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Can Generic Science Skills be Improved through Physics Learning Media with PjBL Model? (A Review)

Aris Doyan[1*], Susilawati[1], Ahmad Harjono[1], Syarful Annam[2], Muhammad Ikhsan[3], Nuraini Rachma Ardianti[3]

[1] Department of Physics Education, Universitas Mataram, Lombok, Indonesia.
[2] Department of Science Education, Universitas Negeri Makassar, Makassar, Indonesia.
[3] Balai Publikasi Indonesia, Mataram, Indonesia.

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Corresponding Author:
Aris Doyan
aris_doyan@unram.ac.id

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Abstract: Project-Based Learning (PjBL) physics learning media has emerged as an effective strategy for improving students' generic science skills. This research aims to identify and analyze research trends of improving generic science skills through physics learning media with PjBL model. This research method is descriptive and analytical. Research procedures use PRISMA guidelines. The data identified and analyzed are the type of publication, publication source, and the title of research on improving generic science skills through physics learning media with PjBL model that is widely cited. The data analysis method uses bibliometric analysis assisted by VOS viewer software. The results of the analysis show that research trend indexed by Google Scholar from 2015 to 2024 has experienced a fluctuating increase. Research trend with an increase in the number of publications from 2015 to 2018. However, in 2019 and 2022 the research trend on the generic science ability in learning has decreased from the previous year and the research trend increase again in 2023. There are many documents in the form of articles, proceedings, book chapters and edited books that discuss research improving generic science skills physics learning media with PjBL model. Key words that are often used in research of generic science are critical thinking, e module, science learning, PBL, etc.

Keywords: Generic science skill; Learning media; Physics; PjBL

Introduction

Project-Based Learning (PjBL) physics learning media has emerged as an effective strategy for improving students' generic science skills. Generic science skills include logical thinking, modeling, problem-solving, inference, and mastery of symbolic language, which play a crucial role in deepening the understanding of physics concepts. PjBL enables students to construct knowledge through active engagement in contextual projects that integrate physics concepts with real-life situations. Through project-based media, students not only learn to understand physical phenomena but also develop skills in identifying variables, organizing data, and making scientific interpretations in accordance with scientific principles. Furthermore, the use of learning media in PjBL, whether in the form of interactive multimedia, simulations, or experiment-based teaching aids, can increase student engagement and motivation in solving scientific problems. For example, virtual laboratory-based media in the PjBL model has been shown to improve generic science skills in the areas of indirect observation, mathematical modeling, and concept building (Putra et al., 2020). Several studies have shown that the application of PjBL-based physics learning media significantly contributes to improving generic science skills.

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Research by Ningsi et al. (2025), reported that students learning through interactive media-assisted projects demonstrated improved abilities in identifying relationships between variables and conducting data-based analyses of experiments. Similarly, a study by Putro et al. (2019), found that PjBL-based media fostered students' scientific thinking skills through collaborative activities in project completion. Thus, PjBL-based physics learning media is not merely a visual or practical tool, but a strategic tool for developing generic science skills. This model provides authentic learning experiences, facilitating students' critical thinking, exploration, and integration of conceptual and procedural knowledge into the physics learning process. One part of 21st century skills is generic science skills. Generic science skills are very important because they can help students understand scientific ideas better. This is because generic science skills are not just skills, but also a type of intellectual ability that comes from the connection between scientific knowledge and skills. Therefore, the role of generic science skills is important in helping the learning process, especially in science learning that focuses on the learning process itself. Generic science abilities are part of higher order thinking abilities (Mustapa et al., 2023; Yusnidar et al., 2024). Generic science abilities can help improve high-level thinking skills well (Anjalina et al., 2019).

