

A systematic review: How to implementation of problem solving model in chemistry learning?

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ABSTRACT

Chemistry is one of the difficult subjects at all levels of education, this is what makes it difficult for students to solve problems so that student learning outcomes decrease. The things that cause chemistry learning problems are influenced by monotonous learning process activities, the application of less innovative learning models and methods that have a negative impact on students' ability to understand chemical concepts. This research aims to find out the implementation of problem solving in chemistry learning. This research method uses a systematic literature review (SLR) by analyzing previous research using the Google Scholar and Scopus databases in the last 10 years, namely 2014-2022. The 14 articles reviewed were obtained after going through the scanning process according to the inclusion criteria. The results of this study indicate that in chemistry learning it is necessary to improve problem solving in chemistry learning.

Introduction

In the 21st century has a challenge in education, in order to produce quality successors, students have abas-21 competencies, which must be able to participate in 21st century life (Jannah et al., 2020). Along with the development of technology, Indonesia should be no stranger to the use of technology, with the development of technology, it also affects teacher pedagogy, where the progress of teacher pedagogy needs to be clearer, and use effective methods (Liu & Liu, 2021). When we experience a lack of quality education, it will cause a weak learning process. The implementation of learning can run well if it is carried out in an interesting, inspiring, fun, challenging manner, so that students feel motivated to explore their potential, and can develop initiative, and creativity.

Chemistry is a basic science that has a role in science and technology, this is indicated by the development of technology that applies chemical concepts (Kusumah et al., 2020). Chemistry studies about the composition, structure, properties, changes in material, and changing energy changes (Sugiharti & Hamid, 2019). Chemistry is one of the difficult subjects at all levels of education, this is what makes it difficult for students to solve problems so that student learning outcomes decrease (Wahyudiati, 2022). The things that cause chemistry learning problems are influenced by monotonous learning process activities, the application of less innovative learning models and methods that have a negative impact on students' ability to understand chemical concepts (Wahyudiati, 2022)

Chemistry learning not only introduces students to abstract concepts, but also explains the ways that can be used to apply or connect in everyday life (Handayani et al., 2021) Students often experience difficulties in understanding chemistry material, because chemistry material is abstract and complex (Sinta et al., 2020) Chemistry is an important field of science but students often experience difficulties in understanding abstract concepts, because the curriculum consists of many abstract concepts or theories that are very difficult for students to understand (Manurung & Manurung, 2021). In meeting the challenges of the 21st century, it is necessary to implement an effective curriculum so that it can instill in students the nature and benefits of chemistry in life (Olubunmi & Aarinola, 2022).

Learners in this era need several skills in learning, one of which is problem solving (Kibga et al., 2022) problem solving ability (Kibga et al., 2022). Problem-solving refers to "an individual's capacity to use cognitive processes to resolve real, cross-disciplinary situations where the solution path is not immediately obvious" (Vula & Berisha, 2022). A learner in order to have problem solving skills, there must be a problem to solve, these problems can arise from all areas of life, especially in chemistry (Kibga et al., 2022). Problem solving ability involves high and low-level thinking. With problem solving ability, students can improve their thinking ability, apply procedures, and deepen conceptual understanding (Siagian et al., 2019). It is a necessary mandate of any educational system to enhance and develop the problem solving skills of students in order for them to be globally competitive

According to Ijirana et al. (2021), when someone is faced with a problem either individual or team, there are three steps in solving the problem, which consists of understanding the problem, leading to problem solving, evaluating the decision, and being able to implement it. The ability to solve problems is very important for a learner. Problem solving is an important part of everyday life that can be used to understand events that occur and used to decide what kind of response to do, problem solving is not only used in the field of education, but is used in all fields, this can encourage students to have skills in solving problems (Gunawan et al., 2020). Problem solving is the ability possessed by each individual in analyzing, identifying problems, formulating problems, compiling and testing hypotheses, and formulating conclusions (Wahyudiati, 2021)

Therefore, some of the objectives of this research are to find out the implementation of problem solving in chemistry education and chemistry topics that implement problem solving in chemistry education.

