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Effects of Research-Based Science Learning on Students' Critical Thinking Skills: A Bibliometric Analysis

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ABSTRACT

In the era of industrial revolution 4.0, 21st century skills such as critical thinking, collaboration, communication and creativity have become essential for individual success in an ever-evolving work environment. There is an urgency to conduct research on the effects of research-based learning in improving students' critical thinking skills, which can provide a strong foundation for learners to succeed in a dynamic and complex future. This study utilized bibliometric research method. Articles were searched using the keywords "Critical Thinking; Research Based Learning". The search included patterns of trends in scholarly publications related to the exploitation and protection of river turtle populations, as well as patterns in author relationships between relevant articles. Data were analyzed and visualized using VOSviewer software. Results Visualization analysis of journals on research-based learning highlighted that topic such as "research samples" and "worksheets" dominated the literature, reflecting consistency in the development of research-based learning practices in the classroom.

INTRODUCTION

The artificial revolution 4.0 pushes and forces the world encyclopedically to always adjust to the pendulum of change that moves so dashingly and sharply from time to time. The 21st century can be said to be the century of knowledge. The 21st century is characterized by a massive metamorphosis from an agricultural society to an artificial and sustainable society to a knowledge society (Fathiya & Asrizal, 2022). In developing 21st century skills, one can develop HR capabilities starting from students in educational units. Capabilities in the aspects of knowledge, skills, attitudes, and superior values continue to be prepared in order to foster 21st century skills in learning (Asrizal et al., 2018). The basic principles of 21st century learning emphasize real-world activities and contexts. In the 21st century learning principles, learning must be student-centered, collaborative, connected to the real world context, and integrated with community life (Asrizal et al., 2019). Human development is of course accompanied by

an increase in the quality of human education. The higher the quality of education of a country, the higher the quality of human beings formed and will be able to advance the country. Although it has switched to an independent curriculum, the learning objectives that students are expected to achieve are still the same, namely for students to be more active in learning, increase reasoning power and critical thinking and have implications for good learning outcomes (Mayasari et al., 2023).

Critical thinking is a major factor in physics learning. Critical thinking needs habituation, trained gradually and continuously. Habituation of critical thinking can be done by conditioning students to find problems and find solutions to these problems (Anggreni et al., 2019). Critical thinking allows learners to evaluate information carefully, question assumptions, and conclude logically. Critical thinking is reasonable and reflective thinking focused on deciding what to believe or do (Ennis, 2015), which means critical thinking is a reflective thinking process that focuses on deciding what to believe or do. Critical thinking also helps to make strong arguments (Linda & Lestari, 2019). Critical thinking skills have a role in global life in the 21st century (Beni et al., 2019).

The fact is that critical thinking skills are still underdeveloped in education in Indonesia. Looking at the results of the 2018 PISA study in the field of science places Indonesia at a low ranking, namely 9th from the bottom (71) with an average score of 396. This is in line with the results of a literature review of 9 research articles, it was found that 44.44% of articles showed that students' critical thinking skills were in the low category, 44.44% of studies were in the medium or sufficient category. Meanwhile, there are 11.11% of articles that show that students' critical thinking skills are in the high category (Punto Aji & Nugraheni, 2023). The traditional education curriculum is often insufficient in developing students' 21st century skills, as highlighted in a study by (Almuharomah et al., 2019) at SMP Negeri 2 Balong District which showed that the profile of creative thinking skills of junior high school students was in the sufficient category with a percentage of 55.38%. Further research by (Benyamin et al., 2021) confirms these findings through critical thinking tests and interviews, indicating that the ability of high school grade X students is in the low category with a percentage of 43.01%

