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THE EFFECT OF THE PROBLEM BASED LEARNING MODEL INTEGRATED WITH CULTURALLY RESPONSIVE TEACHING ON THE NUMERACY SKILLS AND MATHEMATICAL DISPOSITIONS

Ja'faruddin[1], Resky Fadila Amin[2], Awi Dassa[3]
Universitas Negeri Makassar [1,2,3]
Email: jafaruddin@unm.ac.id[1], reskyfadilaaa@gmail.com[2], awi.dassa@unm.ac.id[3]

Corresponding author: Ja'faruddin, **Email.** jafaruddin@unm.ac.id

Abstrak. Penelitian ini menganalisis efektivitas penerapan Culturally Responsive Teaching (CRT) pada Problem Based Learning dalam pembelajaran matematika di SMP Negeri 2 Takalar serta mengukur dampaknya terhadap kemampuan numerasi siswa dan disposisi matematis siswa. Jenis penelitian yang digunakan adalah pra eksperimen dengan desain one-group *pretest-posttest* pada 28 siswa kelas VIII, digunakan instrumen berupa tes numerasi, observasi, angket respons, dan disposisi matematis. Hasil menunjukkan penerapan CRT terlaksana baik melalui integrasi konteks budaya lokal, interaksi inklusif, dan partisipasi aktif siswa. Kemampuan numerasi meningkat signifikan, nilai posttest melampaui KKM, dan N-Gain berada pada kategori sedang hingga tinggi. Aktivitas siswa aktif, respons positif, serta disposisi matematis meningkat ke kategori sedang. Hasil tersebut menunjukkan bahwa penerapan CRT berkontribusi pada peningkatan numerasi siswa serta mendukung pembelajaran matematika yang lebih bermakna dan kontekstual berbasis budaya.

Kata Kunci: **Culturally Responsive Teaching, Problem Based Learning, pembelajaran matematika, kemampuan numerasi, disposisi matematis**

Abstract. This study analyzes the effectiveness of implementing Culturally Responsive Teaching (CRT) within a Problem Based Learning (PBL) framework in mathematics instruction at SMP Negeri 2 Takalar and examines its impact on students' numeracy skills and mathematical dispositions. This research employed a pre-experimental one-group pretest–posttest design involving 28 eighth-grade students, using numeracy tests, classroom observations, student response questionnaires, and mathematical disposition scales as instruments. The findings show that CRT was implemented effectively through the integration of local cultural contexts, inclusive interactions, and active student participation. Students' numeracy skills improved significantly, with posttest scores surpassing the Minimum Mastery Criteria (KKM) and N-Gain values falling within the medium to high categories. Student activity levels were categorized as active, responses were positive, and mathematical dispositions increased to the medium category. These results indicate that the application of CRT contributes to enhancing students' numeracy skills and supports mathematics learning that is more meaningful, contextual, and culturally grounded.

Keywords: **Culturally Responsive Teaching, Problem Based Learning, mathematics learning, numeracy skills, mathematical disposition**

A. Introduction

Students' numeracy skills in Indonesia remain a serious concern at both national and international levels. According to the latest PISA 2022 report, Indonesia ranked 71st out of 81 participating countries, with an average mathematics score of 366—significantly below the OECD average of 472 (OECD, 2023). The report also shows that only about 24% of Indonesian students achieved Level 2 proficiency or higher in mathematics, indicating persistent challenges in basic numeracy competencies. A national survey by the Ministry of Education and Culture in 2022 further revealed that only around 40.63% of students demonstrated numeracy

competence (Tanjung & Widodo, 2024). Major contributing factors include low learning motivation and limited learning resources (Tanjung & Widodo, 2024).

Other findings from the PISA 2022 report showed that Indonesia ranked 71st out of 81 countries, confirming that students' numeracy literacy remains low, with an average mathematics score of 366**,** far below the OECD average of 472 (OECD, 2023). Conceptual and procedural errors in solving numeracy problems are also cited as major causes of weak numeracy literacy (Muniri et al., 2023). ata from the 2021 National Assessment showed the average numeracy competence score at a lower–middle level, with Jakarta having the highest scores and North Maluku the lowest (Safari & Khasanah, 2023). Efforts to improve this condition are directed toward developing more effective teaching methods and enhancing educational facilities (Ati & Setiawan, 2020).

