



Systematic Literature Review: Application of Problem Solving in the Mathematics Curriculum

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Abstract

Problem solving is a very important aspect of mathematics education curricula. Each country has a different approach to integrating problem solving into its curriculum. This article discusses a comparison of the application of problem-solving strategies in mathematics curricula in various countries using a Systematic Literature Review (SLR) approach. The results of the study show that the most widely used research method in the studies was qualitative, with 4 articles. Furthermore, these studies used quantitative and mixed methods, with 3 articles each. Articles that met the inclusion criteria showed that Turkey tended to apply problem solving the most in its mathematics curriculum. Next are Finland, Japan, and the Netherlands, followed by South Korea, Vietnam, Singapore, Germany, Canada, and Malaysia. Curricula in various countries shape students' problem-solving skills through different methods but with the same goal: to produce students who are able to think critically and apply mathematics in everyday life.

Keywords: Problem Solving, Mathematics Education Curriculum, SRL.

Abstrak

Pemecahan masalah adalah salah satu aspek yang sangat penting dalam kurikulum pendidikan matematika. Setiap negara memiliki pendekatan yang berbeda dalam mengintegrasikan pemecahan masalah ke dalam kurikulumnya. Artikel ini membahas perbandingan penerapan strategi pemecahan masalah dalam kurikulum matematika di berbagai negara dengan menggunakan pendekatan Tinjauan Pustaka Sistematis (TPS). Hasil studi menunjukkan bahwa metode penelitian kualitatif yang paling banyak digunakan dalam penelitian adalah sebanyak 4 artikel. Selanjutnya, penelitian ini menggunakan metode kuantitatif dan metode campuran. Masing-masing sebanyak 3 artikel. Artikel yang memenuhi kriteria inklusi menunjukkan bahwa Turki cenderung paling banyak menerapkan pemecahan masalah dalam kurikulum matematika. Berikutnya adalah Finlandia, Jepang, dan Belanda, lalu Korea Selatan, Vietnam, Singapura, Jerman, Kanada, dan Malaysia. Kurikulum di berbagai negara membentuk keterampilan pemecahan masalah siswa melalui metode yang berbeda-beda, tetapi dengan tujuan yang sama: menghasilkan siswa yang mampu berpikir kritis dan menerapkan matematika dalam kehidupan sehari-hari.

Kata kunci: Pemecahan Masalah, Kurikulum Pendidikan Matematika, SRL.

INFO ARTIKEL

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INTRODUCTION

Problem solving is one of the most important skills in mathematics education. This skill not only supports the understanding of mathematical concepts, but also strengthens critical, analytical, and creative thinking skills. Mayer (2013) defines problem solving as a complex cognitive process that involves thinking and reasoning. Problems arise when there is a goal to be achieved, but the path to achieving it is unclear. Polya (1957) explains that problem solving is the art of finding solutions using four steps: understanding the problem, planning the solution, implementing the plan, and evaluating the results. Jonassen (2000) describes problem solving as a highly contextual process, where the solution is greatly influenced by the environment and the experience of the problem solver. If a student has practiced problem solving, then in real life, that student will be able to make decisions related to a problem, because they have the ability to gather relevant information, analyze it, and realize how important it is to evaluate the results that have been obtained (Safrine, 2024).

Problem solving relates to how the curriculum plays a role in shaping that knowledge (Juan Luis Piñeiro, et al., 2022). In the curricula of various countries, problem solving plays different roles (Triyana & Kusno 2025). For example, the education system in Singapore is known for its structured and problem-solving approach, equipping students with the skills necessary to succeed in international exams (World Bank, 2021). In Turkey, problem solving focuses on conceptual aspects, especially in algebra and geometry (Okan Kuzu, Yasemin Çiçek & Zeynep İğdeli, 2023).

Finland is known for its approach that emphasizes conceptual understanding in mathematics. The curriculum in Finland focuses on developing mathematical literacy and applying concepts in real life, as measured in international tests such as PISA. “Students are not burdened with too much material, but rather focus on practical application and mathematical literacy” (Anggraena, 2019). Singapore adopts a “Concrete-Pictorial-Abstract” approach, which provides a solid foundation in conceptual understanding before students move on to problem solving (İsmet Şahin, 2010).

