



## Science Process Skills in Education: Bibliometric Analysis and Review

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### Abstract

This research aims to view and review published research on Science Process Skills (SPS) in 2020–2023 using VOSViewer. Article data from Google Scholar database journals collected using Publish or Perish. In 2020–2021 the number of articles published experienced a significant increase, but starting from 2022–2023 it experienced a drastic decline. Topics such as science process skills, students, development, effects, models, analysis, and learning have often been discussed by researchers. In contrast to keywords such as correlation, STEM, self efficacy, case, comparison, improvement, argumentation, and POGIL, these are research topics that are rarely researched and too broad to be studied in more depth. The results of the review of the top 10 articles cited tend to examine strategies for mastering science process skills which include experimentation, minds-on, inquiry approaches, discovery learning, strategic manipulation, debate skills, ICT, STEM, student-centered teaching, use of a variety of learning tools, hands-on exercises, group activities, PhET, mobile scientific investigations, guided inquiry, PBL, PjBL, learning cycles, use of learning media, modules and worksheets. The novelty of this research is a bibliometric analysis and review of the latest research in the field of SPS. The implication of this research is contributes and support Kurikulum Merdeka's science learning outcomes. Future researchers can use these insights to improve science education, helps focus on their studies, and pinpoint SPS research trends.

**Keywords:** Science Process Skills; Bibliometric Analysis; Vosviewer; Publish or Perish

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## INTRODUCTION

Current and future science process skills must be taught in an interesting way (Mirana, 2019) because through science process skills, students can study real-life problems, take responsibility for their learning while growing, find solutions, communicate with classmates, and actively participate in learning (Pay & Taş, 2022) assessed through observation, performance and written questions (Kurniawati, 2021). Mushani's research (2021) illustrates that there is an uneven integration of SPS in curriculum and their implementation in all levels of science education in both developed and developing countries. There are only a few studies on 21st century science process skills so that educational institutions must evaluate teacher preparation, curricular integration, and implementation of knowledge about Skills 21st century promoted by science process skills (Mushani, 2021). Olowu's (2023) research explains that in improving science process skills, teachers can create science practicum activities, problem solving, inquiry, PjBL, and other direct scientific training are examples (Olowu, 2023).

Research conducted by several researchers found that STEM (Dilek et al., 2020; Apaivatin et al., 2021), laboratory activities (Kalemkus et al., 2021; Ratamun & Osman, 2018), usage video (Solé-Llussà et al., 2021), argumentation (Işiker & Emre, 2021; Kalemkus et al., 2021), student-centered science learning techniques (Özge & Yaman, 2022), model-based science learning (Demirçali & Selvi, 2022), process-based observation and investigation

(Güder et al., 2022), gamification and game-based activities (Macayan et al., 2022), online modules that utilize ICT, internet and social media (Ahmad & Iksan, 2021), problem solving learning (Audu, 2022), and HANDLE project (Bibon, 2022) could enhance students' process skills.

The background of this research is that foundational science education experiences play a large role in determining the long-term course of science for many people, and that successful science education is critical to creating a science-literate student population. However, the low level of science process skills due to the lack of these skills has limited the scope of basic science education (Deehan et al., 2024), students are not used to carrying out experimental or practical activities so that students lack science process skills (Raharjo & Puspita, 2024), and science process skills that were utilized previously, but in their application they do not acquire the greatest outcomes, so that science process skills in pupils do not improve (Tangahu et al., 2024). The implication of this research is contributes and support Kurikulum Merdeka's science learning outcomes. Future researchers can use these insights to improve science education, helps focus on their studies, and pinpoint SPS research trends by determining the most important topics.