Methods

In this research, the author uses the Systematic Literature Review method on the implementation of problem solving in chemistry learning. This method is carried out through the stages of identification, review, and analysis of previous research. The data obtained came from the Google Scholar and Scopus databases in the last 10 years, from 2014 to 2022. The articles reviewed amounted to 20 articles, which were obtained using the keywords "problem solving" and "chemistry education".

General Procedure

Articles used as references in answering research questions are international and national articles indexed by Scopus and Sinta. The selection criteria for the articles reviewed were based on: (1) theme suitability, (2) publication in the last 10 years (2014-2023), (3) scope of education or science, (4) Scopus (Q1-Q3) and Sinta (S1-S3) indexed journals, and (5) language used, namely English. Therefore, articles that did not meet these criteria were not selected.

The systematic review stages are as follows. (1) formulating the problem, (2) formulating research questions, (3) determining the location of the database search for research results, (4) selecting relevant research information, (5) selecting relevant research results, (6) extracting data from primary research results, (7) synthesizing research results, and (8) presenting the research obtained (Fig-1).

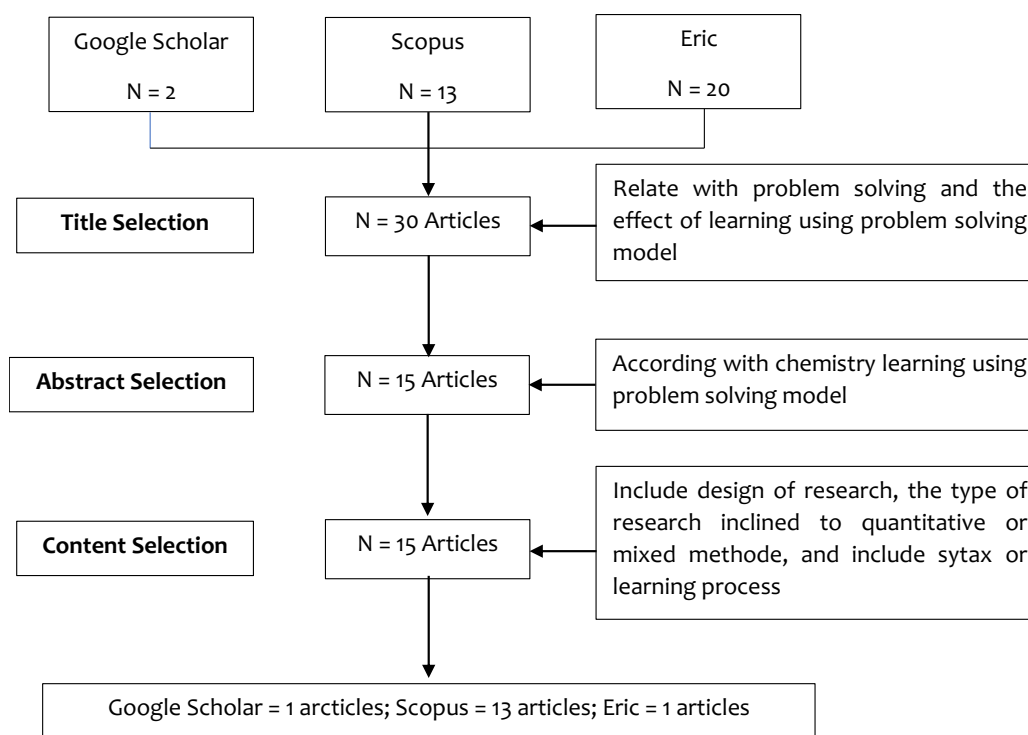


Fig-1. The systematic review flowchart

Results

Research that has been conducted using the Systematic Literature Review method is 14 articles and has gone through a screening process based on the inclusion criteria that have been determined. In Table 1 the results of grouping research from 14 articles that have been analyzed and summarized about problem solving in chemistry learning. Table 2 is the result of problem solving research in chemistry learning.

