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Cultural Values and Their Role in Shaping the Adaptation of Realistic Mathematics Education (RME) in Indonesia

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ABSTRACT

Purpose of the study: The main objective of the study is to analyze how cultural factors influence the implementation of RME in the context of mathematics education in Indonesia.

Methodology: The method used is a qualitative study employing content/document analysis of curriculum guidelines and instructional materials. Additionally, semi-structured interviews were conducted with six educators, and non-participant observations were carried out in three schools to examine the implementation of Realistic Mathematics Education.

Main Findings: The results show that DWiG and PMRI textbooks present more contextual questions (38% and 22%) compared to BSE (15%), while BSE is dominated by plain number questions (85%). In terms of learning facilitators, both DWiG and PMRI demonstrate the use of context, models, and student independent production, while BSE does not involve student independent production.

Novelty/Originality of this study: The novelty of this research lies in the in-depth analysis of the interaction between RME principles and Indonesian cultural characteristics, providing new insights into the development of more contextual and effective mathematics learning strategies.

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1. INTRODUCTION

As a result of globalization and in efforts to modernize and improve educational systems, policymakers and educators across the globe often look beyond their borders for educational theories and approaches deemed successful in other countries [1]-[3]. This trend has become increasingly prominent with the rise of international large-scale assessments such as TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment) [4]-[6]. Countries with lower performance scores often emulate top-performing nations in hopes of achieving similar outcomes [7]- [9] . Others, however, continue to look towards their former colonizers, due to enduring postcolonial influences within their educational bureaucracies.

This practice of educational borrowing, however, carries significant risks. Scholars have cautioned against the uncritical transfer of educational models, emphasizing the dangers of false universalism—the assumption that educational practices are universally applicable, regardless of cultural or contextual differences [10]-[12]. Even when a borrowing country appears structurally or economically ready, cultural mismatches may emerge and hinder the successful implementation of foreign methods [13]-[15]. For instance, in Israel, the adoption

of Cooperative Learning a method rooted in American educational culture encountered barriers due to contrasting values such as individualism and classroom competitiveness [16]-[18].

Similar mismatches have been documented elsewhere. In Japan, the integration of Western problem-based learning models clashed with deeply rooted traditions of teacher-led instruction and collectivist values [19]-[21]. In South Africa, post-apartheid curriculum reforms that drew on Western progressive education ideals struggled against longstanding inequalities and resource disparities. These cases further demonstrate that borrowing educational models across diverse cultural contexts can result in unintended outcomes and adaptations that deviate from the original framework.

The risk of false universalism becomes even more complex in mathematics education, which is often erroneously regarded as culturally neutral or universally applicable [22]. The assumption that "math is the same everywhere" overlooks the culturally embedded ways in which mathematics is taught, learned, and valued. In the context of Indonesia, a postcolonial nation with a long history of Dutch educational influence, these issues are particularly salient. As reflected in the 2018 PISA results, Indonesian students scored an average of 379 in mathematics, compared to the Netherlands' 519—highlighting a performance gap of 140 points. This substantial difference raises important questions about the compatibility of educational methods and the local contexts in which they are applied.

Several previous studies have highlighted the successes and challenges of implementing Realistic Mathematics Education (RME) in various countries, including Indonesia. Research by Azmi [23] showed that the contextual approach in PMRI was able to increase students' engagement and understanding of mathematical concepts in a meaningful way. Emphasized that the principles of RME, such as the mathematization process and the use of real contexts, have been translated into classroom practices in Indonesia through textbooks and teacher training [24]. However, various studies also reported cultural and pedagogical challenges that hindered the overall implementation of this approach, such as the tendency of teachers to continue using direct instruction methods and orientation to exam results [15]. On the other hand, there has not been much research that systematically compares the integrity of RME principles in curriculum materials and learning practices in Indonesia with their original implementation in the Netherlands, especially in terms of task preparation, teacher roles, and learning facilitators.

This study has a novelty by presenting a cross-cultural comparative analysis of the implementation of RME between Indonesia and the Netherlands from the perspective of curriculum design, open materials, and pedagogical practices. Different from previous studies that tend to focus on the effectiveness of learning or teacher perceptions, this study combines the approaches of textbook content analysis, classroom practice observations, and mapping of teacher beliefs in understanding the essence of RME [25]-[27]. By involving researchers who have direct experience in RME training in the Netherlands, this study also provides a more reflective internal perspective on the adoption and adaptation process [28], [29]. Another novelty lies in the cultural approach used as an interpretive framework, allowing for a deeper understanding of the local dynamics in adopting foreign pedagogical approaches in a postcolonial country like Indonesia.

