Journal of Mathematics and Mathematics Education
https://jurnal.uns.ac.id/jmme

p-ISSN 2089-8878; e-ISSN 2089-8878
Vol. 13, No. 1, June 2023

STUDENTS' MATHEMATICAL PROBLEM SOLVING ABILITY REVIEWED FROM ADVERSITY QUOTIENT: *SYSTEMATIC LITERATURE REVIEW*

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Abstrak: Tujuan dari penelitian ini adalah untuk menjelaskan temuan penelitian tentang kemampuan pemecahan masalah matematis siswa yang diuji dengan menggunakan tipe *Adversity Quotient* (AQ). Penelitian ini menggunakan metode *Systematic Literature Review* (SLR) dengan protokol PRISMA untuk semua artikel penelitian yang terindeks di Google Scholar, Garuda, ERIC, dan Semantic. Sampel dalam penelitian ini terdiri dari 29 publikasi tentang kemampuan pemecahan masalah matematis siswa yang ditinjau menggunakan *Adversity Quotient* (AQ) dan diterbitkan antara tahun 2018 hingga Januari 2023 di Indonesia. Temuan penelitian ini akan dievaluasi berdasarkan tahun publikasi, tingkat pendidikan, lokasi penelitian, materi yang dipilih, fase pemecahan masalah yang digunakan, dan gambaran kemampuan pemecahan masalah matematis siswa berbasis AQ. Dengan menggunakan metode SLR diketahui bahwa penelitian tentang kemampuan pemecahan masalah matematis siswa ditinjau dari tipe AQ banyak mendapat perhatian setiap tahunnya, dengan mayoritas penelitian ini dilakukan pada jenjang pendidikan SMP dengan tahapan Polya. pada topik aljabar dan di pulau jawa. Selanjutnya ditemukan bahwa AQ mempengaruhi karakteristik siswa ditinjau dari kemampuan pemecahan masalah matematis secara kualitatif dengan mensintesiskan hasil belajar terhadap kemampuan pemecahan masalah matematis siswa ditinjau dari tipe AQ.

Kata kunci : *Kemampuan pemecahan masalah matematis, Adversity Quotient, Systematic Literature Review*

Abstract: The purpose of this study is to explain the findings of a study on students' mathematical problem-solving abilities, which were examined using the Adversity Quotient (AQ) type. This study uses the Systematic Literature Review (SLR) method with the PRISMA protocol for all research articles indexed on Google Scholar, Garuda, ERIC, and Semantic. The sample in this study consisted of 29 publications about students' mathematical problem-solving abilities that were reviewed using the Adversity Quotient (AQ) and were published between 2018 and January 2023 in Indonesia. The findings of this study will be evaluated based on the year of publication, education level, research location, selected material, problem-solving phases used, and the AQ-based description of students' mathematical problem-solving ability. Using the SLR method, it was discovered that research on students' mathematical problem-solving abilities in terms of AQ type received a lot of attention each year, with the majority of this research being conducted at the junior high school education level with the Polya stage on the topic of algebra and on the island of Java. Furthermore, it was discovered that AQ effects students' characteristics in terms of mathematical problem solving abilities qualitatively

Accepted: May 21, 2023 Approved: June 13, 2023 Published: June 14, 2023
DOI: 10.20961/jmme.v13i1.73997

p-ISSN 2089-8878; e-ISSN 2089-8878

by synthesizing the results of study on students' mathematical problem solving abilities in terms of AQ type.

Keywords: *Mathematical problem-solving ability, Adversity Quotient, Systematic Literature Review*

INTRODUCTION

Mathematics is the fundamental science of scientific development, and it plays a vital role in all aspects of life. Of course, a student will face learning about the concept of counting and is expected to be able to use it in daily life while studying mathematics. Phonapicha et.al (2012) stated that students are gradually encouraged to understand concepts and solve mathematical problems by posing real-world scenarios (in Nugraheni & Marsigit, 2021). Mathematics can help someone acquired to think logically, scientifically, and creatively. Mathematics is useful not just for quantitative calculations, but also for structuring one's way of thinking, particularly in terms of developing the ability to evaluate, synthesize, and undertake evaluations in order to solve problems (Sari et al., 2019).

