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[Review Article]

LITERATURE REVIEW STUDENT'S SCIENTIFIC LITERACY AND METACOGNITIVE ABILITY: BIBLIOMETRIC ANALYSIS

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ABSTRACT

Previous research that has been done on scientific literacy and metacognitive abilities has been widely carried out in scientific publications. However, research using bibliometric analysis methods has not been studied enough. This study aims to determine the relationship between scientific literacy and students' metacognitive abilities. The research method used is literature study, bibliometric analysis using VOSviewer software, and Microsoft Excel processing. The research data was obtained from metadata from Scopus with the keyword science, literacy and metacognitive and in 3,881 documents from 2016-2020, but Scopus only provides metadata for the first 2000 documents downloaded. The research was conducted in May 2021. The discussion results show that there is still little research on scientific and metacognitive literacy. The topic of scientific literacy and metacognitive trends has the opportunity to be studied more deeply. Nevertheless, scientific literacy has the most significant research opportunity on issues with science education.

Keywords: Scientific Literacy; Metacognitive; Learning; Bibliometrics

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1. INTRODUCTION

Science education can help students to solve problems in everyday life. One of the targets achieved in science education for students in scientific literacy (Fakhriyah et al., 2017). Organization for Economic Co-operation and Development or OECD (2016) defines scientific literacy as scientific knowledge, the ability to identify a question and be able to draw evidence-based conclusions and definitions as the ability to understand their nature and changes and make informed decisions through activities. Scientific literacy ability covers knowledge about science, science process skills and scientific attitude (Rohman et al., 2017).

The average scientific value for the scientific literacy domain in OECD countries is 493, while Indonesia has only achieved a score of 403. In the 2018 PISA results for scientific competence, Indonesia ranks 62 out of 71 participating countries. Percentage of scientific literacy that is considered sufficient, while 73.61% is stated to be lacking (Narut & Supradi, 2019). Although in 2016 there was an increase in Indonesian science students, it is still indicated to be low (Nofiana, 2017).

Students who understand science can contribute to the economic well-being of society, provide greater support for the domain of science, have more realistic expectations of science, contribute to democratic decision-making, and benefit society at large because of the relationship between science and culture (Yacoubian, 2018). This is relevant to the current state of the COVID-19 pandemic. Scientific literacy can be useful in sorting out information about the COVID-19 pandemic. It aims to measure the extent to which the general public identifies pandemic information that is in line with evidence-based consensus in the scientific community to defeat the accompanying infodemic (Gu & Feng, 2021).

For this reason, students are expected to have three aspects of analyzing scientific literacy skills. Based on PISA 2015, these three aspects are able to describe scientific phenomena; evaluate and carry out scientific planning; draw conclusions from scientific data and evidence. Students' scientific literacy can be increased by teaching them critical thinking abilities (Pamungkas et al., 2018). This pertains to pupils' critical thinking abilities, which can assist them in resolving challenges involving scientific literacy. Critical thinking is a self-regulatory examination that leads to the interpretation, analysis, evaluation, findings, and explanations of evidence that is conceptual, methodological, or contextual (Gherardini, 2016). For open thinking, critical thinking can also generate crucial issues and problems in order to clearly express them, acquire, and appraise relevant information (Nur, 2021). As a result, critical thinking skills will assist students to comprehend challenges and develop alternative problem-solving strategies, with problem-solving stages including clarification, assessment, inference, and strategy (Biyan & Setyarsih, 2020).

A metacognitive assessment of scientific literacy-based instruments can be used to test students' critical thinking skills in addressing scientific literacy problems. This is because critical thinking is defined as a collection of skills that enable people to solve logical difficulties and reflect autonomously through metacognitive regulation (Rani, 2021). Metacognition is the process of becoming more conscious of one's own thinking and learning processes (H. Yanti et al., 2017). Metacognitive knowledge is demonstrated to have a vital part in the learning process because it is critical for regulating and managing one's cognitive processes in learning and thinking (Warni et al., 2018). The scientific literacy-based assessment metacognitive instrument is a scientific literacy assessment tool that includes declarative, procedural, and conditional knowledge metacognitive knowledge questions. Declarative knowledge is information about oneself as a learner and the factors that influence one's performance; procedural knowledge is information about how to do things as heuristics and strategies; and conditional knowledge is information about when and why to use

declarative and procedural knowledge (Güner & Erbay, 2021). Based on this description, metacognitive exams based on scientific literacy can be used to assess students' critical thinking abilities when addressing scientific literacy problems. One of the purposes of learning physics is to improve students' critical thinking skills, as well as their capacity to solve issues (Supeno et al., 2018). As a result, it's crucial to assess students' critical thinking abilities when it comes to solving scientific literacy problems.

