



REACT Strategy Application on Junior High School Students' Mathematical Problem-Solving Ability Based on Adversity Quotient

^{1*}Asisa, ²Anggraini, ³Dasa Ismailmuza, ⁴Nurhayadi, ⁵Junaidi

^{1,2}Magister of Mathematics Education Study Program, Universitas Tadulako, Palu, Indonesia

^{3,4}Mathematics Education Study Program, Universitas Tadulako, Palu, Indonesia

⁵Statistics Study Program, Universitas Tadulako, Palu, Indonesia

*Corresponding author e-mail: asisa.anwar@gmail.com

Received: August 2026; Revised: September 2026; Published: October 2026

Abstract

This study aims to examine differences in mathematical problem-solving abilities among Grade IX Junior High School students with different types of Adversity Quotient (AQ) who learned using the Relating, Experiencing, Applying, Cooperating, Transferring (REACT) strategy and conventional learning. This study employed a quasi-experimental method with a 2×3 factorial design. The population consisted of 467 Grade IX students in Junior High Schools in Banawa District. The sample was selected using purposive and simple random sampling, involving students from SMP Negeri 2 Banawa and SMP Negeri 3 Banawa. The experimental class consisted of 55 students, while the control class consisted of 56 students. Data were analyzed using the Independent Sample t-test and Two-Way ANOVA. The results of the study show that the mathematical problem-solving ability of students who learned using the REACT strategy differed significantly and were higher than those of students who learned through conventional instruction. The mean problem-solving ability was 73.58 in the experimental class and 45.32 in the control class, with Sig. (2-tailed) < 0.001 < 0.05. For Climber, Camper, and Quitter students, the experimental class also achieved significantly higher mean scores than the control class (Sig. < 0.001). These results indicate that there was a significant difference in students' mathematical problem-solving abilities both overall and within each AQ type between those who learned using the REACT strategy and those who learned through conventional learning.

Keywords: REACT learning strategy; Mathematical problem-solving; Adversity quotient; Quasi-experimental study; Mathematics education.

How to Cite: Asisa, A., Anggraini, A., Ismailmuza, D., Nurhayadi, N., & Junaidi, J. (2025). REACT Strategy Application on Junior High School Students' Mathematical Problem-Solving Ability Based on Adversity Quotient. *Prisma Sains: Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, 14(4), 2276–2300. <https://doi.org/10.33394/j-ps.v14i4.22429>



<https://doi.org/10.33394/j-ps.v14i4.22429>

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INTRODUCTION

Mastery of logical, analytical, and critical thinking skills is essential for the rapid advancement of science and technology (S&T) in today's digital age. Mathematics as a fundamental discipline that serves as the cornerstone of various fields of science and technology, plays a crucial role in supporting this advancement. Mathematical concepts and principles are widely used and necessary in daily life, both as tools in the application of other scientific fields and in the development of mathematics itself (Noerjuniaty et al., 2022). A strong grasp of mathematics from an early age will facilitate the mastery and creation of future technologies (Marlissa & Widjajanti, 2015). According to the National Council of Teachers of Mathematics (NCTM), mathematics has five basic competency standards that a student must possess are problem solving, reasoning and proof, communication, connections, and representation (Nurhasanah & Luritawaty, 2021). In addition, the Organization for Economic Co-operation and Development (OECD, 2023), states that mathematics learning essentially encompasses concepts, procedures, facts, and tools for describing, explaining, and predicting

phenomena, there by helping students make sound judgments and decisions when solving problems. This aligns with the view of Sari & Darhim (2020) that mathematics is a discipline that can enhance thinking, reasoning, and communication skills, and contribute to solving everyday and workplace problems, as well as the advancement of science and technology.

One of the skills that must be developed in mathematics education is the ability to solve mathematical problems (Sutisna & Pujiastuti, 2023). Problem solving involves the process of formulating, applying, and interpreting mathematics in various situations (OECD, 2023). Problem solving skills require not only mastery of concepts but also higher-order thinking skills, such as critical, creative, and reflective thinking. Therefore, mathematics instruction in schools should be directed toward developing these skills through meaningful and contextual approaches. Problem solving is at the core of the mathematics learning process for achieving learning objectives (Rakhmawati et al., 2019). According to NCTM (2000), problem solving ability is not only one of the primary goals of mathematics learning but also a crucial means of developing conceptual understanding and critical thinking skills. According to Polya (Sutanto et al., 2023), mathematical problem solving is the process of finding a way out of a difficulty or achieving a goal that cannot be reached directly, through systematic thinking. Polya (Firdausi & Supinah, 2021) outlines four main stages in the mathematical problem solving process are understanding the problem, planning the solution, implementing the plan, and confirmation of the answer obtained.

Problem solving abilities are one of the key elements in mathematics education, encompassing the ability to understand problems, formulate strategies, and identify and apply solutions (Ningsi et al., 2025). Mathematical problem solving abilities involve intelligent and rational cognitive processes to identify problems and develop logical solutions. This ability is crucial for helping individuals effectively tackle daily challenges. However, real-world evidence indicates that students' problem solving skills remain unsatisfactory. This is reflected in PISA scores that have not shown significant improvement and consistently remain below 400 (Sugita & Murdiana, 2024), as well as various studies indicating that students' ability to solve mathematical problems remains low. At the Junior High School level, Piaget (Guo, 2024) states that students are in a transitional phase of cognitive development from the concrete operational stage to the formal operational stage, where the ability to think abstractly and systematically begins to form. Mathematics instruction at this stage must be designed to challenge students to think more deeply, rather than merely memorizing formulas, so that learning becomes more meaningful.

Learning strategies that make learning meaningful for students are essential to ensure their active participation in the learning process. According to Marlissa & Widjajanti (2015), one learning model that can actively engage students in learning as proposed by the Center of Occupational Research and Development (CORD) is the Contextual Teaching and Learning (CTL) model, which employs the REACT strategy (Relating, Experiencing, Applying, Cooperating, and Transferring). The REACT strategy is effective for correcting alternative concepts and helping students retain new concepts in long-term memory. Crawford (2001) explains that Relating is a learning procedure based on students' daily experiences, which are then connected to the lesson material to help them grasp new concepts; Experiencing involves learning that requires students to engage in mathematical activities (doing math) through hands-on activities, exploration, discovery, or creation; Applying is learning that requires students to use the concepts they have acquired in practical situations; Cooperating is learning that requires students to learn together through activities involving sharing, responding, and communicating with their peers; while Transferring is learning that encourages students to apply the knowledge or understanding they already possess in new situations.

The REACT strategy is grounded in the constructivist approach (Feronika & Gazali, 2020), which posits that knowledge is not simply imparted but is constructed by students themselves based on their experiences and interactions. The REACT strategy is also consistent

with Contextual Teaching and Learning (CTL). According to Johnson (Nawas, 2018), CTL emphasizes that learning is more effective when the material is linked to students' real-world situations. This aligns with the view of Haetami et al. (2024), who state that the REACT strategy is based on contextual learning that fosters student engagement in the classroom. The REACT strategy is implemented to help students discover meaningful connections between abstract concepts through practical applications related to real life (Sugandi & Akbar, 2019).

The success of effectively implementing the REACT strategy in the learning process can also be seen in another factor, namely students' Adversity Quotient (AQ), as student success is inseparable from their perseverance and tenacity in learning, particularly in problem solving (Luthfiyani et al., 2024). According to Septianingtyas & Jusra (2020), in the problem solving process, students engage in trial-and-error activities until they find an answer, then verify the correctness of their answer by rechecking the solution to the problem. This is where the role of AQ is considered crucial in assisting students when facing mathematical problem solving challenges. According to Stoltz (2000), AQ can serve as an indicator of how well a person can persevere through a difficulty, ultimately emerging as a winner (Climber), giving up halfway (Camper), or refusing to try at all (Quitter). AQ is a measure of how far a person can go in facing and overcoming the difficulties they encounter. Every student has a different AQ when facing difficulties, which encourages them to handle difficulties in their own way. However, to achieve optimal results in problem-solving, students must follow several steps outlined by Polya. According to Stoltz (2000), AQ is defined by four main dimensions are Control, Origin and Ownership, Reach, and Endurance, known as the CO2RE model. To enhance students' problem solving abilities, designed learning strategies must consider psychological aspects, particularly AQ (Istiqomah & Astuti, 2025). This is supported by Afri (2018), who found a positive relationship and significant influence between AQ and problem solving ability. This finding is reinforced by the results of a study by Hakim & Murtafiah (2020), which showed that AQ has a positive effect on mathematical proof problem solving ability, both individually and simultaneously. AQ levels are not fixed factors but can be strengthened through a supportive learning environment and appropriate learning strategies (Ginting, 2024).

