

Integration of Culturally Responsive Teaching and Augmented Reality to Improve Mathematics Learning Outcomes Based on Elementary School Students' Adversity Quotient

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Abstract

This study aims to analyze the mathematical problem-solving abilities of Indonesian School Students in Sekolah Indonesia Luar Negeri (SILN) located in Sabah-Sarawak, Malaysia based on Polya's theory, viewed through the lens of Pragmatic philosophy. This research method is qualitative. This study employed a descriptive qualitative approach to explore the learning difficulties faced by Indonesian School Students in Sekolah Indonesia Luar Negeri (SILN), particularly in the topic of Two-Variable Linear Equation Systems (SPLDV). According to Polya, effective problem-solving involves four stages: understanding the problem, devising a plan, carrying out the plan, and evaluating the solution. Meanwhile, Pragmatic philosophy emphasizes learning through real-life experiences, suggesting that students achieve meaningful mathematical understanding when they are able to solve problems encountered in their daily lives. The findings reveal that aligning mathematics instruction with students' everyday contexts in Sekolah Indonesia Luar Negeri (SILN) enhances their ability to solve mathematical problems effectively. As such, incorporating the principles of Pragmatic philosophy into mathematics education is essential to support and strengthen students' problem-solving skills.

Keywords: Mathematical problem solving ability, Polya's theory, Pragmatic philosophy school

Abstrak

Penelitian ini bertujuan untuk menganalisis kemampuan pemecahan masalah matematis siswa Sekolah Indonesia di Luar Negeri (SILN) yang berlokasi di Sabah-Sarawak, Malaysia, berdasarkan teori Polya dan ditinjau melalui perspektif filsafat Pragmatisme. Metode penelitian ini adalah kualitatif dengan pendekatan deskriptif kualitatif untuk mengeksplorasi kesulitan belajar yang dialami siswa SILN, khususnya pada materi Sistem Persamaan Linear Dua Variabel (SPLDV). Menurut Polya, pemecahan masalah yang efektif meliputi empat tahap, yaitu: memahami masalah, merencanakan penyelesaian, melaksanakan rencana, dan mengevaluasi hasil. Sementara itu, filsafat Pragmatisme menekankan pembelajaran melalui pengalaman nyata, yang mengisyaratkan bahwa siswa memperoleh pemahaman matematis yang bermakna ketika mampu menyelesaikan masalah yang ditemui dalam kehidupan sehari-hari. Hasil penelitian menunjukkan bahwa mengaitkan pembelajaran matematika dengan konteks keseharian siswa di SILN dapat meningkatkan kemampuan mereka dalam menyelesaikan masalah matematis secara efektif. Oleh karena itu, penerapan prinsip filsafat Pragmatisme dalam pembelajaran matematika penting untuk mendukung dan memperkuat kemampuan pemecahan masalah siswa.

Kata Kunci: kemampuan pemecahan masalah matematis, teori Polya, filsafat Pragmatisme

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INTRODUCTION

Mathematics is one of the core subjects in the basic education curriculum which plays a pivotal role in developing students' logical, critical and systematic thinking skills. However, empirical evidence suggests that elementary school students continue to exhibit relatively low performance in mathematics, particularly in the domains of conceptual understanding and problem-solving proficiency. Preliminary observational data collected from several elementary schools in the Ngrampal District of Sragen indicate that the majority of students experience significant difficulties in comprehending abstract mathematical concepts, including number operations, plane geometry, and measurement. These learning difficulties are further compounded by the limited diversity in instructional approaches employed by teachers, as well as the suboptimal integration of technology in supporting the teaching and learning process (Lestari & Kurniawan, 2020).

In addition to instructional methods, individual learner characteristics also play a critical role in determining academic success, with the Adversity Quotient (AQ) being one such influential factor. The Adversity Quotient (AQ) serves as an indicator of an individual's capacity to confront challenges, persevere through adverse conditions, and recover from setbacks or failures (Stoltz, 1997). Conversely, students with a low Adversity Quotient (AQ) are more likely to experience frustration and disengagement when confronted with academic challenges. Therefore, implementing instructional approaches that accommodate variations in students' AQ is essential to support optimal individual learning and development (Rahma & Fitria, 2021).