These abilities can be developed through science learning because they are really important in science education (Izetbigovic et al., 2019). If students have good generic science abilities, their understanding of science will also be strong. Preparing active learning is a government plan to deal with the times of globalization and meet the needs of the 21st century (Stehle & Peters-Burton, 2019; Larson & Miller, 2011; González-Pérez & Ramírez-Montoya, 2022). This approach is meant to create people who are good at using technology and science so that they can help the country grow (Dewi Muliani et al., 2019; Mynbayeva et al., 2015), It is understood that the requirements of the 21st century are important to take into account, especially in education to handle future problems (Geisinger, 2016; Kaufman, 2013). In other words, the skills needed in the 21st century must be well understood (DiCerbo, 2014; Fry & Seely, 2011). Generic science abilities are students' ability to think and act using the knowledge they have. These abilities can be used in doing scientific activities and are aimed at higher knowledge (Syugiyanto, 2021). The quality of generic science abilities includes high-level thinking, communication, reasoning, and lifelong learning skills (Sanjaya, 2019).

Generic science abilities can be applied in the world of work because they are produced from intellectual abilities combined with psychomotor abilities to produce attitudes that will last a lifetime (Ardiansyah et al., 2023). Generic science abilities are abilities that students must have so that the knowledge and skills obtained in the learning process can be applied in everyday life and answer the challenges of an increasingly developing era (Saklressy et al., 2021). Generic science abilities produce lifelong attitudes because of the combination of intellectual abilities and psychomotor skills. This skill is used to learn various concepts and solve science problems (Lambert & Gong, 2010; Sibille et al., 2010). The generic science skills has nine indicators, namely direct observation, indirect observation, awareness of scale, logical inference, mathematical modeling, symbolic language, law of cause and effect, logical framework, and discovery of new concepts. Students' generic science abilities must be improved in all subjects, including science.

One part of science is modern physics. Modern physics is one of the important courses in physics because it underlies several other advanced courses, including quantum physics, solid state physics, statistical physics and nuclear physics. In generic, the concept of modern physics includes the special theory of relativity, quantum theory for electromagnetic radiation and matter, hydrogen-like atoms, multielectron atoms, nuclear physics, and atomic systems (Knecht et al., 2020). Another factor is the still rare use of learning media in the Modern Physics course that can provide a better understanding of abstract materials. One of the efforts to improve students' generic science skills is by developing interactive web-based media using a model that can facilitate the improvement of scientific attitude of students. The learning model used is Project Based Learning (PjBL). Project-Based Learning (PjBL) is a form of learning that focuses on students. Students are actively involved in the learning process. Students' thinking skills in dealing with problems will be trained through PjBL. Students work together with others and reflect on what they have learned. In addition, students can be active in the search and decision-making process by improving their practical thinking skills (Rivas et al., 2023).

The use of learning models is very good when combined with the use of learning. This is closely related to the use of information and communication technology which is increasingly developing rapidly as an effort to digitize education in the implementation of the independent curriculum (Griffin, 2017; Jang, 2016). Information and Communication Technology (ICT)-based learning in the world of education cannot be separated from the needs of 21st century learning, especially in science learning. One alternative that can be done is that learning media is integrated with technology, such as interactive web-based media. Through interactive website-based learning media, lecturers can monitor the learning process and

development of students. This will help the learning evaluation process in Modern Physics courses. Therefore, this research wants to know the research trend of the improving generic science skills through interactive web-based modern physics learning media with PjBL model.

Method

This research method is descriptive and analytical, which aims to understand and describe research trends in improving generic science skills through interactive web-based modern physics learning media with PjBL model. The data used in this study was obtained from information sources indexed by Google Scholar using analytical tools such as Publish or Perish and Dimension.ai. To carry out a search on Google Scholar, keywords related to research trends on improving generic science skills through interactive web-based modern physics learning media with PjBL model.