The topic of the volume of curved-sided three-dimensional shapes is one that can help develop students' mathematical problem solving abilities because it can be related to real world situations. Furthermore, in solving these problems, students must not only understand the formulas used but also be able to analyze information, choose a solution strategy, and interpret their calculation results. This process aligns with Polya's indicators of mathematical problem solving ability: understanding the problem, planning a solution, implementing a strategy, and reviewing the results obtained. This topic is also related to students' AQ because the characteristics of the problems in this topic include complex problems that require perseverance and a refusal to give up when facing difficulties.

Based on the results of initial observations conducted, the characteristics of Junior High School students in Banawa Subdistrict in mathematics learning include difficulty understanding narrative or story-based problems, as mathematics instruction generally focuses on the use of formulas in the classroom. During the learning process, many students pay little attention to the lesson daydreaming, dozing off, lacking enthusiasm, or talking with friends resulting in low student engagement in classroom activities. Consequently, when given problems by the teacher, many students are unable to solve them correctly because they do not understand the material. Every student has a unique personality, so their ability to cope with challenges will also vary from one student to another.

Research on the implementation of the contextual learning model using the REACT strategy combined with AQ remains very limited, consequently, it is not yet clear how this innovative learning strategy can support students with diverse AQ types in improving their mathematical problem solving skills. Therefore, further research is needed to address this gap by simultaneously examining the application of the REACT learning strategy on students'

mathematical problem solving abilities in relation to AQ, as well as investigating how the interaction between the REACT learning strategy and students' AQ types (Climbers, Campers, Quitters) affects mathematical problem solving ability, in order to design a more effective and adaptive learning approach tailored to student characteristics.

The primary novelty of this study lies not merely in comparing the outcomes of the REACT learning strategy against conventional instruction for enhancing mathematical problem-solving abilities a topic extensively explored in prior research. Instead, the study's originality stems from directly examining the implementation of the REACT strategy with ninth-grade junior high school students while accounting for their Adversity Quotient (AQ) types, and analyzing the interaction between the REACT strategy and AQ regarding students' mathematical problem-solving abilities. Consequently, this study aims to examine differences in mathematical problem-solving skills between students taught using the REACT strategy and those receiving conventional instruction, categorized by AQ type, and to investigate the interaction between the learning strategy and AQ type regarding these skills. The interaction analysis seeks to determine whether the impact of the REACT strategy on mathematical problem-solving skills varies across AQ types (Climbers, Campers, and Quitters). Empirical research on the interaction between the REACT strategy and AQ types has been relatively limited to date.

For these reasons, research on the application of the REACT learning strategy to the mathematical problem solving ability of 9th grade Junior High School students in Banawa subdistrict, as viewed through the lens of Adversity Quotient, is necessary. The hypotheses to be tested in this study are as follows:

- H₁: There is a significant difference in mathematical problem-solving ability between students who learn using the REACT learning strategy and those who learn through conventional instruction.
- H₂: There is a significant difference in mathematical problem-solving ability between "Climber" students who learn using the REACT learning strategy and students who learn through conventional instruction.
- H₃: There is a significant difference in mathematical problem-solving ability between "Camper" students who learn using the REACT learning strategy and students who learn through conventional instruction.
- H₄: There is a significant difference in mathematical problem-solving ability between "Quitter" students who learn using the REACT learning strategy and students who learn through conventional instruction.
- H₅: There is a significant interaction between learning strategies and Adversity Quotient on students' mathematical problem-solving abilities.

METHOD

This study employed a quantitative method using a quasi-experimental design with a non-equivalent control group. This design was chosen because the participants came from pre-existing intact classes, so the assignment of students to the treatment and control groups was not done through individual randomization. This design is called quasi-experimental because the researcher cannot control or manipulate all relevant variables, except for the specific variables under study (Sugiyono, 2013).

The research design used was a 2×3 factorial design, which allowed the researcher to test the application of learning strategies, AQ, and the interaction between these two variables on students' mathematical problem-solving abilities. This design involved two groups, an experimental group and a control group. The experimental group was treated by applying the REACT learning strategy, while the control group was treated using conventional (expository) instruction. The experimental and control groups were divided into three categories of student AQ groups, namely students with Climber, Camper, and Quitter AQ. The research design is presented in Table 1.

Table 1. Factorial Design 2×3

Learning (A_i)	Adversity Quotient Type (B_j)		
	Climber (B_1)	Camper (B_2)	Quitter (B_3)
REACT Learning Strategy (A_1)	A_1B_1	A_1B_2	A_1B_3
Conventional Learning (A_2)	A_2B_1	A_2B_2	A_2B_3

The population of this study consisted of all ninth-grade students in Banawa Subdistrict, comprising 6 schools with a total of 467 students. The sampling technique used in this study was purposive sampling, which involves selecting a sample based on specific considerations relevant to the research objectives. Consequently, two schools were selected as the research sample are SMP Negeri 2 Banawa, with 132 ninth grade students, and SMP Negeri 3 Banawa with 110 ninth grade students. The selection of these two schools was based on the following criteria: (1) the schools have accreditation and relatively comparable academic characteristics, (2) the students have relatively similar initial mathematics abilities, as evidenced by the results of the previous semester's final exams, (3) the schools have never implemented the REACT learning strategy, (4) there is variation in students' Adversity Quotient (AQ) levels, (5) they use the same curriculum, namely the Merdeka Curriculum from seventh through ninth grade, and (6) classes are available that can serve as experimental and control groups. After selecting the school using purposive sampling, the researcher then employed simple random sampling.

Sampling was conducted randomly through a lottery process, resulting in the selection of two classes from each school as the research sample, namely at SMP Negeri 2 Banawa, which has five classes, Class IX Asoka was selected as the experimental class with 27 students, and Class IX Bougenvil was selected as the control class with 27 students. Next, at SMP Negeri 3 Banawa, which consists of 4 classes, Class IXB was selected as the experimental class with 28 students and Class IXC as the control class with 29 students. Thus, the total sample for the experimental class was 55 students, and for the control class, 56 students. This technique was used to provide equal opportunities to every class in the schools selected as research samples. All students in the selected classes were included as research samples without individual selection.

The study was conducted over six sessions, with each session lasting 2×40 minutes. The treatment was administered during sessions 1 through 5, while the sixth session consisted of a final test of mathematical problem-solving skills. During the study, instruction in the experimental group was conducted by the researcher using the REACT strategy, while instruction in the control group was conducted by the mathematics teacher assigned to that class using conventional teaching methods.

These differences in teaching practices are part of the field conditions that must be taken into account during the research. To minimize the impact of teacher differences on the research results, the researcher and the teachers in the control group used the same materials, learning objectives, time allocation, and scope of material. In addition, the researcher prepared a Lesson Plan for the control group to serve as a guideline for teaching and observed the learning process to ensure that activities were carried out according to the established plan. This step was taken to maintain consistency in the research implementation and minimize the influence of teacher differences (teacher effect) outside the treatment.

The intervention was administered over five sessions to both the experimental and control groups. In the experimental group, instruction was conducted by applying the REACT strategy, which consists of the stages of Relating, Experiencing, Applying, Cooperating, and Transferring. Each stage of instruction was supported by Student Worksheets that were contextually organized and designed to help students understand concepts, develop problem-solving strategies, and apply concepts to solve mathematical problems. The activities in the Student Worksheets were organized according to the REACT stages and guided students to develop mathematical problem-solving abilities through activities such as understanding the problem, planning a solution, implementing a strategy, and checking the results. Instruction in

the experimental group was delivered directly by the researcher to ensure that each stage of the REACT strategy was implemented according to the instructional design.