The low ability of students in critical thinking is a serious problem that must immediately get a solution because it will be very detrimental to many parties if it continues. It is feared that students will not be able to analyze and solve real problems that they experience in their daily lives and they will have difficulty in making decisions quickly and accurately (Anisa et al., 2021). One solution to deal with this problem is Research-Based Learning. In the process of learning science, in addition to theory, practicum and tasks that support learning are also held. Research-based learning (PBR) is one of the student-centered learning (SCL) methods that integrate research in the learning process. PBR is multifaceted which refers to a variety of learning methods. PBR provides opportunities for students to seek information, formulate hypotheses, collect data, analyze data, and make conclusions on the data that has been arranged; in this activity learning with a "learning by doing" approach applies (Slameto, 2015). In PBR, steps such as literature study, experience, and exposure (exposure, experience, and capstone) are integrated with the scientific approach to improve process skills in science learning. In the implementation of practicum students must also carry out process skills in the form of observation, measurement, data interpretation, inference and so on. To master these process skills requires perseverance, patience, and high diligence to obtain learning achievements in this case the maximum value. Students are required to understand the subject matter in the module to be able to solve problems and are required to

think critically, actively, innovatively, creatively as well as diligently, and thoroughly (Sukarso & Muslihatun, 2021). Research shows that RBL can improve students' research competencies, including the ability to review literature, methodology, reflection on research findings, communication, and content knowledge (Thiem et al., 2023). In the context of higher education, RBL has been shown to improve students' cognitive skills, although it may decrease their affective-motivational disposition (Wessels et al., 2021). In addition, RBL can also improve students' critical thinking and problem-solving skills.

The paper was conducted to investigate in depth the existing literature on the effect of research-based science learning on students' critical thinking skills. The main purpose of this paper is to conduct a bibliometric analysis of articles that have been published on this topic, with a focus on exploring the various approaches, methodologies and findings put forward by relevant researchers. The research is expected to provide a better understanding of how and how effective research-based science learning is in improving students' critical thinking skills in various educational contexts. This bibliometric analysis also aims to identify research trends, weaknesses, and opportunities for further development in this area, with the hope of making a positive contribution to the development of evidence-based learning methods for natural science education.

METHODS

In this research, the author adopts the bibliometric analysis method, which is an approach to evaluate scientific activity by utilizing bibliographic data. This approach departs from the assumption that researchers should not only conduct research, but also disseminate the results. The focus of bibliometric analysis in this research is descriptive analysis that aims to describe the characteristics of literature. The purpose of this analysis is to show the development and progress of knowledge, especially when researchers collaborate in studying certain research topics. Bibliometric analysis techniques fall into two categories: performance analysis and mapping. Bibliometric mapping is considered beneficial to the general public, especially the scientific community, as it can help in visualizing literature data into a diagram form that is easier to understand. Bibliometric analysis also helps in understanding the current research intensity in various fields, as mentioned in the study by (Comarú et al., 2021). This study itself focuses on analyzing articles published between 2014-2024, with a special focus on research-based learning on students' critical thinking skills.

In the data collection stage, this research chose Google Scholar as the document search base because of its consistency in document selection standards for its index. In addition, the Publish or Perish application was used to collect data related to creative thinking skills from Google Scholar. The article data obtained was then exported in RIS format. For bibliometric analysis, this research uses VOSviewer software which is able to describe the relationship between subjects and citations, group articles, create publication maps, and analyze existing article trends. The VOSviewer application is software that has the ability to visualize and explore the results of bibliometric studies. The following are the steps of data collection and processing that have been carried out:

