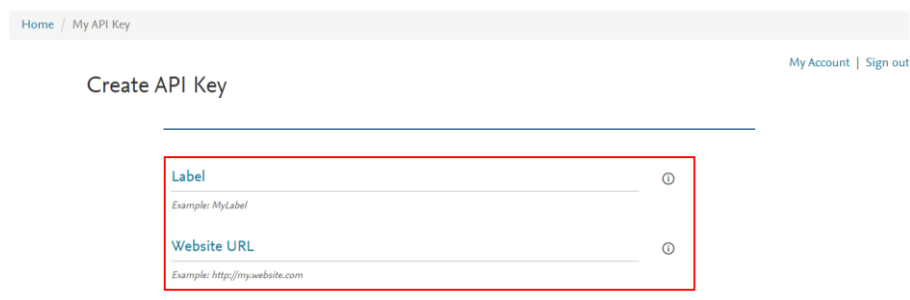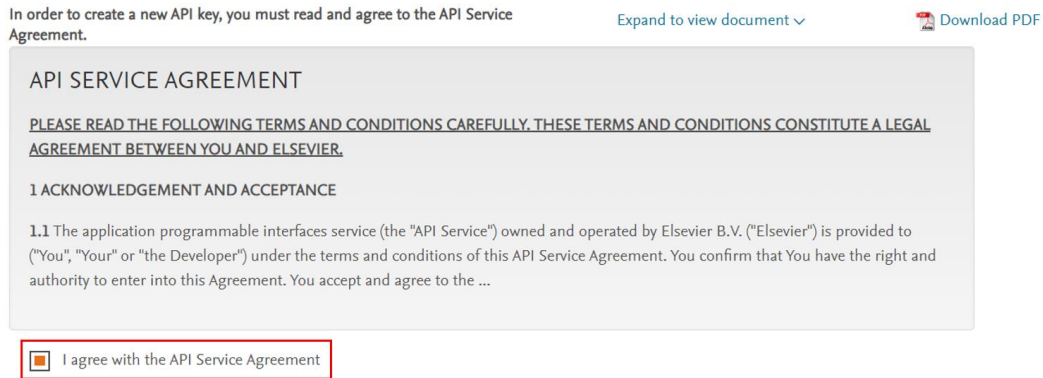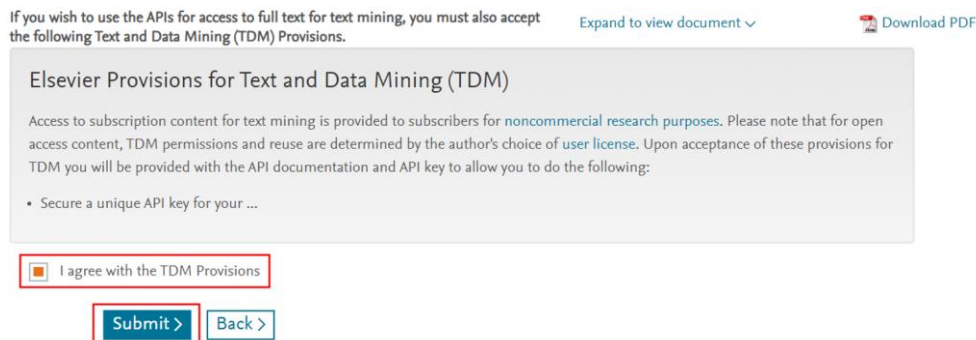

Figure 13. Fill label API data.

viii)After that check the box "I agree with the API Service Agreement" (**Figure 14**).

Figure 14. "I agree with the API Service Agreement" Column.

ix) Then also check the "I agree with the TDM Provisions" box, and the final step is to click the "submit" button (**Figure 15**).

Figure 15. "I agree with the TDM Provisions" Column and Submit button.

x) After that, you will be asked to enter a confirmation email and enter the email you used to log into your Scopus account (**Figure 16**).
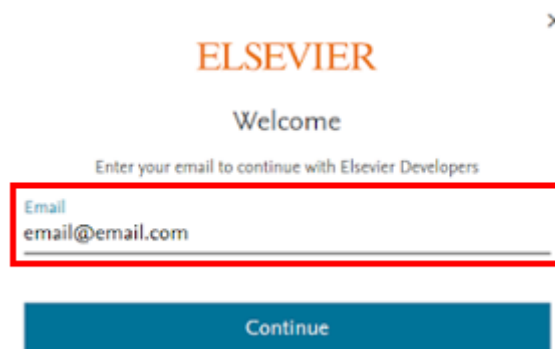
Figure 16. Email Confirmation.

xi) Then you can return to the "My API Key" page, and you can save the registered API key.

3.2. Data Used

The data taken through Scopus is used as an example for this research. This means that every article data in Scopus that is following the research theme will be used as a file to be used in VOSviewer. The steps of data collection are as follows.
i) Open the Publish or Perish Application

The first step that must be taken in data collection is to open a reference manager application, namely Publish or Perish (**Figure 17**). After the Publish or Perish application opens, the Publish or Perish main page will appear as shown in Figure 18.
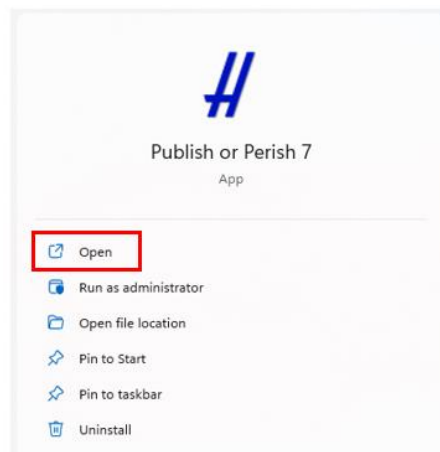

