



eISSN : 3030-5543

The 16th Regional Symposium of The Malay Archipelago

16TH SIMPORA

International Conference

Religion, Traditions and Local Wisdom

Proceedings International SYMPOSIUM NUSANTARA

Organised by:

Centre for Knowledge and Understanding of Tropical Architectural and Interior (KUTAI)
Universiti Teknologi MARA Perak Branch
Seri Iskandar Campus, Perak, MALAYSIA



**PROCEEDINGS OF THE 16TH REGIONAL
SYMPOSIUM OF THE MALAY ARCHIPELAGO
SIMPORA XVI: 2025**

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Seri Iskandar Campus, Perak, MALAYSIA

Diterbitkan oleh:

Unit Penerbitan UiTM Perak

Alamat:

Unit Penerbitan UiTM Perak,
Pejabat Jaringan Industri, Masyarakat dan Alumni (PJIMA)
Universiti Teknologi MARA, Perak Branch,
32610 Seri Iskandar Perak, Malaysia.

05-3742716

uitmperakpress@gmail.com

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Perpustakaan Negara Malaysia

Cataloguing in Publication Data

No e- ISSN: 3030-5543

Cover Design: Richard Mareno

Typesetting : Dr Nur Huzeima Mohd Hussain

Dr Wan Faida Binti Wan Mohd Azmi

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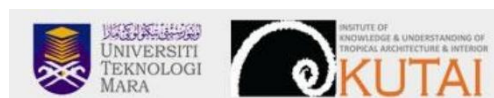
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RME AND FOLKLORE: A LOCAL CULTURE-BASED MATHEMATICS LEARNING STRATEGY TO IMPROVE CONCEPTUAL UNDERSTANDING AND PROBLEM-SOLVING SKILLS

Rahmi Hayati^{1*}, Edi Syahputra², Edy Surya³

¹Universitas Almuslim

^{2,3}Universitas Negeri Medan

Corresponding Author: hayatirahmi027@gmail.com *

Abstract: This study aims to develop and test the effectiveness of Realistic Mathematics Education (RME)-based mathematics learning tools integrated with the context of Acehese folklore in improving elementary school students' conceptual understanding and problem-solving abilities. The study used a research and development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. The effectiveness test was conducted through a quasi-experimental design with a nonequivalent control group design in two fifth-grade elementary schools, involving an experimental group ($n = 29$) and a control group ($n = 31$). The research instruments included an expert validation sheet, an implementation observation sheet, a practicality questionnaire, a mathematical concept understanding test, and a problem-solving ability test based on Polya's four stages. The results showed that the folklore-based learning tools had very high validity (mean content score 4.67; construction 4.50; cultural relevance 4.83) and high practicality (90.2%). Quantitative analysis showed a significant increase in the experimental group, with an N-Gain score of 0.65 (high category) compared to the control group's 0.37 (medium category), with a significant difference ($t(58) = 3.72$; $p < 0.001$; Cohen's $d = 0.87$). Students' problem-solving abilities in understanding the problem, designing a strategy, implementing a plan, and reviewing also improved significantly ($p < 0.01$). Qualitative data from observations and interviews confirmed increased student engagement, motivation, and cultural resonance in learning. These findings indicate that the integration of folklore within the RME framework not only improves cognitive achievement but also strengthens students' cultural identity and makes learning more meaningful and contextual.

Keywords: Realistic Mathematics Education, folklore, conceptual understanding, problem solving, elementary school.

INTRODUCTION

Mathematics education in elementary schools essentially aims not only to instill numeracy skills but also to develop strong conceptual understanding and problem-solving skills from an early age. However, a major challenge faced in various Indonesian educational contexts is the low level of student engagement in the mathematics learning process, which directly impacts their conceptual understanding and problem-solving skills. Many students struggle to connect

mathematical concepts to the realities of everyday life, ultimately hindering the development of their reasoning and reflective thinking. The low results of national and international assessments such as PISA reflect this phenomenon: students are able to answer procedural questions, but fail on context-based questions that require reasoning, in-depth understanding, and problem-solving strategies.