In this research, an analysis was carried out on 1.000 documents that had been indexed by Google Scholar between 2015 and 2024. The Google Scholar database was chosen as a place to search for documents because Google Scholar applies consistent standards in selecting documents to be included in its index, and Google Scholar displays more documents than the top databases. Others, especially research in the field of education (Hallinger & Chatpinyakoop, 2019; Hallinger & Nguyen, 2020; Zawacki-Richter et al., 2019). To filter data that has been collected via Publish or Perish, researchers used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Result and Discussion

This research aims to describe research trends on Problem Based Learning model to improve scientific attitude conducted from 2014 to 2023. Research documents on research trends improving generic science skills through interactive web-based modern physics learning media with PjBL model are taken from documents from 2015 to 2024. Figure 1 is presented below regarding research trends on the improving generic science skills through interactive web-based modern physics learning media with PjBL model. Figure 1 shows that the trend in research on the improving generic science skills through interactive web-based modern physics learning media with PjBL model experiencing increases and decreases. Where the research trend with an increase in the number of publications from 2015 to 2018. However, in 2019 and 2022 the research trend on improving generic science skills through interactive web-based modern physics learning media with PjBL model has decreased from the previous year and the research trend increase again in 2023.

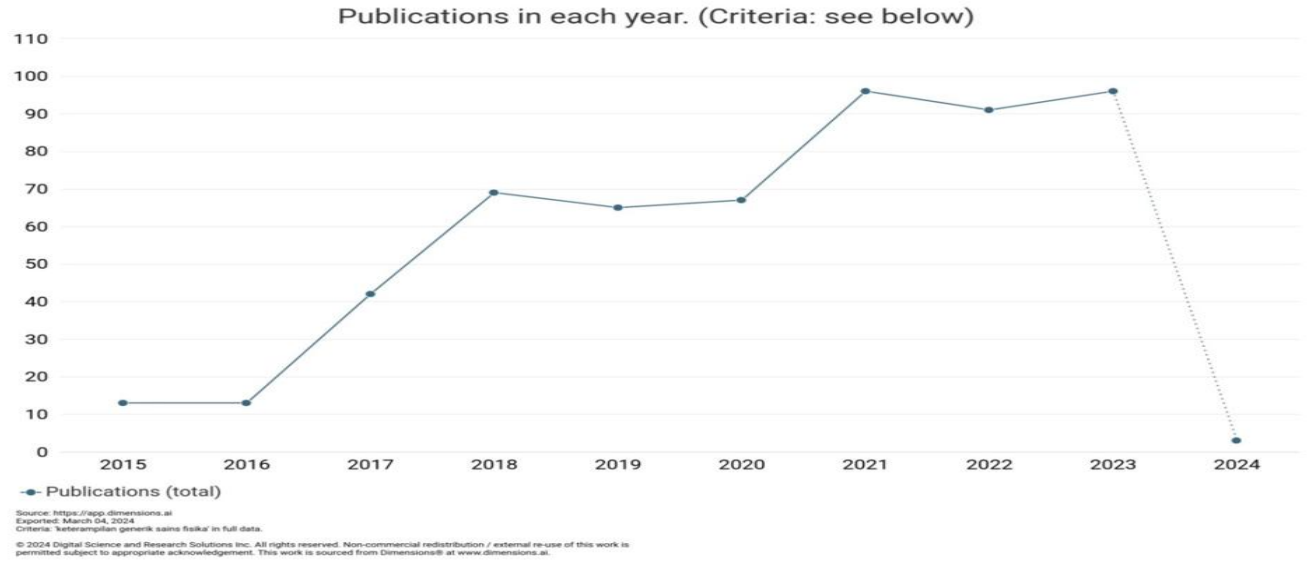

Figure 1. Research trends in improving generic science skills through physics learning media with PjBL model

The increasing trend in research on the improving generic science skills through interactive web-based modern physics learning media with PjBL model caused by 21st century education has focused on improving generic science competence. In 2015 there were 13 publications related to the improving generic science skills through interactive web-based modern physics learning media with PjBL model, then this will continue to increase to 69 publications in 2018. But publication decrease to 65 in 2019 and going increase again until

2023 with 96 publications. This increasing research trend provides a deeper understanding the problem which is low of generic science skills in science learning and ways to solve that problem. Research is able to improve generic science skills through various methods, one of them is project based learning model. Below are also table 1 presented research of improving generic science skills through interactive web-based modern physics learning media with PjBL model based on the type of publication.