In comparison with previous researchers such as Anjugam and Chellamani (2024) and Idris et al. (2022), who conduct a systematic literature review. Anjugam and Chellamani (2024) focused their analysis on research trends in science process abilities at the primary school level, secondary school level, and tertiary level, utilizing 23 Scopus papers from 2019 to 2024. Meanwhile, Idris et al. (2022) focused on theme analysis of strategies for acquiring science process skills, employing 104 papers from 2015 to 2021, including 62 from Scopus pieces and 40 from Web of Science articles. It also differs from Mushani (2021), who conducted a literature review analysis and confined his research to examining research trends in scientific process skills in developed and developing nations utilizing 198 publications published between 1987 and 2018.

This study differs from previous research in several ways. First, this study provides a bibliometric analysis to assess trends in the expansion of research on science process skills in education, including network, overlay, and density analysis. Second, this study relies on a smaller data set than previous studies, focusing on the period 2020-2023. Third, we found reviews of the ten most cited articles. Fourth, we chose to evaluate the findings of the ten most popular papers from 2020 to 2023 and provide recommendations for future research.

The novelty of this research is a bibliometric analysis and review of the latest research in the field of Science Process Skills. The criteria for selecting 10 articles were based on the most frequently appearing keywords on VOSViewer during 2020-2023. Bibliometric analysis is very important to help and serve as a reference for researchers in determining research topics to be carried out, especially those related to the Science Process Skills research field. So, this research aims to look at the latest research published on Science Process Skills in 2020–2023.

## METHOD

This research uses bibliometric analysis to analyze research quality, research topics, and future research projections. Discovering keywords, initial search outcomes, filtering results, providing data information, and interpreting data are stages in this research (Rostiany & Tjandra, 2022). The available article data comes from Google Scholar, which can be used to create comprehensive bibliometric maps and facilitate understanding of relationships between articles. The world's largest citation-based academic database containing summaries of scientific research and peer-reviewed literature can be found on Google Scholar. One of the key factors in choosing this database is how well it visualizes, crawls, and analyzes articles.

This research uses bibliometric analysis across keywords using Publish or Perish to examine search data as a form of co-occurrence research. This tool was chosen because Publish or Perish (PoP) is a software application that facilitates the search for metadata in the Google Scholar database. Analysis of the Science Process Skills literature with the keyword 'science

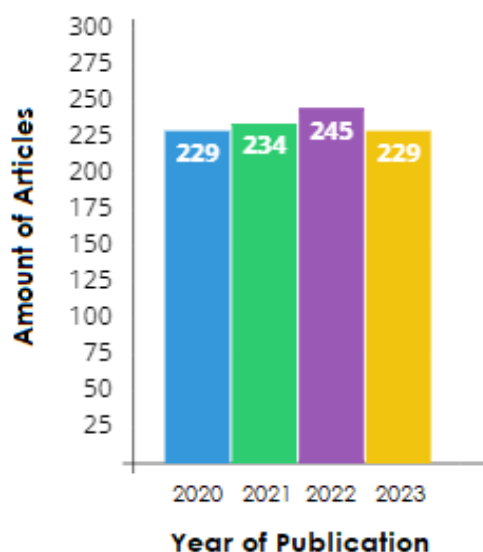
process skills' produced 939 articles that were evaluated according to the selected topic. Articles published in 2020–2023 were collected and saved in \*.ris format for research. Data collection limitations revealed that a number of journals could not be opened, which hampered data collection on this topic.

This research analyzes research patterns on bibliometric maps and creates data mapping visualizations from database sources that have been prepared using VOSviewer. This research uses network data mapping visualization, overlays, and computational density to gather information about the development of Science Process Skills research. Mapping network visualizations to show strong long-term associations, overlay visualizations to increase the recency of research terms and show how fresh a phrase is from year to year and to show that many keywords in yellow represent well-studied topics, while keywords that are missing or inaudible indicates under-researched topics using density visualization (Sidabutar et al., 2022).

## RESULTS AND DISCUSSION

After interpreting data, research results were found such as publication data, research development, visualization of topic areas for each cluster, data mapping using networked visualization, overlay visualization, and density visualization.