Culturally Responsive Teaching (CRT) is a culture-based instructional approach that can be effectively integrated across various subject areas. Culture plays a vital role in contemporary life, serving as a reflection of regional identity. Incorporating cultural elements into the learning process fosters deeper and more meaningful learning experiences. The CRT approach underscores the importance of connecting instructional content to students' cultural backgrounds. As noted by Gonzales and Ruiz (2021), CRT seeks to create an inclusive classroom environment in which students' lived experiences, values, and cultural identities are integral components of the learning process. Within the context of elementary education, this approach can enhance students' sense of connection to the subject matter and increase their motivation to learn (Wardani & Kurniawan, 2024).

In addition to the implementation of the Culturally Responsive Teaching (CRT) approach, contemporary education must also align with ongoing technological advancements, particularly in the integration of digital tools into the learning process. Augmented Reality (AR) is an emerging technology that merges the physical environment with virtual elements in an interactive, real-time format. In the context of mathematics education, AR has the potential to facilitate the visualization of abstract concepts, rendering them more concrete, engaging, and accessible for students (Putri & Wulandari, 2023). The integration of CRT and AR in mathematics instruction is anticipated to foster a learning environment that is contextual, adaptive, and enjoyable, thereby contributing to improved student learning outcomes.

Based on the description above, this study was conducted to examine the influence of the Culturally Responsive Teaching (CRT) approach based on Augmented Reality (AR) on the learning outcomes of elementary school students

from a perspective of Adversity Quotient.

This study is significant in offering both theoretical and practical contributions to the development of innovative instructional approaches that are aligned with students' Adversity Quotient (AQ) characteristics. Moreover, through the integration of cultural and technological pedagogies, mathematics instruction is expected to become more

effective, inclusive, and capable of fostering student resilience in the face of academic challenges.

METHOD

This study employs a quantitative approach utilizing a quasi-experimental research design, specifically a 3×3 factorial design (Sugiyono, 2019). The research involves three key variables: an independent variable, a dependent variable, and a moderator variable. The independent variable is the instructional approach implemented in the classroom. The dependent variable is students' learning outcomes, while the moderator variable is the Adversity Quotient (AQ), which is examined for its potential influence on the relationship between the instructional approach and learning outcomes.

The participants in this study consisted of approximately 67 sixth-grade students drawn from three elementary schools in the Ngrampal District of Sragen Regency: SDN Bener 2, SDN Pilangsari 3, and SDN Ngarum 1. The sampling technique employed was purposive sampling, based on the schools' and teachers' preparedness to implement technology- and culture-based instructional approaches. Students were assigned to one of three treatment groups: (1) instruction using the Culturally Responsive Teaching approach integrated with Augmented Reality (CRT-AR), (2) instruction using the CRT approach without technological integration, and (3) conventional (direct) instruction. Within each group, students were further categorized according to their Adversity Quotient (AQ) levels—namely climbers, campers, and quitters—based on the AQ classification model developed by Stoltz (1997), as measured through an AQ questionnaire.

The research instruments included an Adversity Quotient (AQ) questionnaire and a set of mathematics test items administered as both pre-test and post-test. The AQ questionnaire was adapted from the Stoltz (1997) model and modified to suit the developmental level of elementary school students, while the mathematics test consisted of descriptive items constructed based on the basic competency indicators outlined for sixth-grade mathematics (Kemendikbud, 2017). Data analysis was performed using a two-way Analysis of Variance (ANOVA) to examine the effects of the instructional approach, AQ levels, and their interaction on students' mathematics learning outcomes (Field, 2018).

RESULT AND DISCUSSION

A two-way Analysis of Variance (ANOVA) was employed to analyze the data. The findings from this analysis are summarized in Table 1.

Tabel 1 The Two-way Analysis of Variance (ANOVA)

	Source	SS	df	MS	F _{obs}	F _{table}	Test Decision
Quotient	Instructional Approach (A)	490,945	2	1626,442	22,097	3,14	H _{0A} rejected
	Adversity Quotient (B)	450,134	2	1491,241	20,260	3,14	H _{0B} rejected
	Interaction (AB)	123,360	4	204,339	2,776	2,52	H _{0AB} rejected
	Error	4637,130	63	73,605	-	-	-
	Total	11689,854	66	-	-	-	-

Based on the summary of the test results presented in Table 1, the following statement shows: 1) **Effect of Learning Approach (A)**: The calculated F-value (F_{obs}) was 22.097, while the F-table value was 3.14. Given the critical region df = {FIF > 3.14}, the null hypothesis H_{0A} is rejected. This result indicates that there is a statistically significant difference in mathematics learning.