Table 1. Trends in Improving Generic Science Skills Through Physics Learning Media with PjBL Model Research Based On Publication Types

Publication Type	Publications
Article	533
Proceeding	20
Edited Book	10
Chapter	5
Monograph	1

Based on Table 1, it is known that research improving generic science skills through interactive web-based modern physics learning media with PjBL model from 2015 to 2024 contained in 5 types of publications. In the form of articles there were 533 documents, chapters as many as 5 documents, proceedings as many as 20 documents, edited books as many as 10 documents, and monographs only 1 document. Research trends improving generic science skills through interactive web-based modern physics learning media with PjBL model in article form is the type of publication that contains the most research about the trend (Sugihartini et al., 2025). Meanwhile, the type of publication contains the least amount of research results improving generic science skills through interactive web-based modern physics learning media with PjBL model is a monograph. Research conducted by Oltarzhevskyi (2019) and Suseno et al. (2020), states that an article is a complete factual essay of a certain length created for publication in online or print media (via newspapers, magazines or bulletins) and aims to convey ideas and facts that can convince and educate. These articles are usually published in scientific journals both in print and online.

Below are also table 2 presented top ten (10) sources title trends in research on improving generic science skills through interactive web-based modern physics learning media with PjBL model which are often cited by other researchers related to this matter. Table 2 shows that the most widely published source of research trends on the improving generic science skills through interactive web-based modern physics learning media with PjBL model is the Jurnal Penelitian Pendidikan IPA, namely 28 publications with 43 citations and an average citation of 1.54. Jurnal Penelitian Pendidikan IPA contains scientific articles form of research results that include science, technology, and teaching in the field of science. The first edition were published in 2015. All edition in this journal are open access, i.e. the articles published in them are immediately and permanently free to read, download, copy & distribute. Below are also table 3 presented top ten (10) article title trends in research on improving generic science skills through interactive web-based modern physics learning media with PjBL model which are often cited by other researchers related to this matter.

Table 2. Top 10 Sources Title Trend of Improving Generic Science Skills through Physics Learning Media with PjBL Model Research in 2015-2024

Name	Publications	Citations	Citations Mean
Jurnal Penelitian Pendidikan IPA	28	43	1.54
Journal of Physics Conference Series	24	91	3.79
Advances in Social Science, Education and Humanities Research	15	23	1.53
Jurnal Pendidikan Sains Indonesia	14	69	4.93
Jurnal Ilmiah Pendidikan Fisika	14	19	1.36
Jurnal Ilmiah Profesi Pendidikan	13	3	0.23
Jurnal Pendidikan Fisika	9	21	2.33
Jurnal Penelitian Pembelajaran Fisika	9	10	1.11
Jurnal Penelitian & Pengembangan Pendidikan Fisika	7	27	3.86
Berkala Ilmiah Pendidikan Fisika	7	38	5.43

Table 3 shows that research on the improving generic science skills through interactive web-based modern physics learning media with PjBL model that is widely cited by other researchers is about "The Effectiveness of Module Based on Discovery Learning to Increase Generic Science Skills" which is 12.00 (Khabibah et al., 2017). Then the research entitled "Effectiveness of Quantum Physics Learning Tools Using Blended Learning Models to Improve Critical Thinking and Generic Science Skills of Students" was cited 11.00 times per year (Doyan et al., 2023). Research by Razali et al. (2020), Tuononen et al. (2022), entitled "Effect of inquiry learning methods on generic science skills based on creativity level" is also widely cited by other researchers,

namely 6.00 per year. (Nastiti et al., 2019), in their research entitled "The Need Analysis of Module Development Based on Search, Solve, Create, and Share to Increase Generic Science Skills in Chemistry" was cited 5.83 per year. This research data is comparable to data on the increasing trend of research on the improving generic science skills through interactive web-based modern physics learning media with PjBL model from 2015 to 2024. This means that in that year, research related to it was continuously cited by other researchers. In the articles researched and written by these researchers, there are many terms related to the trend. Below are presented ten (10) popular keywords related to improving generic science skills through interactive web-based modern physics learning media with PjBL model.