A total of 200 articles were collected through data searches carried out using Publish or Perish, using the keyword 'Science Process Skills'. The data obtained is presented as article metadata, including author's name, title, year of publication, journal name, publisher, number of citations, article link and related URL. The amount of citations for all articles used in this research is 3795. The annual number of citations is 1265.00. The number of citations for each article is 4.04. The average authorship in publications is 2.58. On average, articles show an h index of 29 and a g index of 39.



**Figure 1.** Development of the Number of Scientific Process Skills Research Publications in 2020-2023

Figure 1 depicts research trends on Science Process Skills from 2020 to 2023. In 2020, a total of 229 articles were published on this topic. Furthermore, the number of articles increased to 245 articles in 2021. It again decreased to 234 articles in 2022 followed by a slight decrease to 229 articles in 2023. From the available literature, it is evident that Science Process Skills have been the subject of extensive investigation over the last three years, with a marked decline in research activity seen in recent years. Figure 1 below illustrates the development of the number of SPS research publications published in Google Scholar indexed journals to show the threshold of development of SPS research during the 2020-2023. Next, the most frequently appearing keywords are analyzed before mapping the visualization. 10 keywords were obtained and presented in Table 1.

**Table 1.**Top 15 Keywords for Science Process Skills Research for 2020-2023

Keywords	Occurence	Total Link Strength
Science Process Skills	527	3688
Student	187	511
Development	132	307
Effect	120	339
Model	115	467
Analysis	76	162
Learning	69	206
Inquiry	65	189
Science	57	164
Implementation	49	136
Effectiveness	49	145
Project	48	155
Problem	44	126
Outcome	41	152
Application	40	116

It can be seen that the keyword that appears most often and has the highest total link strength is Science Process Skills with 527 occurrences and a total link strength of 3688. Followed by Student in second place with 187 occurrences and a total link strength of 511. Then Development is in third place with 132 occurrences and total link strength 307. Effect is fourth with 120 occurrences and total link strength 339. Model is fifth with 115 occurrences and total link strength 467. Analysis is sixth with 76 occurrences and total link strength 162. Learning is in seventh with 69 occurrences and total link strength of 206. Inquiry is eighth with 65 occurrences and total link strength of 189. Science is ninth with 57 occurrences and total link strength of 164. Implementation is tenth with 49 occurrences and total link strength of 136. Effectiveness is eleventh with 49 occurrences and total link strength of 145. Project is twelfth with 48 occurrences and total link strength of 155. Problem is thirteenth with 44 occurrences and total link strength of 126. Outcome is fourteenth with 41 occurrences and total link strength of 152 and Application is fifteenth with 40 occurrences and total link strength of 116.

The articles obtained were then subjected to computational mapping bibliometric analysis using the VOSViewer tool. A total of 77 words were identified through the use of computational mapping techniques. The categorization of each identified item related to Science Process Skills is divided into 7 clusters with 1009 links and a total link strength of 3688. Strong relationships between terms are displayed in extensive bibliometric maps in network visualization mapping, which is the basis of the first mapping in this research (Sidabutar et al, 2022).

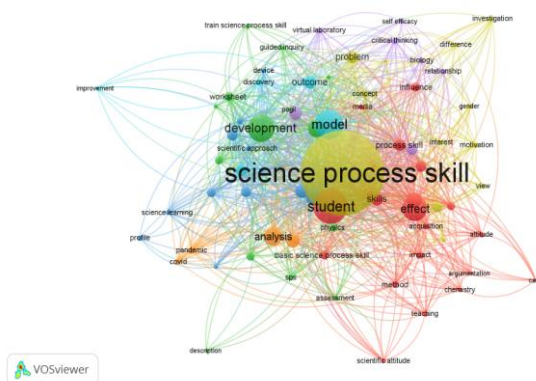
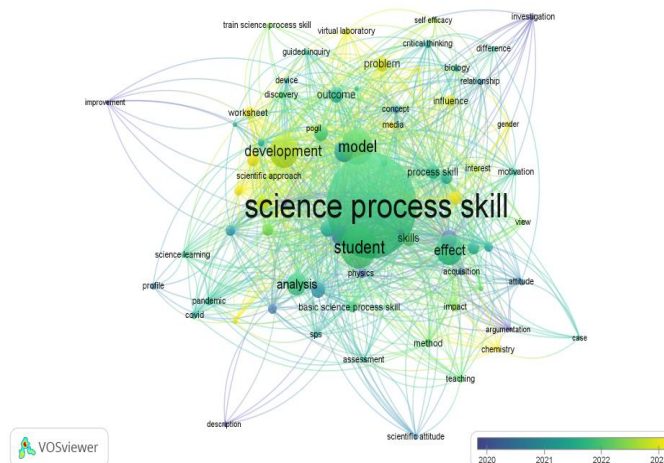