Previous research that has been done on scientific literacy and metacognitive abilities has been widely carried out in scientific publications. However, research using bibliometric analysis methods has not been studied enough. Research using bibliometric analysis methods on scientific literacy and metacognitive abilities using Scopus indexed publications has not been carried out. This is because the Scopus journal is a data center or scientific literacy and citation database. Scopus is part of a world-renowned international scientific publication or publication company, namely Elsevier. In the Scopus database, there are approximately 22,000 titles from 5,000 publishers from around the world (Firmansyah, 2020). In addition, scientific literacy and metacognitive is related to student development, so an in-depth study is needed.

Based on this, the research was conducted with the aim of examining the development trend of scientific publications regarding scientific literacy in terms of metacognitive abilities during the 2016-2020 vulnerable years from the Scopus database by analyzing bibliometrically with the keywords scientific literacy, metacognitive, and learning. This research is expected to provide information related to the development of research methods regarding scientific literacy in terms of metacognitive abilities during the vulnerable years of 2016-2020 so that it can be used as a further research analysis to find out information on the relationship between scientific literacy and students' metacognitive abilities.

2. METHOD

This research was conducted by literature study using the bibliometric analysis method. The bibliometric analysis is based on research that will reveal the development of the literature, such as a number of publications, articles, research approach and author productivity. Results of bibliometric mapping from the VOSviewer application that applies Co-Occurrence calculations. The Co-Occurrence analysis reveals the research topic statistically, provided that the more frequent pairs between two keywords, the closer the relationship between the keywords (Masitoh et al., 2021). Based on the analysis technique, it is known that scientific literacy has a relationship with metacognitive learning in the classroom.

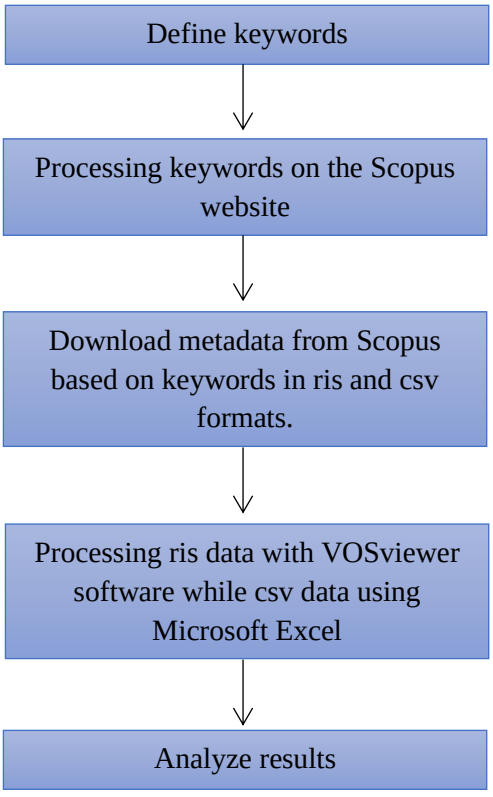


Figure 1. Research steps with bibliometric analysis

Research conducted based on metadata from Scopus produced 8,331 documents for the whole year. Meanwhile, for the vulnerable 2016-2020 document metadata, as many as 3,881

documents. Scopus only provides metadata for the first 2000 documents downloaded. Download the database in the form of ris and CSV formats. The research uses data by filtering several documents through an advanced search with the keyword's science AND literacy AND metacognitive. Metadata with ris format is processed using the VOSviewer application, while metadata in CSV format is processed using Microsoft Excel.

