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SYSTEMATIC LITERATURE REVIEW: SCHEMA-BASED LEARNING METHOD (SBI) TO IMPROVE STUDENTS' MATHEMATICAL PROBLEM-SOLVING SKILLS

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Abstract

ABSTRACT
Mathematical problem-solving ability is one of the key goals of mathematics education and is taught from early childhood through higher education. In Indonesia, however, students' skills in this area remain relatively low. Many struggle with non-routine tasks, particularly in linking the given information to the process of solving the problem. This study seeks to examine the role of the Schema-Based Instruction (SBI) approach in enhancing students' mathematical problem-solving abilities. The research employs a literature review by analyzing and synthesizing information from existing articles. One common problem-solving technique involves drawing diagrams or creating schemes. Findings from the reviewed studies suggest that SBI can be effectively integrated into classroom practice to enhance students' problem-solving skills. Through SBI, learners are guided to transform problem information into visual schemes, which aids their comprehension. Once they grasp the problem, they are better able to plan effective strategies for solving it. Therefore, SBI can serve as a valuable instructional method for teachers to apply in mathematics learning.

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INTRODUCTION

Mathematics is one of the subjects that students learn from kindergarten to college. Mathematics is a universal language that forms the basis for many disciplines, technologies, and industries (Herzamzam et al., 2024; Yeh et al., 2019). Its existence plays an important role in understanding natural phenomena, developing advanced technologies, and solving complex problems in various fields. Historically, mathematics has been the foundation of various civilizations, enabling humans to measure, model, and predict natural phenomena and social events (Öztürk et al., 2020). Historically, mathematics has been the foundation of various civilizations, enabling humans to measure, model, and predict natural phenomena and social events (Öztürk et al., 2020). From tall buildings to computer networks, mathematics is present in every step, providing a solid foundation for innovation and progress.

There are several objectives to be achieved through mathematics learning. One of these objectives is problem-solving skills (Kopparla et al., 2019). Problem-solving requires students to find solutions after understanding what the problem is. To find solutions, students must know the relevant concepts. Next, students develop generalizations and mathematical representations in such a wayas to communicate their understanding and problem-solving strategies. Problem-solving skills are generic skills that can be implemented in other subjects or in dealing with everyday problems.

There are several learning methods that have been implemented in Indonesia to help students develop problem-solving skills. For example, the Problem-Based Learning method, which can be applied to learning at the elementary to secondary school levels (Hendriana et al., 2018; Salim et al., 2024). In addition, the Discovery Learning method can improve students' problem solving by strengthening their understanding of concepts, encouraging critical thinking, facilitating meaningful learning experiences, and strengthening their intrinsic motivation (Rizki et al., 2024; Windiyani et al., 2023). Various cooperative learning methods can also improve students' mathematical problem-solving abilities because they are given the opportunity to collaborate and work together in heterogeneous groups (Yapatang &Polyiem, 2022). This provides an opportunity for students with higher abilities to help their groupmates who are experiencing difficulties.

Unlike previous studies, one way teachers can improve problem-solving skills in the learning process is by applying the Schema Based Instruction method. The Schema Based Instruction (SBI) method is a teaching method that utilizes schematic diagrams to encode information on problems that help solve problem-solving questions (Root et al., 2017). In SBI, students discover and complete schematic diagrams, find solution plans, execute plans, and check the validity of those plans (Hughes & Cuevas, 2020). This method helps students visualize important information in problems through schemas, thus encouraging students to plan solutions to problems.

METHOD

The method used in this research is a Systematic Literature Review (SLR), a structured research approach that identifies, reviews, evaluates, and interprets all research relevant to the topic (Juandi & Rusdiana, 2023). Through this method, researchers seek to gather empirical evidence from various scientific sources to build a solid theoretical foundation to support the research. SLR serves not only as a means of finding a theoretical basis but also as a means of uncovering alternative theories related to the research problem, thus obtaining a more comprehensive perspective (Khairunnisa et al., 2022). Therefore, the initial step in the research was to collect data from various previous studies with a similar focus, both in the context of learning methods and mathematical problem-solving skills. The collected data was then enriched with other relevant journal articles, resulting in a broader and more in-depth study. After all data was collected and reviewed, the next stage was processing it so that the information obtained could be systematically organized according to the research objectives.

In the data processing process, descriptive analysis was used as the primary method to examine the selected articles. This analysis helps researchers summarize information from various studies without complex quantitative data manipulation, allowing results to focus more on descriptions, trends, and patterns emerging from the reviewed literature. Articles were searched using the keywords "Schema-Based Instruction and Mathematical Problem-Solving Skills," which were then filtered based on specific inclusion and exclusion criteria to meet the research needs. This screening process involved several stages, starting with reading the title and abstract and then reviewing the content of the articles to ensure relevance to the research focus. Articles that met the criteria were then evaluated in more depth to identify key findings, the methodology used, and their contribution to developing an understanding of schema-based learning and problem-solving skills. This allowed researchers to develop a comprehensive overview of research developments in this field and identify research gaps that could be explored further.

In addition to the selection and evaluation process, the quality of the selected articles was maintained by ensuring that all articles were from credible journals and indexed in reputable databases such as Scopus. The articles used were limited to publications from 2017–2024, ensuring that this research remained focused on the latest findings relevant to scientific developments and contemporary learning practices. This timeframe was chosen to capture current research trends while also limiting potential bias due to the use of literature that is no longer relevant to the current learning context. Therefore, the results of this systematic literature review are expected to provide a comprehensive picture of the role of Schema-Based Instruction in improving mathematical problem-solving skills, while also offering a strong foundation for further research.