**Figure 2.** Networked Visualization of Science Process Skills Research on 2020-2023

Figure 2 shows a network visualization of Science Process Skills terms taken from VOSviewer. Each topic area studied is represented by a cluster, and the connection across each term and research on SPS is displayed within each cluster. Cluster 1 is marked in red. There are 21 items in cluster 1, namely acquisition, argumentation, attitude, basic science process skills, case, chemistry, effect, impact, improving science process skills, influence, media, method, process skill, science, scientific attitude, skills, student, study, teaching, understanding, and use. Cluster 2 is marked in green. There are 14 items in cluster 2, namely assessment, description, development, guided inquiry, integrated science process skills, learning, physics, POGIL, SPS, STEM, student worksheet, train science process skills, validity, and worksheet. Cluster 3 is marked in dark blue. There are 13 items in cluster 3, namely correlation, creativity, device, effectiveness, elementary school student, high school student, improve science process skills, inquiry, junior high school student, module, profile, science learning, and scientific approach. Cluster 4 is marked in yellow. There are 12 items in cluster 4, namely activity, comparison, concept, difference, gender, interest, investigation, motivation, problem, science education, science process skill, and view. Cluster 5 is marked in purple. There are 8 items in cluster 5, namely approach, biology, critical thinking, implementation, relationship, science process, self efficacy, and virtual laboratory. Cluster 6 is marked in light blue. There are 5 items in cluster 6, namely application, discovery, improvement, model, and outcome. Cluster 7 is marked in orange. There are 4 items in cluster 7, namely analysis, covid, pandemic, and project.

There are two areas of Science Process Skills research based on network visualization clusters. The term science is included in cluster 1 with a total of 51 links, total link strength is 164, and the term process skills is included in cluster 1 with a total of 41 links, total link strength is 99.

Vosviewer offers an overlay visualization that increases the recency of research terms and makes it possible to see how new a term is from year to year (Sidabutar et al., 2022).

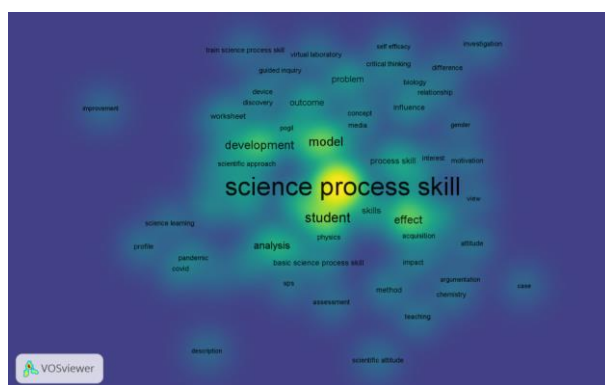


**Figure 3.** Overlay Visualization of Science Process Skills Research on 2020-2023

Figure 3 shows the popular keywords that researchers talk about regarding science process skills in 2020-2023. In 2020, it is popular to discuss development, inquiry and implementation. In 2021, keywords such as analysis, influence, and application are very popular to research. Keywords such as effectiveness, model, and problem will become popular keywords discussed by researchers in 2022. In 2023, keywords such as media, module, guided inquiry, and student worksheet will be very popular research researched by researchers.