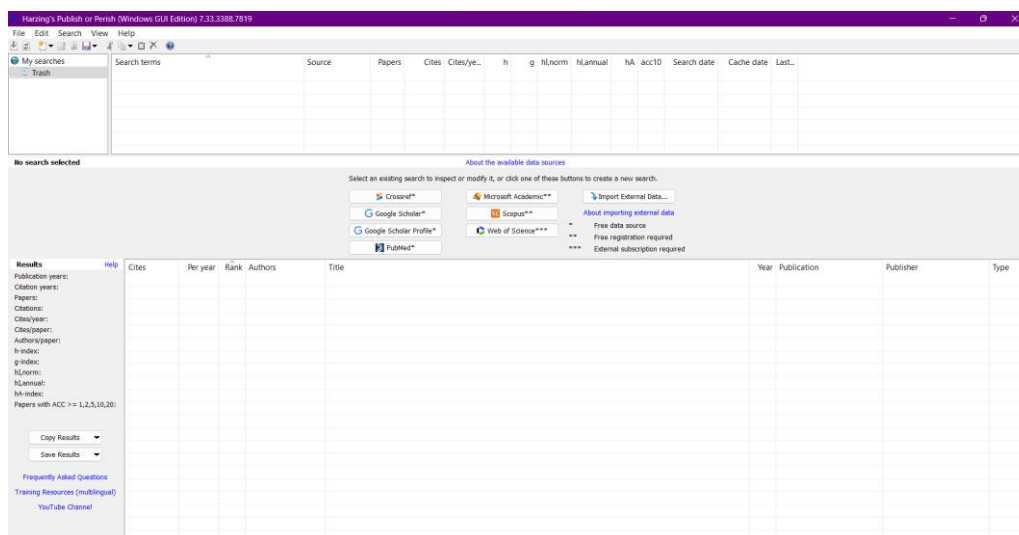**Figure 17**. Open the Publish or Perish application.

Figure 18. The main page Publish or Perish application.

ii) Select Scopus** data source to retrieve Scopus-indexed article data (**Figure 19**).
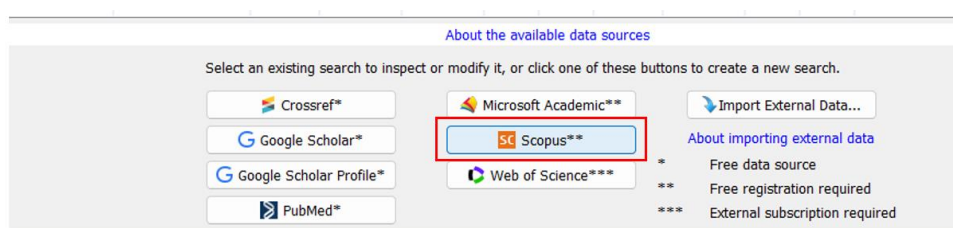

Figure 19. Choose Scopus** data resource.

iii) After that, enter the data or research keywords that you will be looking for starting from authors, affiliations, publications names, title words, and keywords. For example, we enter two search keywords through the "publications name and keyword fields" (**Figure 20**).

Figure 20. Fill field publications name and keywords.

iv) Also, enter the year range of the research you are looking for; in this example, we enter the year range 2013-2023. After completing entering the year range, press the search button to start the search (**Figure 21**).
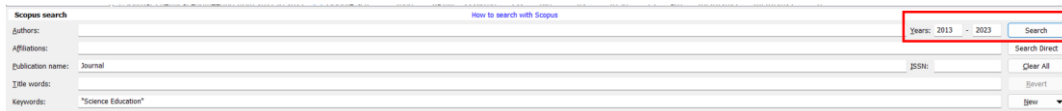

Figure 21. Fill in the year range and click the search button.

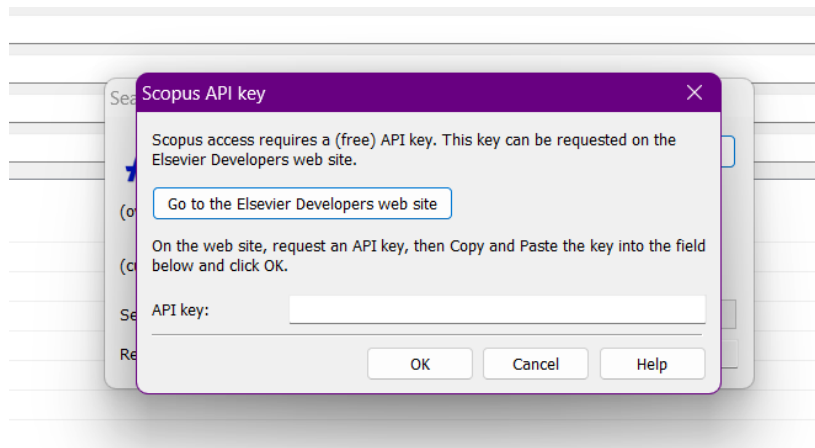v) After you click the "Search" button, a pop-up will appear as shown in Figure 22.

Figure 22. Pop Up after clicking the search button.

vi) In the pop-up shown in **Figure 22**, you must enter the Scopus API key that you got in the previous step (**Figure 23**).
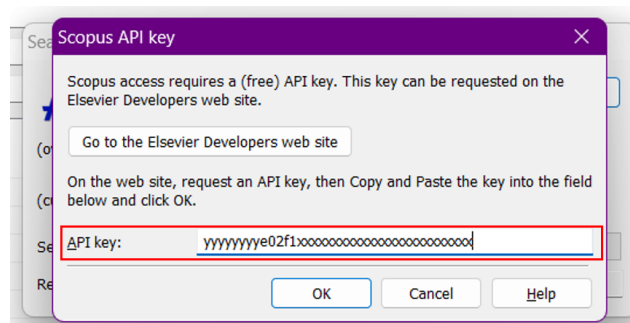

Figure 23. Fill API Key Scopus in API Key Column.