The researcher, a member of the 2010 PMRI cohort trained in the Netherlands, aims to identify which elements of RME are effectively integrated into Indonesia's mathematics education system, and which elements are transformed or resisted due to cultural differences. This research focuses on analyzing consistency between RME principles and the (1) exemplary curriculum materials, (2) teacher beliefs, and (3) classroom instructional practices in Indonesia, with comparative insights drawn from the Netherlands as a reference. Considering the significant cultural divergence between Indonesia and the Netherlands, this study takes a cultural lens to interpret the local implementation of RME. The findings aim not only to evaluate the feasibility of educational borrowing but also to contribute to the broader discourse on the localization of educational reforms in postcolonial contexts.

2. RESEARCH METHOD

This study used a mixed methods approach with a sequential explanatory design. This approach was chosen because it allows researchers to combine the strengths of quantitative and qualitative data sequentially, so that the results of one method can strengthen and explain the findings of the other method [30]-[33]. The first stage was carried out with a quantitative survey using a questionnaire to determine teachers' attitudes towards the Realistic Mathematics Education (RME) approach, followed by a qualitative stage involving classroom observations, in-depth interviews, and analysis of curriculum documents and textbooks. Triangulation strategies were also applied to increase the validity and reliability of the findings [34]-[36]. The subjects of this study consisted of elementary school mathematics teachers in Central Java who had implemented the PMRI (Indonesian Realistic Mathematics Education) approach, as an adaptation of the RME approach in Indonesia. In addition, classroom observations and interviews were also conducted in several elementary schools in Central Java, Indonesia, to identify the application of RME principles in educational culture. The determination of subjects was carried out purposively based on the active involvement of teachers in RME practices. This conception is shown in figure 1.

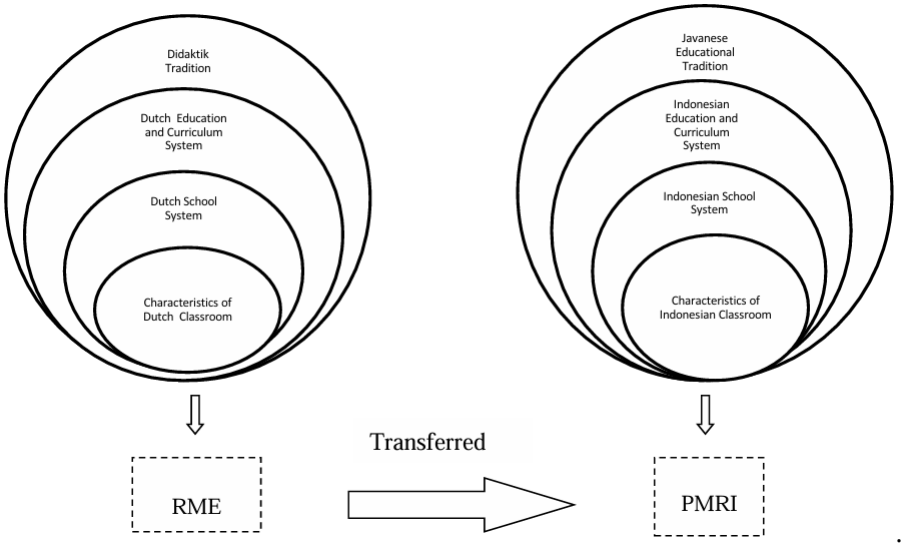

Figure 1. Aframework for this study

To gain a comprehensive understanding of the consistency of Realistic Mathematics Education (RME) principles between Indonesia and the Netherlands, this study used several types of instruments. The research instrument used in this study was developed by Revina & Leung [37], based on the six principles of RME. The final version consisted of 48 items with a 5-point Likert scale. The results of the factor analysis showed three main factors which can be seen in table 1 below

Table 1. Attitude Questionnaire towards RME (AVRR Questionnaire)

Factor	Number of Items	Reliabilitas (α)
Teacher Intention	22	0.90
Lesson Structure	11	0.83
Student Opportunity	15	0.90

