



SYSTEMATIC LITERATURE REVIEW: STUDENTS' GENERIC SCIENCE SKILLS IN CHEMISTRY LEARNING

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Received: August 11, 2025; Accepted: August 24, 2025; Published: August 31, 2025

Abstract

Science generic skills are part of 21st-century skills. This has triggered massive innovation in science generic skills research, especially in chemistry subjects including in Indonesia. These skills contribute to an individual's practical participation and success in their environment. This research aims to analyze by literature study the trend of science generic research in Indonesia based on articles published in national and international journals. This qualitative research used a content analysis approach with a systematic literature review technique to analyze the research trends of generic science skills in chemistry subjects in Indonesia. Based on the predetermined inclusion criteria, 26 articles were collected for analysis using the Paper Classification Form (PCF) instrument. The research findings show the dominance on the topic of science generic skills research strategies in chemistry subjects conducted on various issues showing that learning strategies as much as 37%, dominate the improvement of generic skills in chemistry subjects, followed by teaching materials at 22%, learning models 18%, learning instruments 11%, and on the topic of learning evaluation being a minor topic as much as 4%, where the most commonly addressed dependent is related to science generic skills in chemistry learning.

Keywords: Science Generic Skills, Chemistry Learning, and Systematic Literature Review (SLR).

INTRODUCTION

Education is critical in preparing developing highquality human resources. The learning process is inseparable from the role of education (Wangi et al., 2021). Reliable human resources can act as the main driver in preserving and creating natural resources that can be used for human survival on Earth (Adawiyah et al., 2020). One way to produce good human resources is to improve the quality of learning (Prayitno et al., 2022). Therefore, the rapid development of science and technology and global changes in various aspects of life are a challenge for the nation in preparing future generations, including students to survive in facing the challenges of the times. In the current era, science is one of the symbols of national

progress. If a nation masters science, then it will be able to produce various technologies (Ni Putu & Budi Wijaya, 2023).

Learning in the current curriculum is learning that emphasizes the scientific process (Doyan et al., 2024). One of the thinking skills that can be developed is generic science skills (Safitri et al., 2020). The objective of cultivating scientific generic competencies is to ensure that the knowledge and skills acquired from the educational process can be effectively utilized in practical contexts, thereby addressing the demands posed by an era characterized by rapid development, particularly in the domains of science and technology (Sudianah et al., 2021). Science generic skills are the ability to think and act based on students' science knowledge, which is obtained from science learning (Izetbigovic et al., 2019). In the field of science itself, generic skills are known as Generic Science Skills (GSS) (Khoiri & Fauziyah, 2020). Generic skills are one of the key skills for improving the quality of human resources in the 21st century (Sarita & Kurniawati, 2020). These skills are needed by students as a preparation for learning and understanding science concepts at higher levels and when working in the world of work after students complete their studies (Marnila et al., 2023). Generic science skills can be applied in various fields. These skills are skills that can be used to study various concepts and solve various science problems (Setiawan et al., 2022).

Generic Science Skills (GSS) can be defined as psychomotor, strategic, and affective and can be practiced and learned by students (Ma'isyah & Ardhana, 2024). Generic chemistry skills are abilities that can be used to study higher chemistry or other sciences independently (Dibyantini & Azaria, 2020). Generic science skills can be practiced during the learning process with appropriate learning models. The right learning model must be adjusted to the subject being taught. The use of the right model can Using an appropriate instructional model can enhance students' knowledge, attitudes, and skills, thereby facilitating a better understanding of the lesson, attitudes, and skills so that it is easier to understand the lesson (Meinarni et al., 2024). This skill supports students' success in building high-level thinking skills because this skill requires reviewing information to find out how it can be applied in solving everyday problems (Saputro et al., 2022). There are eight indicators of KGS in science learning, namely: direct and indirect observation, awareness of scale, symbolic language, principled logical framework, logical inference, laws of cause and effect, mathematical modeling, and building concepts (Mashami & Khaeruman, 2020). Generic science skills in the field of chemistry are added to the 9th skill, namely abstraction (Khikmah & Astuti, 2019).

This study aims to analyze the research trends, influencing factors, and learning models related to Generic Science Skills (GSS) in chemistry education in Indonesia through a systematic literature review. A systematic literature review that collects research on generic science in high school students in chemistry subjects in Indonesia holistically and comprehensively has never been done. Consequently, this investigation seeks to rigorously examine the research trajectories pertaining to Generic Science Skills within the Indonesian context, as delineated by scholarly articles disseminated in both national and international academic journals. The specific research inquiries that direct the analytical framework are articulated as follows: 1) What are the research trends related to generic science skills in chemistry learning in recent

years?, 2) What factors influence students' generic science skills in chemistry learning?, 3) How is the application of chemistry learning models or methods that can improve students' generic science skills?. These questions are designed to provide a comprehensive understanding of the current state and development of generic science skills within the context of chemistry education. By exploring recent research trends, the study aims to map the evolution and scholarly attention given to this area.