RESULTS AND DISCUSSION

Results:

This study presents a systematic review of Schema Based Instruction methods and mathematical problem-solving abilities. Initial data collection was conducted using Publish or Perish and searching for articles in the Scopus database published between 2017 and 2024. An initial search using the keyword "Schema based Learning" yielded 57 articles. A search using the keywords "schema-based instruction" AND "word problem" yielded 35 articles. The final search using the keywords "schema-based instruction" AND "word problem" AND "Mathematics" yielded 26 articles. After excluding review articles, 10 articles were relevant for the systematic review in this study.

Table 1. Results of Studies Related to Schema-Based Instruction Methods and Mathematical Problem-Solving Skills

No	Author	Journal	Title	Findings
1	Flores et al., 2016	Preventing School Failure	Teaching Problem Solving to Students Receiving Tiered Interventions Using the Concrete-Representational - Abstract Sequence and Schema-Based Instruction	student progress in the process of problem solving using the SBI method can be applied in various situations and can be developed along with increasing complexity of problems
2	Peltier & Vannest, 2017	Review of Educational Research (Q2)	A Meta-Analysis of Schema Instruction on the ProblemSolving Performance of Elementary School Students	The SBI method refers to an approach that enables students to link new information to schemes or knowledge that they already possess. By building connections between new mathematical concepts and existing knowledge, students can develop a deeper understanding of these concepts
3	Cook et al., 2020	Learning Disability Quarterly	Schema-Based Instruction for Mathematical Word Problem Solving: An Evidence-Based Review for Students With Learning Disabilities	The results of this review show that SBI is a potential evidence-based practice (EBP) for students with learning disabilities

No	Author	Journal	Title	Findings
4	Hughes & Cuevas, 2020	Georgia Educational Researcher	The Effects of Schema-Based Instruction on Solving Mathematics Word Problems	The average accuracy of problem solving increased from 22 percent to 34 percent from the pretest to the posttest. Students who learned using the SBI method had higher problem-solving abilities.
5	Skinner & Cuevas, 2023	International Journal of Instruction (Q2)	The Effects of Schema-Based Instruction on Word Problems in a Third-Grade Mathematics Class	The SBI method is more effective to use in mathematics learning that focuses on students' ability to solve word problems.

Discussion:

Based on the explanation in Table 1, schema-based problem solving is designed to meet the cognitive demands specified in the problem-solving story model (Faujiah et al., 2024; Hughes & Cuevas, 2020). This approach focuses on helping students understand the structure of a problem through the introduction of keywords and the classification of word problems into specific types. Thus, students not only practice calculations but also hone higher-order thinking skills, such as analysis, classification, and visual representation. Schema-based problem solving helps students learn to conceptualize keywords as part of a particular word problem type (Salim et al., 2024). Next, students represent each type of problem-solving story problem with an appropriate diagram or equation, which serves as a cognitive bridge between the problem text and the mathematical procedure to be used. Once students identify the word problem type, they execute a step-by-step solution strategy specific to that problem type. This process involves sorting relevant information, placing it in a diagram or schema, and developing a logical sequence of steps leading to a solution. This way, students can be more focused in solving complex word problems and avoid being easily trapped by misleading or irrelevant information.

The Schema-Based Instruction (SBI) method is designed to develop a deep understanding and skills in organizing the information contained in problem-solving word problems. The information students obtain from the problem text is not only understood literally but also reorganized into diagrams, charts, or other visual representations that are easier to understand and process (Shanta & Wells, 2022). This aligns with the view that using schematic representations is an effective way to highlight the underlying structure of a problem, enabling students to more clearly see the interrelationships between information elements (Jitendra et al., 2011). Through this stage, students are encouraged to place relevant information from the word problem into a schema, then organize it into a mathematical sentence before finally performing the calculation (Fuchs et al., 2021). In addition to helping students in general, this approach has also proven beneficial in supporting the development of problem-solving skills in students with special needs, as it provides a clearer and more concrete structure for processing information. In other words, SBI can function as a cognitive scaffolding tool that helps students reduce cognitive overload when faced with complex word problems.

Previous research findings reinforce the effectiveness of the SBI method in various learning contexts. Several studies report that the consistent implementation of SBI results in significant

improvements in the problem-solving abilities of students with special needs (Jitendra et al., 2013; Desmarais et al., 2019; Özkubat et al., 2020). This success demonstrates that SBI can provide a structured strategy, making it easier for students to identify important information, develop solution strategies, and carry out calculations correctly. This positive impact can also serve as a foundation for expanding the application of SBI in regular classrooms, considering that problems in understanding word problems are not only experienced by students with special needs but also by students in general. Therefore, SBI can be viewed as a universal, adaptive approach, relevant not only for inclusive learning but also for improving the quality of mathematics learning in heterogeneous classes. With this method, teachers have alternative, more targeted learning strategies for teaching problem solving, while simultaneously fostering critical and systematic thinking skills in students. This confirms that the integration of a schema-based approach in mathematics learning has great potential in creating more meaningful and effective learning.

CONCLUSION

The Schema instruction method can be one of the learning methods that can be applied to mathematics lessons to improve elementary school students' mathematical problem-solving skills. This method helps students map information onto schemas so that they can create appropriate problem-solving plans. This method can be a solution to help students understand the information in the question and describe it visually using a schema. The researchers hope that future research can apply the SBI method in mathematics learning for elementary school students. This can help elementary school students solve mathematical problems, especially in story questions.

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