Meanwhile, the control group received conventional instruction through lectures, question-and-answer sessions, sample problems, and individual problem-solving exercises. The control group also used Student Worksheets as practice materials and to support learning activities. The Student Worksheets for the control group were designed with the same content, learning objectives, and scope of competencies as those for the experimental group, but did not include the steps or activities associated with the REACT strategy. Thus, the use of worksheets in both groups served as a learning aid, while the main difference lay in the learning strategies and processes employed. Instruction in the control group was conducted by the mathematics teacher in charge of that class, using Lesson Plans and Student Worksheets prepared by the researcher.

The implementation of instruction in both groups was monitored using observation sheets based on the REACT strategy stages for the experimental group and conventional learning stages for the control group. Observations were conducted at each session to ensure that instructional activities and the use of Student Worksheets were carried out in accordance with the Lesson Plans that had been developed. The observation results were used to evaluate the implementation of the treatment and ensure the appropriateness of the learning design, the use of the Student Worksheets, and their implementation in the classroom. The learning steps are presented in Table 2.

Table 2. Treatment Application Procedures

Meetings and Materials	REACT Strategic Steps	Procedures for Applying the Treatment	Duration
Meeting 1 (Volume of a Cylinder)	• Relating • Experiencing • Applying • Cooperating • Transferring	• <i>Relating</i>: 1. The teacher guides students to observe teaching aids and real-world objects in their surroundings that are related to the lesson material	2 × 40'
Meeting 2 (Volume of a Cone)		2. Teachers connect new material to students' real-life experiences or prior knowledge. The goal is for students to feel that the material is relevant to their lives, thereby increasing their motivation and interest in learning.	2 × 40'
Meeting 3 (Volume of a Sphere)		3. The teacher distributes Student Worksheets specifically designed for the REACT strategy.	2 × 40'
Meeting 4 (Combined Volume)		• <i>Experiencing</i>: 1. Students are given the opportunity to experience concepts through exploration or simple hands-on activities related to the learning material. 2. Students record all experimental results obtained in the Student Worksheets. 3. At this stage, learning is inductive, allowing students to	2 × 40'

Meetings and Materials	REACT Strategic Steps	Procedures for Applying the Treatment	Duration
		discover concepts through direct experience.	
		• <i>Applying</i>: 1. Students apply concepts or formulas they have understood to new situations or to contextual problem-solving related to the learning material, working individually on the Student Worksheets. 2. This stage aims to reinforce understanding and demonstrate that mathematics is useful in real life. • <i>Cooperating</i>: 1. Students work in groups to discuss, exchange ideas, and complete group assignments. 2. This process fosters social skills, broadens horizons, and encourages constructive interaction among students. • <i>Transferring</i>: 1. Students are encouraged to apply the knowledge and skills they have acquired to real-world situations or other, different problems. 2. This stage indicates a high level of mastery of the material, as it can be applied flexibly outside the classroom.	
Meeting 6 (Administration of a Mathematical Problem-Solving Test)		After the learning process is complete, students engage in individual reflection, and the teacher provides feedback. Administering a test of students' mathematical problem-solving abilities after they received the intervention.	2 × 40'

The data collection methods used in this study consisted of questionnaires and tests. The questionnaire was administered to determine students' AQ levels. The questionnaire used in this study was adapted from a previously developed instrument, namely the Adversity Response Profile in Mathematics Learning (ARP-ML) questionnaire by Gradini & Noviani (2025) based on Paul G. Stoltz's AQ theory. The questionnaire consisted of 20 items that measure the dimensions of AQ, namely Control, Origin and Ownership, Reach, and Endurance. The measurements were taken using a Likert scale (1–5). The questionnaire underwent content validity testing by an expert is lecturer in Guidance and Counseling Education and validity testing using product-moment correlation following field trials. The questionnaire underwent reliability testing using Cronbach's Alpha to ensure that the statements in the questionnaire consistently and accurately measure the aspects under investigation. The criteria for grouping students based on AQ are as follows (Wardani & Mahmudi, 2019), presented in Table 3.

Table 3. Categorization of the Adversity Quotient

Interval	Empirical Threshold Values (scores)	Adversity Quotient Types (AQ)
$x > Mi + 1SDi$	$x > 73,33$	Climbers
$Mi - 1SDi \leq x < Mi + 1SDi$	$46,67 \leq x < 73,33$	Campers
$x < Mi - 1SDi$	$x < 46,67$	Quitters

Note: Mi = ideal mean; SDi = ideal standard deviation.

Furthermore, a test was administered to measure students' mathematical problem solving skills. The test assessing students' mathematical problem solving skills was developed by the researcher based on the Merdeka Curriculum material applicable to 9th grade Junior High School students, specifically the volume of curved sided three dimensional shapes. The test consisted of three essay questions. It underwent content validity testing by an expert is a mathematics education lecturer and validity testing using product moment correlation. Additionally, the test underwent reliability testing using Cronbach's Alpha, as well as tests for item discrimination and item difficulty. The categorization of students' mathematical problem-solving abilities based on score intervals refers to Septianingtyas & Jusra (2020) presented in Table 4.

Table 4. Categorization of Mathematical Problem-Solving Ability

Category	Value
Low	$0 \leq TKS \leq 60$
Medium	$60 < TKS \leq 75$
High	$75 < TKS \leq 100$

Note: TKS is a measure of a student's mathematical problem-solving ability.

A breakdown of the indicators for the problem-solving steps, modified according to Polya (Sipayung et al., 2021; Rakhmawati et al., 2019) presented in Table 5.

Table 5. Indicators of Mathematical Problem Solving

Polya's Steps	Indicators of Problem-Solving Skills Based on Polya's Steps
Understanding the problem	a. Writing down what is known b. Writing down what is being asked
Planning the Solution	Be able to identify strategies, formulas, and concepts that can be applied to generate alternative solutions.
Implementing the Plan	Able to solve problems using the selected strategies, formulas, and concepts, and present the steps systematically.
Confirmation of the Answer Obtained	Provide clear and comprehensive final answers and write a conclusion based on the answers obtained, in accordance with the context of the problem.

Indicators of mathematical problem-solving skills have been developed in the form of assessment guidelines. The measurement of problem-solving skills is based on the process students follow on their answer sheets when solving problems and must be assessed or weighted as fairly as possible based on objective evaluation. The guidelines or rubric for assessing mathematical problem-solving skills are presented in Table 6.

Table 6. Guidelines for Assessing Mathematical Problem-Solving Ability

Question Indicators	Indicators of Mathematical Problem-Solving	Score
Students can calculate the volume of a cone and determine the height of the liquid in the tube after it has been transferred.	Understanding the problem:	4
	Writing down what is known and what is being asked.	7
	Planning the Solution:	
	Determining the formulas for the volume of a cone and the volume of a cylinder	16
	Implementing the Plan:	
	Solve problems using the formulas for the volume of a cone and the volume of a cylinder, following a systematic approach	

Question Indicators	Indicators of Mathematical Problem-Solving	Score
Students are able to calculate the volume of a composite three-dimensional shape (a cylinder and a hemisphere) and determine its mass based on the calculated volume.	Confirmation of the Answer Obtained:	3
	Write the final conclusion based on the answers obtained	
	Total	30
	Understanding the problem:	6
	Writing down what is known and what is being asked.	
	Planning the Solution:	7
	Determining the formulas for the volume of a cylinder, the volume of a hemisphere, the total volume, and the total mass	
	Implementing the Plan:	18
	Solve problems using the formulas for the volume of a cylinder, the volume of a hemisphere, total volume, and total mass, following a systematic approach	
	Confirmation of the Answer Obtained:	4
Students are able to calculate the total volume of 20 cones and determine whether the 3 liters of batter provided is sufficient.	Write the final conclusion based on the answers obtained	
	Total	35
	Understanding the problem:	8
	Writing down what is known and what is being asked.	
	Planning the Solution:	5
	Determine the formula for the volume of a cone and the total volume required.	
	Implementing the Plan:	15
	Solve the problem by using the formula for the volume of a cone and calculating the planned total volume, then compare it to the available volume using a systematic approach	
	Confirmation of the Answer Obtained:	7
	Write the final conclusion based on the answers obtained	
	Total	35

Final Score = Total points for Question 1 + Total points for Question 2 + Total points for Question 3 (maximum 100)

Final Grade = (Total weighted score / 100) × 100.