2) **Effect of Adversity Quotient (B):** The observed F-value (F_{obs}) was 20.260, exceeding the F-table of 3.14. With a critical region $df = \{F|F > 3.14\}$, the null hypothesis H_{0B} is likewise rejected. This suggests that the levels of adversity quotient (climbers, campers, and quitters) have a significant impact on students' mathematics learning outcomes. 3) The interaction effect of the learning approach and adversity quotient (AB) yielded an F-table of 2.52 and a F_{obs} of 2.776, with a critical region $df = \{F|F > 2.52\}$, thus rejecting H_{0AB} . This indicates an interaction between the learning approach and adversity quotient on students' mathematics learning outcomes.

These findings demonstrate that the learning approach significantly influences students' mathematics learning outcomes. An interactive and engaging instructional strategy has the potential to enhance students' motivation and active participation in the learning process. Moreover, the integration of pedagogical methods with interactive technological tools can further facilitate a deeper understanding of mathematical concepts and promote more effective learning experiences (Putri & Wulandari, 2023; Nugroho & Dewi, 2022; Prasetyo & Purnamasari, 2023).

The *adversity quotient* (AQ), conceptualized as an individual's capacity to persevere through and effectively resolve challenges, has been identified as a significant factor influencing students' academic performance, particularly in mathematics. As mathematics often requires sustained cognitive effort and the ability to engage in complex problem-solving, students with higher levels of AQ are more likely to demonstrate resilience and persistence when encountering academic difficulties. Distinctions among AQ levels—namely, *climbers*, *campers*, and *quitters*—reflect varying degrees of problem-solving ability and adaptive response to adversity, which contribute differentially to learning outcomes. This is consistent with previous studies suggesting that resilience and the ability to cope with learning obstacles are closely associated with academic achievement (Muqtafa et al., 2023; Wicaksono & Lestari, 2020).

Furthermore, the findings reveal a significant interaction between the learning approach and adversity quotient (AQ) in influencing students' mathematics learning outcomes. This interaction suggests that these two variables are not only individually influential but also interdependent in shaping students' academic performance. Collectively, the results underscore the importance of both instructional strategies and students' personal resilience in enhancing mathematics achievement. In this context, the integration of culturally responsive pedagogy, digital learning technologies, and individual adaptive capacities—such as AQ—emerges as a critical consideration in the development of effective and contextually relevant mathematics instruction, particularly at the elementary school level.

Overall, the findings reinforce the proposition that both learning approaches and adversity quotient (AQ) significantly contribute to the enhancement of students' mathematics learning outcomes. These results highlight the necessity of a multifaceted instructional design that not only incorporates effective pedagogical strategies but also attends to learners' psychological resilience. In particular, the integration of cultural values, digital technologies, and individual adaptability represents a pivotal foundation for the development of adaptive and contextually responsive mathematics instruction in elementary education settings.

CONCLUSIONS

The results of this study demonstrate three key findings related to students' mathematics learning outcomes. First, significant differences were observed in learning outcomes based on the learning approach employed, indicating that the choice of instructional method has a measurable impact on student achievement in mathematics. Second, variations in students' adversity quotient (AQ) levels were found to significantly

influence their mathematics performance, suggesting that psychological resilience plays a critical role in academic success. Third, a significant interaction effect was identified between the learning approach and AQ levels, indicating that the effectiveness of a particular instructional method may depend on students' levels of resilience and adaptability. These findings underscore the importance of considering both pedagogical strategies and individual learner characteristics in the design of effective mathematics instruction.

The findings of this study confirm that both learning approaches and adversity quotient (AQ) significantly contribute to the enhancement of students' mathematics learning outcomes. The observed interaction between instructional methods and AQ levels highlights the importance of adopting adaptive and personalized strategies within mathematics education. These results suggest that elementary school educators should integrate innovative pedagogical approaches and interactive technologies to foster contextualized, engaging, and effective learning experiences. Additionally, students' AQ levels should be taken into account when designing instructional interventions, as individual resilience appears to influence learning effectiveness. Future research is warranted to examine the long-term implications of these approaches and to support the development of systematic, scalable, and pedagogically sound CRT-AR (Culturally Responsive Teaching–Augmented Reality) instructional tools for broader classroom implementation..

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