3. RESULT AND DISCUSSION

The search that was carried out on Scopus metadata in May 2021 obtained 3,881 documents for scientific literacy and metacognitive research. The metadata processed in the VOS Viewers software shows the writing trends of the researchers from 2016 to 2020. Over the years, it shows that more and more people are interested in scientific literacy and metacognitive. This is represented in figure 2. In the data processing process in the VOSviewer metadata software, only the last three years, 2018 to 2020 (Figure 2). This is because the data downloaded on Scopus is the most recent 2,000 of the 3,881 documents. In 2018, there were only 80 articles published, while in 2019 there was an increase to 88 articles published. The highest peak of the writing trend was in 2020, reaching 1055 successfully published articles.

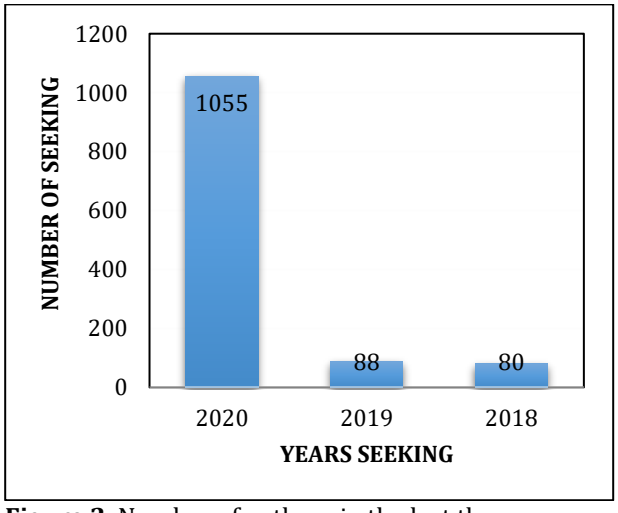


Figure 2. Number of authors in the last three years

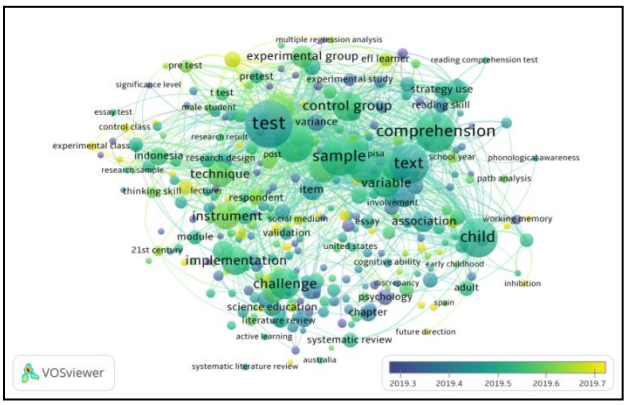


Figure 3. Overlay visualization

The research update shows that the brighter the colour appears, the more people who do research. On the other hand, when the colour gets darker and smaller, it is still rare to conduct research (Figure 3). With VOSviewer as the primary material to identify the variables that have been studied.

World researchers in various journals widely study the topic of scientific and metacognitive literacy. This is indicated by the number of publications in articles, which reached 83% or 1629 of the total publications in the world. In the vulnerable period of 2016 to 2020, researchers are still not looking at notes as a place to publish their thoughts on this topic. Only 2% of the world's researchers and writers are interested in publishing literacy topics in notes. (Figure 3).

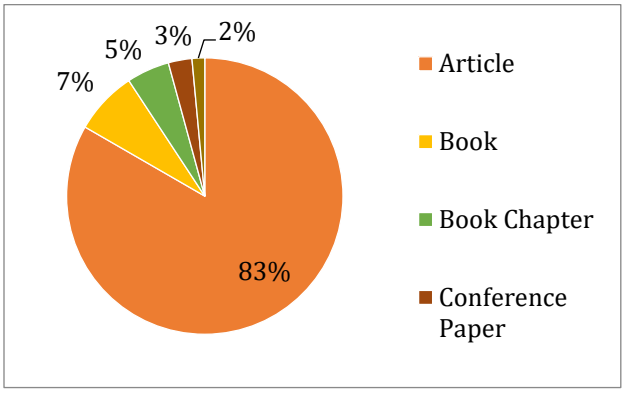


Figure 4. Document publication type

Based on the number of published documents, several countries dominate scientific literacy and

metacognitive (Figure 5). The most dominating country in this publication is the United States as many as 541 authors. Indonesia is the second country to publish scientific literacy research topics, with 203 authors. Furthermore, Germany became the third most populous country by publishing as many as 113 authors. This proves that worldwide are interested in discussing scientific and metacognitive literacy so that there are more and more updates in the discussion of this topic.