The Netherlands uses a realistic approach to mathematics education known as Realistic Mathematics Education (RME). This approach involves students in real-life situations that encourage them to use mathematical models to solve problems. "Students in the Netherlands are encouraged to construct their own models from real situations and use them to solve mathematical problems" (Murdiyani, 2019). The Canadian curriculum emphasizes the importance of mathematical literacy as a tool for solving real-world problems" (OECD, 2013).

Germany has adopted a problem-based approach in its mathematics curriculum. Problem solving in mathematics in Germany focuses not only on calculations, but also on developing analytical and logical thinking skills. "Students are taught to identify and describe problems, and to use evidence-based approaches to solve them" (Siti Malikiyah, 2019).

On the other hand, the information processing theory applied in Canada and Japan emphasizes the importance of cognitive strategies that help students solve problems systematically with clear steps (Fatma Serçe & Filiz Acar, 2021). Therefore, an in-depth study is needed on how the curricula in these countries shape students' problem-solving skills.

Based on the above explanation, the objectives of this study are: (1) To determine the trends in research methods used in articles related to the application of problem solving in mathematics curricula in several countries from 2019 to 2024; and (2) To examine how problem solving is implemented in mathematics curricula in various countries?

METODE

This research method uses the Systematic Literature Review (SLR) method. Systematic Literature Review is a method used in the stages of identifying, assessing, and describing research data that is accessible and meets certain criteria (Septiani et al., 2022). In identifying and reviewing this study, the SLR research stages proposed by Triandini et al. (2019) were used, including: (1) Research Question; (2) Search Process; (3) Inclusion and Exclusion Criteria; (4) Quality Assessment; (5) Data Collection; (6) Data Analysis; and (7) Deviation from Protocol. This study used the Systematic Literature Review (SLR) method. Systematic Literature Review is a method used with stages of identifying, assessing, and describing research data that is accessible and meets certain criteria (Septiani et al., 2022). In identifying and reviewing this study, the SLR research stages proposed by Triandini et al. (2019) were used, including: (1) Research Questions, (2) Search Process, (3) Inclusion and Exclusion Criteria, (4) Quality Evaluation, (5) Data Collection, (6) Data Analysis, and (7) Deviations from the Protocol.

The first stage was conducted by formulating research questions (RQ) based on the needs of the topic to be studied. In this study, the proposed RQs were: (1) Trends in research methodologies used in articles on the application of problem solving in mathematics curricula in various countries from 2019 to 2024; and (2) How is problem solving applied in mathematics curricula in various countries?

The second stage is the process of searching for the literature needed to find literature relevant to answering the research questions asked. The researcher conducted a search for relevant literature by collecting international journal articles from 2019 to 2024 through the Scopus and Google Scholar databases with the help of Publish or Perish. In this study, the researcher used the keywords “Application of Problem Solving in Mathematics Curriculum.” The researcher selected articles published between 2019 and 2024 because the data obtained was relevant to current issues.

The third stage, inclusion and exclusion criteria, was used to determine the eligibility of the articles obtained for use in this study. In this study, articles were eligible for selection and use if they met the criteria in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
National and international articles discussing the implementation of problem solving in mathematics curricula in various countries.	National and international articles that do not discuss the implementation of problem solving in mathematics curricula in various countries.
The time frame used is articles published between 2019 and 2024.	The time period used is articles published before 2019.
Articles obtained from Scopus and Google Scholar.	Articles obtained from sources other than Scopus and Google Scholar.

The fourth stage, Quality Assessment (QA), evaluates the data or articles obtained based on predetermined assessment criteria. The QA proposed in this study is: (1) Was the article published between 2019 and 2024?; (2) Does the article describe the application of problem solving in mathematics curricula in various countries? Furthermore, each article will be answered with ‘Yes’ or ‘No’.

The fifth stage, data collection, is to collect data or articles in the form of secondary data. The secondary data used is a literature study of articles discussing the application of problem solving in mathematics curricula in several countries obtained from Scopus and

Google Scholar. The sixth stage, data analysis, is carried out by analyzing the data or articles that have been collected with reference to the established RQ. The final stage, deviation from the protocol, is carried out by correcting word equivalence to match the search keywords in the database.

RESULT AND DISCUSSION

Inclusion Criteria for Search and Selection Results

The initial search results through the Publish or Perish database with Scopus and Google Scholar using the keyword “Application of Problem Solving in Mathematics Curriculum” yielded 326 articles. Then, articles that met the inclusion criteria were selected, resulting in 10 articles. The following is the data from the literature that has been collected and presented in Table 2.