vii) If so, then click the "Ok" button (**Figure 24**), then the data search process will be carried out (**Figure 25**). While the data search process is in progress, what must be done is to wait until the data search process is finished.
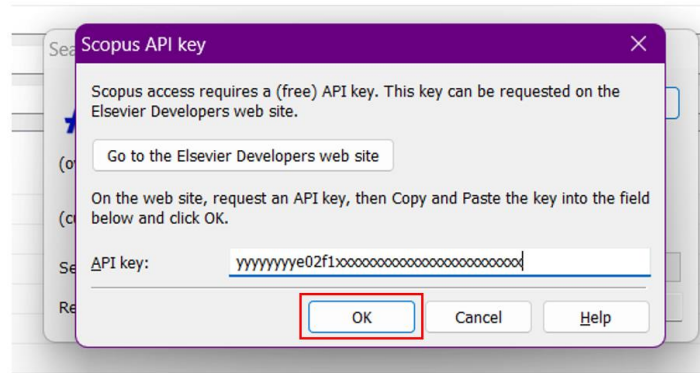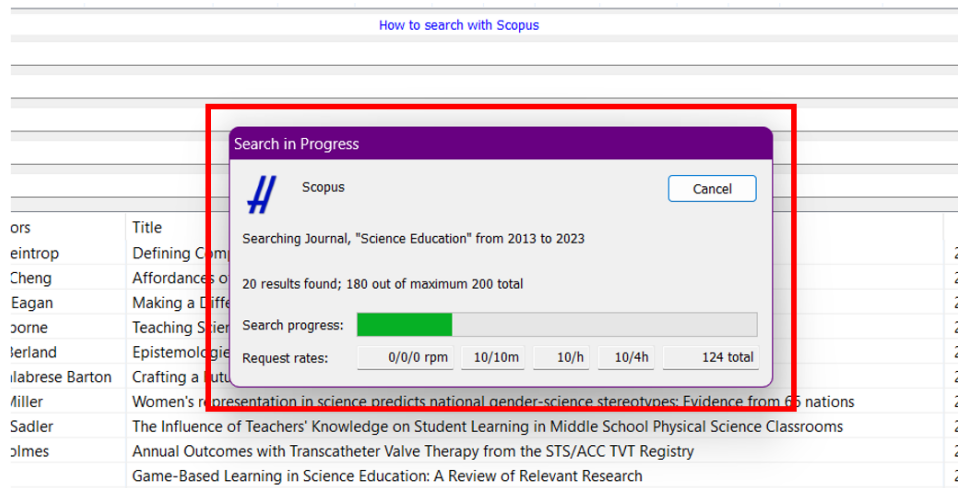
Figure 24. Click the "OK" button.

Figure 25. Data search process.

viii)If the search process is complete, a list of publications that match the search keywords that were entered in the previous stage will appear (Figure 26).

Figure 26. List of data search result publications.

The data search process was completed. As explained in the Method, the search result data must be saved in 2 formats namely *.ris and *.csv so that it can be processed again using Ms. Excel and VOSviewer. The steps for storing search results publication data in Publish or Perish are as follows.

i) Click the "Save Results" button on the Publish or Perish page (**Figure 27**).
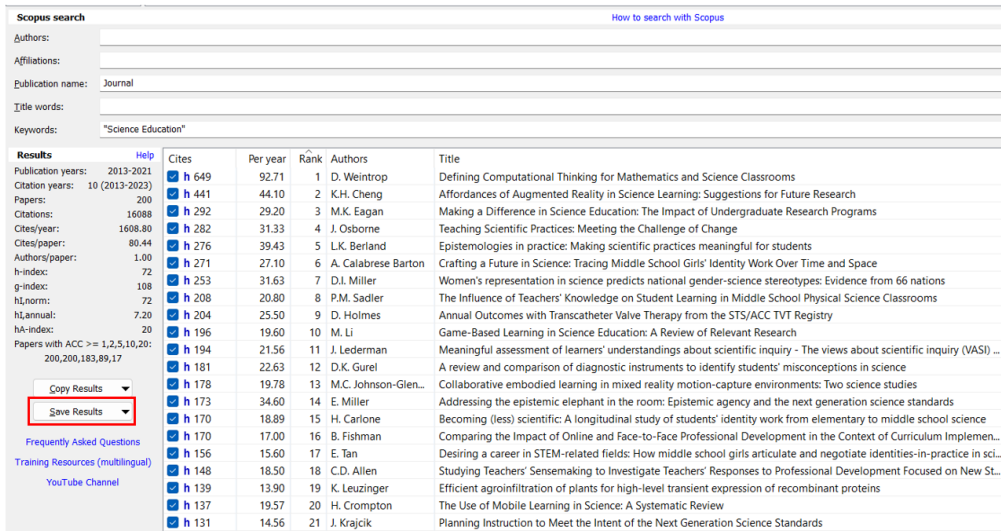
Figure 27. Save results button.

ii) After you press the "Save Results" button various kinds of save options will appear, then you just need to save in .RIS and .CSV types (**Figure 28**).
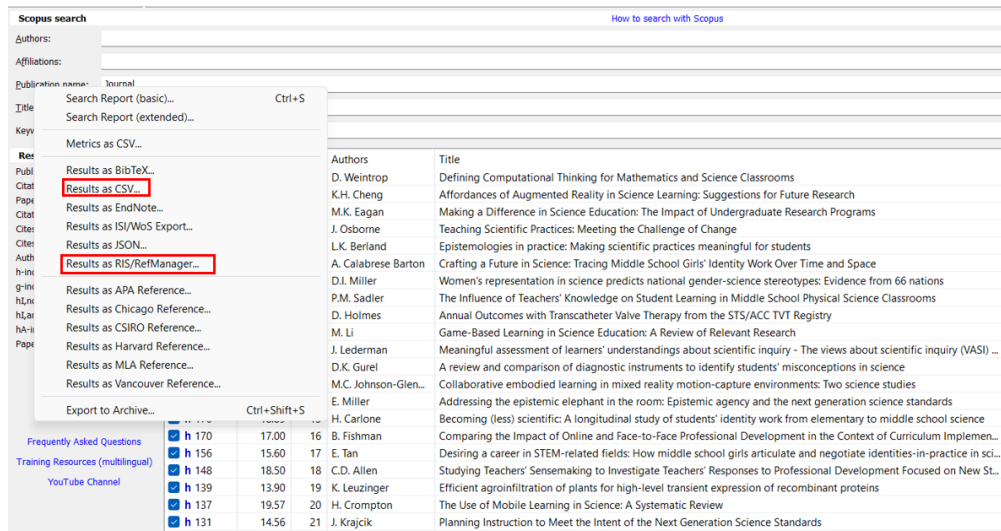
Figure 28. Choose *.ris and *.csv format.

iii) Then you will get two file formats as shown in **Figure 29**.

Figure 29. File *.ris format and *.csv format.

Up to this point, you have obtained publication data sourced from the SCOPUS database which is ready to be used for analysis using the VOSviewer application. The data displayed by Publish or Perish is in the form of metadata such as the author's name, title, year, the journal that published it, and the publisher of the article found. **Table 1** shows 20 examples of search data from Publish or Perish search results used in VOSviewer analysis based on the number of citations. We got 200 articles about "Science Education" published in Journal indexed Scopus. The number of citations is 16088, the number of citations per year is

1608.80, the number of citations per article is 80.44, the author of each article is 1.00, the h-index is 72, and the g-index is 108 (see **Table 2**).