RESEARCH METHOD

This qualitative investigation employs a content analysis methodology in conjunction with a systematic literature review technique to scrutinize research trends pertaining to Generic Science Skills within the realm of Chemistry education in Indonesia. This research adheres to the review process delineated by Dita et al. (2021), which is elucidated as follows: (1) articulating research inquiries; (2) establishing criteria for inclusion (Table 1); (3) searching for articles in various databases (Google Scholar, journal websites) by typing the keywords "Generic Science/KGS" and "In Chemistry Subjects"; (4) coding articles using the Paper Classification Form (PCF); (5) identifying patterns in the articles; and (6) synthesizing these patterns to answer research questions.

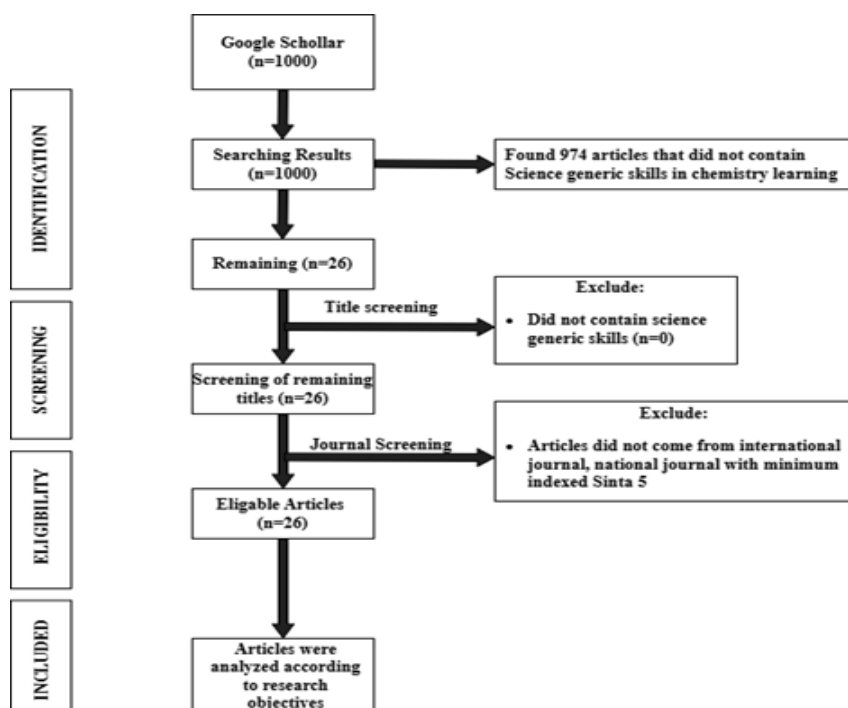


Figure 1. Model of Articles Screening

A systematic literature review examines scientific articles that include substantive findings, theoretical contributions, and methodologies relevant to the topic being studied. The

search resulted in 1000 articles, and then the article unit selection criteria were applied, as shown in Figure 1.

Table.1 The Inclusion Criteria

Category	Inclusion Criteria
Type Of Publication	Scientific articles published in journals
Journal Spesifications	National peer-reviewed journal accredited minimum grade 5 (Sinta 5); international peer reviewed journal indexed minimum SCOPUS
Publication Years	2019-2024
Research Setting	Indonesia
Research Nationally	Indonesian; the combination of Indonesian and foreigners
Independent Variable	Keterampilan Generik sains pada mata pelajaran kimia
Field	Chemistry
Type Of Study	Empirical and theoretical
Research Subject	Students in senior high school

Table.2 The distribution of articles based on the national journals' identity

Journal Type	Status		Journal Name	Quantity
International	Scopus	Q1	Jurnal Pendidikan Ipa	1
	Sinta 1			
National	Scopus	Q4	Journal Of Physics : Conference series	3
	Sinta 2		EduChemia (Jurnal Kimia dan Pendidikan)	1
			Jurnal Pendidikan MIPA	1
			Jurnal Penelitian Pendidikan Ipa (JPPIPA)	1
	Sinta 3		Journal of The Indonesian Society of Integrated Chemistry	1
			ORBITAL: JURNAL PENDIDIKAN KIMIA	1
			Jurnal Penelitian Pembelajaran Fisika	2
			LITPAM Journal Center	2
	Sinta 4		Dharmas Eduvation Journal	1
			Eduproxima: Jurnal Ilmiah Pendidikan IPA	1
			Hydrogen: Jurnal Ilmiah Pendidikan Kimia	1
			Jurnal Education and development	1
			INKUIRI: Jurnal Pendidikan IPA	1
			Journal Of Innovation in Chemistry Education	1
			Jurnal Chemistry Education Practice	2
			Jurnal Pijar MIPA	1
			Jurnal Pendidikan, Sains, Geologi dan Geofisika (JPPIPA)	1
			UNESA Journal Of Chemical Education	1
	Sinta 5		OPTIKA: Jurnal Pendidikan Fisika	1
			Empiricism Journal	1
			Total	26