Based on Tables 1 and 2 related to the results of problem solving research in chemistry education, where these studies have been conducted in schools and universities. The results of this study focus on the implementation of problem solving in learning chemistry, materials that use this problem solving method include basic chemistry, stoichiometry, thermochemistry,

hydrocarbons, thermodynamics, and so on. Problem solving can not only be used among students or college students, but can be for teachers as well. Where teachers can see how students process in solving problems using their own minds.

Table 1. Results of article grouping research.

No	Author	Year	Sample	Material	School/College
1	(Stroumpouli & Tsaparlis, 2022)	2022	All 4 th smster students	Chemistry kinetics	Higher education, at university of Ioannina
2	(Riberio et al., 2022)	2022	29 chemistry technician course students	Chemistry technician course	Public school in Porto city
3	(Kibga et al., 2022)	2022	169 senior students	Chemistry	3 public schools in Dares Sallam
4	(Ijirana et al., 2021)	2021	240 students of class XI	Hydrocarbon and Thermochemistry	School in Palu and Madani
5	(Ozgur, 2021)	2021	80 undergraduate students majoring in chemistry and chemistry education	Chemistry	Universities in Ankara
6	(Torres, 2020)	2020	11 students and 7 teachers	Physics and chemistry	Colleges
7	(Ijirana & Supriadi, 2018)	2018	2 students year 2016/2017	Basic chemistry	Colleges at Tadulako University
8	(Valdez & Bungihan, 2019)	2019	96 students	Chemistry	General high school in Philippines
9	(Mandina & Dube, 2018)	2018	110 chemistry students	Electrochemistry	Secondary school
10	(Aydin-Günbatır & Kalender, 2019)	2019	15 Students	Stoichiometry and chemistry	School
11	(Rudibyani et al., 2020)	2020	20 students of class 12	Electrochemistry	School
12	(Bueno, 2014)	2014	University of Peru students	Thermodynamics, kinetics, and chemistry equilibrium	Universities in Peru
13	(Su, 2016)	2016	All students from 17-19 years old	Gas chemistry	Colleges in Taiwan
14	(Adigwe, 2015)	2015	340 students	Chemistry	Secondary school in Nsukka education zone
15	(Zeng et al., 2023)	2023	236 students	Chemistry	Two lower-secondary schools in Jiangsu, China

Table 2. Results of research on problem solving in chemistry education.

No	Author	Title	Research Results
1	(Stroumpouli & Tsaparlis, 2022)	Chemistry students conceptual difficulties and problem solving behavior in chemical kinetics, as a component of an introductory physical chemistry course	Based on this research, students still have difficulty when solving problems
2	(Riberio et al., 2022)	Problem solving methodology in chemical technician education	Based on the results of the research, it shows that the teaching order prioritizes conceptual, procedural, and attitudinal learning. With this problem-solving methodology, it can support students' ability to self-regulate and make their own decisions, as well as think critically and reflectively
3	(Kibga et al., 2022)	Development of chemistry learner's problem solving skills through hands on instructional model	This research uses a convergent mixed method that shows in the aspect of students' problem solving skills have a big impact on students
4	(Ijirana et al., 2021)	The ability of chemistry problem solving of senior high school students in Palu Sulawesi Tengah	Based on the results of the study, it shows that students are only able to solve problems without understanding, designing, and evaluating. This causes students to be unable to organize problem solving and correlate results with theories or concepts
5	(Ozgur, 2021)	Chemistry self-efficacy beliefs as predictors of students metacognitive skills when solving chemistry problems	This study uses correlation research where the results reveal that students maintain chemical self-efficacy and metacognitive skills when solving problems in chemistry
6	(Torres, 2020)	A cognitive model to analyse physics and chemistry problem solving skills: Mental representations implied in solving actions	This study uses a simple cognitive model to analyze the development of problem solving skills, experts show high convergence in the distribution of actions among mental representations
7	(Ijirana & Supriadi, 2018)	Metacognitive skill profiles of chemistry education students in solving problem at low ability level	The results found that both chemistry education students who have low levels of basic chemistry adopt planning skills in solving problems, namely, identifying problems, determining goals, and managing strategies
8	(Valdez & Bungihan, 2019)	Problem-based-learning approach enhances the problem solving skills in	This study uses a descriptive-comparative design, has the result that the level of problem solving skills