Problem solving has historically been seen as an integral component of mathematics education (Brahier, 2020; Jiang et al., 2021; Mailani, 2018; Noviyana, 2018; NCTM, 2017; Siahaan & Surya, 2020; Şimşek et al., 2020; Supendi & Nurjanah, 2020; Yuwono et al., 2018). Recent research, however, suggests that problem solving is crucial in many other topics, including engineering (Nordstrom & Korpelainen, 2011), physics (Bassok & Novick, 2012), and English language arts (Common Core State Standards Initiative [CCSSI], 2010). Students' problem-solving talents are particularly beneficial in tackling challenges in everyday life (Bradshaw & Hazell, 2017). Students who can answer issues can connect numerous mathematical notions that they have learned previously and can also increase their conceptual knowledge (Syaifudin, 2019). According to Polya (1973), problem solving is a fundamental objective of existence itself. Polya's most commonly used solution consists of four stages including: (i) understanding the problem, (ii) devising a plan, (iii) carrying out the plan, and (iv) looking back (Polya, 1978).

The stages of problem solving can be used to solve problems with a high level of difficulty. When solving non-routine problems (Temur, 2012), complex problems (Greiff & Fischer, 2013), or difficulties where the problem solver does not know the preceding scheme (Schoenfeld, 1992), problem-solving is frequently applied. Problem-solving is utilized to teach problem solvers how to think mathematically and systematically (Rott et al., 2021; GouletLyle et al., 2020). The problem-solving model should serve as a guide to assist problem solvers in their thought process. Problem-solving is part of the mathematics curriculum in almost all countries, including the United States (Schoenfeld, 2007), China (Cai & Nie, 2007), French (Artigue & Houdement, 2007), Netherlands (Doorman et al., 2007), Hungarian (Szendrei,

2007), Australia (Clarke et al., 2007) and English (Burkhardt & Bell, 2007). Problem solving is also listed as a skill in the curriculum (Dagan et al., 2018; Indriyani et al., 2018).

For pupils, the purpose of learning mathematics is not only to be able to answer questions, but also to process problem-solving processes in order to obtain solutions (Gözde, 2020). Thus, one of the goals of learning mathematics is to be able to solve issues, which includes being able to analyze problems, construct mathematical models, solve mathematical models, and conclude the solutions achieved (Depdiknas, 2006 in Nurhayati et al. 2022). This is due to the fact that addressing difficulties necessitates fresh and distinct actions or tactics in comparison to tackling normal or ordinary problems (Barham, 2020). Various data and facts illustrate the low ability of students' mathematical problem solving. The results of the TIMSS survey (2015) showed that students' abilities in mathematics were ranked 44th, with an average score of 397 out of a standard value of 500 (Hadi & Novaliyosi, 2019). Meanwhile, according to the 2018 PISA results, the average student score was 379, ranking 73rd (OECD, 2019). Previous research findings by Fitria (2018), Siswanto & Ratiningsih (2020), and Wahyuddin et al., (2021) also indicated students' low capacity to answer math issues.

One aspect that influences problem solving abilities is determination and fighting spirit (Hakim, 2020). In order to achieve the goals of learning mathematics, a student must have the attitude of not giving up easily (Kemendikbud, 2016; Chabibah et al., 2019). Because pupils will experience a variety of challenges during the problem-solving process. Investigating differences in student behavior when dealing with problems is significant as a teacher since it can increase student performance when dealing with problems (Haleva et al., 2021). In keeping with this, the Adversity Quotient (AQ) measures pupils' ability to deal with problems. When confronted with a challenge, a student's response can be read as AQ (Saniyyah & Triyana, 2020). According to Stoltz (2000), Intelligence Quotient and Emotional Quotient are insufficient to enable success; instead, a fighting spirit, motivation, and a never-say-die attitude known as AQ are required (in Chabibah et al., 2019).

