

Trends Research Problem Based Learning (PBL) Model to Improve Generic Science Skills in Students' Science Learning (2015-2024): A Systematic Review

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Abstract: 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. Generic science skills can be facilitated through learning with a Problem Based Learning (PBL) model. This research aims to identify and analyze research trends of PBL model to improve generic science skill in science learning. This research method is descriptive and analytical. The data used in this research was obtained from documents indexed by Google Scholar from 2015-2024 using Publish or Perish and Dimension.ai. Research procedures use PRISMA guidelines. The data identified and analyzed are the type of publication, publication source, and the title of research on PBL model to improve generic science skill in science learning 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 on PBL model to improve generic science skill in science learning 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 Problem Based Learning model to improve generic science skills in science learning. Key words that are often used in research of generic science are critical thinking, e module, science learning, PBL, etc.

Keywords: Generic science; Problem based learning; Review; Science learning

Introduction

Learning in the current curriculum is learning that emphasizes the scientific process (Meltzer, 2002). It is expected that students will be able to improve scientific activities, scientific attitudes and also scientific process skills in the learning process. Scientific process skills are needed in scientific activities (Rahayu et al., 2021). In the

2013 curriculum and merdeka curriculum, learning takes place with four learning models, namely discovery learning, exploration, problem learning and project learning (Parker et al., 2022). The purpose of implementing this learning model is for students to learn independently so that the learning process is not centered on the teacher.

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Preparing active learning is also a government strategy to face the era of globalization and respond to the demands of the 21st century (Stehle & Peters-Burton, 2019; Van Laar et al., 2020; Larson & Miller, 2011; González-Pérez & Ramírez-Montoya, 2022). This strategy is expected to produce individuals who are competent in technology and science so that they can advance the nation (Muliani & Citra Wibawa, 2019; Mynbayeva et al., 2015). It is known that the demands of the 21st century are the main things that must be considered, especially in the field of education to face future challenges (Geisinger, 2016; Larson & Miller, 2011; Kaufman, 2013). So, in other words the skills required in the 21st century must be mastered (DiCerbo, 2014; Fry & Seely, 2011; Griffin, 2017; Jang, 2016; Lambert & Gong, 2010; Sibille et al., 2010).

One aspect that is part of 21st century skills are generic science skills (Yuberti et al., 2021). Generic science skills becomes very essential because able to improve students' understanding towards scientific concepts (Hadzigeorgiou & Schulz, 2019). This is because generic science skills not just a skill, but also is an intellectual ability arise from the interaction between scientific knowledge and skills. The role of generic science skills is essential in supporting the process learning, especially in context science learning that focuses on aspects of the learning process (Tuononen et al., 2022). Generic science abilities are one of the higher order thinking abilities (Devi et al., 2021). Generic science abilities can improve high-level thinking abilities well (Anjalina et al., 2019). Generic science abilities can be developed through science learning because they are really needed in science learning (Agustin, 2014). If students' generic science abilities are good then their understanding of science will also be good.

Generic science abilities are students' ability to think and act based on the knowledge they have. Generic science abilities can be used in carrying out scientific activities and are oriented towards higher knowledge (Syugiyanto, 2021). The quality of generic science abilities includes high-level thinking abilities, communication abilities, reasoning abilities, and lifelong learning (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 (Karpinski et al., 2018). 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 (Sakliressy 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. 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.

In science learning, students are not only equipped with mastery of a number of sciences, but are also given sufficient space to apply the knowledge they learn in everyday life (Astalini et al., 2022; Kurniawan et al., 2019; Nurlia, 2023; Darmaji et al., 2021; Kurniawan et al., 2023; Ayu Sri Wahyuni, 2022). This is because in science learning, students do not only memorize concepts and answer questions, but students are also expected to be able to understand, observe, analyze and solve problems that will later be useful in everyday life (Maison et al., 2020).

One of the efforts to improve students' science process abilities is by implementing active learning models in the classroom, for example Problem Based Learning (PBL) assisted by Information and Communication media. Technologies (ICT) (Wulandari & Sari, 2023). Therefore, this research wants to know the research trend of the Problem Based Learning model to improve generic science skills. It is hoped that this research can become a reference in developing further research related to generic science in students' science learning.

Method

This research method is descriptive and analytical, which aims to understand and describe research trends in the Problem Based Learning model to generic science skills in science learning. 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 the Problem Based Learning model to improve generic science skills in science Learning.