Next is the AVRR questionnaire developed by Revina & Leung [37], which is designed based on the six main principles of RME. This questionnaire has undergone a process of language and context adaptation by two linguists with a background in Dutch Literature to ensure equality of meaning. The AVRR instrument grid can be seen in table 2 below:

Table 2. Structure of the AVRR Questionnaire based on the Principles RME

Prinsip RME	Indikator	Jumlah Item
Activity	Prior knowledge, Individual solution, Asking questions	16
Interactivity	Peer learning, Interactive discussion	12
Realistic	Contextual problems, Relation to real life	16
Intertwinement	Inter-conceptual connection, holistic view	16
Level	Thinking level, multiple strategies	16
Guidance	Support, high standards, responsibility	16

The questionnaire was translated into Indonesian by two linguists with a background in Dutch Literature, to ensure accuracy of context and meaning. Observations were analyzed using a coding scheme based on the five main tenets of RME presented in table 3.

Table 3. Class Coding Indicators based on the Five Tenets RME

RME Tenet	Indicators
Phenomenological Exploration	Use of context (realistic vs abstract problems)
Vertical Instrumentation	Use of models and schemes
Students' Contribution	Teacher-student interaction, student-student interaction, group work
Interactivity	Active two-way interaction
Intertwinement	Relationships between mathematical concepts

In-depth interviews are also one of the research data collection techniques. In-depth interviews were conducted to explore the perspectives of various stakeholders on the implementation of RME principles in each country. Semi-structured interview techniques were used to allow flexibility in exploring respondents' answers, but still focus on the topics that had been designed. Three categories of respondents were interviewed, namely:

- Curriculum Developers: Interviews focused on the process of developing the mathematics curriculum, emphasizing the theoretical basis used, the extent to which the RME principles were used as a reference, and what policies or support were provided to facilitate its implementation in the field.
- Mathematics Textbook Writers: Discussions focused on academic sources of reference in the preparation of the book, the design of activities or questions in the textbook, and how their understanding of the RME principles was realized in the learning materials.
- Mathematics Teachers: Interviews with teachers aimed to explore their pedagogical beliefs, perceptions of RME, and the obstacles or challenges they faced in implementing it in the classroom.

Data analysis in this study was carried out through quantitative and qualitative approaches sequentially [38]-[40]. Quantitative data obtained from the questionnaire were analyzed using descriptive statistics to determine the tendency of teachers' attitudes towards the principles of RME, followed by exploratory factor analysis (EFA) to test the suitability of the emerging factor structure with the RME theory which is the basis for compiling the instrument. The results of this quantitative analysis were then compared with previous studies in the Netherlands to identify differences that may be influenced by the cultural context and education system of each country. Meanwhile, qualitative data obtained from classroom observations, in-depth interviews, and document analysis were analyzed thematically [41]. Each data was coded based on the RME principle indicators and reduced to find the main patterns. The results of the interviews were used to deepen the interpretation of observational and document data, as well as to trace the consistency between teacher perceptions, field practices, and the basis of curriculum policy. A triangulation approach between data sources was used to ensure validity and thoroughly reveal the gaps or harmony between RME theory and practice in both countries.

3. RESULTS AND DISCUSSION

The basic education curriculum in Indonesia is very centralized, especially in terms of the scope of mathematics material that must be taught. This curriculum regulates in detail the mathematics topics that must be taught during the six years of basic education, including grouping materials per grade level and semester. The three main domains that are the focus of mathematics learning at the elementary school level include numbers, geometry and measurement, and data analysis. Details of the core competencies recommended in the curriculum are shown in Table 4 below.

Table 4. Basic competencies recommended by the Indonesian Curriculum

Grade 1 Semester 1	Standard Competency	Core Competencies
1. Performing addition and subtraction operations up to 20	1.1 Counting numbers up to 20	
2. Using units of time and length	1.2 Arranging the sequence of numbers up to 20	Core Competencies
3. Recognizing various forms of geometric shapes	1.3 Adding and subtracting up to 20	Core Competencies
Grade 1 Semester 2	1.4 Solving problems related to numbers up to 20	
4. Solving addition and subtraction problems of two-digit numbers (up to 100)	2.1 Mentioning time (days and hours)	Core Competencies
5. Using units of weight	2.2 Calculating the length of time	Core Competencies
6. Recognizing various forms of geometric shapes	2.3 Measuring the length of objects through everyday sentences (short, long) and comparing them	