		chemistry of high school students	increases and there is a significant difference in the level of problem solving ability
9	(Mandina & Dube, 2018)	Implementing a target task problem solving approach in teaching electrochemistry to advance level chemistry learners	In this study using the Target-Task approach which with this approach has improved performance when taught electrochemistry
10	(Aydin-Günbatar & Kalender, 2019)	Comparison of learners problem solving approaches and succes in stoichiometry	This study revealed that participants engaged in a more unresponsive than responsive approach when solving problems
11	(Rudibyani et al., 2020)	Development of problem solving base knowledge assessment instrument in electrochemistry	Based on the research results, knowing the characteristics, teacher and student responses to the problem solving assessment instrument can be used as a reference for evaluating indicators at the end of learning
12	(Bueno, 2014)	Assessment of achievement in problem solving skills in a general chemistry course	This research uses Sugrue's model which provides an understandable framework for assessing problem solving skills, this shows that it can help in instrument development.
13	(Su, 2016)	Strengthening strategic applications of problem solving skills for taiwan students chemistry understanding	Based on the results of this study with the application of strategic problem solving can encourage students to have more effective learning performance and active learning attitudes
14	(Adigwe, 2015)	Emotional intelligence and problem solving achievement of chemistry students	Based on the results of this study with the application of strategic problem solving can encourage students to have more effective learning performance and active learning attitudes
15	(Zeng et al., 2023)	Developing and validating an instrument to assess ninth-grade students online metacognitive skills in solving chemistry problems	This study shows that emotional intelligence is a significant factor in the achievement of students to be able to solve chemistry problems
			Based on the results of this study, almost 60% of students were able to monitor the thinking process of metacognitive skills in solving chemical problems

Discussion

Based on the research results in Table 1, it explains that this study uses previous research from 2014 to 2022, problem solving is widely used in all levels of education not only in secondary schools, high schools, but in universities also use problem solving in solving problems contained in the research. The chemical topics discussed in the study are chemical kinetics, thermochemistry, stoichiometry, electrochemistry, gas chemistry, basic chemistry, thermodynamics and so on.

Based on the research results in Table 2, it explains that the research uses quantitative, qualitative, convergent mixture, case study, and correlation research. In the results of the research that has been conducted, not all show that problem solving is successful in the implementation of learning, as for the implementation of learning, there are still problems, students still have difficulty when solving problems, while the research emphasizes conceptual, procedural teaching, but with problem solving it can support the ability of students to regulate themselves, and can make their own decisions, where the decision is required students can think critically and reflect. Problem solving itself can encourage students to be more effective and active during the learning process.

Based on research from (Mandina & Dube, 2018), stated that students taught using the Target-Task Problem Solving Approach performed better than students taught using the lecture method. It is hypothesized that the difference in achievement between students taught using the Target-Task Approach and those taught using the conventional method is significant.

Based on the research (Rudibyani et al., 2020), the problem solving-based knowledge assessment instrument on electrochemical material developed can be used as a reference for teachers to conduct evaluations in measuring the achievement of indicators at the end of learning to achieve predetermined learning objectives, this is reviewed from the aspects of reliability, construction, and suitability with electrochemical material.

However, in problem solving there are still students who are only able to solve problems, without understanding, designing, and evaluating the problems that arise. This causes students to be unable to organize problem solving and correlate with theories and concepts. In applying problem solving, of course, it is combined with methods or media so that it can be a reference in evaluating student assessments. The existence of media or methods can help in the ongoing learning process.

Conclusion

Based on the results and discussions that have been carried out, with the topic of discussion of problem solving, it can be concluded that in learning it is necessary to apply problem solving in the process of implementing learning, not only in learning, but outside of education problem solving can be applied. Of course, teachers and students can use problem solving so that the concepts explained are not abstract and can connect in everyday life so that students understand the concept of chemistry.

Conflict of Interests

The author(s) declares that there is no conflict of interest in this research and manuscript.

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