Twenty-six articles met the inclusion criteria, and these articles were related to learning chemistry to improve Science Generic Skills. The collected data were analyzed qualitatively and descriptively. The data were presented in percentage form to describe the distribution of

learning strategies to improve students' science generic skills, the type of research, and the instruments used to measure science generic skills.

The screening stage resulted in 26 articles that met the inclusion criteria (Table 2). The coding instrument produced from the adaptation of PCF developed by Sozbilir et al., (2012) is by the scientific disciplines focused on owned by the paper such as biology and physics, especially in chemistry. The tool fulfilled the criteria for validity and reliability. This instrument was carefully modified to suit the scope of the current study, ensuring relevance in capturing key dimensions of generic science skills in diverse educational contexts. Moreover, the tool fulfilled the criteria for both validity and reliability, indicating that it was methodologically sound and capable of producing consistent, credible data for further analysis. Its successful validation strengthens the overall trustworthiness of the study's findings and supports its potential for replication or application in future systematic reviews in science education.

RESULT AND DISCUSSION

Research trends related to science generic skills in chemistry learning in recent years (2019-2024). Research on generic science skills in chemistry subjects was conducted on various topics, Figure 2. shows various topics. Table 3 shows that learning strategies (37%) dominate the improvement of generic skills in chemistry subjects, followed by Teaching Materials (22%), Learning Models (18%), Learning Instruments (11%), and the topics of learning evaluation is a minor topic.

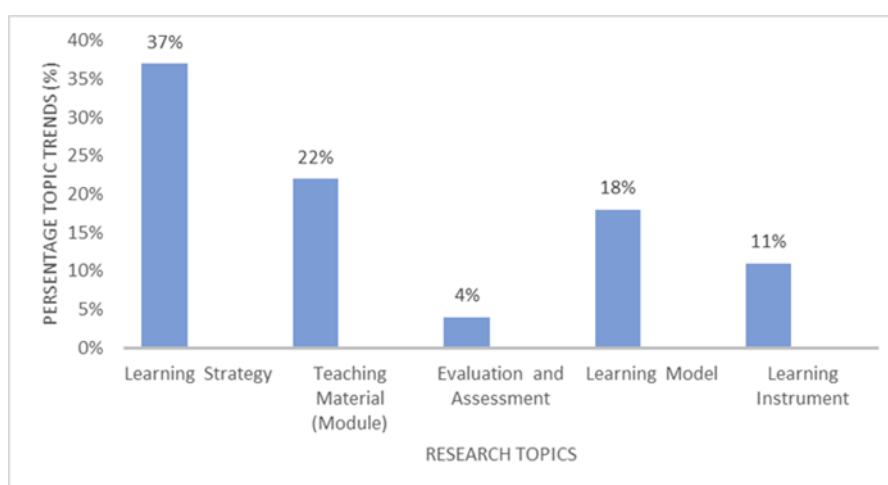


Figure 2. The generic science skills topics trends

Figure 3 shows that attention to generic science skills research in chemistry learning began to increase in 2020 and decreased in 2023. Generic science research increased in 2020 due to the impact of the COVID-19 pandemic which forced changes in learning methods. Many institutions shifted to online and blended learning, which encouraged the development of generic science skills to adapt to the new conditions.