Bibliometric analysis can be used to show that many keywords colored yellow indicate that the topic has been widely researched, while missing or dimmed keywords indicate that the topic has not yet been widely researched. analyzed using density visualization. (Sidabutar et al., 2022).





**Figure 4.** Density Visualization of Science Process Skills Research on 2020-2023

Figure 4 shows bibliometric analysis using density visualization which includes keywords such as science process skills, student, development, effect, model, analysis, and learning which have often been discussed by researchers. This is supported by a review of the top 10 publications on Science Process Skills research cited as impactful research over the past eleven years, as Table 2 shows.

**Table 2.**Review of the Top 10 Publications Cited in Science Process Skills Research for 2020-2023

Author	Year	Findings
N. Idris	2022	The seven main strategies in mastering SPS are experiment and minds-on, inquiry approach, discovery learning, strategic manipulation, debate skills, ICT and application of STEM.
G. Gizaw & S. Sota	2023	Student-centered strategies and multi-representational approaches successfully boost pupils' SPS coupled with pedagogy that involves the use of a variety of teaching aids, SPS practice in growth via hands-on and group activities.
A.D. Inayah	2020	Science process skills are essential to learners. Learners will grasp topics well with solid scientific process abilities.
M. Syazali	2021	In building SPS you can use guided inquiry, inquiry, PBL, PjBL, and learning cycles, including among the forms, as well as learning media in the form of modules and worksheets.
R.S. Budiarti	2022	Students' enthusiasm for science on scientific procedure expertise impact educational outcomes and pupil accomplishment.
D.A. Kurniawan	2020	The scientific process skills in both urban and rural pupil excel.
E.F.S Rini & F.T. Aldila	2023	Practical activities and evaluation of science process abilities are rarely carried out so that students' science process abilities are less developed due to a lack of direct experience which has an impact on their critical thinking abilities, as can be seen from the exam results which are still below. average.
R. Haryadi & H. Pujiastuti	2020	PhET simulation software-based learning is an interactive learning method that can improve students' process skills.
M.D.W Ernawati	2022	Learners' passions, values, as well as science process skills shape subjects related to science.
M. Ekici & M. Erdem	2020	Engaging in mobile scientific inquiry has a profound and beneficial impact on the development of science process skills.

Each article is analyzed based on the findings in the article. The majority of articles discuss findings that there are several strategies for mastering science process skills such as experimentation, minds-on, inquiry approaches, discovery learning, strategic manipulation,

debate skills, ICT, STEM (Idris et al., 2022), student-centered teaching, use of a variety of learning tools, hands-on exercises, group activities (Gizaw & Sota, 2023), PhET (Haryadi & Pujiastuti, 2020), mobile scientific investigations (Ekici & Erdem, 2020), guided inquiry, PBL, PjBL, learning cycles, use of learning media, modules and worksheets (Syazali et al., 2021) can train and improve students' science process skills.

Finally, students' scientific interests, attitudes and processing abilities are interrelated (Ernawati et al., 2022). However, practical activities and assessing science process skills are rarely carried out so that without direct experience, students' science process abilities and critical thinking skills are less developed, seen from the test results which are still below average (Rini & Aldila, 2023) because students can better understand the topic learning if you have strong scientific process skills (Inayah et al., 2020) so that involvement and science process skills are needed which can improve student progress, learning and achievement (Budiarti et al., 2022) to allow urban as well as rural pupils have the skills strong scientific process (Kurniawan et al., 2020).

In contrast to the keywords that are popularly discussed, keywords such as correlation, STEM, self efficacy, case, comparison, improvement, argumentation, and POGIL, these are research topics that are rarely researched and are too broad to be studied in more depth in relation to Science Process Skills.

The findings of this study reveal that, although researchers around the world have contributed to the field of science process skills, their research is consistent by country. Analysis of the extracted keywords revealed that the researchers' main focus remained on strengthening scientific process capabilities. However, like any research, this study has limitations. First, our dataset only includes publications published between 2020 and 2023, thereby reducing earlier and later articles. Second, the keywords we obtain, as well as other keywords, may or may not appear again in the future.