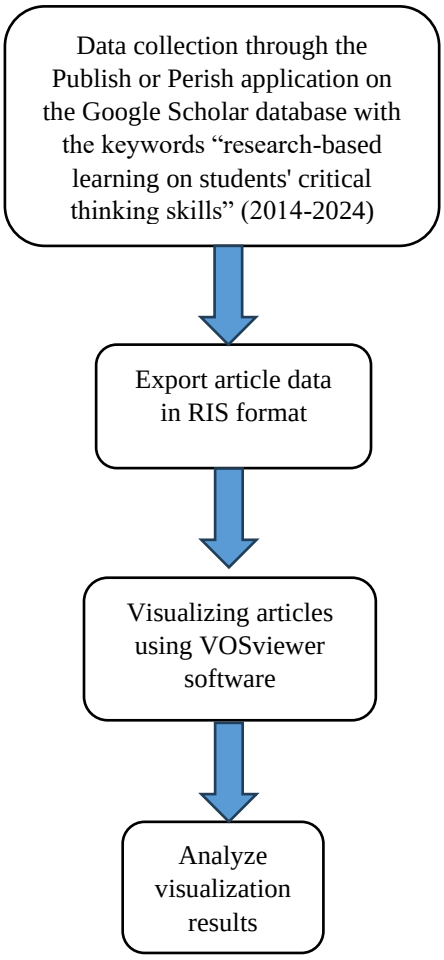

Figure 1. Data Collection and Processing Methods

Figure 1 shows the steps of this research. The first step is to collect data through the Publish or Perish application on the Google Scholar database with the keywords "research-based learning on students' critical thinking skills" from 2014-2024. The criteria for articles used in this study are articles indexed by Scopus and accredited by Sinta. The second step, the article data obtained is exported and stored in RIS format. The RIS format is a standard used to store reference data that can be imported into various bibliometric analysis tools, including VOSviewer. The RIS format is compatible with many bibliometric analysis tools, facilitating the process of visualization and data analysis (Sinambela & Rifai, 2024). The third step is to visualize the articles using VOSviewer software. The fourth step is to analyze the results of the VOSviewer visualization.

RESULTS AND DISCUSSION

Search results for articles with keywords: Research Based Learning and Critical Thinking related to specific keywords in the time span 2014 to 2024. This report provides a very useful overview of the impact and distribution of citations to these publications. Of the 600 publications investigated, the total number of citations reached 927, indicating a significant level of influence. The analysis of an average of 185.40 citations per year highlights the level of attention-grabbing and relevance of these publications over the time period studied.

Information on the average citations per publication and per author provides more specific insights into how often publications are cited and how the scientific work is distributed by author. The average of 1.55 citations per publication indicates that each work has a relatively large impact, while the average of 516.00 citations per author highlights the individual contributions in receiving citations. With an average of 323.26 publications per author, the report also highlights the productivity of authors in producing scholarly works during the investigated time period.

The breakdown of authors per publication further adds to the complexity of the analysis by highlighting author collaboration in scientific papers. With an average of 2.14 authors per publication, and a median and mode of 2.0 and 1 respectively, it can be concluded that collaboration between authors is quite common in these publications. This suggests that cooperation between authors has played an important role in producing well-cited papers. As such, this report not only provides an overview of the impact and citation distribution of the publications, but also reveals the collaboration patterns and productivity of the authors involved in the research process.

Network Visualization

The results of the bibliometric analysis using VOSviewer illustrate the linkages between the key words identified in Figure 2. In the figure, different colors are used to visualize different clusters, which represent groups of articles that have similar research focus and topics. This analysis helps in identifying patterns of relationships between different concepts and themes related to research-based science learning and reveals dominant trends and research centers in the existing literature.