AQ is the ability to overcome issues by devising various methods, to be decisive in problem solving, and to influence will, attitudes, abilities, and performance (Gusta et al., 2022). Students with higher AQ will be able to achieve their goals more quickly than students with lower AQ (Saidah & Aulia, 2014). AQ influences pupils' fighting power and has been shown to improve mathematical problem solving abilities (Ningrum, 2017; Nurlaelah & Ilyas, 2021; Afri, 2018). AQ is classified into three categories based on student replies to a problem, namely climbers, campers, and quitters. Climbers are a sort of person with a high AQ who, when faced with a difficulty, will solve it and will not give up quickly until the expected goals are met. While the campers category has moderate AQ, it has a willingness to solve issues, but only to a certain level before stopping. Meanwhile, the quitters category

p-ISSN 2089-8878; e-ISSN 2089-8878

has a low AQ because they always believe that the difficulty they are facing will persist a long time and hence lack the motivation to overcome it (Hidayat & Sari, 2019).

Previous research on mathematical proving ability has been conducted, such as research Hidayat & Sariningsih (2018), Abdiyani et al. (2019), Nada et al. (2020), Rahmi et al. (2021), Permatasari et al. (2022) and Hofifah et al. (2023). Despite the fact stated above, it is still unclear how the characteristic for each adversity quotient type is described in mathematical problem solving. Thus, another research should be undertaken to combine all findings related to this research in order to determine the students' characteristics and proclivity for each adversity quotient kind in applying mathematical problem solving. The study required for this situation is Systematic Literature Review (SLR), which attempted to answer an uncommon research question in a transparent and reproducible manner by accumulating all available information on the subject and assessing the quality of that evidence (Lame, 2019). This type of research is conducted to recognize, assess, and interpret findings related to certain research topics, to answer research questions that are has been determined (Iskandar & Juandi, 2022; Lusiana & Suryani, 2014; Triandini et al., 2019).

The goal of this study is to clarify research findings on students' mathematical problem solving as they relate to their AQ type. This study's description will be reviewed based on the year of publication, level of education, research locations, selected material, problem-solving stages used and synthesis result from all articles having been collected. Therefore the formulation of the research problem includes: (1) How does the description of the research findings relate to students' mathematical problem solving viewed from Adversity Quotient type in the term of the year of publication? (2) How does the description of the research findings relate to students' mathematical problem solving viewed from Adversity Quotient type in the term of level of education? (3) How does the description of the research findings relate to students' mathematical problem solving viewed from Adversity Quotient type in the term of research location? (4) How does the description of the research findings relate to students' mathematical problem solving viewed from Adversity Quotient type in the term of selected material? (5) How does the description of the research findings relate to students' mathematical problem solving viewed from Adversity Quotient type in the term of problem-solving stages used? (6) How is the description of students' mathematical problem solving viewed from Adversity Quotient type?

RESEARCH METHOD

A Systematic Literature Review (SLR) using a quantitative descriptive approach is adopted as a method in this research. SLR was chosen to justify it based on past studies connected to mathematical problem solving abilities examined using the Adversity Quotient. Data collecting, data processing, and drawing conclusions are all part of this study phase (Juandi & Tamur, 2020). Researchers traced and

collected data in the form of primary research published in national and international journals during the data collection stage. Google Scholar, Garuda, ERIC, and Semantic are among the electronic databases utilized by scholars. Then, all relevant articles that met the inclusion criteria were extracted and examined.

The inclusion criteria used include: (1) The study was conducted in Indonesia; (2) The study was conducted between 2018 – 2023; (3) The study examines the profile of students' mathematical problem-solving abilities in terms of Adversity Quotient (AQ); (4) The study uses a descriptive qualitative approach; and (5) The study was conducted at the Elementary School to Senior High School level.