Table 3. Top 10 Citations on Trend of Improving Generic Science Skills Physics Learning Media with PjBL Model Research in 2015-2024

Cites/year	Year	Author	Title
12.00	2017	Elok Norma Khabibah, Mohammad Masykuri, Maridi	The Effectiveness of Module Based on Discovery Learning to Increase Generic Science Skills
11.00	2022	Aris Doyan, Susilawati, S Hadisaputra, L Mulyadi	Effectiveness of Quantum Physics Learning Tools Using Blended Learning Models to Improve Critical Thinking and Generic Science Skills of Students
6.00	2020	Razali, A Halim, A G Haji, E Nurfadila	Effect of inquiry learning methods on generic science skills based on creativity level
5.83	2018	D. Nastiti, S. B. Rahardjo, Elfi Susanti VH, R. Perdana	The Need Analysis of Module Development Based on Search, Solve, Create, and Share to Increase Generic Science Skills in Chemistry
5.67	2015	Johar Maknun	The Implementation of Generative Learning Model on Physics Lesson to Increase Mastery Concepts and Generic Science Skills of Vocational Students
5.00	2022	Aris Doyan, Susilawati, S Hadisaputra, L Mulyadi	Analysis Validation of Quantum Physics Learning Devices using Blended Learning Models to Improve Critical Thinking and Generic Science Skills of Students
4.50	2018	M Faradilla, M Hasan, Sulastri	The effectiveness of guided inquiry-based student worksheets on students' generic science skills
3.25	2020	Herianto, I Wilujeng	The correlation between students' curiosity and generic science skills in science learning
3.00	2023	Aris Doyan, Susilawati, Ahmad Harjono, L Mulyadi, Hamidi, H Fuadi, I G N Y Handayana	The effectiveness of modern optical learning devices during the Covid-19 pandemic to improve creativity and generic science skills of students
2.50	2022	N. M. Pujani, K. G. Y. Arsana, K. Suma, K. Selamet, N. Erlina	The Effectiveness of Introduction to Astronomy Teaching Materials to Improve Problem-Solving and Generic Science Skills

Table 4. Keywords on Trend Improving Generic Science Skills through Physics Learning Media with PjBL Model Research in 2015-2024

Terms	Occurrences	Relevance
Critical Thinking	11	2.85
E module	9	2.78
Science Learning	8	2.59
Ethnoscience	7	2.33
Virtual Laboratory	5	1.67
Generative Learning	5	1.60
Interactive Multimedium	7	1.60
Technology	9	1.13
PBL	9	1.07
Project	7	1.04

Table 4 shows that the keywords that often appear related to research on the the improving generic science skills through interactive web-based modern physics learning media with PjBL model are critical thinking 11 times with a level of 2.85. This indicates that generic science abilities are often researched together with critical thinking abilities, for example, research conducted by Syuzita et al. (2023), García-Carmona, (2025), and Park et al. (2023). Table 4 also shows that e modul is also a keyword that appears frequently in research trends on the improving generic science skills through interactive web-based modern physics learning media with PjBL model, namely 9 times with a relevance of 2.78. E module has been proven to be able to improve students' generic science abilities (Sukarso et al., 2023; Bulut Ates & Aktamis, 2024; Bates et al., 2025).