Mathematics plays an important role in daily life, yet many students struggle to apply its concepts practically. Students tend to perceive only basic mathematics as relevant, while more complex concepts are considered useless (Putranto & Ratnasari, 2022). Weak mathematical connections are evident in students' inability to represent real-life situations in graphs or mathematical models (Prihartiwi & Milla, 2024). Furthermore, the lack of practice in solving complex problems often leads students to guess solutions without proper procedures. Therefore, it is important for teachers to provide contextual learning experiences to make mathematics more meaningful (Prihartiwi & Milla, 2024).

A culturally relevant learning approach is one possible solution. Research indicates that teaching connected to culture, such as storytelling or the use of local contexts, helps students grasp abstract mathematical concepts (Abdulrahim & Orosco, 2020). This approach also creates inclusive learning environments, which are important for students from diverse cultural backgrounds (Abdulrahim & Orosco, 2020). Based on the 2023 Education Report, SMP Negeri 2 Takalar achieved a numeracy rate of 75.56%, meaning that the majority of students reached the standard. However, 24.44% of students had not achieved mastery. Furthermore, the quality of teaching was rated at a moderate level, with scores of 58.74 for teaching methods and 62.08 for psychological support out of 100. These findings suggest the need for a more humanistic, culturally relevant, and student-responsive teaching approach.

Culturally Responsive Teaching (CRT) is considered suitable because it connects learning materials with students' cultural backgrounds, builds personal connections, and enhances motivation. To support its application, a learning model emphasizing active involvement is needed, such as Problem Based Learning (PBL), which focuses on solving real-world problems. The integration of CRT and PBL allows students to make sense of mathematics concepts through their cultural lens (Kusdiana et al., 2021) and has been proven to improve numeracy skills, critical thinking (Mawadah et al., 2024), motivation, and self-confidence (Molita et al., 2024).

The novelty of this research lies in the integration of Culturally Responsive Teaching (CRT) with Problem Based Learning (PBL) in mathematics learning at the junior high school level, specifically in the local cultural context of Takalar Regency. Although the effectiveness of CRT and PBL has been widely examined separately, studies combining both approaches in Indonesian mathematics classrooms remain limited. Therefore, this study aims to describe the implementation of CRT within PBL in mathematics learning at SMP Negeri 2 Takalar and analyze its impact on students' numeracy skills..

B. Research Method

This study employed a pre-experimental design using one class as the experimental group. The treatment aimed to determine the effect of integrating the Problem Based Learning (PBL) model with Culturally Responsive Teaching (CRT) on students' numeracy skills in

mathematics learning. The research design used was a **One Group Pretest-Posttest Design**, illustrated as follows:

Table 1. One Group Pretest–Posttest Design

Pre-test	Treatment	Post-test
O_1	X	O_2

Source: (Sugiyono, 2013)

Explanation:

O_1 = Pretest: administered before treatment.

O_2 = Posttest: administered after treatment.

X = Treatment (X): mathematics learning integrating PBL–CRT.

The population of this study was all eighth-grade students of SMP Negeri 2 Takalar in the even semester of the 2024/2025 academic year, consist of 11 classes. The sampling technique used was Cluster Random Sampling, with one class selected as the research sample.

Data were collected through tests, observations, and questionnaires. The numeracy skills test was administered twice during the pretest and posttest to measure students' improvement after the implementation of the PBL–CRT based mathematics learning. Observations were conducted to assess the implementation of PBL syntax integrated with CRT principles and to monitor students' engagement during lessons. Questionnaires were used to obtain data on students' responses and mathematical dispositions, focusing on their perceptions of learning as well as their perseverance, curiosity, self-confidence, and responsibility in studying mathematics.

The effectiveness of the CRT intervention was evaluated based on three indicators: (1) improvement in numeracy performance (pretest–posttest gain, percentage of students meeting the minimum competency level), (2) the quality of the learning process (student activity, teacher performance, and students' responses), and (3) improvement in students' mathematical disposition. Numeracy skill was measured using four indicators adapted from PISA 2022: (1) formulating mathematical problems, (2) employing mathematical procedures, (3) interpreting mathematical results, and (4) applying mathematics in real-life contexts. Mathematical disposition was assessed using four dimensions: confidence, perseverance, interest in mathematics, and positive attitudes toward problem-solving (Grootenboer, 2021).

The data were analyzed using descriptive and inferential statistics. Descriptive analysis was employed to present the mean scores, percentages, and categories of pretest and posttest results, lesson implementation, student responses, and mathematical dispositions. Inferential analysis was conducted to test the research hypotheses. A normality test was first performed to verify data distribution, followed by a Paired Sample t-test to determine the significant difference between pretest and posttest numeracy scores. Additionally, a mastery learning proportion test was used to identify the percentage of students who met the Minimum Mastery Criterion (KKM) after the implementation of the PBL–CRT-based mathematics learning.