Table 4. shows the recommended core competencies in the Indonesian Curriculum for grade 1 elementary school students in semesters 1 and 2. From the table, it can be seen that the curriculum sets problem solving as a competency that is taught separately and is usually placed at the end of each topic. Based on this description, there are similarities and differences in the objectives and content between the Indonesian curriculum and the curriculum of other countries, especially the Netherlands [42], [43]. Both curricula have similar objectives, namely to equip

students with a good understanding of mathematics and its application in real-life contexts. Both also emphasize the importance of mastering mathematical concepts and developing students' communication and problem-solving skills [44], [45]. In terms of attitude, the Indonesian curriculum emphasizes the importance of building learning motivation, student interest, and developing ways of thinking, self-confidence, cooperative attitudes, and understanding of appropriate aspects of mathematics [46]. However, there are several fundamental differences. First, there is no centralized decision-making regarding the mathematics content that must be taught in Dutch schools. In contrast, the Indonesian curriculum is highly centralized, where the content, sub-contents, and time allocation have been determined by the central government through BSNP. Second, in contrast to the content-based approach used in the Indonesian curriculum, the Dutch curriculum is more flexible in determining the material to be taught at the elementary level. The emphasis is more on students' cognitive development than on the mathematical content itself. Third, in the Indonesian curriculum, problem solving is only taught after students have mastered the required basic knowledge. This competency is positioned as a separate section and is taught at the end of each topic. Fourth, although both curricula expect students to learn algorithms and standard procedures, the Dutch curriculum explicitly encourages students, especially at the upper levels, to learn how to use calculators.

Based on the Indonesian curriculum (Table 4), the basic competencies of grade 1 include addition and subtraction operations up to 100. To see its implementation in textbooks, Table 4 below presents the distribution of the contents of addition and subtraction tasks in three types of books: DWiG, PMRI, and BSE.

Table 5. Content of 'Addition and Subtraction' Tasks in Textbooks

Sub-Category	DWiG	PMRI	BSE
Number	528 (85%)	408 (94%)	126 (100%)
Measurement	24 (4%)	0	0
Money	63 (11%)	24 (6%)	0
Total	615	432	126

From the table, it can be seen that the DWiG book contains the largest number of tasks and covers three sub-categories: numbers, measurement, and money. However, most of the tasks still focus on numbers. The PMRI book also contains a dominance of tasks on numbers, with a few tasks linking the concept of numbers to money. The BSE book only focuses on pure number operations up to 100, in line with the basic competencies in the Indonesian curriculum. However, the use of the context of money in the PMRI book is considered inappropriate. This is due to the difference in currency systems. Indonesian currency units (such as Rp1000, Rp2000) have a much greater value than the Euro, so they are less appropriate if used to teach basic concepts of small numbers (for example up to 20). This can obscure students' understanding in linking numbers to real contexts.

This analysis aims to identify the existence of learning facilitators in textbooks, which include the use of context, models (such as number lines, tables, and diagrams), various calculation methods, and students' own production results. The summary results of the analysis are shown in Table 6 below:

Table 6. Learning facilitators in textbook assignments

Sub-Category	DWiG	PMRI	BSE
Use of Context	As a learning resource and application	As a source of learning and application	For application
Use of Schema/Model	Yes	Yes	Yes
Student's Own Production	Yes	Yes	No

Next, a more detailed analysis was conducted on the use of context in addition and subtraction problems. The aim was to distinguish between problems that were only numbers (bare number problems) and problems that contained real-life context. The results are presented in Table 7.

Table 7. Use of context in addition and subtraction tasks

Question Type	DWiG	PMRI	BSE
Questions Without Context (%)	385 (62%)	339 (78%)	107 (85%)
Questions with Context (%)	230 (38%)	93 (22%)	19 (15%)
Total	615 (100%)	432 (100%)	126 (100%)

From Table 7, it can be seen that the DWiG and PMRI textbooks present a higher proportion of contextual questions than BSE. BSE textbooks tend to focus on questions without context, where contextual questions generally appear after the concept is taught. In contrast, in DWiG and PMRI, contextual questions are often used at the beginning to introduce concepts and strategies, such as number decomposition and recognition of the value of money, so they can function as a more meaningful learning resource.