Future research possibilities for educators, curriculum designers, and policymakers in work to improve learning outcomes in the Merdeka Curriculum include investigating approaches that incorporate STEM, self-efficacy, case, comparison, improvement, argumentation, and POGIL as learning frameworks into schools and specifically, by including the most significant research outcomes from Q1. This research helps future researchers to pinpoint the most relevant topics for further exploration by combining multiple databases, such as Scopus, Google Scholar, and WoS, allowing researchers to quickly limit current issues and enrich the keywords acquired in the domain of this research. Furthermore, cross-country and multi-country research are required since they aid in the application of a wide range of issues and demographics. Age, background, education, country, and ethnicity are all examples of demographic variety that require more investigation. As a result, future researchers have the chance to focus their research on this area in order to generate a fuller understanding.

There are several contributions to this research. First, this study investigates publication trends in science process skills by evaluating publications over a given period of time. Second, this study collected and examined the ten most cited publications on science process skills research from 2020 to 2023. Third, we mapped keywords with networked analysis, overlay, and density visualization to help researchers avoid stagnation and advance the matter. Fourth, through bibliometric analysis, this study provides a complete and objective examination of the topic under consideration. Fifth, we noted numerous limitations in our study. This study identifies prospective areas for future research on science process skills.

## CONCLUSION

This research aims to view and review published research on Science Process Skills in 2020–2023 using VOSViewer. Article data from Google Scholar database journals collected using Publish or Perish. In 2020-2021 the number of articles published experienced a significant increase, but starting from 2022-2023 it experienced a drastic decline. Topics such as science process skills, students, development, effects, models, analysis, and learning have

often been discussed by researchers. In contrast to keywords such as correlation, STEM, self efficacy, case, comparison, improvement, argumentation, and POGIL, these are research topics that are rarely researched and too broad to be studied in more depth. The results of the review of the top 10 articles cited tend to examine strategies for mastering science process skills which include experimentation, thinking-on, inquiry approaches, discovery learning, strategic manipulation, debate skills, ICT, STEM, student-centered teaching, use of a variety of learning tools, hands-on exercises, group activities, PhET, mobile scientific inquiry, guided inquiry, PBL, PjBL, learning cycle, use of learning media, modules and worksheets. The novelty of this research is a bibliometric analysis and review of the latest research in the field of Science Process Skills.

This study reveals that although researchers around the world have contributed to the field of scientific process skills, their goal remains the same across countries. The research focuses on building scientific process capabilities, but the dataset only includes publications published between 2020 and 2023, reducing earlier and later articles. Future research could include exploring approaches integrating STEM, self-efficacy, cases, comparison, improvement, argumentation, and POGIL as learning frameworks in schools. Combining multiple databases such as Scopus, Google Scholar and WoS helps identify relevant topics for further exploration. Cross-national and multi-country research is needed to address a wide range of questions and demographics, such as age, race, education, country, and ethnicity. The study also examines publication trends on scientific process skills, collects and examines the ten most cited publications, maps keywords using network analysis, overlay and density visualization, and provides a comprehensive and objective examination of the subject. Despite its limitations, the study identifies potential areas for future research into scientific process skills.

The implication of this research is to find several examples of research trends regarding Science Process Skills so that this study might be an acknowledged for further research. This research can also find the most relevant issues regarding Science Process Skills. Thus, this also limits further trends that can be developed in this area of research.

## RECOMMENDATION

Enhance learning by providing students with a variety of opportunities to engage in developing and improving science process skills through implementing a variety of learning strategies that can grow students' science process skills by exploring topics such as correlation, STEM, self efficacy, case, comparison, improvement, argumentation, and POGIL.