Table 1. Science Education Research Data based on 20 top citations.

No	First Authors	Title	Year	Author Count	Cites	Cites Per Year	Cites Per Author	Ref
1	D. Weintrop	Defining Computational Thinking for Mathematics and Science Classrooms	2016	6	649	92.71	649	Weintrop *et al.* (2016)
2	K.H. Cheng	Affordances of Augmented Reality in Science Learning: Suggestions for Future Research	2013	2	441	44.10	441	Cheng and Tsai (2013)
3	M.K. Eagan	Making a Difference in Science Education: The Impact of Undergraduate Research Programs	2013	6	292	29.20	292	Eagan *et al.* (2013)
4	J. Osborne	Teaching Scientific Practices: Meeting the Challenge of Change	2014	1	282	31.33	282	Osborne (2014)
5	L.K. Berland	Epistemologies in practice: Making scientific practices meaningful for students	2016	6	276	39.43	276	Berland *et al.* (2016)
6	A. Calabrese Barton	Crafting a Future in Science: Tracing Middle School Girls' Identity Work Over Time and Space	2013	6	271	27.10	271	Calabrese *et al.* (2013)
7	D.I. Miller	Women's representation in science predicts national gender-science stereotypes: Evidence from 66 nations	2015	3	253	31.63	253	Miller *et al.* (2015)
8	P.M. Sadler	The Influence of Teachers' Knowledge on Student Learning in Middle School Physical Science Classrooms	2013	5	208	20.80	208	Sadler *et al.* (2013)
9	D. Holmes	Annual Outcomes with Transcatheter Valve Therapy from the STS/ACC TVT Registry	2015	7	204	25.50	204	Holmes *et al.* (2015)
10	M. Li	Game-Based Learning in Science Education: A Review of Relevant Research	2013	2	196	19.60	196	Li and Tsai (2013)

Table 1 (continue). Science Education Research Data based on 20 top citations.

11	J. Lederman	Meaningful assessment of learners' understandings about scientific inquiry - The views about scientific inquiry (VASI) questionnaire	2014	6	194	21.56	194	Lederman *et al.* (2014)
12	D.K. Gurel	A review and comparison of diagnostic instruments to identify students' misconceptions in science	2015	3	181	22.63	181	Gurel *et al.* (2015)
13	M.C. Johnson-Glenberg	Collaborative embodied learning in mixed reality motion-capture environments: Two science studies	2014	4	178	19.78	178	Johnson-Glenberg *et al.* (2014)
14	E. Miller	Addressing the epistemic elephant in the room: Epistemic agency and the next generation science standards	2018	5	173	34.60	173	Miller *et al.* (2018)
15	H. Carlone	Becoming (less) scientific: A longitudinal study of students' identity work from elementary to middle school science	2014	3	170	18.89	170	Carlone *et al.* (2014)
16	B. Fishman	Comparing the Impact of Online and Face-to-Face Professional Development in the Context of Curriculum Implementation	2013	7	170	17.00	170	Fishman *et al.* (2013)
17	E. Tan	Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science	2013	4	156	15.60	156	Tan *et al.* (2013)
18	C.D. Allen	Studying Teachers' Sensemaking to Investigate Teachers' Responses to Professional Development Focused on New Standards	2015	2	148	18.50	148	Allen *et al.* (2015)

Table 1 (continue). Science Education Research Data based on 20 top citations.

No	First Authors	Title	Year	Author Count	Cites	Cites Per Year	Cites Per Author	Ref
19	K. Leuzinger	Efficient agroinfiltration of plants for high-level transient expression of recombinant proteins	2013	6	139	13.90	139	Leuzinger *et al.* (2013)
20	H. Crompton	The Use of Mobile Learning in Science: A Systematic Review	2016	4	137	19.57	137	Crompton *et al.* (2016)

Table 2. Matrix Data Publication.

Name	Description
Publication Year	2013-2021
Citation years	10 (2013-2023)
Papers	200
Citations	16088
Cites/year	1608.80
Cites/paper	80.44
Authors/paper	1.00
h-index	72
g-index	018
h1, norm	72
h1, annual	7.20
hA-index	20

3.3. The Development of Publication Regarding Computer or Personal Computer

Based on the results of searching data on the Scopus database, it shows that the development of research on "Science Education" has experienced inconsistent changes as shown in **Figure 30**. Based on **Figure 30**, the study "Science Education" has fluctuated from 2013 to 2017.
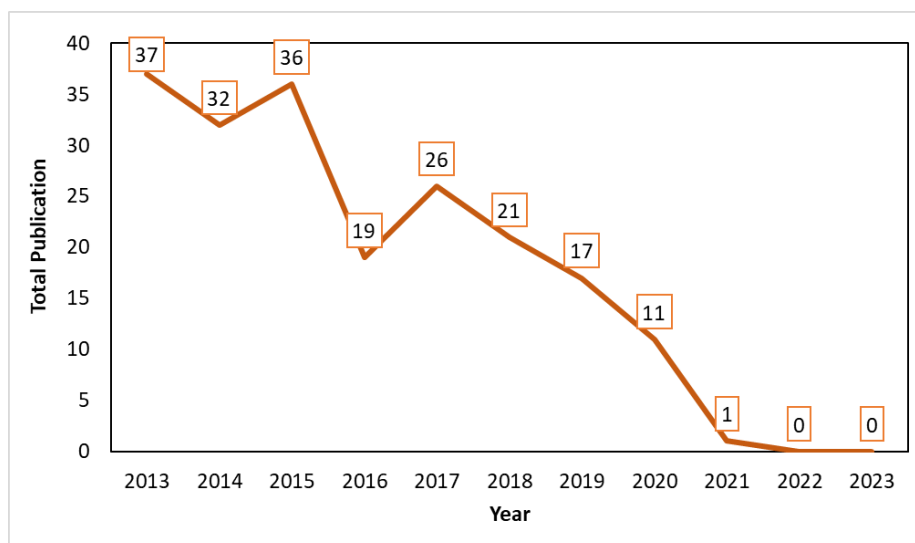
Figure 30. The Development of Publication Regarding Science Education.

Development publication from 2017 to 2021, research on science education published in Scopus indexed journals has decreased. In 2022 there will be no research on science education and in 2023 there will be no research on this theme that will be published in Scopus indexed journals. In 2013 the number of researches with the theme used was 37 publications, but in 2014 it decreased by 5 publications to 32 publications. In 2017, the number of researches related to keywords increased again to 26 publications. In 2018, the number of research publications related to keywords was still the same as the previous year (2017), namely 19 publications. In 2018 - 2021 research on Science Education published in Scopus indexed journals continues to decline with the number of publications sequentially, namely 21, 17, 11, and 1 article.