Table 2. Classification of Selected Literature and Types of Research Methods Used

Author	Journal	Method Type
Okan Kuzu, Yasemin Çiçek, & Zeynep İğdeli (2023)	<i>Journal of Teacher Education and Lifelong Learning. Vol 5 (1)</i>	Kualitatif
Bingolbali & Ferhan (2019)	<i>Mathematics Education Research Journal, (31) 3. 237-257</i>	Kualitatif
Sevda Koc Akran & oguz Gurbuzturk (2019)	<i>International Journal of Educational Methodology. (5)1, 135 – 150</i>	Kuantitatif
Mustafa Tefvik Hebebcı, (2022).	<i>Participatory Educational Research (PER), 9 (6)</i>	Kuantitatif
Fatma Serçe & Filiz Acar (2021)	<i>Journal of Pedagogical Research (JPR), 5(1).</i>	Mix methode
Susanna Kaitera & Sari Harmoinen, (2022)	<i>LUMAT Special Issue, (10)2, 111–146</i>	Kuantitatif
Toh, Tin Lam, et,al (2019)	<i>Mathematics Education Research: Impacting Practice (Proceedings of the 42nd annual conference of the Mathematics Education Research Group of Australasia) pp. 81-98. Perth: MERGA.</i>	Mix Methode

Gerrit Roorda, Siebrich de Vries & Annemieke E. Smale- Jacobse. (2024)	<i>Frontiers In Education</i>	Kualitatif
Hoa Anh Tuong, et,al (2023)	<i>Journal of Technology and Science Education 13(1): 73-91</i>	Mix Methode
Abdul Halim Abdullah, et,al (2020)	<i>Authorized licensed use limited to: Rockwell Collins. UTC from IEEE Xplore</i>	Kualitatif

DATA ANALYSIS RESULTS

Next, the research data from each article is presented in Table 3, which relates to findings on the application of problem solving in mathematics curricula in various countries.

Table 3. Literature findings related to the application of problem solving in mathematics curricula in various countries.

Author	Country	Findings
Okan Kuzu, Yasemin Çiçek, and Zeynep İğdeli (2023)	Turkey	In Turkey, the mathematics curriculum focuses on five main areas: Numbers and Operations, Algebra, Geometry and Measurement, Data Processing, and Probability. Students are taught to solve problems step by step, but PISA results show that student performance in problem solving is below the international average.
Bingolbali and Ferhan (2019)	Turkey	This article examines the problem-solving approach in two sixth-grade mathematics textbooks in Turkey, analyzing the curriculum and how problem solving is integrated. The results of the study show that the curriculum is not prescriptive of any particular approach to teaching problem solving, and the textbooks do not strictly follow any particular approach either. This provides a significant perspective for evaluating the implementation of problem solving in mathematics teaching in Turkey.
Sevda Koc Akran and oguz Gurbuzturk (2019)	Turkey	This study evaluates the impact of layered curricula on students' problem-solving skills in science and technology subjects in Turkey. Layered curricula encourage a more reflective and independent approach to learning, which has been shown to have an impact on the development of students' problem-solving skills.
Mustafa Tevfik Hebebcı (2022)	Turkey	The results of the study show that integrated STEM education has a positive and significant effect on students' problem-solving skills, scientific creativity, and critical thinking dispositions, when compared to conventional teaching methods.