Below are the visualization is accomplished by generating a landscape map, which offers a visual representation of subjects related to scientific studies. The outcomes of bibliometric mapping for the co-word network in articles related to the topic improving generic science skills through interactive web-based modern physics learning media with PjBL model are illustrated in Figure 2. Figure 2 shows the results of bibliometric keyword mapping on research trends on the improving generic science skills through interactive web-based

modern physics learning media with PjBL model. In Figure 2 there are 63 keyword items that are often used in research on the generic science skills from 2015 to 2024. Figure 2 also contains 5 clusters, where the first cluster is colored red and consists of 16 keyword items, namely inquiry, learning process, critical thinking, ethnoscience, etc. The second cluster in green consists of 15 keyword items, namely e module, PBL, teaching material, validation, etc. The third cluster in blue consists of 11 keyword items, namely development, interactive multimedium, discovery, etc. The fourth yellow cluster consists of 11 keyword items, namely teacher, application, technology, physics learning, etc. The fifth purple cluster consists of 10 keyword items, namely generative learning model, virtual laboratory, etc.

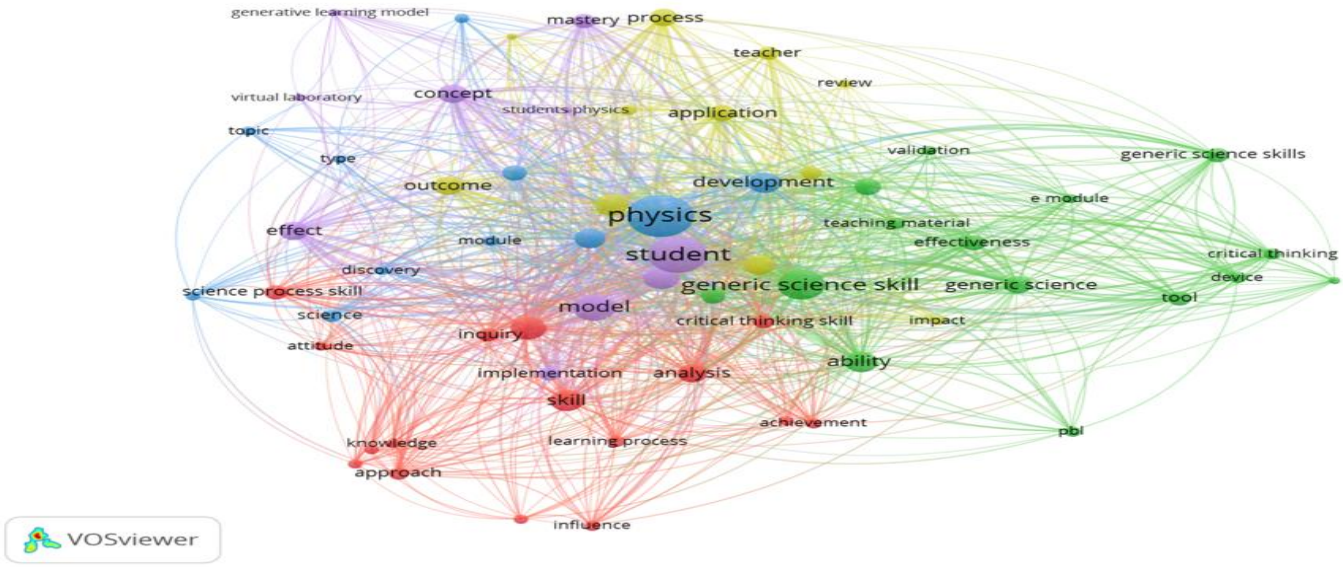

Figure 2. Network visualization on trend improving generic science skills physics learning media with PjBL model research

Figure 2 above also shows that network visualization shows the network between the terms being visualized. Keywords classified into five clusters are arranged in a color chart showing the divisions that are connected to each other. The results of this analysis can be used to determine keyword research trends in the last year. This analysis shows several keywords that are often used in research on the improving generic science skills through interactive web-based modern physics learning media with PjBL model. The more keywords that appear, the wider the visualization displayed. Below are also presented keywords regarding the improving generic science skills through interactive web-based modern physics learning media with PjBL model based on overlay visualization.