Articles that do not match the inclusion criteria will be removed from consideration in this systematic literature review. A protocol relating to inclusion and exclusion criteria, which could take the form of observation sheets, was utilized as the study instrument. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyzes) is the procedure utilized in this SLR. The selection procedure refers to the four stages of PRISMA, which are Identification, Screening, Eligibility, and Included (Liberati et al., 2009). This study's population consisted of all publications published in indexed journals both nationally and globally about students' mathematical problem solving abilities in terms of Adversity Quotient. A total of 54 publications were obtained as a sample, consisting of 29 studies employing a qualitative technique, based on a search using the specified keywords on the search engine. The PRISMA diagram used in this investigation is shown below.

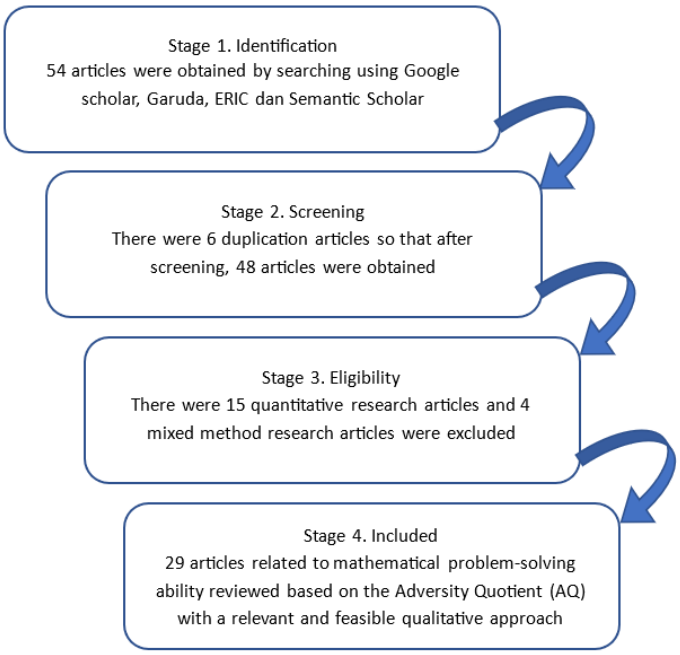

Figure 1. PRISMA Diagram

p-ISSN 2089-8878; e-ISSN 2089-8878

RESULTS AND DISCUSSION

The findings of this study are presented in the form of an analysis and overview of previously published publications on mathematical problem-solving abilities as measured by the Adversity Quotient (AQ). After including 29 relevant publications, the articles were further classified based on study features or moderator variables. The year of publication, level of education, research location, selected materials, and problem-solving phases used are all moderator variables in this study. Table 1 shows the variety of research on mathematical problem-solving abilities reviewed based on the Adversity Quotient (AQ) depending on study parameters.

Table 1. Number of studies based on criteria

	Criteria	Number of articles
Year of study	2018	5
	2019	6
	2020	3
	2021	3
	2022	11
	2023	1
Level of Education	Elementary School	1
	Junior High School	21
	Senior High School	7
Research location	Sumatera	5
	Java	17
	Sulawesi	2
	Kalimantan	1
	Nusa Tenggara Barat	3
	Nusa Tenggara Timur	1
Selected material/topic	Algebra	15
	Geometry	4
	Arithmetic	2
	Number	3
	Not specific	5
Problem-solving stages used	Polya	24
	John Dewey	1
	Bransford & Stein	1
	Mason	1
	OECD	1
	Combination	1

Next, each study will be described based on the criteria previously set such as The year of publication, level of education, research location, selected materials, and problem-solving phases used.

Year of Study

The articles used in this study were published between 2018 and 2023. The graphic below depicts the distribution of primary studies from 2018 to 2023.