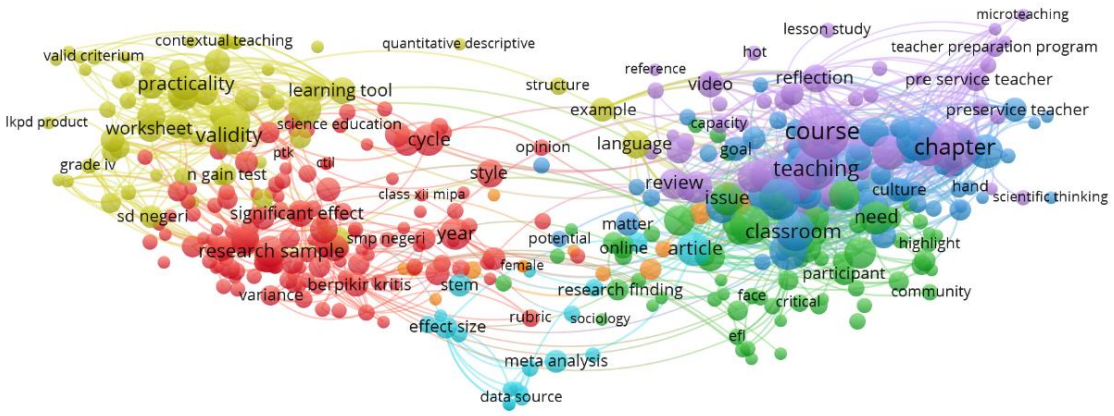

Figure 2. Network Visualization

From the visualization analysis of related journals, there are more than 440 keywords grouped into 7 clusters. The red cluster features major keywords such as "research sample", "variance", "significant effect", and "cycle", which describe the application of research-based learning and various models that support critical thinking skills. On the other hand, the yellow cluster features keywords such as "worksheet", "learning tool", "LKPD product", "contextual teaching", and "teaching language", reflecting the use of teaching materials focused on practicum tools and student worksheets in research-based learning. Furthermore, the blue cluster contains keywords such as "Meta analysis", "effect size", "stem", and "article", indicating the results of design-based learning which can be in the form of articles, effect size analysis, source data, or Meta analysis, and its relation to the STEM model. The purple cluster, with basic keywords such as "course teaching", "chapter review", "reflection", "lesson study",

and "micro teaching", describes common learning phases in research-based learning, such as reviewing lessons, discussing material, reflecting on learning outcomes, and others. Finally, the green cluster features keywords such as "research finding", "sociology", "issue", and "community", reflecting how research-based learning helps develop socialization, collaboration, and communication skills.

Overlay Visualization (OV)

An overlay visualization was used as a second analysis to map the development of research on Research-Informed Science Learning (RLE) over the years. Figure 3 displays the evolution of changing research themes and focus over time, with timelines highlighting significant periods in the literature. Using this technique, it is possible to observe how research interest in and emphasis on RBF has evolved from particular aspects of the natural sciences, as well as identify trends and changes in the approaches and methodologies used in this research. This analysis provides an in-depth view of the dynamics of this field of study and how research interests have changed over time.

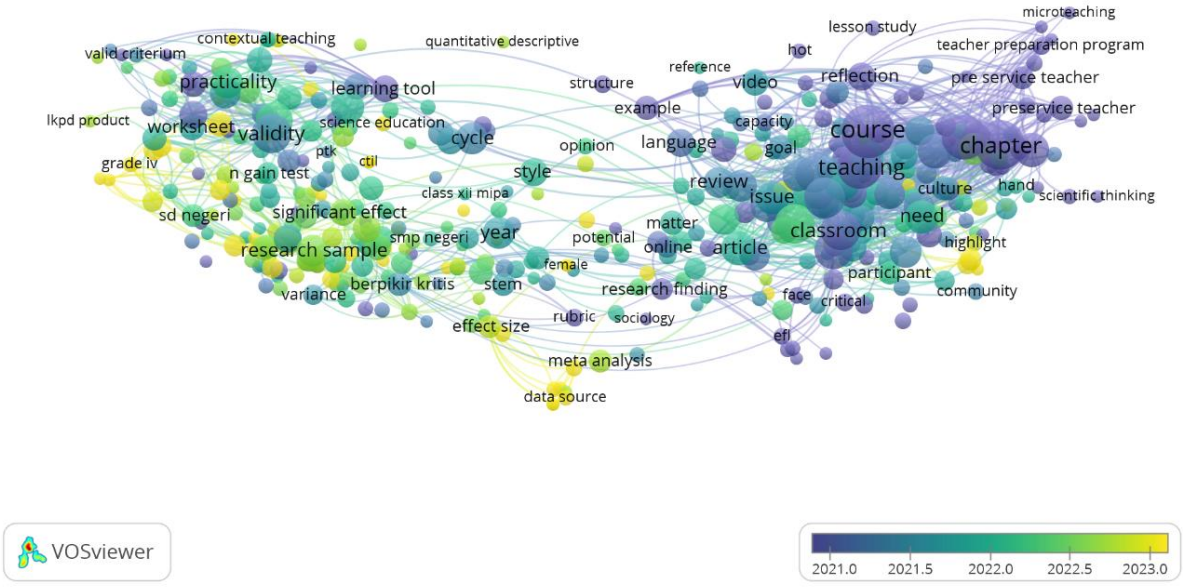

Figure 3. Overlay Visualization

The visualization depicts a spectrum of colors that reflect the level of research use of a topic, from long-standing to relatively new. The difference in color from dark to light indicates the duration of the research, where dark colors indicate research that has been conducted over a considerable period of time, while light colors indicate topics that are still new to research. Clusters with dark colors tend to be older studies compared to brighter clusters, such as yellow and green, which indicate more recent studies. The oldest research findings focus on preparation for research-based learning, such as materials, teaching exercises and learning aids. While the newer studies focus more on how research-based learning engages researchers with specific research models, such as population categories, control classes, and more. From this visualization, it can be seen that research-based learning activities are currently dominated by students.