Fatma Serçe and Filiz Mobil (2021)	Finland	Finland uses a constructivist approach that places students as the main actors in the problem-solving process. Their curriculum focuses not only on the end result, but also on the critical thinking process undertaken by students.
Susanna Kaitera & Sari Harmoinen (2022)	Finland	Developing students' ability to solve mathematical problems and fostering creative thinking has been a major focus of the Finnish National Core Curriculum in 2004 and 2014. To support the development of these skills, students need to be given meaningful and relevant problem-solving tasks from elementary school onwards. In this case, teachers play an important role by equipping students with the various strategies and tools needed to deal with a variety of mathematical problems.
Toh, Tin Lam, et al. (2019)	Singapore	Mathematics education in Singapore places problem solving at its core, as reflected in the Singapore School Mathematics Curriculum Framework. This focus has been in place since the 1990s and has been further strengthened in the latest curriculum. Research shows that students in Singapore are trained to apply problem-solving skills in both mathematical and everyday contexts, allowing for more comprehensive development of their understanding and abilities.
Okan Kuzu, Yasemin Çiçek and Zeynep İğdeli (2023)	Germany	The curriculum in Germany encourages students to apply mathematics in real-life contexts. A problem-based approach is widely used, especially in algebra and geometry.
Fatma Serçe and Filiz Acar (2021)	Japan	In Japan, classroom discussion is strongly emphasized in mathematics learning. Students work together to find solutions, which strengthens their understanding of mathematical concepts.
Gerrit Roorda, Siebrich de Vries and Annemieke E. Smale-Jacobse (2024)	Japan	Problem-Based Learning (PBL) in Mathematics in Japan is often studied by teachers through Lesson Study (LS), a collaborative approach in which teachers work in teams to design and implement research-based learning in order to understand student learning processes. TTP provides a systematic and promising didactic approach to introducing problem solving in mathematics learning, while LS is an effective means for teachers to explore and master TTP.
Fatma Serçe and Filiz Mobil (2021)	Canadian	Canadian mathematics combines problem-solving projects with the application of Self-Regulated Learning (SRL) strategies, which enable students to manage and monitor their learning independently.
Fatma Serçe & Filiz Mobil (2021)	Netherlands	In the Netherlands, students are taught to apply mathematics in real-world contexts, similar to the Finnish and Canadian approaches. The curriculum also emphasizes the importance of practical problem solving.
Gerrit Roorda, Siebrich de Vries	Netherlands	This study emphasizes that problem solving is a core skill that is very important in mathematics education in the Netherlands. The authors

and Annemieke E. Smale-Jacobse (2024)		assert that “problem solving should be an integral part of the curriculum,” but they also note that “although there have been efforts to integrate problem solving into learning, the systematic attention given to this skill is still relatively limited.”
Hoa Anh Tuong, et al. (2023)	Vietnam	This study uses a mixed-method approach with three phases: the first phase uses quantitative methods to examine Vietnamese teachers’ perspectives on STEM education. The second phase is a teaching experiment involving the application of STEM education in designing and managing mathematics learning systems. Furthermore, the third and final phase was conducted using a qualitative study to understand Vietnamese students’ experiences in STEM education, particularly those related to solving real-world problems and developing 21st-century skills.
Abdul Halim Abdullah, et	Malaysia	In Malaysia, teachers teach problem-solving skills in mathematics by using open-ended questions and problems derived from students’ daily lives. In addition, teachers also use mathematics questions available in textbooks and reference books.
Abdul Halim Abdullah, et al. (2020)	South Korea	In South Korea, teachers use open-ended questions and problems taken from students’ daily lives to teach problem-solving skills in mathematics classes. In addition, teachers also use mathematics questions found in textbooks and reference books.

RQ1: What are the trends in research methods used in articles on the implementation of problem solving in mathematics curricula in various countries from 2019 to 2024?

From the results in Table 2, the following pie chart shows the types of research methods used in articles related to the application of problem solving in mathematics curricula in various countries from 2019 to 2024:

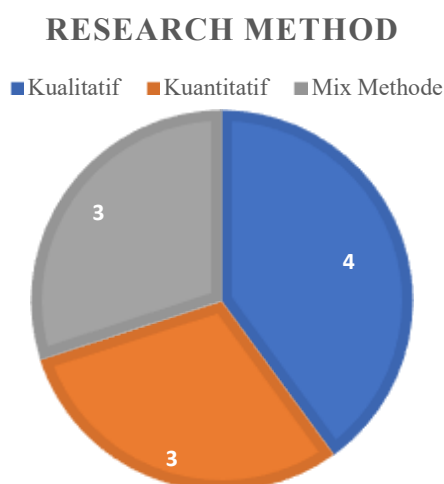


Figure 1: Trends in research methods related to the application of problem solving in mathematics curricula in various countries from 2019 to 2024.

The results of the analysis of research method trends related to the application of problem solving in mathematics curricula in various countries from 2019 to 2024 refer to 10 articles from international journals. Figure 1, related to research method trends in articles that meet the inclusion criteria, shows that qualitative research methods tend to be the most widely used in research, namely in 4 articles. Furthermore, there were 3 articles each that used quantitative and mixed methods.

RQ2: How is problem solving implemented in mathematics curricula in various countries?

Based on Table 3, the following bar chart illustrates the implementation of problem solving in mathematics curricula in various countries during the period 2019–2024.