## REFERENCES

- Ahmad, N. F., & Iksan, Z. H. (2021). Edmodo-Based Science Module Development on Students' Mastery of Science Process Skills: Need Analysis. *Creative Education*, 12(11), 2609-2623.
- Anjugam, R. & Chellamani, K. (2024). Science Process Skills: A Trend Analysis of Research. *International Journal of Indian Psychology*, 12(1), 772-781.
- Apaivatin, R., Srikoon, S., & Mungngam, P. (2021). Research synthesis of STEM Education effected on science process skills in Thailand. In *Journal of Physics: Conference Series* (Vol. 1835, No. 1, p. 012087). IOP Publishing.
- Audu, C. (2022). Effect Of Problem Solving Teaching Strategy On Biology Students' acquisition Of Science Process Skills And Critical Thinking In Secondary Schools In Taraba State, Nigeria. In *EDULEARN22 Proceedings* (pp. 3426-3432).
- Bayar, M. F., & Taş, Y. (2022). Effects of Robotic Coding Supported Design-Based Science Instruction on Students' Science Process Skills. *Alberta Journal of Educational Research*, 68(3).
- Bibon, M. B. (2022). Project HANDLE: Home-Based Activities Needed for Distance Learning Experiments and their Effect on the Development of Science Process Skills of Grade 7



- Learners. *Asia-Pacific Journal of Educational Management Research* Vol. 7, No. 2, pp. 75-98.
- Budiarti, R. S., Kurniawan, D. A., & Rohana, S. (2022). A Comparison by Gender: Interest and Science Process Skills. *Journal of Education Research and Evaluation*, 6(1), 88-97.
- Deehan, J., MacDonald, A., & Morris, C. (2024). A scoping review of interventions in primary science education. *Studies in Science Education*, 60(1), 1-43.
- Demirali, S., & Selvi, M. (2022). Effects of model-based science education on students' academic achievement and scientific process skills. *Journal of Turkish Science Education*, 19(2).
- Dilek, H., TAŞDEMİR, A., Konca, A. S., & Baltacı, S. (2020). Preschool children's science motivation and process skills during inquiry-based STEM activities. *Journal of Education in Science Environment and Health*, 6(2), 92-104.
- Ekici M. & Erdem M. (2020). Developing Science Process Skills through Mobile Scientific Inquiry. Thinking Skills and Creativity.
- Ernawati, M. D. W., Asrial, A., Perdana, R., Septi, S. E., Rohana, S., & Nawahdani, A. M. (2022). Evaluation of Students' Interest, Attitudes, and Science Process Skills in Science Subjects. *Journal of Education Research and Evaluation*, 6(1), 181-194.
- Gizaw, G., & Sota, S. (2023). Improving Science Process Skills of Students: A Review of Literature. *Science Education International*, 34(3), 216-224.
- Güder, O., Demir, M., & Özden, M. (2022). The effect of STEM education on science process skills of students in Turkey: A meta-analysis study. *International Journal of Eurasian Education and Culture*, 7(17), 1104-1142.
- Haryadi, R., & Pujiastuti, H. (2020). PhET simulation software-based learning to improve science process skills. In *Journal of Physics: Conference Series* (Vol. 1521, No. 2, p. 022017). IOP Publishing.
- Idris N., Talib O., & Razali F. (2022). Strategies in Mastering Science Process Skills in Science Experiments: A Systematic Literature Review. *Jurnal Pendidikan IPA Indonesia*, 11(1), 155-170.
- Idris, N., Talib, O., & Razali, F. (2022). Strategies in mastering science process skills in science experiments: A systematic literature review. *Jurnal Pendidikan IPA Indonesia*, 11(1), 155-170.
- Inayah, A. D., Ristanto, R. H., Sigit, D. V., & Miarsyah, M. (2020). Analysis of science process skills in senior high school students. *Universal Journal of Educational Research*, 8(4), 15-22.
- Işiker, Y. & Emre, İ. (2021). The impact of argumentation-based instruction on academic achievements and scientific process skills of primary school students and their attitudes towards the science course. *International Journal of Scholars in Education*, 4(1). 1-14.
- Kalemkus, J., Bayraktar, S., & Çiftçi, S. (2021). Comparative Effects of Argumentation and Laboratory Experiments on Metacognition, Attitudes, and Science Process Skills of Primary School Children. *Journal of Science Learning*, 4(2), 113-122.
- Kurniawan, D. A., Perdana, R., & Ikhlas, M. (2020). Do a Science Process Skills Affect on Critical Thinking in Science? Differences in Urban and Rural. *International Journal of Evaluation and Research in Education*, 9(4), 874-880.
- Kurniawati, A. (2021). Science Process Skills and Its Implementation in the Process of Science Learning Evaluation in Schools. *Journal of Science Education Research*, 5(2), 16-20.
- Macayan, V. D., Baguistan, D. C., & Golias, J. B. (2022). GAME-BASED ACTIVITIES AND GAMIFICATION IN THE MASTERY OF SCIENCE PROCESS SKILLS: A SYSTEMATIC LITERATURE REVIEW. *EPRA International Journal of Multidisciplinary Research (IJMR)*, 8(7), 388-398.
- Mirana, V. (2019). Attitude towards science and process skills of junior high school students. *Available at SSRN 3389072*.