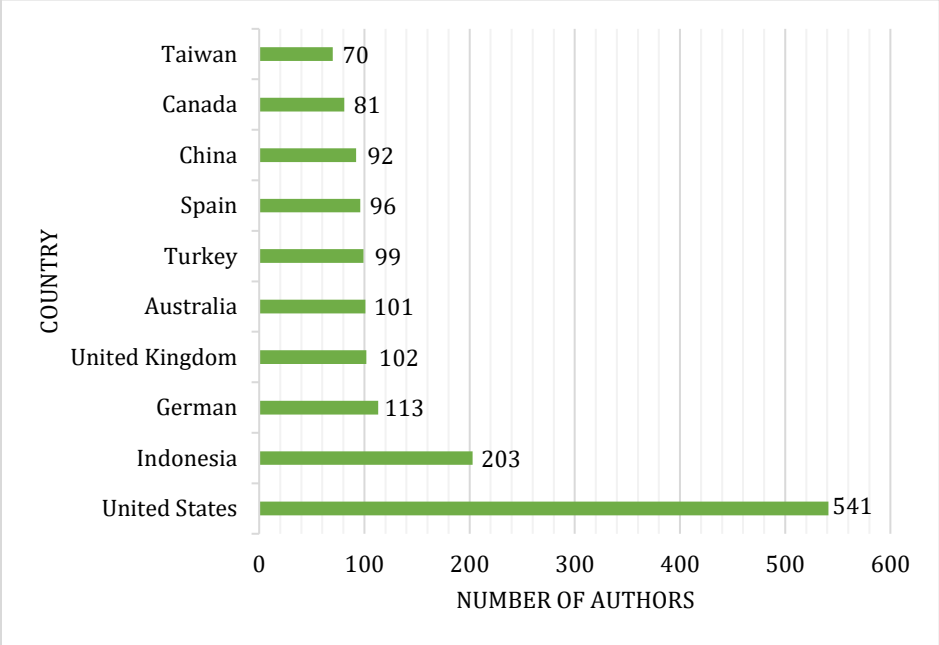


Figure 5. Distribution of scientific literacy documents in various countries

5350 authors have researched the topic of scientific literacy and metacognitive. Figure 6 shows the top authors and their clusters in the study. List, a becomes the leading author in cluster 1, red. Research conducted by (List et al., 2020) discusses the concept of scientific literacy that can improve teacher education in the United States and Sweden. Ichsan I.Z. Become the top author in cluster 2 in green. (Ichsan et al., 2019) found that the students' metacognitive skills with Cirsa learning which emphasized reading and scientific-based activities, could be applied by teachers. Graham S. leads in the third blue cluster. (Limpo & Graham, 2020) conducted a study that poor and slow handwriting can interfere with writing by negatively impacting readers, creating a mismatch between idea generation and recording, burdening working memory, and turning paper into a painful experience.