C. Result and Discussion

The learning process took place six meetings. In the first meeting, a pretest on numeracy skills was administered; the second to fifth meetings involved learning through the Problem Based Learning (PBL) model integrated with the principles of Culturally Responsive Teaching (CRT); and in the final meeting, a posttest on numeracy skills was conducted.

1. Descriptive Statistical Analysis

a. Implementation of Learning

The results of classroom observation on the implementation of learning in the experimental class using the Problem Based Learning (PBL) model integrated with the principles of Culturally Responsive Teaching (CRT) showed an average score of 3.67, categorized as Very Good. This indicates that the teacher was able to consistently integrate CRT principles into PBL. The learning activities encompass the explanation of learning objectives and the incorporation of local cultural context, distribution of student worksheets, roblem-solving discussions, presentation of results, collective reflection, and closing. The increasing implementation score aligned with the heightened student engagement in each meeting.

b. Numeracy Skills

Tabel 2. Descriptive Statistics of Pretest Scores

Statistic	Value	
	Pretest	Posttest
Sample Size	29.0	29.0
Ideal Score	100	100.0
Highest Score	85.0	94.0
Lowest Score	36.0	78.0
Median	56.0	91.0
Mean	57.6	87.5
Standard Deviation	15.48	5.05
Variance	239.61	25.54
Range	49.0	16
Coefficient of Variation	26.88%	5.77%

The pretest results (Table 2) show an average score of 57.6, with the highest score being 85 and the lowest 36. The majority of students (73%) were in the "Low" category, with only about 27.6% of students meeting the Minimum Competence Criteria (KKM). This reflects that, prior to the intervention, students' numeracy skills were generally weak. The posttest results (Table 2) showed a significant improvement: the mean score rose to 87.5, with the highest score of 94 and the lowest of 78, while the standard deviation decreased to 5.05. This suggests that students' performance became not only higher but also more evenly distributed.

Tabel 3. Frequency Distribution and Percentage of Posttest Scores

Interval	Category	Frequency	Percentage (%)
91 – 100	Excellent	15	52
83 – 90	Good	10	34
75 – 82	Fair	4	14
0 – 74	Poor	0	0
Total		29	100

The distribution (Table 3) shifted positively, with 52% of students categorized as Excellent, 34% as Good, 14% as Fair, and 0% as Poor. This indicates that all students met the KKM, with the majority in the higher achievement categories.

Table 4. Classification of Normalized Gain (N-Gain)

N-Gain	Category	Frequency	Percentage
$N\text{-}Gain \geq 0{,}7$	High	19	66%
$0{,}3 < N\text{-}Gain < 0{,}7$	Medium	9	31%
$N\text{-}Gain \leq 0{,}3$	Low	1	3%

The normalized gain analysis (Table 4) shows that most students experienced medium to high improvement. These results reflect a substantial increase in students' numeracy performance across the class. In addition, students showed improvement across the four PISA numeracy indicators—formulating problems, applying mathematical procedures, interpreting results, and connecting solutions to real-life contexts. This improvement was supported by the use of culturally familiar examples from Takalar, which made the mathematical tasks more meaningful and easier to understand. These results are consistent with the characteristics of PBL, which emphasizes solving real-life problems, and CRT, which emphasizes cultural contexts—both of which made it easier for students to grasp numeracy concepts.

c. Student Activities

Observations of student activity over four meetings showed a consistent increase. Student engagement rose from 77% (active) in the first meeting to 90% (very active) in the second and third meetings, and further to 96% (very active) in the fourth meeting. This indicates that the implementation of the CRT approach successfully fostered students' participation, collaboration, and enthusiasm in connecting mathematical concepts with their cultural context. Thus, CRT-based learning proved effective in enhancing students' responses, mathematical dispositions, and overall learning activity.

d. Students Responses

The results showed that students' responses were in the "very positive" category, with an average score of 85%. Six aspects were classified as very positive, indicating that learning which connects mathematical concepts with cultural contexts effectively enhanced students' understanding and engagement. The remaining four aspects were categorized as positive, still reflecting a high level of appreciation toward the learning process. Overall, these findings confirm that the CRT approach was well received and successfully created a learning experience that is relevant, inclusive, and meaningful.

e. Mathematical disposition

Students' mathematical dispositions were measured across fifteen aspects, including confidence, perseverance, interest, curiosity, and views on the relevance of mathematics. The average score reached 3.65 or 74%, which is classified as high category. Ten aspects were classified as high, while five were in the moderate category. Improvements were observed across key disposition indicators—confidence, perseverance, interest, and positive attitudes toward problem-solving. These gains were supported by the application of CRT, which made the learning materials culturally familiar and personally meaningful, thereby increasing students' motivation and engagement. These results indicate that the CRT approach fostered positive attitudes, confidence, and students' interest in mathematics, although certain aspects—such as perseverance in solving difficult problems—still need further reinforcement.