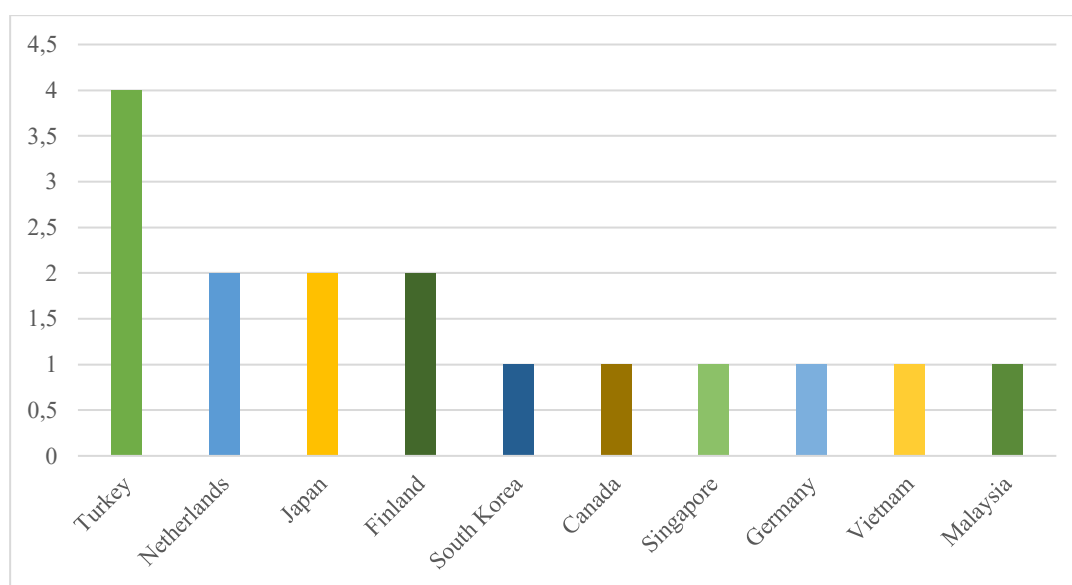


Figure 2. Implementation of problem solving in mathematics curricula in various countries from 2019 to 2024.

The findings of the analysis show that the implementation of problem solving in mathematics curricula in various countries from 2019 to 2024, referring to 10 articles from international journals, indicates that there are 10 countries that implement problem solving in their mathematics curricula. Figure 2 shows the implementation of problem solving in mathematics curricula in various countries. Based on articles that meet the inclusion criteria, it appears that Turkey is the country that has implemented problem solving the most in its mathematics curriculum. Finland, Japan, and the Netherlands follow, then South Korea, Vietnam, Singapore, Germany, Canada, and Malaysia.

Furthermore, literature findings on the implementation of problem solving in mathematics curricula in various countries based on Table 3 show that, according to Okan Kuzu, Yasemin Çiçek, & Zeynep İğdeli (2023), the mathematics curriculum in Turkey focuses

on five main areas: Numbers and Operations, Algebra, Geometry and Measurement, Data Processing, and Probability. Students are taught to solve problems in stages, but PISA results show that student performance in problem solving is still below the international average. Bingolbali & Ferhan (2019) discuss the problem-solving approach in two 6th grade mathematics textbooks in Turkey, analyzing the curriculum and how problem solving is integrated. The results of the study show that the curriculum is not prescriptive for a particular approach to teaching problem solving, nor does it fully follow a particular approach. This provides an important perspective in evaluating the implementation of problem solving in mathematics teaching in Turkey.

Sevda Koc Akran and Oguz Gurbuzturk (2019) evaluated the impact of layered curricula on students' problem-solving skills in science and technology courses in Turkey. Layered curricula encourage a more reflective and independent approach to learning, which is considered to have an impact on the development of students' problem-solving abilities. The results of the study show that integrated STEM education has a positive and significant influence on students' problem-solving skills, scientific creativity, and critical thinking attitudes when compared to traditional teaching methods (Mustafa Tevfik Hebebcı, 2022).

In line with the research by Fatma Serçe & Filiz Acar (2021), Finland uses a constructivist approach that places students as the main actors in the problem-solving process. Their curriculum focuses not only on the end result but also on the critical thinking process carried out by students. The development of students' skills in mathematical problem solving and support for creative thinking have been the main focus of the 2004 and 2014 Finnish National Core Curriculum. To achieve these goals, students need to be given rich and meaningful problem-solving tasks from elementary school onwards. Teachers play an important role in equipping students with the various strategies and tools needed to solve a variety of mathematical problems (Susanna Kaitera & Sari Harmoinen, 2022).