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 & Chatpinyakoo, 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 generic science skills conducted from 2014 to 2023. Research documents on research trends Problem Based Learning model to improve generic science skills in science learning are taken from documents from 2015 to 2024. Figure 1 is presented below regarding research trends on the Problem Based Learning model to improve generic science skills in science learning.

Figure 1 shows that the trend in research on the Problem Based Learning model to improve generic science skills in science learning 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 Problem Based Learning model to improve generic

science skills has decreased from the previous year and the research trend increase again in 2023. The increasing trend in research on the Problem Based Learning model to improve generic science skills caused by 21st century education has focused on improving generic science competence.

In 2015 there were 13 publications related to the Problem Based Learning model to improve generic science skills, 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 Problem Based Learning model. Below are also table 1 presented research of Problem Based Learning model to improve generic science skills based on the type of publication.

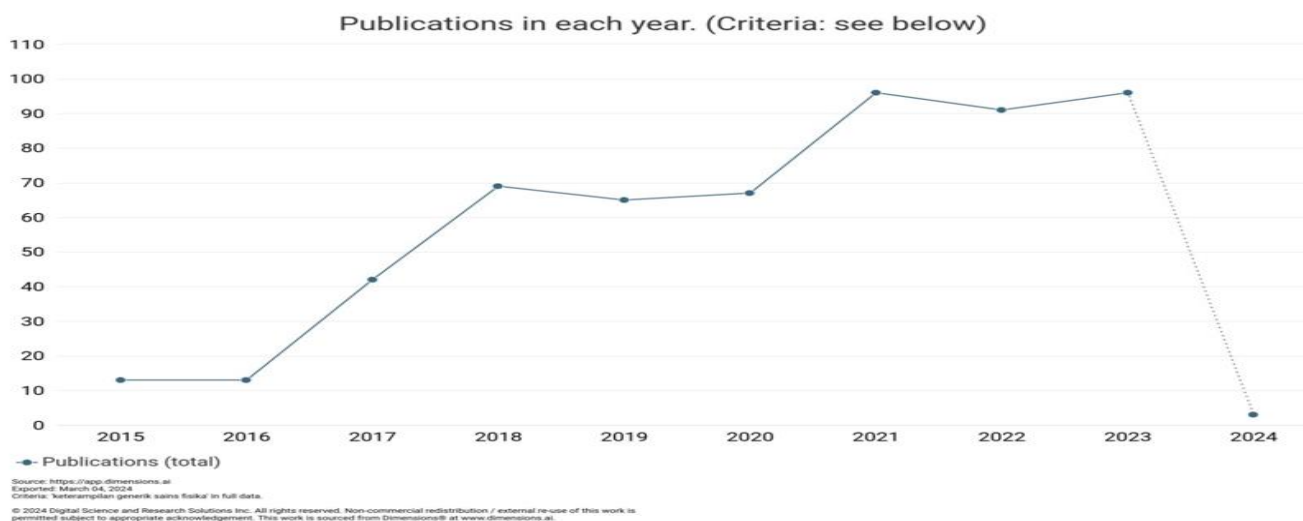


Figure 1. Research trends in problem based learning model to improve generic science skills

Table 1. Trends in Problem Based Learning Model to Improve Generic Science Skills 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 Problem Based Learning model to improve generic science skills in science learning 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 Problem Based Learning model to improve generic science skills in science learning in article form is the type of publication that contains the most research about generic science skills in science learning compared to other types of publications. Meanwhile, the type of publication contains the least amount of research results Problem Based Learning model to improve generic science skills in science learning is a monograph. Research conducted by (2019) 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 (Suseno & Fauziah, 2020).

Below are also table 2 presented top ten (10) sources title trends in research on Problem Based Learning model to improve generic science skills in science learning 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 Problem Based Learning model to improve generic science skills in science learning 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 Problem Based Learning model to improve generic science skills in science learning which are often cited by other researchers related to this matter.

Table 2. Top 10 Sources Title Trend of Problem Based Learning Model to Improve Generic Science Skills in Science Learning 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 problem based learning model to improve generic science skills in science learning 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., 2022). Research by Razali et al. (2020), 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 Problem Based Learning model to improve generic science skills in science learning 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 Problem Based Learning model and generic science skills in science learning. Below are presented ten (10) popular keywords related to Problem Based Learning model to improve generic science skills in science learning.