This phenomenon is inseparable from the predominantly expository and textbook-centered learning approach. Teachers tend to use procedural and algorithmic approaches to teaching mathematics without connecting concepts to students' real-world experiences. This approach ignores the diversity of students' cultural backgrounds and local experiences, which could actually offer pedagogical potential for bridging mathematical abstractions with the real world. In the Indonesian context, rich in local culture, folktales, as narrative expressions of local wisdom, have great potential as authentic contexts for mathematics learning. Unfortunately, this potential has not been systematically utilized in the curriculum or in teaching practice.

Theoretically, Realistic Mathematics Education offers a solution to this problem. Realistic Mathematics Education (RME) is an approach developed by the Freudenthal Institute that emphasizes the importance of connecting mathematical concepts to students' real-world contexts through contextual activities and modeling. The principles of guided reinvention and progressive mathematization in RME enable students to gradually develop conceptual understanding from concrete contexts to more formal forms. However, most RME implementations in Indonesia still use generic contexts such as "buying apples at the market" or "calculating the length of a fence," which lack cultural meaning for students. In fact, the use of contexts rooted in local culture, such as folk tales, can strengthen the relevance of the context to students' identities and experiences.

The theoretical gap lies in the lack of in-depth elaboration on the integration of folktales into the RME progression scheme. Although RME accommodates realistic contexts, few studies have explicitly addressed how the narrative structure of folktales can function as a source of complex and meaningful mathematical situations. Folktales, with their plot, conflict, and resolution structures, hold significant potential as sources of mathematical problems that can be modeled in RME scenarios. Furthermore, folktales also contain moral, social, and ecological dimensions that enable the development of holistic mathematical literacy, encompassing not only cognitive but also affective and cultural values.

Several studies have demonstrated the effectiveness of RME in improving conceptual understanding and problem-solving skills, but the majority of these studies are generic and have not systematically integrated local cultural values. Meanwhile, studies that address the integration of local culture into mathematics learning are generally descriptive and place little emphasis on measuring conceptual understanding and problem-solving skills in a structured manner based on quantitative and qualitative data. Little research has explicitly examined how folktales can serve as a vehicle for contextualizing and modeling mathematics within a coherent RME framework. In addition, there are still very few studies that develop RME learning tools based on folk tales that are empirically validated in improving elementary school students' mathematics learning outcomes.

In this context, this research offers novelty both theoretically and practically. The main novelty lies in the integration of two pedagogical domains that have previously operated separately: RME as a mathematical cognition-based approach and folklore as a narrative-based local cultural heritage. By positioning folklore as a realistic context in RME learning design, this approach enables the creation of authentic, meaningful, and value-laden learning experiences. This approach not only connects mathematics to students' real-world experiences but also strengthens local cultural identities and makes learning more inclusive and relevant. In addition, this research develops learning tools in the form of modules, Student Worksheets, and assessment instruments based on local folklore that are contextually selected according to the students' cultural environment.

The purpose of this research is to develop and test the effectiveness of an RME-based mathematics learning strategy that uses folktales as context, in order to improve elementary school students' conceptual understanding and problem-solving skills. By combining the RME approach and the richness of local folktale narratives, this study is expected to contribute to the development of pedagogical strategies that are more contextual, humanistic, and rooted in local values. In the long term, this approach can also serve as a foundation for the development of a culture-based mathematics curriculum, while simultaneously addressing the global challenge of shaping a generation of learners who are not only cognitively competent but also possess a strong sense of identity and socio-cultural values. Such mathematics education will be better able to address the complexities of the real world and prepare students to face the challenges of the times with reflective, creative, and contextual thinking.

METHODOLOGY

This study employed a research and development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model to produce a Realistic Mathematics Education (RME)-based mathematics learning tool integrated with the context of local folklore. Effectiveness testing was conducted through a quasi-experimental design with a nonequivalent control group design in two fifth-grade elementary schools.