Mathematics in Singapore is highly focused on problem solving, as outlined in the Singapore School Mathematics Curriculum Framework. This focus has been implemented since the 1990s and continues to be reinforced in the latest curriculum. Research shows that Singaporean students are taught to use problem-solving skills in mathematical and real-life contexts, thereby strengthening their overall understanding and abilities (Toh, Tin Lam, et al., 2019). The German curriculum encourages students to apply mathematics in real-life contexts. Problem-based approaches are widely used, especially in algebra and geometry (Okan Kuzu, Yasemin Çiçek & Zeynep İğdeli, 2023).

In Japan, classroom discussions are strongly emphasized in mathematics learning. Students work together to find solutions, which strengthens their understanding of mathematical concepts (Fatma Serçe & Filiz Acar, 2021). Mathematics Learning Through Problem Solving (TTP) in Japan is often studied by teachers through Lesson Study (LS), a collaborative approach in which teachers work in teams to design and implement research-based learning to understand student learning processes. PBL provides a systematic and promising didactic approach to introducing problem solving in mathematics learning, while LS is an effective means for teachers to explore and master PBL (Gerrit Roorda, Siebrich de Vries & Annemieke E. Smale-Jacobse, 2024).

The Canadian mathematics curriculum combines problem-solving projects with the application of Self-Regulated Learning (SRL) strategies, which enable students to manage and monitor their learning independently (Fatma Serçe & Filiz Acar, 2021). In the Netherlands, students are taught to apply mathematics in real-life contexts, similar to the Finnish and Canadian approaches. The curriculum also emphasizes the importance of practical problem solving (Fatma Serçe & Filiz Acar, 2021). Gerrit Roorda, Siebrich de Vries & Annemieke E. Smale-Jacobse (2024) highlight the importance of problem solving as a core skill in mathematics education in the Netherlands. The authors state, “Problem solving should be an integral part of the curriculum” and observe that “although there have been efforts to incorporate problem solving into learning, systematic attention to this skill is still limited.” The results of this study are relevant in the context of mathematics teaching at various levels of education, as they demonstrate the importance of innovation in teaching strategies to improve student learning outcomes in critical thinking and problem-solving skills.

In Vietnam, starting in 2018, a STEM-focused teaching approach has been recommended for use in schools by combining various subjects. Teachers' views on integrated STEM education, as well as how to design STEM learning that supports student learning processes, are crucial to ensuring the successful implementation of an integrated STEM learning curriculum (Hoa Anh Tuong, et al., 2023).

Malaysia and South Korea show many similarities in their approaches to teaching mathematics. In both countries, teachers use open-ended questions and problems taken from students' daily lives to practice problem-solving skills in class. Although both countries use questions from textbooks or references, the level of difficulty of the questions in South Korea is higher than in Malaysia. In addition, the South Korean Ministry of Education has paid attention to problem solving in mathematics learning much earlier than Malaysia, which only began to emphasize it since Curriculum 6 (Abdul Halim Abdullah, et al., 2020).

CONCLUSION

The results of the study indicate that qualitative research methods tend to be most widely applied in research, with a total of 4 articles. Furthermore, research using quantitative and mixed methods was also conducted. There were 3 articles for each method. Articles that met the inclusion criteria showed that Turkey tended to apply problem solving most widely in mathematics curricula. This was followed by Finland, Japan, and the Netherlands, then South Korea, Vietnam, Singapore, Germany, Canada, and Malaysia. Curricula in various countries develop students' problem-solving skills through different methods but with the same goal: to produce students who are able to think critically and apply mathematics in everyday life.

Countries such as Finland and Singapore have shown that problem solving can be improved with the right strategies, such as constructivism and incremental learning. On the other hand, countries such as Germany and Canada have integrated mathematics into real life to increase the relevance of learning. There are many similarities in the teaching approaches in Malaysia and South Korea. In both countries, teachers use open-ended questions and problems taken from students' daily lives to practice problem-solving skills in class. Although teachers use math problems in textbooks or reference books, the level of difficulty of math problems in South Korea is higher than in Malaysia. In addition, the South Korean Ministry of Education has focused on problem-solving in mathematics much longer than the Malaysian curriculum, which began in Curriculum 6.

Other countries may adopt curricula from various countries to develop students' problem-solving skills, of course after adjusting them to the circumstances and conditions of their students.

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