The validity of the questionnaire and the problem solving ability test was assessed using a 5% significance level, with the following decision rule if $t_{\text{count}} \geq t_{\text{table}}$, then the item is valid; if $t_{\text{count}} < t_{\text{table}}$, then the item is invalid. The criteria for the empirical validity of the instrument were adapted (Dewi et al., 2022; Lestari et al., 2023; Rosyadi et al., 2024) and are presented in Table 7.

Table 7. Item Validity Criteria

Validity Coefficient Range	Category
$0,800 \leq r_{xy} \leq 1,000$	Very High
$0,600 \leq r_{xy} \leq 0,799$	High
$0,400 \leq r_{xy} \leq 0,599$	Moderately High
$0,200 \leq r_{xy} \leq 0,399$	Low
$0,000 \leq r_{xy} \leq 0,199$	Very Low (Invalid)

The reliability test, using Cronbach's alpha and a 5% significance level, was interpreted using Guilford's criteria (Dewi et al., 2022; Megawati et al., 2024; Hartono et al., 2024), as presented in Table 8.

Table 8. Criteria for the Reliability Correlation Coefficient of the Instrument

Correlation Coefficient	Correlation	Interpretation of Reliability
$0,90 \leq \alpha \leq 1,00$	Very High	Excellent
$0,70 \leq \alpha < 0,90$	High	Good
$0,40 \leq \alpha < 0,70$	Currently	Fair
$0,20 \leq \alpha < 0,40$	Low	Poor
$\alpha < 0,20$	Very Low	Very Poor

The instruments in this study can be used if the correlation coefficient is greater than or equal to 0.70 ($\alpha \geq 0.70$), meaning they meet one of the criteria of “good” or “very good.” Furthermore, regarding discriminant power, the criteria are based on Arikunto’s (Dewi et al., 2022; Hartono et al., 2024; Rosyadi et al., 2024) guidelines, as presented in Table 9.

Table 9. Item Discrimination Criteria

Distinctive Features	Interpretation
$DP \leq 0,00$	Very Poor
$0,00 < DP \leq 0,20$	Poor
$0,20 < DP \leq 0,40$	Satisfactory
$0,40 < DP \leq 0,70$	Good
$0,70 < DP \leq 1,00$	Excellent

A value of 0 or a negative value for the DP indicates that the item is unsuitable and should be discarded. Next, to determine whether an item is easy, moderate, or difficult, the adapted item difficulty criteria (Lestari et al., 2023; Rosyadi et al., 2024) are used and presented in Table 10.

Table 10. Item Difficulty Criteria

Difficulty Level Interval	Interpretation
$IK = 0,00$	Too difficult
$0,00 < IK \leq 0,30$	difficult
$0,30 < IK \leq 0,70$	Moderate/Fair
$0,70 < IK < 1,00$	Easy
$IK = 1,00$	Too Easy

The data analysis techniques used in this study included descriptive statistics to describe the distribution of students’ mathematical problem solving ability scores in the experimental and control classes, as well as the mathematical problem solving ability of students with each AQ type in both classes. Furthermore, inferential statistics were used after first conducting prerequisite tests, namely the Normality Test (Kolmogorov-Smirnov and Shapiro-Wilk) and the Homogeneity Test using Levene’s test with a significance level of 5%. The decision criteria for the Normality Test are that the data are normally distributed if the significance value (Sig.) > 0.05 and the data are not normally distributed if the significance value (Sig.) ≤ 0.05 . Similarly, the decision criteria for the Homogeneity Test are that the data have homogeneous variances if the significance value (Sig.) > 0.05 and the data have non-homogeneous variances if the significance value (Sig.) ≤ 0.05 .

After meeting these prerequisite tests, the analysis proceeded with a t-test and a two way ANOVA. The t-test was used to determine significant differences in mathematical problem solving ability between students in the experimental and control classes, as well as differences in mathematical problem solving ability among the different AQ types (Climber, Camper, and Quitter) in both classes. The t-test was conducted using the Independent Samples t-test with the assistance of IBM SPSS Statistics version 27 at a 5% significance level. The decision criterion for the t-test was that a significant difference existed if the two-tailed sig. value was ≤ 0.05 . Furthermore, a two-way ANOVA was used to determine the combined effect of learning strategies and students’ AQ types on their mathematical problem solving abilities, as well as to examine whether there was an interaction between learning strategies and AQ types. The decision criterion for the two-way ANOVA was that an interaction was present if the significance value was ≤ 0.05 .

In addition to significance testing, the analysis also includes effect sizes to support the interpretation of the results, namely Cohen’s d with a 95% confidence interval for each t-test, and Partial Eta Squared (η_p^2) in the two-way ANOVA to determine the effects of each factor and their interactions. The value of η_p^2 always falls between 0 and 1. The closer it is to 1, the greater the effect of the factor being analyzed in the two-way ANOVA model. The

interpretation of effect sizes follows Cohen (1988) criteria, approximately 0.01 for a small effect, 0.06 for a moderate effect, and 0.14 or higher for a large effect. Since the analysis involves four t-tests, namely the overall comparison and the three AQ types subgroup comparisons within the same dataset the tests for the AQ subgroups were corrected to control for the increased risk of Type 1 errors resulting from multiple testing. The correction was performed using the Holm-Bonferroni method with an initial significance level of $\alpha = 0.05$. This procedure was carried out by sorting the p-values from smallest to largest and comparing them stepwise with the adjusted significance level (adjusted $\alpha = 0.05/3 = 0.017$).

The treatment in this study was applied at the class level; thus, students were not entirely independent but were nested within four classes and two schools. This condition could potentially result in smaller standard error estimates if all students were treated as independent observations in conventional t-tests and ANOVAs. The researchers are aware of this limitation and discuss it further in the section on research limitations.

RESULTS AND DISCUSSION

Result

In this Results and Discussion section, the research data which has been analyzed using descriptive and inferential statistics with the aid of Microsoft Excel and IBM SPSS Statistics version 27 will be presented in full. The analysis results include normality tests, homogeneity tests, and hypothesis testing using the Independent Samples t-test and two way ANOVA. In addition, the differences in students' mathematical problem solving abilities in general and for each AQ type (Climber, Camper, and Quitter) between the experimental class using the REACT strategy and the control class using conventional (expository) learning are also presented.

Descriptive Statistics Results

The study was conducted from January to February 2026. Before the questionnaire was used as a data collection instrument to map students' AQ types in the study, a pilot test was conducted to determine the questionnaire's validity and reliability. The pilot test was conducted in Class IX D at SMP Negeri 3 Banawa, which was not part of the study sample. The pilot test results showed that 20 of the AQ questionnaire items analyzed met the validity criteria, namely $t_{\text{count}} \geq t_{\text{table}}$. After conducting the validity test, the next step was to conduct a reliability test using Cronbach's Alpha. Based on the reliability test results, Cronbach's Alpha was found to be 0.93. Since $\alpha = 0.93 \geq 0.70$, the AQ questionnaire was deemed reliable and consistent for measuring students' AQ types.

After the AQ questionnaire was declared valid and reliable, it was administered in the experimental and control classes to map students based on their AQ type. The results are presented in Table 11.

Table 11. Mapping of Students' Adversity Quotient (AQ) Types

Class	AQ Type	SMP Negeri 2 Banawa	SMP Negeri 3 Banawa	Amount
Experimental	Climber	9	9	18
	Camper	8	10	18
	Quitter	10	9	19
	Amount	27	28	55
Control	Climber	8	9	17
	Camper	11	9	20
	Quitter	8	11	19
	Amount	27	29	56

The next step was to pilot-test the mathematical problem solving test instrument at SMP Negeri 1 Banawa, which was not included in the research sample. The pilot test results indicated that all three essay questions were valid because they met the criterion of $t_{\text{count}} \geq t_{\text{table}}$. The results are presented in Table 12.