The study subjects consisted of two groups: an experimental group ($n = 29$) using the RME-folklore-based learning tool, and a control group ($n = 31$) using a conventional approach. The instruments used included an expert validation sheet, an implementation observation sheet, a practicality questionnaire, a mathematical concept understanding test, and a problem-solving ability test based on Polya's four stages. Quantitative data were analyzed using the N-Gain Score, an independent t-test, and Cohen's d calculations to measure learning effects. Qualitative data were obtained through observations and interviews and analyzed descriptively to corroborate the numerical findings. Validation was conducted by three experts, and limited implementation was conducted to assess the implementation and practicality of the tool before testing its effectiveness.

RESULTS AND DISCUSSION

4.1 Development of Local-Culture-Based RME Learning Devices

The learning package was developed following the ADDIE model. The analysis phase involved a needs assessment in two elementary schools in Aceh. Interviews with five mathematics teachers and focus group discussions with students revealed that while RME principles were appreciated, existing materials lacked contextual relevance to the students' cultural background. Teachers expressed a need for culturally embedded content that could increase student motivation and engagement.

Based on these findings, three culturally rooted folktales were selected: *Putroe Neng*, *Banta Seudang*, and *Si Meuseukat*. Each folktale was analyzed for embedded mathematical situations, such as patterns, measurements, and proportional reasoning. From this, lesson scenarios were designed for topics including fractions, geometry, and problem solving.

The **validation stage** involved three expert reviewers (mathematics educator, instructional designer, and cultural expert). The validity scores, based on a 5-point Likert scale rubric, showed:

Content validity: 4.67 (Very Valid)

Construct validity: 4.50 (Very Valid)

Cultural relevance: 4.83 (Very Valid)

The **device's practicality** was measured during a limited trial. Teachers rated the device with a practicality score of 90.2% (Very Practical), citing ease of use, contextual clarity, and student engagement. Observation data showed that the device was implemented with a procedural fidelity of 95% across three observed sessions.

4.2 Improvement in Conceptual Understanding

Quantitative data were collected from two intact groups of fifth-grade students: the **experimental group** (n = 29), which received RME-based instruction using folktales, and the **control group** (n = 31), which received conventional instruction using the school's textbook. Both groups were pretested and posttested using a validated **Mathematics Conceptual Understanding Test** (MCUT) comprising 15 items.

Table 1: Descriptive Statistics

Group	Pretest Mean	Posttest Mean	N-Gain	Category
Experimental	52.41	83.21	0.65	High
Control	51.89	69.76	0.37	Medium

Inferential Statistics

An independent samples t-test on N-Gain scores yielded:

- $t(58) = 3.72, p < 0.001$, indicating a significant difference.
- **Cohen's d = 0.87**, representing a **large effect size**.

These findings demonstrate that the use of RME with folktale-based contexts significantly improved students' understanding of mathematical concepts, especially in abstracting relationships from contextual stories.

4.3 Enhancement of Problem-Solving Ability

A separate instrument, the **Mathematical Problem-Solving Test (MPST)**, was administered. The MPST included four open-ended problems derived from the cultural contexts used in class. Scoring criteria followed Polya's four-step problem-solving model.

Table 2: Inferential Statistics

Aspect	Experimental (M ± SD)	Control (M ± SD)	p-value
Understanding the Problem	3.71 ± 0.41	2.85 ± 0.56	0.002
Devising a Plan	3.64 ± 0.49	2.61 ± 0.61	0.001
Carrying Out the Plan	3.53 ± 0.52	2.71 ± 0.59	0.005
Looking Back	3.42 ± 0.46	2.35 ± 0.62	0.000

Multivariate analysis (MANOVA) confirmed the significance across all aspects (**Wilks' Lambda = 0.61, F(4, 55) = 8.88, p < 0.001**). Students in the experimental group showed stronger metacognitive awareness and contextual reasoning. For instance, when solving a ratio

problem based on a scene in *Banta Seudang*, students effectively interpreted the character's food-sharing actions into proportional reasoning equations.