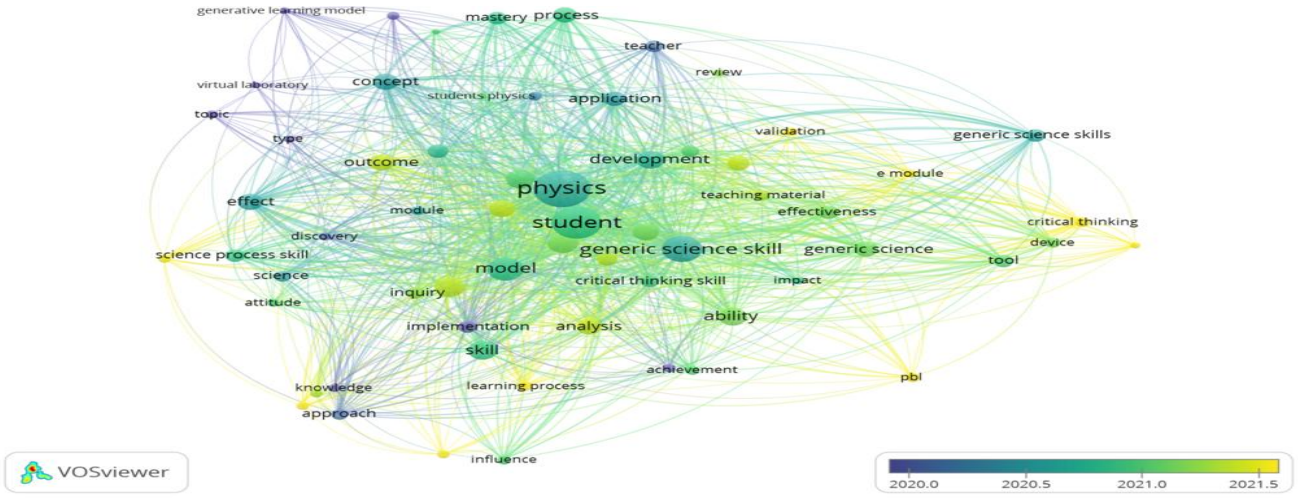

Figure 3. Overlay visualization on trend improving generic science skills through physics learning media with PjBL model research

Figure 3 shows the trend of keywords related to research on improving generic science skills through interactive web-based modern physics learning media with PjBL model in Google Scholar indexed journals from 2015 to 2024. Trends in the themes of writing articles related to the improving generic science skills through interactive web-based modern physics learning media with PjBL model from the oldest to the newest year are marked with purple, blue themes, turquoise, dark green, light green and yellow. In the picture above you can see that the virtual laboratory, generative learning model, etc. This shows that these keywords were widely used by researchers in 2020. In 2021, the keywords that frequently appeared were critical thinking, physics, module, generic science, effectiveness etc.

Research on improving generic science skills through interactive web-based modern physics learning media with PjBL model is one area of research that has developed rapidly in recent years. The following also presents keywords for improving generic science skills through interactive web-based modern physics learning media with PjBL model research based on density visualization. Figure 4 shows density visualization. The density of research themes is shown in bright yellow. The brighter the colors of a theme, the more research is done. The fainter the color means the theme is rarely researched (Kaur et al., 2022; Liao et al., 2018). Faintly colored themes such as need, effort, term, evaluation are dimly colored keywords. This shows that these keywords can be used as a reference for further research. Doyan et al. (2022) and Bahtiar et al. (2023) stated that yellow indicates keywords that are currently and frequently used in research.