Table 12. Results of the Test Instrument Validity Analysis

Item Number	t-count	t-table	Validity Status
1	11.31	2.07	Valid
2	11.12	2.07	Valid
3	12.95	2.07	Valid

Note: All three items were classified as valid because their calculated t-values exceeded the critical t-value ($t\text{-count} > t\text{-table}$).

The three valid question items were tested for reliability, obtaining an Alpha Cronbach value of 0.90 with very good criteria. Because the α value = $0.90 \geq 0.70$, the test instrument is declared reliable and consistent to measure students' mathematical problem solving ability. This Cronbach's Alpha value represents the internal consistency among test items, not inter-rater reliability, given that scores on essay questions depend on a qualitative assessment of students' problem-solving processes, therefore inter-rater reliability testing should be conducted in future research. Furthermore, a high Alpha value for an instrument with a limited number of items (three questions) indicates a high intercorrelation among the items, which must be interpreted carefully as it may be caused by similarities in the aspects measured by the three questions.

After being valid and reliable, a differentiating power test was carried out and it was found that the differentiating power of question Number 1 of 0.405 ($0.40 < 0.405 \leq 0.70$) was in the "Good" criterion, question Number 2 of 0.233 ($0.20 < 0.233 \leq 0.40$) was in the "Sufficient" criterion, and question Number 3 of 0.220 ($0.20 < 0.220 \leq 0.40$) was in the "Sufficient" criterion. The criteria for differentiating the ability of questions, namely "Good" and "Sufficient", are obtained by stating that the three question items can be used to distinguish between students who have high ability and students who have low ability. Although the discriminative power of items Number 2 and Number 3 is only in the "Sufficient" category indicating that these two items are not yet optimal at clearly distinguishing between groups of students, but they can still be used because their discriminative power scores remain within the criteria range, demonstrating the ability to differentiate students based on their ability levels.

Furthermore, a difficulty level test was carried out, and it was obtained that the difficulty level index (TK) value for the three question items was obtained consecutively 0.29; 0.19; and 0.15. By referring to the difficulty level criteria, it was obtained that all of these scores were in the "Difficult" category because the kindergarten score was < 0.30 . This pattern is consistent with classical test theory, which states that the more extreme the difficulty level of an item, the more limited its discriminating power. This is evident in items 2 and 3, which have lower difficulty levels (0.19 and 0.15) and lower discriminating power compared to item 1 (TK = 0.29). Even though the three question items are in the difficult category, this instrument is still suitable for use because it is designed to measure students' mathematical problem-solving ability at the analysis level (C4). Thus, the high level of difficulty is a logical consequence of the characteristics of the ability being measured. However, the high level of difficulty across all test items has the potential to cause a floor effect, that is a concentration of student scores in the lower range. This condition makes the instrument more sensitive in identifying high-ability students but less effective in mapping ability variations among students with moderate to low ability. On the other hand, the instrument's suitability is supported by adequate results from validity, reliability, and discriminant validity tests. Nevertheless, this study did not include an inter-rater reliability test; therefore, this should be acknowledged as a limitation that needs to be considered in future research.

Before starting treatment in the experimental class and the control class, the researcher first analyzed the students' initial ability. The initial ability data of students from both schools were taken from the summative value at the end of the previous semester, which consisted of the Two-Variable Linear Equation System (SPLDV) and building a flat-sided space. These two materials are closely related to the mathematical problem solving skills that are the focus of this study, because they not only measure the mastery of concepts, but also reflect the students' ability to understand problems, plan strategies, solve, and evaluate results, which is in line with

the indicators of mathematical problem solving ability. Therefore, the summative value of the end of the semester in the material is considered relevant and very suitable to be used as initial ability data in this study. The descriptive statistical results of the students' initial abilities are presented in Table 13.

Table 13. Descriptive Statistics of Students' Initial Ability Results

Class	N	Minimum	Maximum	Mean	Std. Deviation
Experimental	55	21	66	38.35	9.336
Control	56	20	67	38.64	10.742

Based on the results of the descriptive analysis of the initial ability of the students, it was found that the initial ability of the students of the experimental class and the control class was relatively equivalent. This is shown by the average value of the initial abilities of the two classes which are relatively equal with a very small difference. In addition, the distribution of data in the control class (10,742) was slightly more varied compared to the experimental class (9,336). However, the difference is not too big so that the diversity of students' abilities in both classes is still comparable. Thus, it can be concluded that the initial ability of students in the experimental class and the control class was in relatively the same or equivalent condition and deserved to be given different treatment in the study. After the implementation of the treatment in learning for five meetings, a problem-solving skills test was administered during the sixth session to assess the problem-solving abilities of students in the experimental class, which used the REACT learning strategy, and the control class, which used conventional instruction. The results of the descriptive data analysis of mathematical problem-solving skills are presented in Table 14.

Table 14. Descriptive Statistics of Problem solving Ability Test Results

Class	N	Minimum	Maximum	Mean	Std. Deviation
Experimental	55	48	99	73.58	14.129
Control	56	20	98	45.32	16.473

From the results of the descriptive analysis of students' mathematical problem solving abilities in Table 14 it can be stated that the average mathematical problem solving ability of students in the experimental class is much higher than that of the control class. This means that students in the experimental class have better problem solving skills after receiving the learning treatment. In addition, the distribution of scores in the experimental class was relatively smaller compared to the control class, which suggests that the learning outcomes of students in the experimental class were more even. Judging from the maximum and minimum scores, both classes have almost the same maximum score, meaning that there are high-ability students in both classes. However, the minimum score of the experimental class was higher than that of the control class, meaning that in the control class there were students with very low mathematical problem solving skills and in the experimental class were able to improve the mathematical problem solving skills of the lowest students to be better.

Furthermore, the results of descriptive data analysis on the mathematical problem solving ability of Climber, Camper, and Quitter students will be presented in the experimental class and control class. The results can be seen in Table 15.

Table 15. Descriptive Statistics of Students' Mathematical Problem solving Ability by Type of AQ

AQ Type	Class	N	Minimum	Maximum	Mean	Std. Deviation
Climber	Experimental	18	56	99	82.72	12.014
	Control	17	34	98	59.76	17.156
Camper	Experimental	18	50	93	74.89	12.428
	Control	20	26	73	43.80	11.157
Quitter	Experimental	19	48	88	63.68	11.314
	Control	19	20	58	34.00	10.061

Based on the results of the descriptive analysis of students' mathematical problem solving abilities for the three AQ types in the experimental and control classes presented in Table 15, it was found that the average mathematical problem solving abilities of Climber, Camper, and Quitter students in the experimental class were significantly higher than those in the control class, meaning that the REACT strategy-based instruction in the experimental class can help students with various AQ types solve mathematical problems more effectively.

Inferential Statistics Results

Inferential statistics were used to statistically test whether the two research groups the experimental class and the control class exhibited a significant difference in mathematical problem solving ability. Prior to conducting the inferential analysis, prerequisite tests were performed first, namely the Normality Test and the Homogeneity Test.

The Normality Test for the students' mathematical problem solving ability test results was conducted to determine whether the data followed a normal distribution or not. The normality test for this data used the Kolmogorov-Smirnov test with the assistance of IBM SPSS Statistics version 27 because the sample size for each class exceeded 50 students. The results of the normality test are presented in Table 16.

Table 16. Normality Test of Mathematical Problem solving Ability

Class	Kolmogorov-Smirnov		
	Statistic	df	Sig.
Experimental	0.100	55	0.200*
Control	0.109	56	0.098

The results of the normality test for the data in the experimental class after the treatment was administered showed a significance value of 0.200, which is greater than 0.05, this indicates that the data on the students' mathematical problem solving abilities in the experimental class are normally distributed. Similarly, in the control class, the significance value was 0.098, which is greater than 0.05, meaning that the data on students' mathematical problem solving abilities in the control class also follow a normal distribution. Based on the results of the normality test using the Kolmogorov-Smirnov test, all data after treatment in both the experimental and control classes met the assumption of normality.