4.4 Qualitative Insights: Engagement and Cultural Resonance

Post-intervention interviews with 10 students revealed enhanced enthusiasm and perceived relevance of math:

"Belajar matematika lewat cerita rakyat seperti Putroe Neng itu menyenangkan, karena saya merasa seperti ikut dalam cerita. Jadi saya lebih mengerti soal perbandingan dan luas." (S5, Female)

Teacher reflections emphasized shifts in student behavior:

"Siswa yang biasanya pasif, menjadi aktif bertanya dan berdiskusi. Mereka bahkan bercerita ulang kisahnya sambil memodelkan soalnya di papan." (T2, Math Teacher)

Classroom observations recorded through video analysis showed high levels of **student agency**, **collaborative modeling**, and **problem posing**, confirming the alignment with the *guided reinvention* principle in RME.

DISCUSSION

The results of this study indicate that the Realistic Mathematics Education (RME)-based mathematics learning tool, developed by integrating the context of local folklore, significantly impacts elementary school students' conceptual understanding and problem-solving skills. This effectiveness is not only evident in quantitative outcomes such as posttest scores and gain scores, but also reflected in student engagement, contextual understanding, and positive responses to the overall learning process.

During the tool validation process, three experts gave very high scores for the content, construction, and local cultural appropriateness aspects. Content validity, with an average score of 4.67, indicates that the learning materials and activities align with curriculum requirements and learning indicators and accommodate competency-based learning outcomes. Construct validity, with a score of 4.50, indicates that the tool has a logical and systematic structure, and is easy for teachers and students to understand and implement. Most striking is the local cultural appropriateness, with an average score of 4.83, indicating that the use of folklore as a learning context truly reflects real life and local values familiar to students. Stories such as Putroe Neng, Banta Seudang, and Si Meuseukat not only function as narrative material, but also as a living didactical context, forming a bridge between students' real world and mathematical abstraction.

The developed tool was then tested on the experimental group and compared with the control group using conventional learning. The results of the effectiveness test showed a significant increase in understanding of mathematical concepts. The experimental group showed an N-

Gain value of 0.65 (high category), while the control group only achieved 0.37 (medium category). This difference was confirmed by the results of the t-test which showed statistical significance ($p < 0.01$), meaning that the folklore-based RME approach was more effective than conventional methods in improving students' conceptual understanding. This reflects that presenting material in a meaningful context close to students' experiences can strengthen the construction of deeper knowledge, in line with the principle of progressive mathematization in RME, where students build understanding from the concrete to the abstract through active engagement in familiar contexts.

The impact of learning is also evident in students' problem-solving abilities. Measurements based on Polya's four stages—understanding the problem, designing a strategy, implementing the strategy, and reviewing the solution—showed that students in the experimental group experienced significant improvements in all of these aspects compared to the control group. The ability to understand and formulate problems improved because students were accustomed to reading situations in narrative form that contained conflict or mathematical events. The folktales presented in the learning became a medium to train students to interpret real-world situations into mathematical language, in accordance with the concept of didactical phenomenology in RME. Students no longer viewed mathematics as merely a collection of numbers and symbols, but as a tool for understanding and solving problems around them, including those contained in cultural stories passed down through generations.

These results are supported by the effect size calculation using Cohen's d , which showed a value of 0.87. This value is considered large, indicating that the treatment's effect on improving learning outcomes is very strong and practically meaningful. This means that the applied learning approach not only significantly improves students' scores but also has a tangible impact on their thinking and understanding. This effect cannot be achieved through a purely mechanistic or algorithmic approach, but rather requires a learning experience that integrates students' cognitive, affective, and socio-cultural aspects. In this regard, the folklore-based RME tool meets this need very well.

In addition to quantitative data, interviews and classroom observations showed that students in the experimental group demonstrated high enthusiasm, active engagement, and developed reflective skills. They felt personally involved with the stories used, even creating mathematical problems based on familiar folktales. Teachers implementing the tool stated that the classroom atmosphere became more lively, discussions were dynamic, and students demonstrated courage in expressing ideas and solving problems collaboratively. These findings reinforce the theory of social constructivism, which emphasizes the importance of social and cultural context in the learning process. Folktales not only serve as a medium for cultural literacy but also serve as a foundation for developing contextual numeracy literacy.