3.4. Bibliometric Map Research on Science Education

Based on search results throughout the Scopus database, 200 research articles were obtained that are relevant to the keywords used. The data obtained is then exported to a *.ris format file. Files with *.ris format will be inputted and analyzed using the VOSviewer application. There are several steps that must be followed to make a gap using the VOSviewer application, these steps are as follows:

i)   Open the VOSviewer Application (**Figure 31**)

Figure 31. Open the VOSviewer Application.

ii)   Then click the "Create" menu (see **Figure 32**).
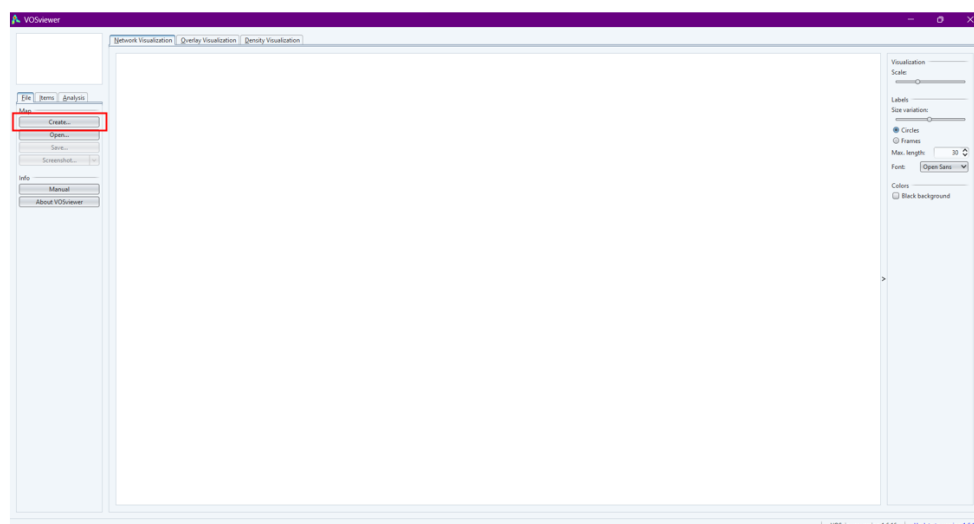
Figure 32. Create menu.

iii) After that, "Create map based on text data" and click the "Next" button (see **Figure 33**).
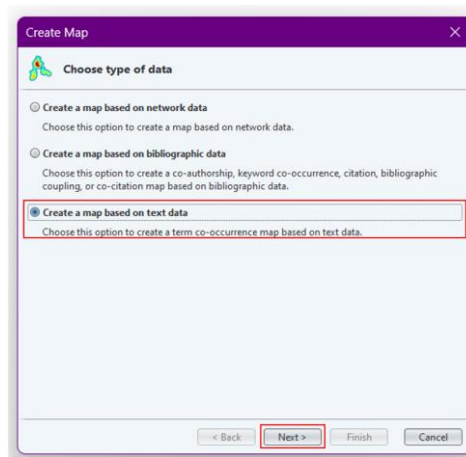
Figure 33. "Create map based on text data" and next button.

iv) In the Choose data source section, select "Read data from bibliographic database files", then click the "Next" button (see **Figure 34**).
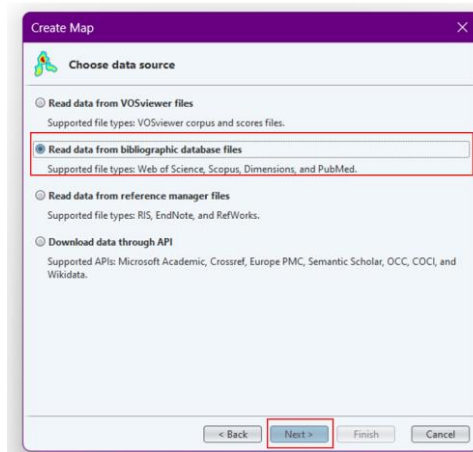
Figure 34. Read data from reference manager file" and next button.

v) On the Select File page, choice option Scopus and Click button "…" (see **Figure 35**)
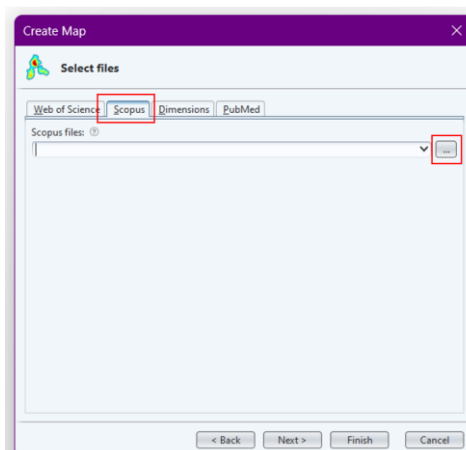
Figure 35. Choose file Scopus.

vi) select the *.csv file that was previously obtained through the Publish or Perish 7 application. If you have found the file, then click the "OK" button and click the "Next" button (see **Figure 36-37**).
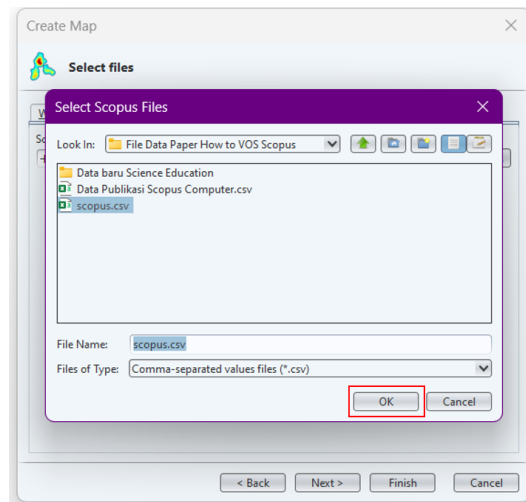
Figure 36. Choose file *.csv.
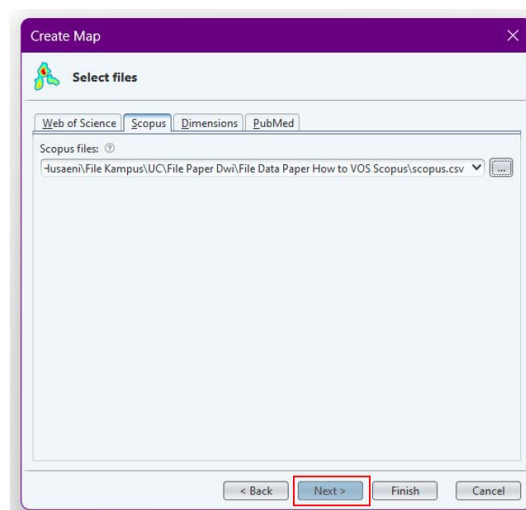
Figure 37. Click the Next button.