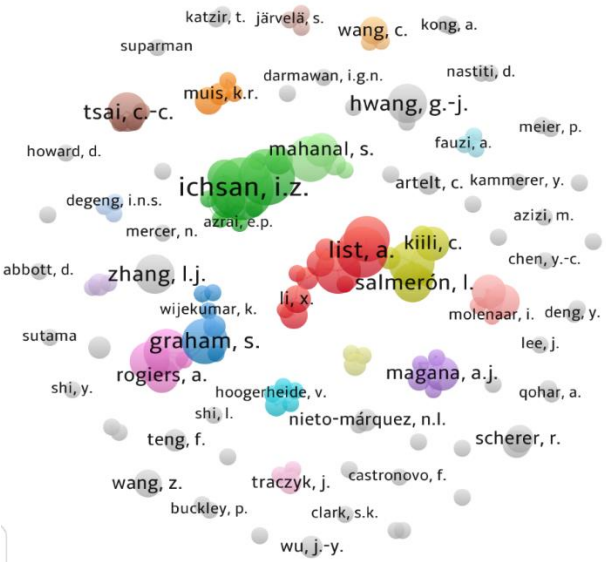


Figure 6. Writers around the world

From the number of articles, citations obtained five articles with the highest number of authorities in Indonesia through CSV data processing on Microsoft excel on 2,000 Scopus metadata. Research conducted by (Lestari et al., 2019) discusses problem testing and students' metacognitive skills in student planning. (Ichsan et al., 2020) in their article, discusses increasing students' HOTS in environmental learning. (Nurtanto et al., 2018) discuss scientific literacy in general. Meanwhile, (Martha & Santoso, 2019)'s article is more public about the topic of scientific and metacognitive literacy.

Table 1. Number of Citations from World Journals

Author	Year	Journal	Number of Citation
Lestari P., Ristanto RH, Miarsyah M.	2019	Journal for the Education of Gifted Young Scientists	23
Ichsan IZ, Sigit DV, Miarsyah M., Ali A., Suwandi T., Titin	2020	European Journal of Educational Research	15
Nurtanto M., Nurhaji S., Widjanarko D., Wijaya MBR, Sofyan H.	2018	Journal of Physics: Conference Series	15
Supriyatin, Rahayu S., Ristanto RH, Ichsan IZ	2019	Universal Journal of Educational Research	13
Martha ASD, Santoso HB	2019	Journal of Educators Online	13

Mapping data with ris data. Scopus, which has been processed in the VOSviewer software, produces 32787 terms and 913 that meet the threshold. Figure 7 represents the network visualization which looks like it produces six clusters. Cluster 1 is shown in red which consists of 196 items. This cluster is dominated by the word challenge. This word is relevant to Encheva's research (2016) that learning strategies using the challenge method of "learning by doing", "interaction in study groups", "learning by trial and error" can train students practically to improve information literacy.

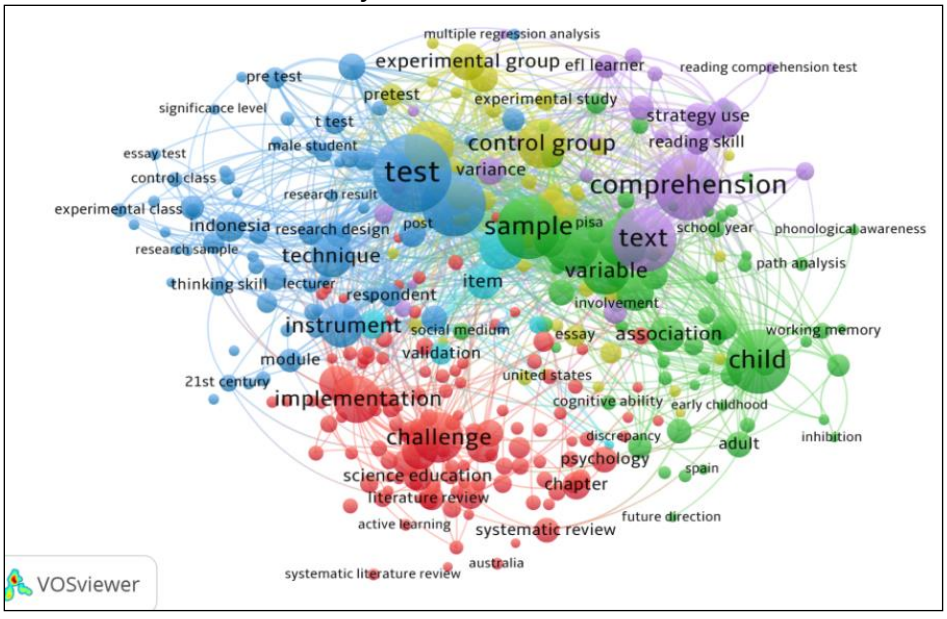


Figure 7. Networking visualization display

Cluster 2, shown in blue, consists of 128 items which are the word group that is closer to the test. This is shown in the research conducted by (Setiawan & Saputri, 2020) and (D. R. Yanti et al., 2019), which used post-test and pre-test data collection methods. Cluster 3, shown in green, consists of 112 items which are the word group that is closer to the child. Cluster 4, shown in yellow, consists of 85 items which are the word group that is closer to the text.