Next, a normality test was conducted for each type of student AQ. The normality test for data on each type of student AQ used the Shapiro-Wilk test with the aid of IBM SPSS Statistics version 27 because the sample size for each AQ type in both classes was less than 50 students. The results are presented in Table 17.

Table 17. Data Normality Test by AQ Type

AQ Type	Class	Shapiro-Wilk		
		Statistic	df	Sig.
Climber	Experimental	0.959	18	0.584
	Control	0.926	17	0.186
Camper	Experimental	0.950	18	0.425
	Control	0.911	20	0.067
Quitter	Experimental	0.930	19	0.174
	Control	0.932	19	0.191

Based on the results of the normality test using the Shapiro-Wilk test, all data on the mathematical problem solving abilities of students classified as Climbers, Campers, and Quitters after receiving treatment in the experimental and control classes had a significance level greater than 0.05, meaning the data were normally distributed. Thus, based on the results of the normality test, it can be concluded that the data in this study satisfy the assumption of normality.

Once the assumption of normality for both the experimental and control classes was met, data analysis could proceed to the homogeneity test. The homogeneity of variance test aims to

determine whether the data from the two groups have the same variance or not. The results of the homogeneity test using Levene's Test for Equality of Variances are presented in Table 18.

Table 18. Results of the Homogeneity Test for Mathematical Problem solving Ability

Value	Levene Statistic	df1	df2	Sig.
Based on Mean	0.183	1	109	0.669
Based on Median	0.092	1	109	0.762
Based on Median and with adjusted df	0.092	1	95.145	0.762
Based in trimmed mean	0.126	1	109	0.723

Table 18 shows that the Levene's Test Based on Mean has a p-value of 0.669, which is greater than the set significance level of 0.05. Similarly, for Levene's Test Based on Median with a significance value of $0.762 > 0.05$, Levene's Test Based on Median with adjusted df with a significance value of $0.762 > 0.05$, and Levene's Test Based on Trimmed Mean with a significance value of $0.723 > 0.05$. All methods in Levene's Test yielded Sig. values > 0.05 ; therefore, it can be concluded that the variances of the mathematical problem solving ability data for students taught using the REACT learning strategy in the experimental class and conventional learning in the control class are the same (homogeneous). The results of the homogeneity test based on AQ types namely Climber, Camper, and Quitter also met the assumption of homogeneity.

After the test results met the assumptions of normality and homogeneity, a hypothesis test was conducted. The first hypothesis test was conducted to determine whether there was a significant difference in mathematical problem solving ability between students who learned using the REACT learning strategy and those who learned through conventional instruction. Data analysis was performed using the Independent Sample t-test with the assistance of IBM SPSS Statistics version 27 at a 5% significance level. The test results are presented in Table 19.

Table 19. Results of the t-Test Based on Learning Strategies

Value	Levene's Test		t-test		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	0.183	0.669	9.694	109	< 0.001
Equal variances not assumed			9.708	107.068	< 0.001

The results of the independent samples t-test yielded a significance value (Sig. 2-tailed) of < 0.001 . Since this significance value is smaller than the set significance level of 0.05, H_0 is rejected and H_1 is accepted. This indicates that there is a significant difference between the mean mathematical problem solving abilities of students in the experimental class and the control class. The mean difference obtained in Table 14 is 28.26, indicating that mathematical problem solving ability in the experimental class, which learned by applying the REACT learning strategy, is higher than that of the control class, which used conventional learning. Thus, it can be concluded that there is a significant difference in mathematical problem solving ability between students who learned by applying the REACT learning strategy and those who learned through conventional learning.

The second hypothesis test was conducted to determine whether there is a significant difference in mathematical problem solving ability between Climber-type students who learned using the REACT learning strategy and those who learned through conventional instruction. The results of this test are presented in Table 20.

Table 20. Results of the t-test by AQ Climber type

Value	Levene's Test		t-test		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	1.274	0.267	4.608	33	< 0.001
Equal variances not assumed			4.561	28.499	< 0.001

From Table 20, a significance value (Sig. 2-tailed) of < 0.001 was obtained. Since this significance value is smaller than the set significance level of 0.05, H_0 is rejected and H_1 is accepted. This indicates that there is a significant difference between the mean mathematical problem solving abilities of AQ Climber type students in the experimental class and the control class. The mean difference for the Climber type obtained in Table 15 is 22.96, indicating that the mathematical problem solving ability of Climber type students in the experimental class, who learned by applying the REACT learning strategy, is higher than that of the control class, which used conventional learning. Thus, it can be concluded that there is a significant difference in mathematical problem solving ability between Climber type students who learned using the REACT learning strategy and those who learned through conventional instruction.

The third hypothesis test was conducted to determine whether there was a significant difference in mathematical problem solving ability between Camper type students who learned using the REACT learning strategy and those who learned through conventional instruction. The results of this test are presented in Table 21.

Table 21. Results of the t-test based on Camper AQ type

Value	Levene's test		t-test		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	1.015	0.321	8.127	36	< 0.001
Equal variances not assumed			8.080	34.408	< 0.001

The significance value (Sig. 2-tailed) obtained was < 0.001 . Since this significance value is smaller than the set significance level of 0.05, H_0 is rejected and H_1 is accepted. This indicates that there is a significant difference between the mean mathematical problem solving abilities of AQ Camper type students in the experimental class and the control class. The mean difference for the Camper type obtained in Table 15 is 31.09, indicating that the mathematical problem solving ability of Camper type students in the experimental class, who learned by applying the REACT learning strategy, was higher than that of the control class, which used conventional learning. Thus, it can be concluded that there is a significant difference in mathematical problem solving ability between Camper type students who learned using the REACT learning strategy and those who learned through conventional instruction.

The fourth hypothesis test was conducted to determine whether there is a significant difference in mathematical problem solving ability between Quitter type students who learned using the REACT learning strategy and those who learned through conventional instruction. The results of this test are presented in Table 22

Table 22. Results of the t-Test Based on the Quitter AQ Type

Value	Levene's test		t-test		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	0.280	0.600	8.546	36	< 0.001
Equal variances not assumed			8.546	35.515	< 0.001

The significance value (Sig. 2-tailed) obtained was less than 0.001 (< 0.001). Since this significance value is smaller than the set significance level of 0.05, H_0 is rejected and H_1 is accepted. This indicates that there is a significant difference between the mean mathematical problem solving abilities of AQ Quitter type students in the experimental class and the control class. The mean difference for the Quitter type obtained in Table 15 is 29.68, indicating that the mathematical problem solving abilities of Quitter type students in the experimental class who learned using the REACT learning strategy were higher than those in the control class using conventional learning. Thus, it can be concluded that there is a significant difference in mathematical problem solving ability between Quitter type students who learned using the REACT learning strategy and those who learned through conventional instruction.

The fifth hypothesis test was conducted to determine whether there was a significant interaction between learning strategies (REACT and conventional) and Adversity Quotient

(Climber, Camper, and Quitter) on students' mathematical problem solving ability. The analysis was performed using a two-way ANOVA test with the assistance of IBM SPSS Statistics version 27 at a 5% significance level. The test results are presented in Table 23.

Table 23. Results of the Two-Way ANOVA Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	η_p^2
Corrected Model	31584.571 ^a	5	6316.914	40.742	< 0.001	0.660
Intercept	396006.738	1	396006.738	2554.136	< 0.001	0.961
Class	21558.621	1	21558.621	139.047	< 0.001	0.570
AQ	9140.237	2	4570.118	29.476	< 0.001	0.360
Class * AQ	339.589	2	169.795	1.095	0.338	0.020
Error	16279.753	105	155.045			
Total	438515.000	111				
Corrected Total	47864.324	110				

^a. R Squared = .660 (Adjusted R Squared = .644)

Based on the test results shown in Table 23, the two-way ANOVA results indicate that the learning strategy has a significant effect on students' mathematical problem-solving ability, $F(1,105) = 139.047$, $p < 0.001$, with a Partial Eta Squared (η_p^2) of 0.570, which falls into the large effect category. The AQ factor also showed a significant effect, $F(2,105) = 29.476$, $p < 0.001$, with a partial eta-squared (η_p^2) of 0.360, which falls into the large effect category. Meanwhile, the interaction between learning strategies and AQ was not significant, $F(2,105) = 1.095$, $p = 0.338$, with a partial eta-squared (η_p^2) of 0.020, which falls into the small effect category. Thus, this study failed to reject H_0 regarding the interaction between learning strategies and AQ and found no statistically significant evidence that the effect of the REACT strategy differs based on AQ type. Thus, it can be concluded that there is no significant interaction between learning strategies (REACT and conventional) and Adversity Quotient (Climber, Camper, and Quitter) on students' mathematical problem solving ability. This is supported by the graph presented in Figure 1.