Table 3. Top 10 Citations on Trend of Problem Based Learning Model to Improve Generic Science Skills in Science Learning 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

- JPln: *Jurnal Pendidik Indonesia*, 2(2), 1-10. <https://doi.org/10.47165/jpin.v2i2.71>
- Astalini, Darmaji, Kurniawan, D. A., Jaya, H., & Husna, S. M. (2022). Analysis of Teacher Responses to the Use of Web-based Assessment to Assess Students' Attitudes towards Science Subjects. *Integrated Science Education Journal*, 3(3), 66-71. <https://doi.org/10.37251/isej.v3i3.282>
- Bahtiar, B., Yusuf, Y., Doyan, A., & Ibrahim, I. (2023). Trend of Technology Pedagogical Content Knowledge (TPACK) Research in 2012-2022: Contribution to Science Learning of 21st Century. *Jurnal Penelitian Pendidikan IPA*, 9(5), 39-47. <https://doi.org/10.29303/jppipa.v9i5.3685>
- Darmaji, D., Astalini, A., Kurniawan, D. A., & Putri, W. A. (2021). Rural Student Analysis: Correlation Science Process Skills and Critical Thinking at a State Senior High School in Jambi Province. *Ta'dib*, 24(2), 229. <https://doi.org/10.31958/jt.v24i2.3645>
- Devi, V. M., Susilawati, S., & Gunada, I. W. (2021). Pengembangan Perangkat Pembelajaran Fisika Model Berbasis Masalah Pada Materi Elastisitas Untuk Meningkatkan Kemampuan Generik Sains Peserta Didik. *ORBITA: Jurnal Kajian, Inovasi Dan Aplikasi Pendidikan Fisika*, 7(1), 109. <https://doi.org/10.31764/orbita.v7i1.3822>
- DiCerbo, K. (2014). Assessment and teaching of 21st century skills. *Assessment in Education: Principles, Policy & Practice*, 21(4), 502-505. <https://doi.org/10.1080/0969594X.2014.931836>
- Doyan, A., Susilawati, Mahardika, I. K., Rizaldi, D. R., & Fatimah, Z. (2022). Structure and optical properties of Titanium Dioxide thin film with mixed Fluorine and Indium doping for solar cell components. *Journal of Physics: Conference Series*, 2165(1), 012009. <https://doi.org/10.1088/1742-6596/2165/1/012009>
- Fry, S., & Seely, S. (2011). Enhancing Preservice Elementary Teachers' 21st-Century Information and Media Literacy Skills. *Action in Teacher Education*, 33(2), 206-218. <https://doi.org/10.1080/01626620.2011.569468>
- Geisinger, K. F. (2016). 21st Century Skills: What Are They and How Do We Assess Them? *Applied Measurement in Education*, 29(4), 245-249. <https://doi.org/10.1080/08957347.2016.1209207>
- González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st Century Skills Frameworks: Systematic Review. *Sustainability*, 14(3), 1493. <https://doi.org/10.3390/su14031493>
- Griffin, P. (2017). Assessing and Teaching 21st Century Skills: Collaborative Problem Solving as a Case Study. In *Innovative Assessment of Collaboration* (pp. 113-134). Springer International Publishing. https://doi.org/10.1007/978-3-319-33261-1_8
- Hadzigeorgiou, Y., & Schulz, R. M. (2019). Engaging Students in Science: The Potential Role of "Narrative Thinking" and "Romantic Understanding." *Frontiers in Education*, 4, 38. <https://doi.org/10.3389/feduc.2019.00038>
- Hallinger, P., & Chatpinyakoo, C. (2019). A Bibliometric Review of Research on Higher Education for Sustainable Development, 1998-2018. *Sustainability*, 11(8), 2401. <https://doi.org/10.3390/su11082401>
- Hallinger, P., & Nguyen, V.-T. (2020). Mapping the Landscape and Structure of Research on Education for Sustainable Development: A Bibliometric Review. *Sustainability*, 12(5), 1947. <https://doi.org/10.3390/su12051947>
- Jang, H. (2016). Identifying 21st Century STEM Competencies Using Workplace Data. *Journal of Science Education and Technology*, 25(2), 284-301. <https://doi.org/10.1007/s10956-015-9593-1>
- Karpinski, R. I., Kinase Kolb, A. M., Tetreault, N. A., & Borowski, T. B. (2018). High intelligence: A risk factor for psychological and physiological overexcitabilities. *Intelligence*, 66, 8-23. <https://doi.org/10.1016/j.intell.2017.09.001>
- Kaufman, K. J. (2013). 21 Ways to 21st Century Skills: Why Students Need Them and Ideas for Practical Implementation. *Kappa Delta Pi Record*, 49(2), 78-83. <https://doi.org/10.1080/00228958.2013.786594>
- Kaur, S., Kumar, R., Kaur, R., Singh, S., Rani, S., & Kaur, A. (2022). Piezoelectric materials in sensors: Bibliometric and visualization analysis. *Materials Today: Proceedings*, 65, 3780-3786. <https://doi.org/10.1016/j.matpr.2022.06.484>
- Khabibah, E. N., Masykuri, M., & Maridi, M. (2017). The Effectiveness of Module Based on Discovery Learning to Increase Generic Science Skills. *Journal of Education and Learning (EduLearn)*, 11(2), 146-153. <https://doi.org/10.11591/edulearn.v11i2.6076>
- Kurniawan, D. A., Astalini, A., & Kurniawan, N. (2019). Analisis Sikap Siswa SMP Terhadap Mata Pelajaran IPA. *Lentera Pendidikan: Jurnal Ilmu Tarbiyah Dan Keguruan*, 22(2), 323. <https://doi.org/10.24252/lp.2019v22n2i14>
- Kurniawan, D. A., Darmaji, D., Astalini, A., & Muslimatul Husna, S. (2023). Study of Critical Thinking Skills, Science Process Skills and Digital Literacy: Reviewed Based on the Gender. *Jurnal Penelitian Pendidikan IPA*, 9(4), 1741-1752. <https://doi.org/10.29303/jppipa.v9i4.1644>
- Lambert, J., & Gong, Y. (2010). 21st Century Paradigms for Pre-Service Teacher Technology Preparation. *Computers in the Schools*, 27(1), 54-70. <https://doi.org/10.1080/07380560903536272>
- Larson, L. C., & Miller, T. N. (2011). 21st Century Skills: Prepare Students for the Future. *Kappa Delta Pi*