Compared to previous studies, this study's main contribution lies in the systematic integration of the RME approach and local wisdom in the form of folktales. Previous studies have largely separated contextual learning approaches from local cultural content, or merely used culture as a backdrop for stories without fully integrating it into mathematical schemes. This study demonstrates that folktales are not only suitable as reading material or extracurricular activities but also possess rich narrative structures and mathematical potential to be utilized

in formal learning. Thus, this approach fills a gap in the literature that has not yet made local culture the foundation of contextual and systematic mathematical didactic models.

The implications of this research are far-reaching. Theoretically, these results support the development of a curriculum that integrates local culture into mathematics learning based on a realistic approach. This approach can bridge the gap between the formal school context and the realities of students' lives. Practically, the developed tools can be replicated in other regions by adapting the folklore of each region. Aceh has thousands of folktales whose mathematical potential has not been explored; as do other regions in Indonesia such as Bali, Kalimantan, or Papua. Further research can expand the scope of contexts and explore the development of tools in digital formats for use in hybrid or technology-based learning.

However, this study also has limitations. The limited scope of the trial to two schools in an urban area limits the generalizability of the results. The characteristics of students in rural areas, 3T (underdeveloped, frontier, outermost) areas, or multiethnic environments may create different dynamics in implementation. Furthermore, although this tool has been effective in improving students' cognitive outcomes, this study has not yet thoroughly assessed its impact on the formation of character values such as honesty, cooperation, and respect for cultural heritage, which are deeply embedded in folklore narratives. Longitudinal studies could be conducted to observe the long-term impact on character formation and cultural literacy.

Considering its strengths and limitations, the RME-based and folklore-based learning approach can be concluded as an innovative and relevant strategy in addressing the challenges of mathematics education in the current era. When the challenges of globalization demand increased competitiveness and numeracy literacy of students, but at the same time there is a degradation of local cultural values, this approach presents a strategic synthesis: building competency through one's own cultural roots. This is the essence of contextual and transformative education—which not only makes students competent in mathematics, but also makes them human beings who are rooted and reasoning in their own world.

CONCLUSIONS

Folklore-based learning not only serves as a realistic context but also as a vehicle for internalizing cultural values, strengthening local identity, and facilitating dialogue between students' real-world experiences and abstract mathematical concepts. Local narratives familiar to students have been shown to stimulate conceptual exploration, foster reflection, and foster a deeper understanding of the material.

Theoretically, this research expands the scope of the RME approach by incorporating cultural elements as an integral part of the didactic model. This emphasizes that reality in RME is not solely physical or practical, but can also be symbolic and narrative, as long as it mediates between concrete experiences and mathematical abstractions. In the context of multicultural education, this approach is highly relevant for developing learning that is not only cognitive, but also affective and sociocultural.

Practically, the developed tools can be used by teachers as innovative learning models aligned with local characteristics and the principles of the Independent Curriculum. Teachers in various regions can adapt by using folklore from their respective regions as contextual development materials. This opens up opportunities for the development of a culture-based curriculum that is not only thematic but also structural in its learning approach.

From a policy perspective, this study recommends that the development of local wisdom-based learning tools be systematically incorporated into learning planning at the school and regional levels. Local governments, education offices, and curriculum centers can encourage the integration of folklore into teaching materials, textbooks, and digital platforms. This is crucial to ensure that the preservation of local culture goes hand in hand with improving the quality of education.

Further implications also include the need to develop teacher training that equips them with the skills to incorporate cultural context into mathematics learning activities. Furthermore, similar research can be expanded to other levels and subjects to build a comprehensive and sustainable framework for culture-based learning.

Thus, a mathematics learning approach based on RME and folklore offers a pedagogical solution that meets the needs of the times: building 21st-century competencies without abandoning local cultural roots. This strategy not only strengthens student learning outcomes but also fosters meaningfulness, engagement, and a sense of identity, which are essential foundations for lifelong learning.

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SIMPORA XVI : 2025