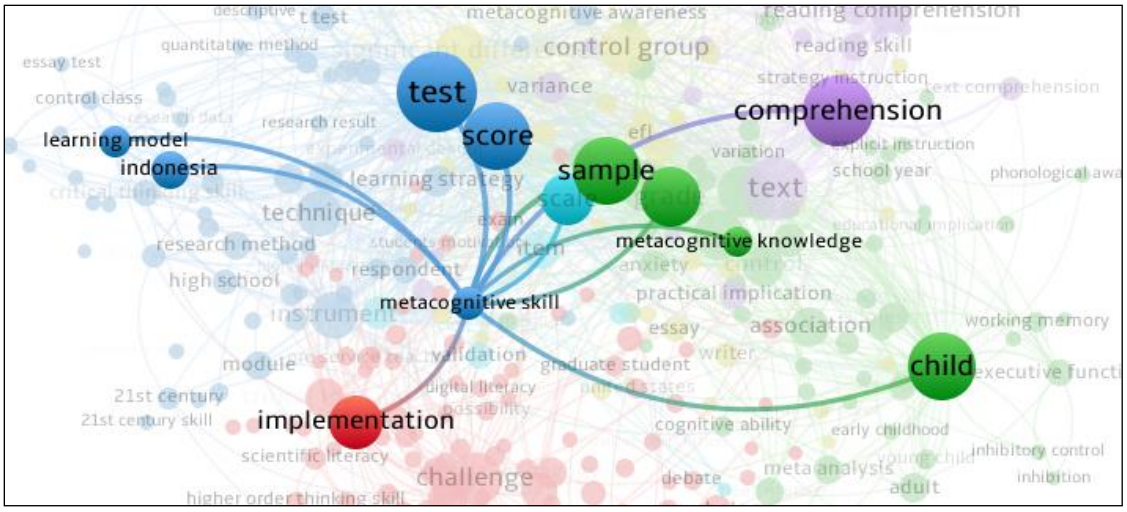


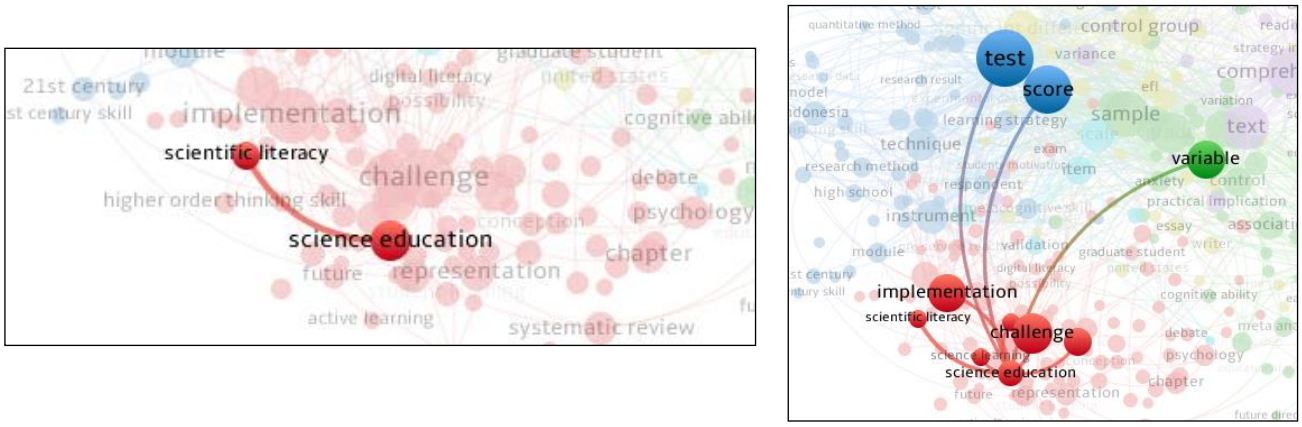
Figure 8. Networking visualization metacognitive ability

Visualization with VOSviewer states that coloured circles in the results indicate items and keywords that often appear in published documents. The circle size states how often research related to the topic is researched. The larger the size, the more analysis is carried out.