vii) In the Choose Fileds section, select the Title and Abstract field or if you want select Title fields or abstract fields are also allowed. After that, click the "Next Button" (see **Figure 38**).
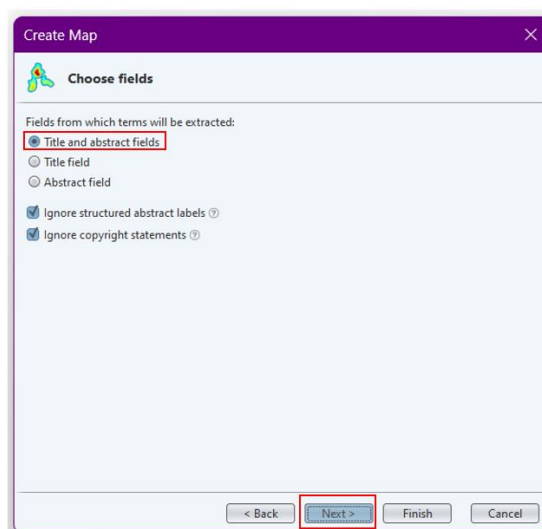
Figure 38. Choose "Title and Abstract field" and click the next button.

viii) After you click the "Next" button, data extraction will be carried out. After the data has been successfully extracted, the Choose counting method page will appear. On the choose counting method page, select "Binary Counting", then click next to continue the process (see **Figure 39**).
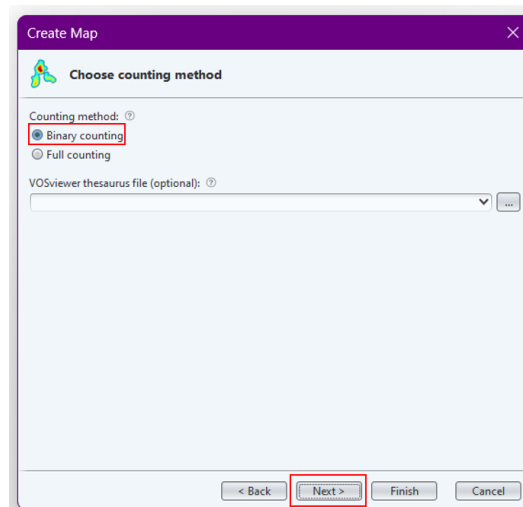
Figure 39. Choose binary counting and click the next button.

ix) On the Choose threshold page, you can specify a minimum number of occurrences of the term. In this example, we will set the minimum number of occurrences of terms to 5 times, so that 395 terms are found out of a total of 6274 terms. Then click the "Next" button (see **Figure 40**).
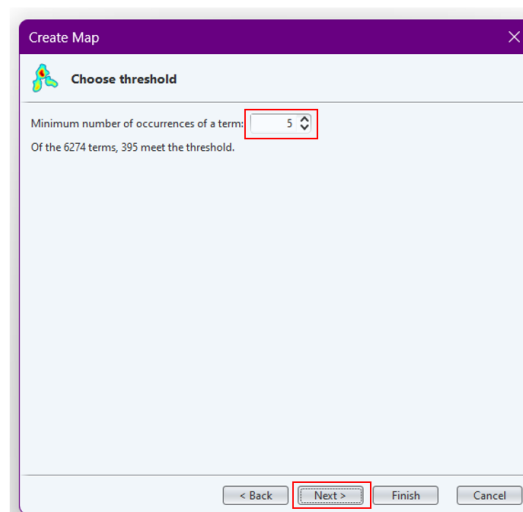
Figure 40. Choose threshold and click the next button.

x) On the Choose Number of Terms page, you can determine the number of terms that will appear based on their level of relevance. By default, a term with a relevance level of 60% will be selected, but you can customize the number of terms according to your needs. In this example we will take 60% of the most relevant terms, so we find 237 terms (see **Figure 41**).

xi) The final step is to verify the selected terms. In this step, you can view and re-select the terms that you will use manually. If you are sure and finished with the terms you will use, the final step is to click the "Finish" button (see **Figure 42**).
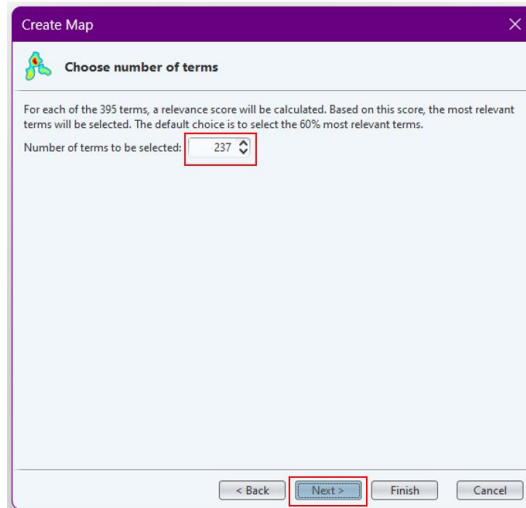
Figure 41. Choose many terms.
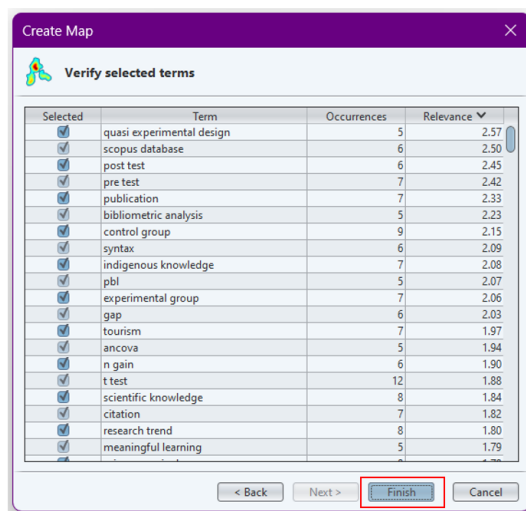
Figure 42. Verify selected terms.