- Mushani, M. (2021). Science Process Skills in Science Education of Developed and Developing Countries: Literature Review. *Unnes Science Education Journal*, 10(1), 12-17.
- Mushani, M. (2021). Science process skills in science education of developed and developing countries: Literature review. *Unnes Science Education Journal*, 10(1), 12-17.
- Olowu, B., Mirian. (2023). An assessment of science process skills among science students in river state, nigeria. *Journal of Advance Research in Applied Science* (ISSN 2208-2352), 9(3), 1-5.
- Özge, K. O. L., & Yaman, S. (2022). The Effects of Studies in the Field of Science on Scientific Process Skills: A Meta-Analysis Study. *Participatory Educational Research*, 9(4), 469-494.
- Raharjo, S., & Puspita, Y. (2024, March). Development of a STEM-Project Model to Enhancing Science Process Skills High School Physics Subject. In *Proceeding International Conference on Religion, Science and Education* (Vol. 3, pp. 257-265).
- Ratamun, M. M., & Osman, K. (2018). The effectiveness of virtual lab compared to physical lab in the mastery of science process skills for chemistry experiment. *Problems of Education in the 21st Century*, 76(4), 544.
- Rini, E. F. S., & Aldila, F. T. (2023). Practicum activity: analysis of science process skills and students' critical thinking skills. *Integrated Science Education Journal*, 4(2), 54-61.
- Rostiany, Y., & Tjandra, E. (2022). Analisis Bibliometrik Studi Perkembangan Metode Service Quality pada Database Google Scholar Menggunakan Vosviewer (Studi Literatur Tahun 2016–2020). *SMATIKA JURNAL: STIKI Informatika Jurnal*, 12(01), 85-93.
- Sidabutar, D., Ningrum, S. S., & Nuryadin, A. (2022). Analisis Bibliometrik Media Pembelajaran di Sekolah Dasar Menggunakan VOSViewer. *Educatio*, 17(2), 165-177.
- Solé-Llussà, A., Aguilar, D., & Ibáñez, M. (2021). Video worked examples to promote elementary students' science process skills: a fruit decomposition inquiry activity. *Journal of Biological Education*, 55(4), 368-379.
- Syazali, M., Erfan, M., & Khair, B. N. (2021). Learning facilities that can develop science process skills in Indonesia: Review of experimental studies. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, 7(4), 910-923.
- Tangahu, S. R., Hasan, A. M., Ahmad, J., Latjompoh, M., Retnowati, Y., & Husain, I. (2024). Application of the Discovery Learning Model to Improve Students' Science Process Skills on Virus Material. *JURNAL PEMBELAJARAN DAN BIOLOGI NUKLEUS*, 10(1), 113-121.