- Record, 47(3), 121–123. <https://doi.org/10.1080/00228958.2011.10516575>
- Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., & Zeng, X.-J. (2018). A Bibliometric Analysis and Visualization of Medical Big Data Research. *Sustainability*, 10(2), 166. <https://doi.org/10.3390/su10010166>
- Maison, M., Kurniawan, D. A., & Pratiwi, N. I. S. (2020). Pendidikan sains di sekolah menengah pertama perkotaan: Bagaimana sikap dan keaktifan belajar siswa terhadap sains? *Jurnal Inovasi Pendidikan IPA*, 6(2). <https://doi.org/10.21831/jipi.v6i2.32425>
- Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible “hidden variable” in diagnostic pretest scores. *American Journal of Physics*, 70(12), 1259–1268. <https://doi.org/10.1119/1.1514215>
- Muliani, N. K. D., & Citra Wibawa, I. Md. (2019). Pengaruh Model Pembelajaran Inkuiri Terbimbing Berbantuan Video Terhadap Hasil Belajar IPA. *Jurnal Ilmiah Sekolah Dasar*, 3(1), 107. <https://doi.org/10.23887/jisd.v3i1.17664>
- Mynbayeva, A., Vishnevskaya, A., & Sadvakassova, Z. (2015). Diagnosis of Students Intellectual Potential on Pedagogical Specialties. *Procedia - Social and Behavioral Sciences*, 171, 776–781. <https://doi.org/10.1016/j.sbspro.2015.01.191>
- Nastiti, D., Rahardjo, S. B., & Van Hayus, E. S. (2019). Using module based on search, solve, create, and share effective to increase students’ science generic skills. *Journal of Physics: Conference Series*, 1175, 012145. <https://doi.org/10.1088/1742-6596/1175/1/012145>
- Nurlia, N. (2023). Analisis Sikap Peserta Didik Terhadap Pembelajaran IPA Secara Online dan Tatap Muka Terbatas. *Jurnal Pendidikan*, 11(1), 100–109. <https://doi.org/10.36232/pendidikan.v11i1.2216>
- Oltarzhevskiy, D. O. (2019). Typology of contemporary corporate communication channels. *Corporate Communications: An International Journal*, 24(4), 608–622. <https://doi.org/10.1108/CCIJ-04-2019-0046>
- Parker, R., Thomsen, B. S., & Berry, A. (2022). Learning Through Play at School – A Framework for Policy and Practice. *Frontiers in Education*, 7, 751801. <https://doi.org/10.3389/feduc.2022.751801>
- Rahayu, S., Ahied, M., Hadi, W. P., & Wulandari, A. Y. R. (2021). Analisis Keterampilan Proses Sains Siswa SMP pada materi getaran gelombang dan bunyi. *Natural Science Education Research*, 4(1), 28–34. <https://doi.org/10.21107/nser.v4i1.8389>
- Razali, Halim, A., Haji, A. G., & Nurfadilla, E. (2020). Effect of inquiry learning methods on generic science skills based on creativity level. *Journal of Physics: Conference Series*, 1460(1), 012118. <https://doi.org/10.1088/1742-6596/1460/1/012118>
- Sakliressy, M. T., Sunarno, W., & Nurosyid, F. (2021). The Generic Science Skill Profile of High School on Theory Momentum And Impulse. *Journal of Physics: Conference Series*, 1842(1), 012058. <https://doi.org/10.1088/1742-6596/1842/1/012058>
- Sanjaya, F. (2019). Keefektifan Model Pembelajaran Murder (Mood, Understand, Recall, Detect, Elaborate, Review) Melalui Teknik Kie Untuk Meningkatkan Aspek Sebab Akibat Kemampuan Generik Sains Siswa. *Indonesian Journal of Natural Science Education (IJNSE)*, 2(1), 134–140. <https://doi.org/10.31002/nse.v2i1.451>
- Sibille, K., Greene, A., & Bush, J. P. (2010). Preparing Physicians for the 21st Century: Targeting Communication Skills and the Promotion of Health Behavior Change. *Annals of Behavioral Science and Medical Education*, 16(1), 7–13. <https://doi.org/10.1007/BF03355111>
- Stehle, S. M., & Peters-Burton, E. E. (2019). Developing student 21st Century skills in selected exemplary inclusive STEM high schools. *International Journal of STEM Education*, 6(1), 39. <https://doi.org/10.1186/s40594-019-0192-1>
- Sukarso, A. A., Syuzita, A., & Susilawati. (2023). Effectiveness of Science E-Module Using Argument-Driven Inquiry Models to Improve Students’ Generic Science, Critical Thinking and Scientific Argumentation Abilities. *Jurnal Penelitian Pendidikan IPA*, 9(12), 11576–11581. <https://doi.org/10.29303/jppipa.v9i12.6279>
- Suseno, B. A., & Fauziah, E. (2020). Improving Penginyongan Literacy in Digital Era Through E-Paper Magazine of Ancas Banyumasan. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3807680>
- Syugiyanto, A. (2021). Analisis Kemampuan Keterampilan Generik Sains Pada Mahasiswa Calon Guru Pendidikan Biologi Fkip Uhamka. *ACADEMIA: Jurnal Inovasi Riset Akademik*, 1(2), 247–252. <https://doi.org/10.51878/academia.v1i2.742>
- Syuzita, A., Susilawati, S., & Sukarso, A. (2023). Validation of E-Module Based on Argument-Driven Inquiry using 3D Page Flip Professional to Improve Students’ Generic Science, Critical Thinking and Scientific Argumentation Abilities. *Jurnal Penelitian Pendidikan IPA*, 9(8), 6272–6277. <https://doi.org/10.29303/jppipa.v9i8.4947>
- Tuononen, T., Hyytinen, H., Kleemola, K., Hailikari, T., Männikkö, I., & Toom, A. (2022). Systematic Review of Learning Generic Skills in Higher Education—Enhancing and Impeding Factors.