xii) After that, a mapping visualization is obtained from the publication data that we have collected through the publish or perish reference manager application (see **Figure 43**).
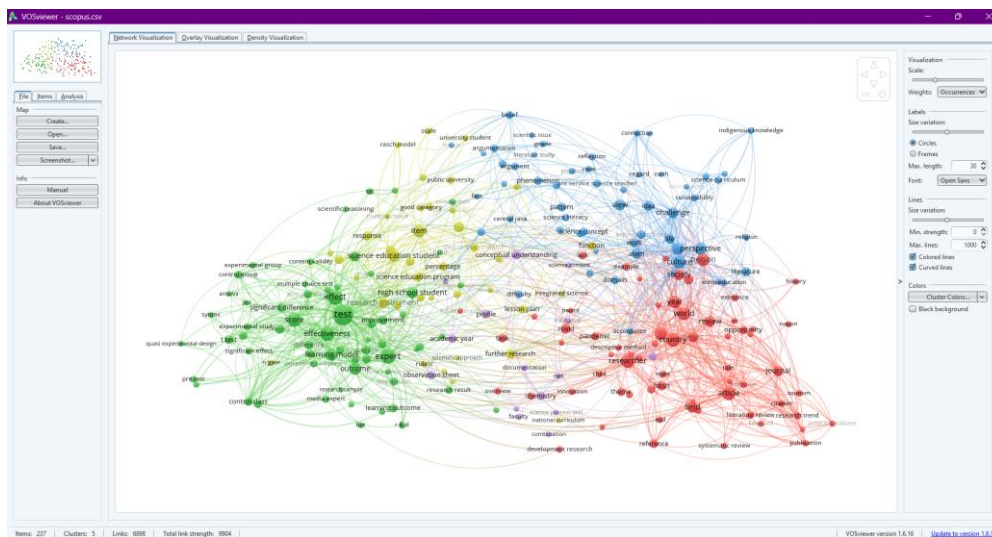
Figure 43. The results of the mapping of the research on VOSviewer.

After the visualization results are obtained, so that the VOSviewer visualization data is not lost, the steps that must be taken are to save the processed VOSviewer map and network file data. The steps for saving VOSviewer data are as follows:

i)   Click the "save" button on the left of the VOSviewer page (see **Figure 44**).
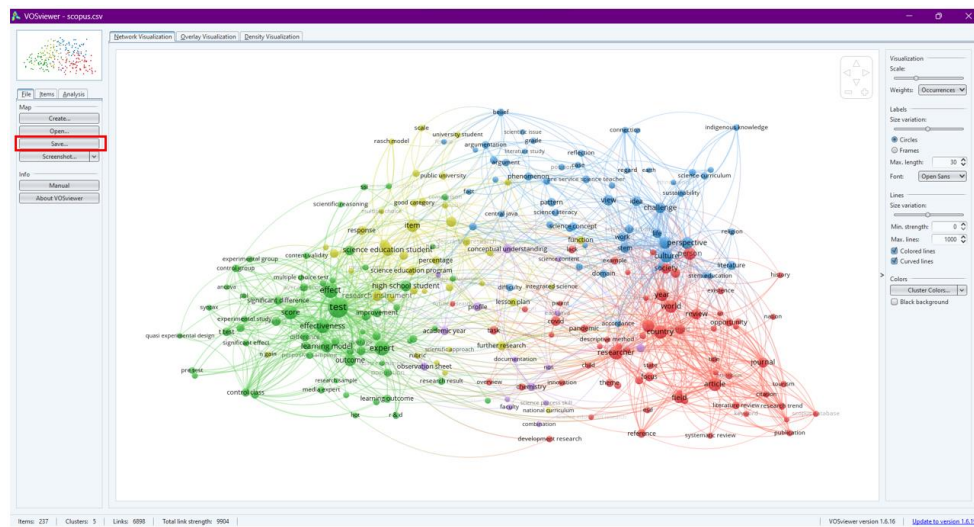
Figure 44. Save button on the VOSviewer page.

ii) Then, after the Save Map pop-up appears, click "…" to select a location to save the file (see **Figure 45**).
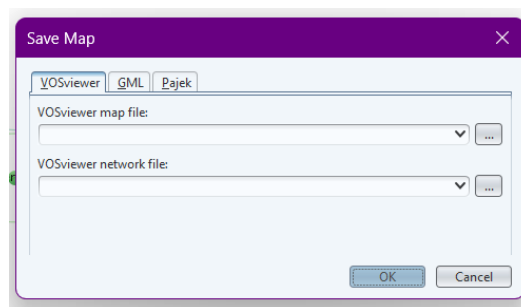
Figure 45. Save Map pop up.

iii) After doing step 2, a page like **Figure 46** will appear, give a name to the file to be saved, then click OK.
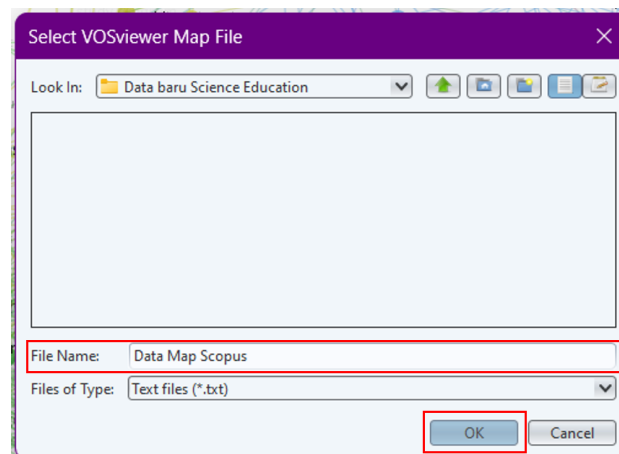
Figure 46. Select the VOSviewer map file page.

iv) Do the same for the network file storage section. Thus, you can see the results shown in **Figure 47**. After that, click the "OK" button. Then your VOSviewer data has been successfully saved.
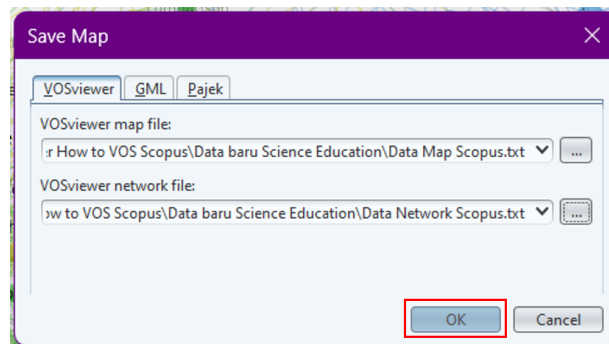
Figure 47. The result of saving the VOSviewer file.