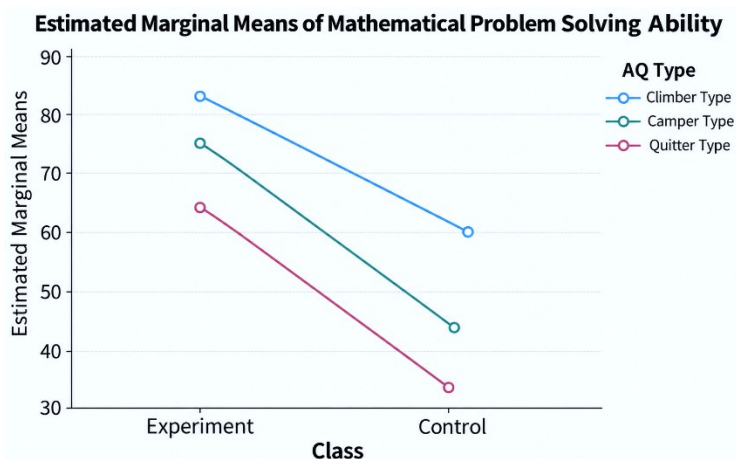


Figure 1. The interaction of REACT and AQ on mathematical problem solving abilities.

Based on Figure 1, it can be seen that the line patterns on the chart appear relatively parallel and do not intersect significantly. This shows that the influence of learning strategies on mathematical problem solving skills tends to be the same in each type of AQ. Thus, it can be interpreted that there is no significant interaction between learning strategies and AQ types on students' mathematical problem solving abilities.

From Table 23, the magnitude of the interaction effect between learning strategy and AQ type calculated using an overall comparison, shows that the average mathematical problem-solving ability of students in the REACT class was 73.58, while that of the conventional class

was 45,32, with an average difference of 28,26. This difference is statistically significant, $t(109) = 9,694$, $p < 0.001$, with a 95% confidence interval for the mean difference of [22,48; 34,04]. The effect size, Cohen's $d = 1,84$ (95% CI [1,39; 2,28]), indicates that the implementation of the REACT strategy resulted in a large difference in mathematical problem-solving ability. Furthermore, the magnitude of the interaction effect between the learning strategy and AQ type, calculated using partial eta-squared ($\eta_p^2 = 0,020$), is classified as small according to Cohen (1988) criteria. This result indicates that, although the interaction was not statistically significant, this study still had limited sensitivity (statistical power) to detect small- to moderate-sized interactions, given that the sample size for each factorial cell ranged from only 17 to 20 students. Therefore, these non-significant results do not imply that AQ type plays no role at all in moderating the effectiveness of the REACT strategy, but rather that this study's design was not sensitive enough to detect such interactions when they are small in magnitude. The non-significant findings regarding this interaction are, in fact, a key point of the study, as they indicate that the advantages of the REACT strategy over conventional learning are relatively consistent across all AQ types (Climber, Camper, and Quitter), suggesting that this strategy has the potential to be applied uniformly without the need for differentiation based on students' AQ types.

The strengths of the REACT strategy in this study can be explained through the interrelationship between its components and Polya's stages of problem-solving. The "Relating" component encourages students to connect the material on the volume of curved-sided three-dimensional shapes to real-world experiences or contexts, which contributes to Polya's "understanding the problem" stage because students can more easily identify what is known and what is being asked. The "Experiencing" and "Applying" components provide opportunities for students to explore and apply concepts directly, which aligns with the stages of "planning a solution" and "implementing the plan" because students are trained to develop and test solution strategies based on concrete experiences, rather than simply memorizing procedures. The "Cooperating" component facilitates group discussions so that students can correct each other's strategies and calculation results, which in turn supports the "confirmation of the answer obtained" stage. Meanwhile, the "Transferring" component trains students to apply problem-solving strategies to new situations or problems, thereby reinforcing the entire Polya problem-solving cycle through repetition. It is this conceptual interconnection that theoretically explains why the REACT strategy consistently outperformed others across all AQ types in this study: its five components target the cognitive problem-solving process comprehensively, rather than just a specific stage, so its benefits are relatively evenly distributed regardless of students' AQ characteristics.

Next, a comparative analysis based on AQ types was conducted as a planned comparison to examine differences in mathematical problem-solving ability between the REACT class and the conventional class for each AQ type (Climber, Camper, and Quitter). Since there were three comparisons, multiple testing was performed using the Holm-Bonferroni correction, which maintains the family-wise error rate at $\leq 5\%$ overall. The results are presented in Table 24.

Table 24. Results of the Holm-Bonferroni Correction

Type AQ	REACT Mean	Conventional Mean	Difference	Cohen's d	95% CI	p	p Holm
Climber	82,72	59,76	22,96	1,56	0,79 – 2,31	< 0,001	< 0,001
Camper	74,89	43,80	31,09	2,64	1,75 – 3,51	< 0,001	< 0,001
Quitter	63,68	34,00	29,68	2,77	1,86 – 3,66	< 0,001	< 0,001

Table 24 shows that the differences between the REACT group and the conventional group remain significant for the Climber, Camper, and Quitter types after Holm-Bonferroni correction, with all p-values < 0.001. The effect sizes also indicate substantial differences in the Climber ($d = 1,56$), Camper ($d = 2,64$), and Quitter ($d = 2,77$) types.

Discussion

The research findings indicate that the implementation of the REACT learning strategy as an alternative to conventional (expository) instruction is significantly more effective in improving students' mathematical problem-solving abilities, both overall and across each AQ type (Climber, Camper, and Quitter), with effect sizes classified as large (Cohen's d ranging from 1,56 to 2,77. These findings align with studies conducted by Nurhasanah & Luritawaty (2021), Wijaya et al. (2019), Yunis & Fauzan (2020), and Amidi et al. (2020), which demonstrate that the REACT learning strategy has a significant impact on improving students' mathematical problem solving skills. Additionally, Nguyen et al. (2026) also state that the REACT strategy is capable of improving students' learning outcomes and strengthening their mathematical problem solving skills. According to Putri et al., (2015), the REACT strategy is more effective than the lecture strategy in conventional learning in improving mathematical problem solving skills. The implementation of the REACT strategy in mathematics instruction resulted in student engagement and problem solving skills ranging from good to very good, with a more significant improvement compared to conventional instruction (Kusumawati & Dwi Rizki, 2014). Thus, it can be concluded that the mathematical problem solving skills of students learning with the REACT strategy differ significantly from those of students learning through conventional instruction. The mathematical problem solving skills of students learning with the REACT strategy are higher than those of students learning conventionally.

Research findings on the AQ Climber type indicate that there is a significant difference in mathematical problem solving ability between AQ Climber students who learn using the REACT learning strategy and those who learn through conventional methods. This suggests that students with the AQ Climber type tend to persevere and strive to find solutions when faced with difficulties in solving mathematical problems. This aligns with the theory proposed by Paul G. Stoltz, who states that individuals with the Climber type possess high resilience and are capable of facing various challenges with perseverance (Stoltz, 2000). These characteristics cause students with the AQ Climber type to be more active in seeking problem solving strategies and less likely to give up when facing difficulties. These findings are also supported by studies conducted by Wahyu & Sariningsih (2018), Baharullah et al. (2022), Asmana & Nugroho (2023), and Salwaa & Munandar (2025), which show that students with the AQ Climber type possess better mathematical problem solving skills. Students with the Climber type are able to understand problems, plan solution strategies, and solve problems more systematically. Thus, it can be concluded that the application of the REACT strategy facilitates students with the AQ Climber type to optimize their potential in solving mathematical problems through active, contextual, and collaborative learning activities. This results in higher mathematical problem solving abilities among students who learn using the REACT strategy compared to those who learn conventionally.