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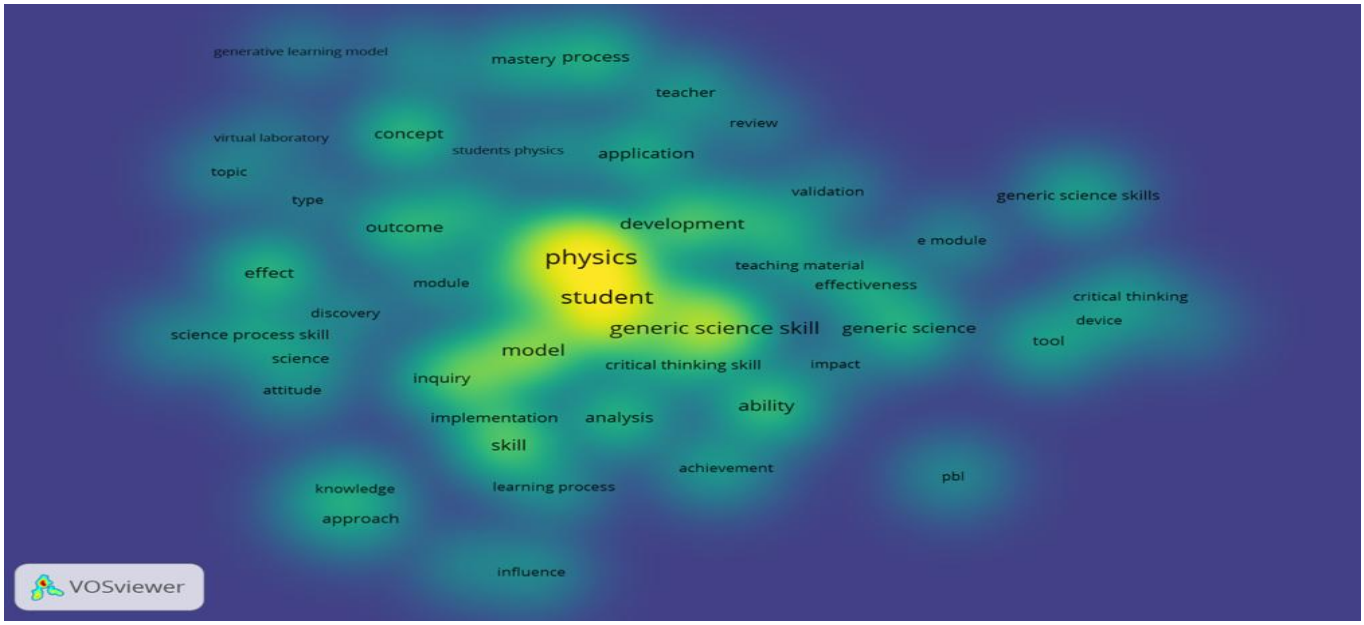

Figure 4. Density visualization on trend improving generic science skills through physics learning media with PjBL model research

Overall, research on improving generic science skills through interactive web-based modern physics learning media with PjBL model is important because it makes significant contributions to the 21st century education and PjBL model is a learning model that is able to facilitate generic science skills (Daulay & Asrizal, 2024). Generic science skills are very important so that students are able to process information to solve problems both in learning and in real life. The research trend in improving generic science skills through interactive web-based modern physics learning media with PjBL model is expected to continue to develop in the next few years. This can be done by developing new combination of PjBL model with technology like interactive web or other things to facilitate students' generic science skills, especially in modern physics (Doyan et al., 2025; Pujianto et al., 2024).

Conclusion

Research on trends in the improving generic science skills through interactive web-based modern physics learning media with PjBL model has urgency high because of its potential to provide various benefits to 21st century education. The research trend on the improving generic science skills through interactive web-based modern physics learning media with PjBL model indexed by Google Scholar from 2015 to 2024 has

experienced a fluctuating increase. Research trend with an increase in the number of publications from 2015 to 2018. However, in 2019 and 2022 the research trend on the generic science ability in learning has decreased from the previous year and the research trend increase again in 2023. There are many documents in the form of articles, proceedings, book chapters and edited books that discuss research about improving generic science skills through interactive web-based modern physics learning media with PjBL model. Key words that are often used in research of generic science are critical thinking, e module, science learning, PBL, etc.

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Author Contributions
Conceptualization, A. D; methodology, A. H.; formal analysis, S. A.; investigation, M. I.; resources, N. R. A.; writing—preparation of original draft, A. D.; writing—reviewing and editing, S.; visualization, A. H; supervision, S, A.; project administration, M. I; obtaining funding, N. R. A. All authors have read and approved the published version of the manuscript.

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