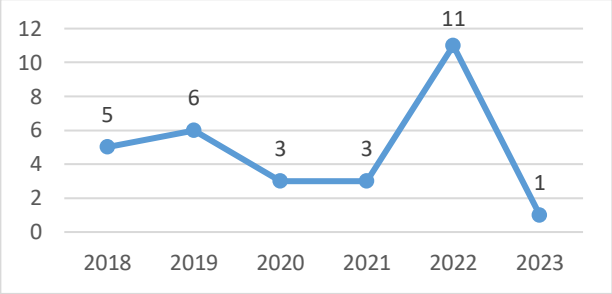

Figure 2. Study based on Year of Publication

Figure 2 shows that the frequency of research connected to mathematical problem-solving abilities reviewed based on the Adversity Quotient (AQ) published from 2018 to 2023 is not consistent, indicating that the number of publications has increased or decreased. The publication of articles relating to mathematical problem-solving abilities evaluated by AQ grew in 2018-2019, then declined in 2019-2020 and then remained constant in 2021. This is owing to the fact that Indonesia is still dealing with the Covid-19 outbreak. The Covid-19 pandemic has shifted research tendencies, particularly in mathematics education. More research has been conducted on learning models that leverage distance learning systems or blended learning than on traditional learning systems (PeranginAngin et al., 2021).

The diagram above also reveals that 2022, post-pandemic, will be the height of the development of the publication of publications connected to mathematical problem-solving abilities reviewed based on AQ, with a total of 11 articles. This is because a paradigm has emerged that AQ studies are crucial to conduct in order to assess student development in carrying out remote learning activities after the pandemic (Laili, 2021). There will still be one article in 2023, allowing the frequency of publishing of mathematical problem-solving ability appraised articles based on AQ to expand further, given that there are many articles that have yet to be published in 2023. According to PeranginAngin et al. (2021), research on mathematics education in recent years has been dominated by HOTS issues that are directly related to mathematical problem-solving abilities. On the other hand, problem-solving ability is the most investigated competency after 2016-2020, compared to the other competencies (Juandi, 2021). This shows that academics are more interested in problem-solving skills than in investigating literacy and critical thinking.

p-ISSN 2089-8878; e-ISSN 2089-8878

Level of Education

This study included data from studies on mathematical proving ability conducted from elementary through high school levels. Figure 3 depicts a presentation of article data based on education level.

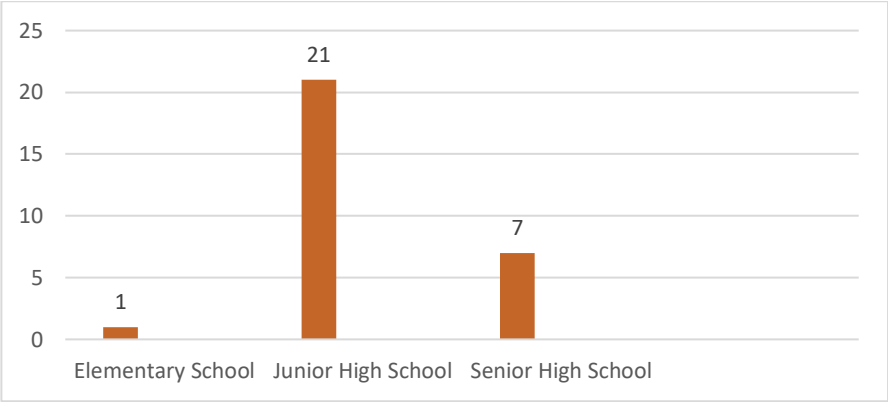

Figure 3. Study based on Level of Education

According to Figure 3, the mathematical problem-solving abilities examined based on AQ were most commonly investigated at the junior high school level, with 21 studies, followed by 1 study at the elementary level and 7 studies at the senior high school. The graph above illustrates that research on mathematical problem-solving abilities evaluated using AQ at the primary level is still limited in the time span 2018-2023. This is consistent with Juandi's (2021) assertion that mathematical problem-solving abilities are studied more in junior high school. Studies on mathematical problem-solving ability evaluated using AQ are more commonly conducted in junior high school because middle school material, particularly junior high school material, is a starting point for abstract mathematics, as opposed to elementary school material, so that the majority of junior high school students have difficulty solving problems. As a result, many researchers are interested in conducting research at the junior high school level. This is rather concerning because problem solving is a critical skill that should be cultivated at a young age.