For students with the AQ Camper type, learning through the REACT strategy results in higher mathematical problem solving abilities compared to students who learn conventionally. Students with the Camper type generally have abilities at a moderate level and still require encouragement to overcome difficulties in the learning process. This aligns with the theory proposed by Paul G. Stoltz, which states that individuals with the Camper type tend to have a desire to achieve success, yet often feel satisfied at a certain level of achievement and do not strive further when faced with greater challenges (Stoltz, 2000). Therefore, learning strategies that directly involve student activities are essential to encourage them to be more active in the learning process. These findings are supported by research conducted by Wahyu & Sariningsih (2018), (Baharullah et al., 2022), and Sutisna & Pujiastuti (2023), which demonstrate that students with the AQ Camper type possess moderate mathematical problem solving abilities and are capable of completing several stages of mathematical problem solving quite well when provided with instruction that supports their thinking processes. Thus, it can be concluded that the implementation of the REACT strategy provides students of the Camper type with

opportunities to actively engage in learning through group discussions, concept exploration, and the application of mathematical concepts in various situations, thereby allowing their mathematical problem solving skills to develop more effectively.

For the AQ Quitter type, the mathematical problem solving skills of students learning with the REACT strategy are higher than those learning conventionally. Although students of the Quitter type tend to have low levels of resilience when facing difficulties, the right learning strategy can help them become more engaged in the learning process. This is reinforced by Paul G. Stoltz, who notes that individuals of the Quitter type tend to give up easily when facing challenges and often avoid difficulties. However, through a supportive learning environment that actively engages students, their problem solving abilities can develop gradually (Stoltz, 2000). The results of this study are consistent with research conducted by Wahyu & Sariningsih (2018), which showed that students with the AQ Quitter type are generally only able to complete some of the stages of mathematical problem solving. However, with guidance and appropriate learning strategies, students can still improve their ability to understand problems and solve math problems. Thus, it can be concluded that the application of the REACT strategy, which emphasizes student engagement, group collaboration, and the application of concepts in various contexts, can help students with the Quitter type to be more confident in facing math problems so that their problem solving skills can improve.

Research Limitations

The researchers acknowledge that this study has several limitations that must be taken into account when interpreting and generalizing the findings. First, the treatment was administered at the class level, so students were nested within four classes and two schools. t-tests and two-way ANOVAs, which treat all students as independent observations, may underestimate the standard error due to cluster effects, even though both schools and classes were selected based on criteria of academic parity. Future research is encouraged to use a mixed-effects model to appropriately accommodate this hierarchical data structure.

Second, the research design was quasi-experimental, without individual randomization and without a direct pretest of the construct of mathematical problem-solving ability (initial equivalence was approximated only by summative scores from the previous semester). Therefore, the statement that the REACT strategy “influences” or “improves” students’ mathematical problem-solving ability should be interpreted as an observed difference in learning outcomes between groups, rather than as a causal claim that is entirely free from confounding factors.

Third, the statistical power of the two-way ANOVA interaction test is also limited by the sample size in each factorial cell, which ranges from 17 to 20 students, therefore generalizations regarding the presence or absence of a moderating role of AQ should be made with caution.

Fourth, instruction in the experimental group was conducted by the researcher, while instruction in the control group was conducted by the mathematics teacher who taught that class. This situation has the potential to introduce a “teacher effect” on the research results; thus, differences in mathematical problem-solving ability cannot be entirely separated from the possibility of differences in characteristics and teaching styles between the two instructors. Nevertheless, the researcher has attempted to minimize this effect by standardizing the material, learning objectives, time allocation, and scope of instruction for both groups. Future research is advised to consider using the same teacher for both the experimental and control groups or to involve multiple teachers to reduce the potential influence of the instructor on the research results.

Fifth, the instructional intervention was implemented only for the topic of curved-sided three-dimensional shapes over a relatively short period of time namely, 5 sessions. This was not sufficient to comprehensively assess the long-term impact of the REACT approach on mathematical problem-solving ability.

Sixth, the high level of difficulty across all test items has the potential to cause a floor effect, making the instrument less than optimal for mapping variations in the abilities of students with average and low ability levels. Furthermore, inter-rater reliability testing has not yet been conducted in this study. Nevertheless, the instrument's suitability is still supported by adequate results from validity, reliability, and discriminant validity tests; therefore, these two limitations should be taken into consideration in the development of future research.

CONCLUSION

The research findings and discussion indicate that the implementation of the REACT learning strategy has a significant effect on students' mathematical problem-solving abilities compared to conventional (expository) instruction, both overall (2-tailed p -value < 0.001 ; Cohen's $d = 1,84$) and for each Adversity Quotient (AQ) type namely, Climber ($d = 1,56$), Camper ($d = 2,64$), and Quitter ($d = 2,77$) all of which are classified as large effects.

The results of the two-way ANOVA test showed that the interaction between learning strategy and AQ type on mathematical problem-solving ability was not significant (Sig. = 0.338; $\eta_p^2 = 0.020$), so H_0 could not be rejected. This result does not imply that AQ type plays no role at all in moderating the effectiveness of the REACT strategy, but rather indicates that the REACT strategy's advantage in enhancing mathematical problem-solving ability is relatively consistent across all three AQ types. This interpretation must take into account the sample size in each factorial cell (17–20 students), which limits the test's sensitivity (power) to detect small- to moderate-sized interactions. Thus, the possibility of a more subtle AQ moderating effect cannot be entirely ruled out.

Overall, these findings reinforce that the REACT strategy is an effective learning approach that offers relatively equal benefits to students with varying AQ characteristics, in line with the spirit of the Merdeka Curriculum, which emphasizes student-centered and problem-solving-oriented learning. Further research with a larger sample size and a design that accounts for nested/multilevel data structures is recommended to confirm the consistency of these findings and to further examine the potential moderating role of AQ, which was not detected in this study.

RECOMMENDATION

Based on the research findings, the REACT strategy is recommended for wider application to various other mathematics topics, not limited to the volume of curved-sided three-dimensional shapes. This strategy can be integrated with deep learning, differentiated instruction, problem-based learning (PBL), and discovery learning to make the learning process more active, innovative, meaningful, and aligned with the characteristics and learning needs of students with various types of Adversity Quotient (AQ). To support effective implementation in the classroom, teacher training is necessary so that teachers can optimally apply the REACT strategy in their classrooms. Consequently, mathematics instruction is expected to become more enjoyable and engaging, with a focus on solving mathematical problems to improve student learning outcomes and critical thinking skills.

Future research is recommended to examine differences in mathematical problem-solving abilities across each AQ type in the experimental class to identify the AQ type that shows the greatest improvement in problem-solving ability after receiving instruction using the REACT strategy. Further research could also examine other variables that influence students' mathematical problem-solving abilities, such as self-efficacy or learning motivation. In addition, the use of a research design that accommodates nested/multilevel data structures, a larger sample size, and a longer study duration should be considered to obtain a more comprehensive picture of the effectiveness of the REACT strategy in improving students' mathematical problem-solving skills within a more diverse range of contexts and sample characteristics.

ACKNOWLEDGMENTS

The author would like to thank the supervisors and examiners at the master of Mathematics Education at Tadulako University who have been willing to provide direction, input, and discussion during the process of preparing the research until the publication of this manuscript. The author also expressed his appreciation and gratitude to the principal, mathematics teachers, and all grade IX junior high school students in Banawa District who have provided support and participation that greatly helped the research to be carried out well.

FUNDING INFORMATION

This research received no external funding.

AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Asisa	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	
Anggraini	✓	✓		✓	✓		✓			✓		✓		
Dasa Ismailmuza	✓	✓		✓	✓		✓			✓		✓		
Nurhayadi		✓		✓			✓			✓		✓		
Junaidi		✓		✓			✓			✓		✓		

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

This study was conducted in accordance with the ethical principles governing educational research involving human participants. The study complied with relevant institutional and national ethical guidelines.

DATA AVAILABILITY

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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