If it is focused on a more specific mapping, it can show the trend of the research being carried out. Figure 8 shows that research often conducted on dominant metacognitive topics is related to implementation, tests, scores, learning models, samples, metacognitive knowledge, children, and comprehension. A research trend that is still rarely found is metacognition knowledge. However, research conducted by (Wall & Hall, 2016) has found a catalytic relationship between the pedagogy used by teachers to develop their students' metacognition and metacognitive learning and knowledge and the teacher's skills.

This topic trend, focuses on the trend of science literacy research topics. Researchers have done a lot of research on this topic related to science education (Figure 9a). Figure 9b has a trend of science education topics, namely science learning, challenge, implementation, test, score, and variables. On the topic of science learning, the red cluster is a topic that has a great opportunity to be researched. This is in line with (Jufrida et al., 2019)' research using the instruments used and the test of science learning achievement is a science literacy test and a science learning achievement test.

The data processing shows that scientific and metacognitive literacy is still little research has been carried out. The researchers focused more on students' metacognitive abilities or only focused on applying scientific literacy. Referring to (Teng, 2020)'s research, metacognitive instruction has the potential to improve reading pedagogy so that it can assist students in planning, integrating, monitoring, and controlling their reading process. Thus, the topic of scientific literacy and metacognitive trends has the opportunity to be studied more deeply.



(a) (b)

Figure 9. Networking visualization (a) Scientific literacy; (b) Science education

Some of these studies show information that scientific literacy has an important role in the development of science to affect life. Scientific literacy, in principle focuses on students' skills to utilize scientific knowledge in real situations (Dragoș & Mih, 2015). Developing students ' metacognitive awareness is very important to use knowledge and reasoning skills in everyday life situations (Erenler & Cetin, 2019). Awareness in receiving the information received relies on the metacognitive abilities of students. (Basam et al., 2017) states that students' metacognition influences low literacy skills.

Learners with general education, science education, and more knowledgeable scientific literacy become more proficient in interpreting evidence to support their choices (Drummond & Fischhoff, 2017). Metacognitive knowledge and activities involving goal setting, planning, and strategy selection and modification (Ohtani & Hisasaka, 2018) are important elements that facilitate the fulfilment of scientific literacy requirements. In the literature, some studies are showing that metacognitive awareness is a key factor in studying science as it enables individuals to self-regulate cognitive skills and evaluate task performance effectively (Winne, 2011).

The research results are expected to be taken into consideration for researchers in conducting future research on the topic of scientific literacy and metacognitive. Both of these topics have complex discussions, so in-depth discussion is needed. The topic of scientific literacy involves many scientific discoveries both in science education and researchers whose findings will continue to develop. So this topic will always be new. Likewise, metacognitive is closely related to the learning model applied to students, where the learning model will continue to develop following the times to bring up new tests in taking student scores.

This research is only limited to literature from several related journals, which is the data id only obtained from around 50% (2000 out of 3881) of all existing data. It is possible to get very different results from this study if the research is carried out using all the data. Therefore, a more in-depth study can be carried out to obtain a strength estimate. In addition, the analysis of word items was also carried out based on the title and keywords from Scopus metadata. The data search results can make it easier to find novelty from research on scientific and metacognitive literacy. This can be used as a consideration for researchers to conduct further research.

4. CONCLUSION

Based on the results and discussions that have been carried out on scientific literacy research related to students' metacognitive abilities using bibliometric analysis, it can be concluded that scientific and metacognitive literacy is still little or no one has conducted research. Thus, the topic of scientific literacy and metacognitive trends has the opportunity to be studied more deeply. However, scientific literacy and metacognitive have a broad relationship. Science literacy is related to science education, while science education is related to science learning topics, challenges, implementation, tests, scores, and variables. So, from these results, metacognitive, which has the most significant research opportunity, is on science learning. Metacognitive relates to implementation, test, score, learning models, samples, metacognitive knowledge, children, and comprehensions. Thus, from these results, metacognitive, which has the most significant research opportunity, is on metacognitive knowledge.

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