Research Location

The third criterion is assessed based on study location, as shown in Figure 4 below, which demonstrates a significant disparity in the number of studies undertaken on each Indonesian island.

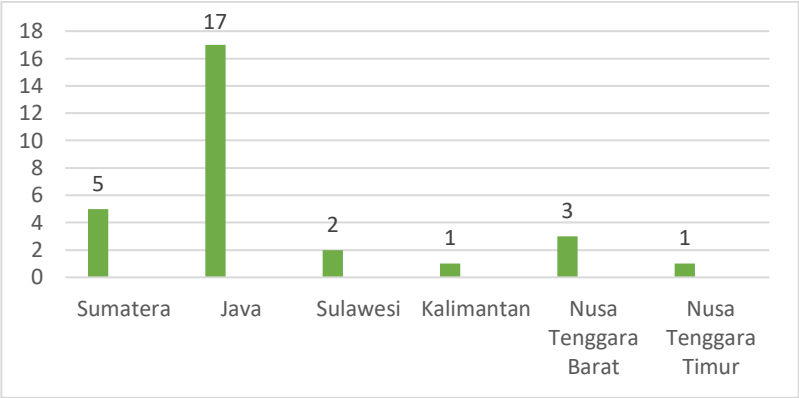

Figure 4. Study based on Research Location

According to Figure 4, the majority of the research on mathematical problem-solving abilities reviewed based on student AQ was undertaken on the island of Java, with 17 papers. This is also supported by the findings that informed the majority of the research on pupils' mathematical competencies such as mathematical literacy (Rum & Juandi, 2022), mathematical reasoning abilities (Ariati & Juandi, 2022), and mathematical understanding abilities (Khairunnisa et al., 2022) has been conducted in Java, with less in Papua. Based on these findings, it is obvious that research on mathematical skill is uncommon on all other islands but Java.

The lack of research on students' mathematical problem-solving abilities evaluated using AQ in Papua, Sulawesi, Kalimantan, and other Indonesian islands has become a concern that must be addressed. One possibility for this outcome is the use of numerous variables to assess students' mathematical problem-solving abilities, particularly based on AQ. Another option is that mathematical problem-solving abilities are appraised based on AQ dominantly investigated through other approaches (Juandi, 2021).

Selected Material

This literature review is separated into three sections based on the research material: algebra, geometry, arithmetic, number and not specific material. Figure 5 depicts the distribution of studies based on research material in detail.

p-ISSN 2089-8878; e-ISSN 2089-8878

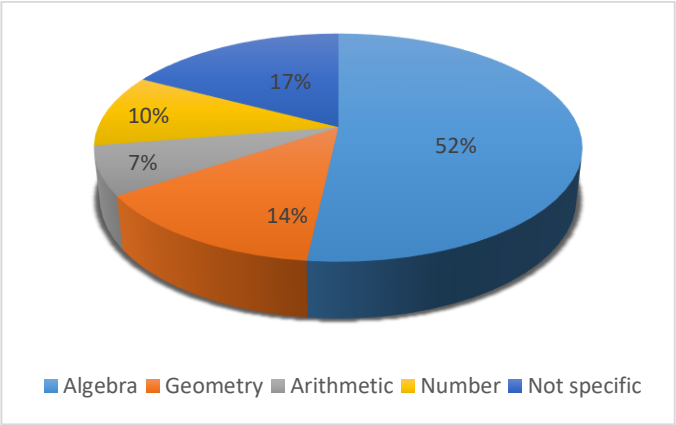

Figure 5. Study based on Selected Material/Topic

According to Figure 5, algebraic material is the most commonly investigated mathematical idea in research on mathematical problem-solving abilities, accounting for 52% of publications discovered between 2018 and 2023. At least 7% for arithmetic material. Because algebra dominates the classroom mathematics curriculum, it is the most widely examined research material. As stated in Permendikbud Numb. 24 in 2016, mastery of algebraic concepts and skills is one of the requirements of the Indonesian curriculum in the aim that this ability can be applied to both mathematics and daily situations. In addition, Algebra is a foundation for dealing with concepts in other fields of mathematics. According to Moru and Motlatsi (2022), students who are not proficient in algebra will struggle in areas of mathematics such as calculus, analysis, geometry, and trigonometry. This piques the attention of researchers in utilising algebraic material.