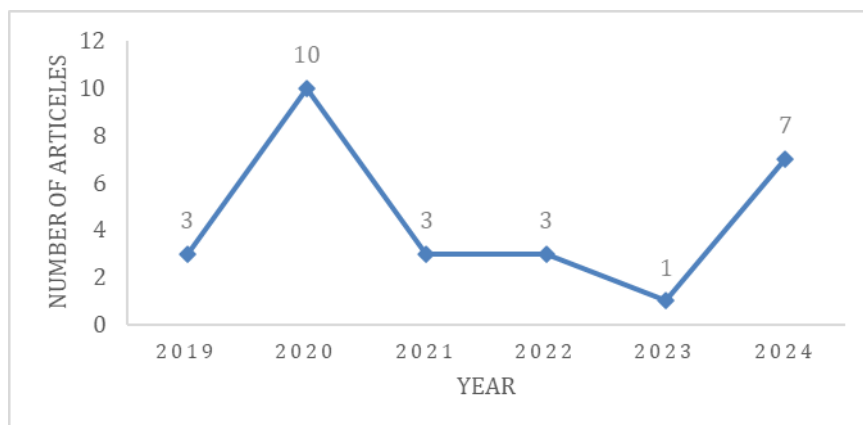


Figure 3. The Distribution of Generic Science Skill Articles Published Annually

Research that discusses specific learning strategies or approaches to improve generic science skills includes several learning models. One of them is the project-based learning model, which can develop students' generic science skills, such as direct and indirect observation, causal relationships, mathematical modeling, logical frameworks, and logical inferences. The project-based learning model is the main character in the implementation of the independent curriculum which aims to improve students' soft skills and form characters based on the Pancasila student profile. This learning model emphasizes the results of a project and student activities as the center of teaching and learning activities. The project-based learning model is a learning model that can train high-level skills and 21st-century learning that targets 4C (critical thinking, collaboration, creativity, communication) and can produce a product (Ni Putu & Budi Wijaya, 2023). In addition, the discovery learning model is also proposed as an interactive and innovative approach to improve students' generic science skills. Discovery learning is a learning that involves students in solving a problem can develop higher-order thinking skills aligned with 21st-century competencies (Izetbigovic et al., 2019).

Research that focuses on the development of learning modules or teaching materials based on generic science skills includes the development of Student Worksheets (LKPD) designed to improve generic science skills on buffer solution material. This development is expected to have an impact on improving student learning outcomes and assist teachers in implementing meaningful learning processes in the classroom. LKPD based on generic science skills is a worksheet that is compiled by paying attention to the indicators in generic science skills (Sarita & Kurniawati, 2020).

Research that focuses on the application of certain learning models to improve generic science skills includes several models, including Project-Based Learning Model: This study identified generic science skills that can be developed through project-based learning models. The skills involved include direct observation, indirect observation, logical framework, logical inference, mathematical modeling, and cause-and-effect relationships. This learning model is considered capable of encouraging students to apply the knowledge they have mastered to

answer authentic problems and provide useful results for themselves (Ni Putu & Budi Wijaya, 2023).

Discovery Learning Model: This study shows that the application of the discovery learning model can improve students' generic science skills, especially in the concept of colloids. The results of the study showed an increase in students' generic science skills after the application of this model. The implementation of the discovery learning model on the concept of colloids can improve students' generic science skills with indicators of indirect observation, logical inference, causal laws, and building concepts with a moderate category (Izetbigovic et al., 2019).

Cooperative Class Experiment (CCE) Model Group Investigation Type: This study describes the achievement of students' generic science skills after learning using the CCE model. The results show that students' generic science skills developed well, especially in the symbolic language and mathematical modeling indicators. The GSS indicators in students as a whole are said to have developed well after learning using the CCE learning model Group Investigation type on the Buffer Solution concept (Ainulhaq & Mahendra, 2024). Thus, various learning models can be applied to improve students' generic science skills.

Research that develops or utilizes tools/media to support generic science skills includes the development of Student Worksheets (LKPD) designed to improve generic science skills. This LKPD is expected to help students understand the material and improve their learning outcomes. In addition, research also shows that the use of appropriate tools/media in learning can help students develop generic science skills needed to carry out scientific work.

This study only used articles available in specific databases, so it's possible that relevant research was not accessible. Publication Timeframe—Articles are restricted to a specific period, so the study results may not reflect recent developments outside that timeframe. Furthermore, Only articles in English/Indonesian were considered, so research in other languages may have been overlooked.

CONCLUSION

SLR analysis shows that general science skills are developed through Blended Learning, Discovery Learning, and Project Based Learning, significantly improves students' science generic skills. Research shows that the use of props, practicum modules, and learner worksheets based on Science Generic Skills also contribute positively to students' understanding and ability to solve chemical problems. In addition, research trends show an increasing focus on developing innovative learning methods to support more effective science learning. Research findings also show the dominance on the topic of science generic skills research strategies in chemistry subjects conducted on various issues showing that learning strategies as much as 37%, dominate the improvement of generic skills in chemistry subjects, followed by teaching materials 22%, learning models 18%, learning instruments 11%, and on the topic of learning evaluation being a minor topic as much as 4%. Where the dominant

dependent variable is related to science generic skills in chemistry learning. Therefore, educators need to continue to develop and implement learning strategies that can improve students' science generic skills in the current educational context.

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