2. Inferential Statistical Analysis

Table 5. Normality Test for Pretest and Posttest

	Shapiro-Wilk Statistic	df	Sig.
Pretest Numeracy Skills	0.977	29	0.746
Posttest Numeracy Skills	0.972	29	0.627

Table 6. Hypothesis Testing Results (Posttest) One-Sample Statistics

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper

Nilai Posttest	12.046	28	.000	12.897	10.70	15.09

The paired t-test results showed a significant difference between the pretest and posttest scores. This indicates that the application of CRT–PBL learning was effective in improving students' numeracy skills. Furthermore, classical mastery was achieved with a percentage exceeding the minimum threshold set.

The increase in numeracy skills aligns with (Gay, 2010) who argues that culturally responsive teaching enhances student engagement, active participation, and conceptual understanding by linking content to cultural contexts. Similarly, N. Abdulrahim & Orosco, (2019) mphasized that culturally based instructional strategies help students comprehend abstract concepts more easily while creating an inclusive learning environment.

The average student scores showed substantial improvement, with N-Gain classified as medium to high. This demonstrates that the intervention influenced not only final outcomes but also the developmental process of students' skills. These findings are consistent with (Hammond, 2015) who noted that culturally based approaches strengthen learning motivation through connections with students' daily experiences.

Moreover, learning activities improved from active to very active. Students' responses toward learning were positive, and their mathematical dispositions showed an upward trend. This condition reflects (Ladson-Billings, 2021) theory that culturally responsive teaching fosters inclusion and equitable participation in classrooms. In agreement with, Rahmah et al., (2023) also confirmed that CRT implementation can enhance both student activity and mathematics learning outcomes.

Thus, this research reinforces the theoretical foundation that integrating Culturally Responsive Teaching within Problem Based Learning provides contextual, inclusive, and meaningful learning experiences. This combination positively impacts numeracy skills while simultaneously improving students' activities, responses, and mathematical dispositions in mathematics instruction.

D. Conclutions

Students' numeracy skills improved significantly after participating in CRT–PBL-based learning. This improvement was evident from the upward shift in learning achievement categories and the attainment of complete mastery across the class. The increase was measured using a numeracy test administered in a one-group pretest–posttest design**,** with the results analyzed through N-Gain scores, which indicated a medium to high level of improvement. In addition, non-cognitive development was observed through multiple instruments**:** student activity sheets showed a steady increase in activeness across meetings until reaching the "Very Active" category; response questionnaires revealed positive attitudes toward the learning process; and mathematical disposition scales demonstrated gains in confidence, persistence, and appreciation of mathematics. These findings indicate that integrating CRT into PBL is effective not only in improving numeracy skills but also in fostering students' attitudes, engagement, and confidence in learning mathematics. Inferential analysis showed that both pretest and posttest data were normally distributed, allowing the use of parametric tests. The paired t-test revealed a significant difference between pretest and posttest scores, indicating that CRT–PBL learning had a real effect on enhancing students' numeracy skills. Furthermore, the proportion test showed that classical mastery exceeded the minimum threshold, confirming the effectiveness of this learning model.

Therefore, the integration of Culturally Responsive Teaching within Problem Based Learning is proven to be effective in improving the numeracy skills, activities, responses, and mathematical dispositions of junior high school students. The learning is considered effective because several criteria were met: students' posttest scores exceeded the minimum mastery

criterion and showed medium to high N-Gain values, classroom observations indicated that student activities consistently increased until reaching the "Very Active" category, response questionnaires revealed positive attitudes toward the learning process, and mathematical disposition scales demonstrated improvements in students' confidence, persistence, and appreciation of mathematics.

E. Suggestion

Mathematics teachers are encouraged to integrate Culturally Responsive Teaching (CRT) into Problem Based Learning (PBL) by utilizing local cultural contexts to make learning more meaningful and improve numeracy. Schools and policymakers should support the implementation of CRT–PBL through teacher training and the provision of culturally based learning resources. Future studies may employ experimental designs with control groups and explore mathematical dispositions in greater depth across specific indicators.

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