Problem-Solving Stages Used

The last criterion is assessed based on problem-solving stages used. Many theories provide problem-solving steps. Dewey (1910) was the first researcher to present problem-solving, followed by Polya (1945), Mason, Burton, and Stacey (1982), Schoenfeld (1985), and Wilson et al. (1993). Each of the problem-solving theories described has distinct properties (Purnomo et al., 2022). Figure 6 below demonstrates a significant disparity in the number of studies undertaken on each problem-solving stage used.

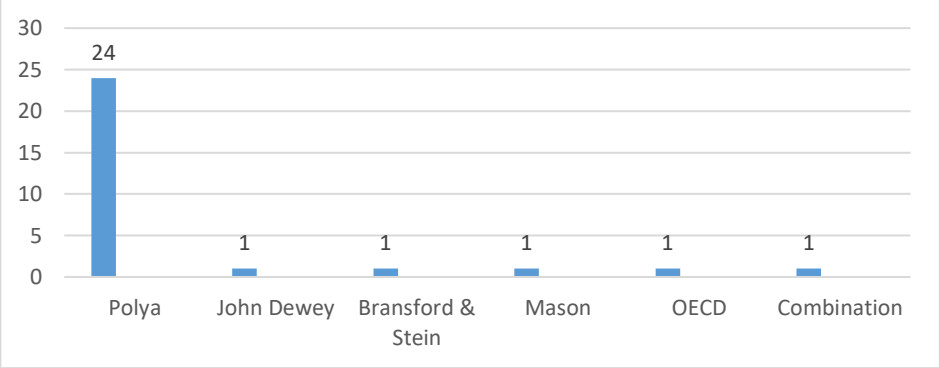

Figure 6. Study based on Problem-Solving Stages Used

Polya's most commonly used solution consists of four stages including (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back (Hofifah et al., 2023; Naimnule et al., 2022). Figure 6 above shows that the most common problem-solving stages used is Polya's. That is because Polya's problem-solving stages are among those that are simple to grasp and are commonly utilized as a reference by students from all over the world (Doko et al., 2020, Lestanti et al., 2016). According to Figure 6, only one article that use for each of the John Dewey, Bransford & Stein, Mason, and OECD (The Organisation for Economic Co-operation and Development) problem-solving phases. Dewey's problem-solving consists of five stages: (1) encountering a problem (suggestions), (2) specifying the nature of the problem (intellectualization), (3) approaching possible solutions (the guiding idea and hypothesis), (4) developing logical consequences of the approach (reasoning (in the narrower sense)), and (5) accepting or rejecting the idea by experiments (testing the hypothesis by action) (in Purnomo et al., 2022; Nada et al., 2020).

On the other hand, the problem-solving model introduced by Bransford & Stein is IDEAL problem-solving which stands for Identify problem, Define goal, Explore possible strategies, Anticipate outcomes and act, and Look back and learn (Maini & Izzati, 2019). The three phases of problem solving stated by Mason are entry, attack, and review (Faizah et al., 2020; Nurhayati et al., 2022). The steps to solving the problem according to the OECD (2013) include: (1) exploring and understanding (2) representing and formulating, (3) planning and implementing, (4) monitoring and evaluating (Hannania et al., 2022). Based on Figure 6, there is an article which the problem-solving steps used are a combination of the opinions of Polya and Bransford & Stein, namely: (1) identifying problems, (2) formulating strategies, (3) implementing strategies, and (4) verifying solutions (Chabibah et al., 2019).

p-ISSN 2089-8878; e-ISSN 2089-8878

Students' Problem-Solving Ability Reviewed from Adversity Quotient (AQ) Types

According to the synthesis of 29 studies on student mathematical problem solving in terms of Adversity Quotient (AQ) varieties, namely climbers, campers, and quitters, students with different AQ have distinct features in their mathematical problem-solving abilities. In general, pupils' ability to answer mathematical problems is proportional to their AQ level. This suggests that climber pupils are more capable of solving mathematical problems than camper and quitter students.