Density Visualization (DV)

The results of density visualization using VOSviewer are shown in Figure 4, focusing on some of the main keywords: Research-based Learning, Critical Thinking Skills and Students. This graph illustrates the intensity of the relationship between these keywords in the analyzed literature, with the size and thickness of the lines indicating how strongly they are related. This density analysis gives an idea of how often and how closely these concepts co-occur in the context of studies on research-based science learning and the development of critical thinking skills in students. This visual data helps to clarify patterns and relationships between key concepts in this research domain, and can provide an in-depth view of the focus and shifts in related research over a period of time.

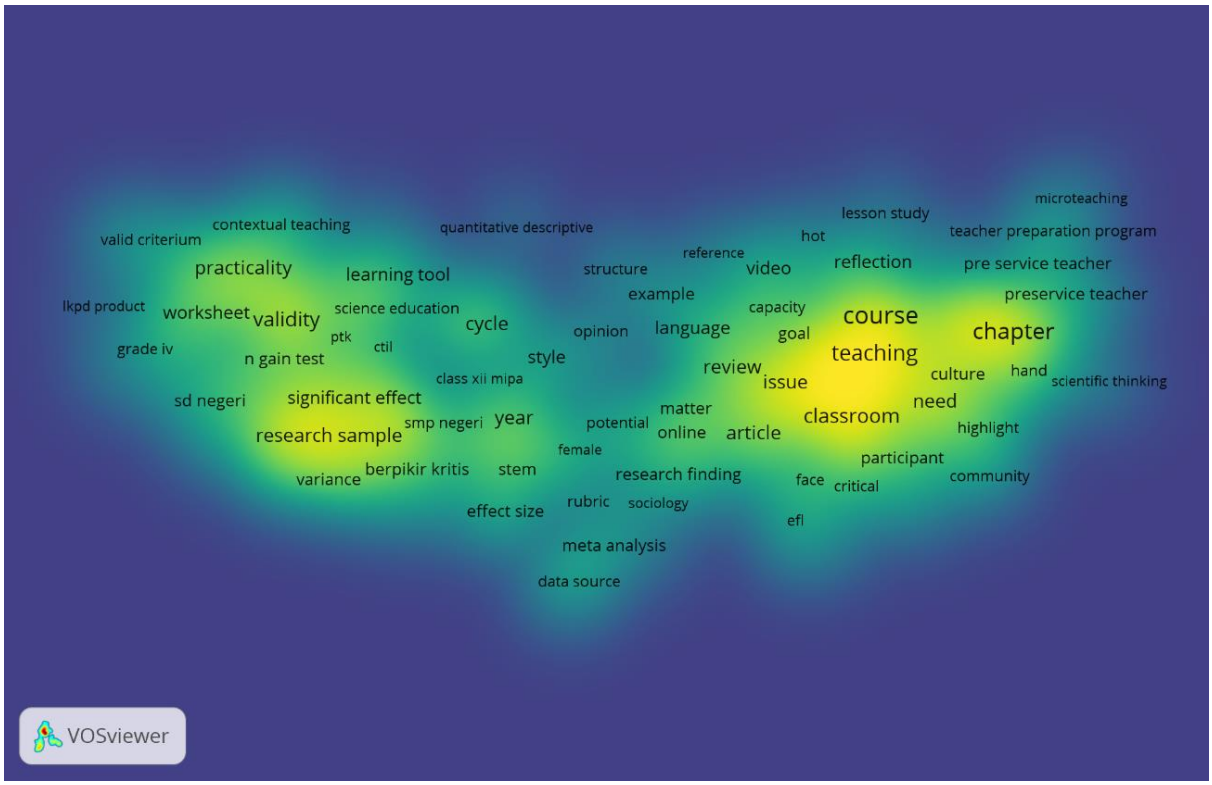

Figure 4. Density Visualization (DV)