3.4.1. Co-Word Map Network Visualization

Figure 48 shows the relationship between terms depicted in a network. Relationships in network visualization are depicted by lines that go from one term to another (Al Husaeni & Nandiyanto, 2022). The results of the visualization of the co-word map network of research developments regarding computer or personal computers are divided into 3 clusters as shown in **Figure 48** below.

i) Cluster 1. The red color consists of 65 items including area, art, article, attention, bibliometric analysis, child, citation, condition, country, covid, descriptive method, development method, development research, element, esd, example, existence, filed, focus, future, future research, history, information technology, innovation, internet, journal, keyword, lack, law, line, literature review, lot, majority, nation, opportunity, overview, pandemic, parent, period, person, place, presence, publication, reference, relevance, requirement, researcher, review, science education research, scopus databse, society, state, study show, suggestion, systematic review, Taiwan, task, theme, title, tourism, trend, urgency, world, and year (see **Figure 49**).

ii) Cluster 2. Green color consists of 63 items including ancova, average, avegare score, biology education, comparison, content validity, control class, control group, critical thinking skill, difference, effect, effectiveness, elementary Scholl, elementary school student, experimental class, experimental group, experimental study, expert, hand, high school student, hot, improvement, learning model, learning outcome, Likert scale, mean score, media expert, module, multiple choice test, online, outcome, pbl, planning, population, post-test, pretest, purposive sampling, qualitative method, quasi experiment, quasi experimental design, r&d, research result, research sample, science education expert, scientific reasoning, score, senior high school student, significance, significant difference, significant effect, socio scientific issue, ssi, student critical thinking, syntax, t test, test, treatment, user, validation, validity, and writing (see **Figure 50**).

iii) Cluster 3. Blue color consists of 55 items including accordance, argument, argumentation, belief, case, central java, challenge, community, concetion, connection, culture, daily life, difficulty, dimension, domain, earth, engineering, ethnoscience, everyday life, fact, female, gap, gender, idea, identification, indigenous knowledgement, life, literature, literature study, local wisdom, meaningful learning, orientation, pattern, perspective, phenomenon, position, pre service science teaching, reason, reflection, regard, relation, religion, science concept, science curriculum, science literacy, science

teaching, scientific issue, scientific knowledgement, stem, stem education, sustainability, view, and work (see **Figure 51**).

iv) Cluster 4. Yellow color consists of 39 items including basis, descriptive research, descriptive statistic, function, further research, good category, increase, integrated science, item, lesson plan, mastery, medium category, metacognition, misconception, multiple choice, n gain, national curriculum, percentage, practicality, prospective science teacher, public university, rash model, reliability, research instrument, research subject, response, rubric, scale, science education department, science education program, science education student, science education study program, science teacher candidate, scientific approach, study program, subject matter, university student, and weakness. (see **Figure 52**).

v) Cluster 5. Purple color consists of 15 items including academic year, chemistry, combination, conceptual understanding, data collection instrument, data collection technique, documentation, east java, faculty, mathematics, nos, observation sheet, profile, science content, and science process skill (see **Figure 53**).

Figure 48. Network Visualization.

Figure 49. Network Visualization Cluster 1.

Figure 50. Network Visualization Cluster 2.

Figure 51. Network Visualization Cluster 3.

Figure 52. Network Visualization Cluster 4.

Figure 53. Network Visualization Cluster 5.

3.4.2. Co-Word Map Overlay Visualization

Figure 54 shows the results of data visualization using VOSviewer in the form of an overlay visualization. The visualization overlay shows the update of each term (Al Husaeni & Nandiyanto, 2022). **Figure 54** shows that of the 200 articles originating from the 2013-2023 range, terms included in the appropriate category and related to the science education keywords are in the 2019 to 2021 range. The color of each term indicates the novelty of the term. The brighter towards the yellow color, the higher the level of renewal (Al Husaeni & Nandiyanto, 2022; Nandiyanto *et al*., 2021).

Figure 54. Overlay visualization.

3.4.3. Co-Word Map Density Visualization

Items that have the same markings as the visible item are displayed in the cluster density view. Depending on the item's density at the time, the item point has a specific color. The

dots' color is fixed and depends on the item that is linked to other objects. By highlighting the items that are deemed crucial for examination, density co-word maps help get a general sense of the structure of bibliometric maps (Muoz-Leiva *et al.*, 2021; Al Husaeni & Nandiyanto 2022). Based on the research findings displayed in **Figure 55**, it can be deduced that computer or personal computer-related terms are the most frequently used keywords in publications that display the depiction of the density map.

A density map produced by a study of all publications about computers or personal computers published between 2013 and 2023 is shown in **Figure 55**. According to the density map, the more yellow color is relative to the largest circle's diameter, the more frequently it occurs. Conversely, if a color fades and blends into the background's green hue, it happens less frequently (Tupan, 2019; Al Husaeni & Nandiyanto, 2022).

Figure 55. Density visualization.

4. CONCLUSION

Based on the results and discussion, it can be concluded that VOSviewer can be used as a disaster tool to analyze data bibliometrically, while Publish or Perish can be used as a reference management tool that can be used to collect research article data on "science education". In this study, the data used in analyzing data with VOSviewer is research on "science education" taken from the Scopus database. The number of publications obtained related to the theme totaled 200 documents spanning 2013-2023. The study "Science Education" has fluctuated from 2013 to 2017. From 2017 to 2021, research on science education published in Scopus indexed journals has decreased. In 2022 there will be no research on science education and in 2023 there will be no research on this theme that will be published in Scopus indexed journals. Network visualization show the development map of science education is divided into 5 clusters. Cluster 1 consists of 65 topics, cluster 2 consists of 63 topics, cluster 3 consists of 55 topics, cluster 4 consists of 39 topics, and cluster 5 consists of 15 topics. So, the total terms in this study are 237 terms from 5 clusters.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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