Climber pupils can complete Polya's four problem-solving steps. Climbers study the questions offered frequently to understand the challenge. They can also use their own language to re-express the information in the challenge. Climbers who are working on planning difficulties might apply the principles and theorems they have learnt. They use open sentences to lay down specific problem-solving strategies. When issue solving, students can answer questions based on the problem solving strategy that has been planned and write down the problem solving approach's implementation in open sentences. Climbers student re-examine the processes and results that have been carried out by returning the results of problem solution into the beginning information. This is done to prove that the results obtained do not contradict what is known in the problem. Climber students are relentless in their approach to problem solving, continually re-checking all of their work, demonstrating that climber students are preoccupied with the process rather than the end result. This finding is consistent with research (Abdiyani et al., 2019; Septianingtyas & Jusra, 2020), which states that students with the climber type are very capable of carrying out the stages of mathematical problem-solving ability according to Polya, and thus students with the climber type AQ will receive the highest score for each question. As a result, it is possible to deduce that a person's AQ level is critical for solving mathematical issues.

Generally, students in the camper group can complete the three processes of problem solving, including understanding the problem, planning, and carrying out the solution. Students, on the other hand, are not accustomed to double-checking. Students must understand issues with high difficulty levels three times in order to put down everything that is known and what is asked. Because camper students were unsure about answering questions with a high level of difficulty throughout the issue planning stage, their work featured several streaks. When the teacher asks, pupils can be held accountable for what they do plainly and logically. Students have no difficulties while answering questions with a low level of complexity. Students only checked problems with high difficulty levels while re-checking, so they were unaware that there was a calculation error in questions with low difficulty levels. As a result, it may be inferred that camper students are less than ideal problem solvers and are more readily satisfied with the results acquired. This is consistent with the findings Nugroho et al. (2022) that stated that although it has not been carried out at the re-examination stage and has not written down all of the items

that are known and asked in the problem, the AQ camper category can carry out problem-solving abilities properly and systematically.

Quitter pupils require more time to comprehend the nature of the problem. When faced with questions of a high level of difficulty, pupils do less than optimal planning at the stage of planning and carrying out the completion, resulting in the task not being completed. Students do not double-check anything, and they are very confident and delighted with everything. As a result, it can be concluded that quitter students ignore important information, and when faced with difficulties, quitter students exhibit a low fighting power, minimal initiative, and emphasizes the end result more quickly, feeling satisfied and confident in all their tasks even without carrying out the process recheck. This is in accordance with the findings (Febrianti et al., 2022) that quitters are able to understand problems and develop plans for solving them. In contrast, several findings suggest that quitters are only able to fulfill one step of problem solving, namely understanding the problem (Baharullah et al., 2022; Rahmayantri & Priatna, 2022; Naimnule et at., 2022).

CONCLUSIONS AND SUGGESTIONS

The articles of students' mathematical problem-solving abilities viewed from the Adversity Quotient (AQ) types were discovered using the SLR approach and have received a lot of attention during the last six years. The research on this topic is widely undertaken on Java Island, with the majority of the participants being junior high school students. As a material for testing the capacity to solve mathematical problems using Polya stages, algebraic material predominates. It was also discovered that pupils with different AQ types demonstrated distinct behaviors when completing mathematics problems. Furthermore, it was discovered that climber students could answer mathematical problems better than AQ camper and quitter students. Further research into the external elements that create these various qualities should be undertaken in order to obtain a precise understanding of it and assist both teachers and students in determining the appropriate learning plan to increase students' mathematical problem-solving abilities.

ACKNOWLEDGMENTS

The researcher would like to express gratitude to The Indonesia Endowment Funds for Education (LPDP) for funding this research under the Postgraduate Scholarship Program.

p-ISSN 2089-8878; e-ISSN 2089-8878

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