- Frontiers in Education*, 7, 885917.
<https://doi.org/10.3389/feduc.2022.885917>
- Van Laar, E., Van Deursen, A. J. A. M., Van Dijk, J. A. G. M., & De Haan, J. (2020). Determinants of 21st-Century Skills and 21st-Century Digital Skills for Workers: A Systematic Literature Review. *SAGE Open*, 10(1), 215824401990017.
<https://doi.org/10.1177/2158244019900176>
- Wahyuni, A. S. (2022). Literature Review: Pendekatan Berdiferensiasi Dalam Pembelajaran IPA. *Jurnal Pendidikan MIPA*, 12(2), 118-126.
<https://doi.org/10.37630/jpm.v12i2.562>
- Wulandari, F., & Sari, P. P. (2023). The effect of project-based learning integrated STEM toward science process skill of elementary school student. *Jurnal Pijar Mipa*, 18(3), 362-368.
<https://doi.org/10.29303/jpm.v18i3.4943>
- Yuberti, Kartika, I., Pratiwi, I., Riyadi, B., Latifah, S., & Pilia, Q. M. (2021). An analysis of generic science skills as 21st -century skills for preservice physics teacher at UIN Raden Intan Lampung. *Journal of Physics: Conference Series*, 1796(1), 012043.
<https://doi.org/10.1088/1742-6596/1796/1/012043>
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education - where are the educators? *International Journal of Educational Technology in Higher Education*, 16(1), 39.
<https://doi.org/10.1186/s41239-019-0171-0>