The density visualization in the VOSviewer reveals the level of research on various topics, where bright colors such as yellow indicate topics that have been widely researched. In the context of analyzing journal articles related to research-based learning for students' critical thinking skills, the main focus involves aspects such as “research sample”, “worksheet”, “practicality”, “course”, “teaching”, “classroom”, and “chapter”. This reflects the research trend towards classroom application of specific materials using research samples and the development of student worksheets that have been validated and tested for practicality. Further discussion of research-based learning resulted in the information-rich mapping shown in Figure 2. With over 440 keywords grouped into 7 different clusters, this visualization illustrates the complexity and variety of topics covered in the relevant academic literature. Each cluster, such as red, yellow, blue, purple and green, indicates a different focus in the context of research-based learning. For example, the red cluster highlights concepts such as “research sample” and “variance” that are relevant in the application of research

methodologies, while the yellow cluster focuses more on practical tools and teaching materials such as "worksheet" and "learning tool".

Figure 3 depicting the Overlay Visualization (OV) graph provides an additional perspective by illustrating the evolution of research topics over time. The different colors reflect the duration of research, with dark colors indicating established research and light colors signifying newer topics in research. This highlights the shift in focus from basic preparation in research-based learning to more sophisticated and specific research models, as seen from new research involving population categories and control classes. The Density Visualization (DV) adds a more detailed understanding of the distribution of research topics, particularly in relation to research-based learning and students' critical thinking skills. This visualization shows that topics such as "research samples" and "worksheets" have been the main focus in the literature, indicating a consistent trend in the application and development of research-based learning practices in the classroom. It also emphasizes the importance of validation and practicality testing in the use of teaching materials in research-based learning contexts.

This is in accordance with the theoretical review Research-based learning promoted as a student centered pedagogy can improve student learning outcomes, especially related to the development of higher order thinking skills such as the process of seeking new knowledge and understanding (Healey, Mick., Jordan, F., Pell, B. and Short, 2010). greater use of research-based teaching by using inquiry-based learning (Healey, Mick., Jordan, F., Pell, B. and Short, 2010). This learning method starts with students being confronted with a problem, followed by a student-centered information-seeking process. The findings show that PBL excels when it comes to long-term retention, skill development and student and teacher satisfaction. There is no research to support the effectiveness of this technique; moreover, there is no evidence, so far, from controlled studies, that minimal (student centered, constructivism-based learning guidance for primary or secondary education students) is successful (Slameto, 2015).

CONCLUSION

The visualization analysis of journals related to research-based learning produced a mapping that revealed key concepts such as "research sample" and "variance" that are essential in the application of research methodologies and the development of teaching materials. Overlay Visualization (OV) provides an additional perspective by showing the evolution of research topics, illustrating the shift in focus from basic approaches in research-based learning towards more specific research models, including studies involving population categories and control classroom settings. In addition, Density Visualization (DV) shows that topics such as "research samples" and "worksheets" have become a major focus in the literature, reflecting a consistent trend in the implementation and development of research-based learning practices in the classroom environment. The analysis also confirms the importance of validation and practicality testing in the use of teaching materials, underscoring efforts to ensure the effectiveness and relevance of learning practices in scientific contexts.

REFERENCES

Almuharomah, F. A., Mayasari, T., & Kurniadi, E. (2019). Pengembangan Modul Fisika STEM Terintegrasi Kearifan Lokal "Beduk" untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa SMP. *Berkala Ilmiah Pendidikan Fisika*, *7*(1), 1.

Anggreni, Y. D., Festiyed, & Asrizal. (2019). Meta-Analisis Pengaruh Model Pembelajaran Project Based Learning terhadap Kemampuan Berpikir Kritis Peserta Didik SMA. *Pillar of Physics Education*, *12*(4), 881–888.

Anisa, A. R., Ipungkarti, A. A., & Saffanah, K. N. (2021). Pengaruh Kurangnya Literasi serta Kemampuan dalam Berpikir Kritis yang Masih Rendah dalam Pendidikan di Indonesia. *Conference Series Journal*, *01*(01), 1–12.

Asrizal, A., Amran, A., Ananda, A., & Festiyed, F. (2019). Effects of Instructional Material of Natural Science with Literacy Skills of Our Respiratory and Excretory Health Theme on Academic Achievement of Students. *Journal of Physics: Conference Series*, *1317*(1).

Asrizal, Amran, A., Ananda, A., Festiyed, F., & Sumarmin, R. (2018). The Development of Integrated Science Instructional Materials to Improve Students' Digital Literacy in Scientific Approach. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 442–450.

Beni, K. N., Dewanti, N., Yanriatuti, I., Prakosa, M. M., & Purwanza, S. W. (2019). Spiritual Intelligence Roles to Improve the Quality of Nursing Care: A Systematic Review. *Jurnal Ners*, *14*(3 Special Issue), 93–97.

Benyamin, B., Qohar, A., & Sulandra, I. M. (2021). Analisis Kemampuan Berpikir Kritis Siswa SMA Kelas X Dalam Memecahkan Masalah SPLTV. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(2), 909–922.

Comarú, M. W., Lopes, R. M., Braga, L. A. M., Batista Mota, F., & Galvão, C. (2021). A Bibliometric and Descriptive Analysis of Inclusive Education in Science Education. *Studies in Science Education*, *57*(2), 241–263.

Ennis, R. H. (2015). *Conception* (pp. 31–32). Palgrave Handbooks.

Fathiya, N., & Asrizal, A. (2022). Development of Stem Education Integrated Sound and Light Waves E-Module for Critical and Creative Thinking Skills of High School Students. *Pillar of Physics Education*, *15*(4), 276–287.

Healey, Mick., Jordan, F., Pell, B. and Short, C. (2010). The Research-Teaching Nexus: A Case Study of Students' Awareness, Experiences and Perceptions of Research. *Innovations in Education and Teaching In- ternational,* 47 (2), 235-246.

Linda, Z., & Lestari, I. (2019). Berpikir Kritis dalam Konteks Pembelajaran. In *Erzatama Karya Abadi* (Issue August).

Mayasari, A., Asrizal, A., & Usmeldi, U. (2023). The Effect Size Pengaruh Pembelajaran Berbasis Sets terhadap Kemampuan Berpikir Kritis dan Hasil Belajar Siswa. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, *13*(1), 67–76.

Punto Aji, G., & Nugraheni, B. I. (2023). Critical Thinking Skills of High School and Vocational School Students in Indonesia: a Literature Review. *International Journal of Education and Social Science Research*, *06*(03), 353–367.

Sinambela, Y. A. T., & Rifai, A. I. (2024). Bibliometric Analysis of Road Damage Due to High Rainfall Intensity in Mountainous Areas Using VOSviewer. *OPSearch: American Journal of Open Research*, *3*(4), 940–952.

Slameto, S. (2015). Pembelajaran Berbasis Riset Mewujudkan Pembelajaran yang Inspiratif. *Satya Widya*, *31*(2), 102–112.

Sukarso, A. A., & Muslihatun, M. (2021). Mengembangkan Keterampilan Berpikir Kreatif, Sikap dan Kemampuan Bekerja Ilmiah Melalui Pembelajaran Praktikum Proyek Riset Otentik. *Jurnal Ilmiah Profesi Pendidikan*, *6*(3), 467–475.

Thiem, J., Preetz, R., & Haberstroh, S. (2023). How Research-Based Learning Affects Students' Self-Rated Research Competences: Evidence From a Longitudinal Study Across Disciplines. *Studies in Higher Education*, *48*(7), 1039–1051.

Wessels, I., Rueß, J., Gess, C., Deicke, W., & Ziegler, M. (2021). Is Research-Based Learning Effective? Evidence from a Pre–Post Analysis in The Social Sciences. *Studies in Higher Education*, *46*(12), 2595–2609.