Next, table 8 presents a thematic summary of the results of interviews conducted with elementary school teachers, namely as follows:

Table 8. Results of In-depth Interviews Based on Themes and Categories of Informants

Informant Category	Interview Themes	Key Findings
Curriculum Developer	Basis of Curriculum Development	The curriculum is designed based on a constructivist approach; RME is cited as one of the pedagogical references.
	Reference Theory	The RME principle is used to build contextual learning, but has not become an explicit national reference.
Textbook Writer	Adoption and Implementation of RME	Implementation depends on school readiness and teacher training; not all schools implement it consistently.
	Institutional Support	There are training modules and guides, but they have not been socialized evenly throughout the region.
Math Teacher	Writing Purpose	Books are designed to support conceptual understanding and the context of everyday life.
Informant Category	Reference Sources	Several authors refer to the Dutch RME theory, but adaptations are made to suit the local context.
Curriculum Developer	Question and Activity Design	Questions are designed based on context, but integration between concepts and exploration of models is not yet consistent.
	Understanding of RME	RME is understood as an approach that encourages active student involvement, but its application is still partial.
Textbook Writer	Pedagogical Beliefs	The majority of teachers agree that learning must start from the context and experiences of students.
	Implementation of RME	Some teachers apply a contextual approach and group discussions, but are hampered by time constraints.
Math Teacher	Implementation Barriers	Lack of training, administrative burdens, and curriculum demands are obstacles to the full implementation of RME.

Based on the results of in-depth interviews, it is known that the principles of Realistic Mathematics Education (RME) have begun to be adopted in curriculum development and textbook writing in Indonesia, although they have not been fully integrated explicitly into national policies. Curriculum developers stated that the constructivist approach is the main basis for curriculum development, and RME is used as one of the references in building contextual learning. However, they also acknowledged that the implementation of RME principles in the field is highly dependent on school readiness and teacher training. On the other hand, textbook authors stated that the design of questions and activities in the book has been directed at the context of everyday life and aims to improve students' conceptual understanding, although the intertwinement between concepts and the use of mathematical models are still not consistently applied.

Adaptation to the local context has also led to some simplifications of the original RME principles originating from the Netherlands. Meanwhile, mathematics teachers showed a fairly good understanding of the importance of contextual learning and active student participation in the learning process. Most teachers have tried to apply the RME approach through group discussions, the use of contextual problems, and encouraging independent problem solving. However, various obstacles such as limited learning time, administrative burden, and lack of specific training related to RME are the main obstacles in implementing these principles comprehensively in the classroom. These findings indicate a gap between policy, teaching material design, and field practice that needs to be bridged through strengthening training, teacher mentoring, and curriculum harmonization with a more explicit and systematic RME approach.

The results of the analysis of the Indonesian mathematics curriculum for grade 1 of elementary school show that problem solving has been included as a basic competency that is specifically taught at the end of each learning topic. This shows that the Indonesian curriculum recognizes the importance of problem-solving skills as part of the learning outcomes that students must achieve [47]-[49]. In addition, this curriculum is arranged centrally, where the content, sub-contents, and allocation of learning time are determined by the central government, so that the delivery is uniform across schools . The main focus lies on mastering the content of the material first before students are introduced to its application in real contexts.

From the side of the learning facilitator reflected in the textbook, it was found that the DWiG and PMRI books facilitate contextual learning more than the BSE books. All three books do use visual schemes and models, such as number lines and tables, as learning aids. However, only the DWiG and PMRI books provide space for students to produce their own solutions or strategies (own productions), while the BSE books tend to emphasize

the procedural approach. This shows that the learning approach in the BSE books is still teacher-centered and provides less opportunity for student exploration and creativity.

Furthermore, the analysis of addition and subtraction problems shows a striking difference in the use of context. Most of the problems in the BSE book are bare number problems (85%), while in the DWiG and PMRI books the proportion is lower (62% and 78%). Contextual problems in the DWiG and PMRI books generally appear at the beginning of learning to build conceptual understanding, while in the BSE book, contextual problems are only given after the concept is introduced. This indicates that the DWiG and PMRI books tend to be in line with the principles of Realistic Mathematics Education (RME), while the BSE book is still oriented towards routine exercises that are separate from real-life contexts.

Based on the results explained above, this finding is supported by studies such as those conducted by [50], [51], showing that the use of context in mathematics learning not only improves students' conceptual understanding, but also helps them develop problem-solving strategies. Research by Karaca [52] also shows that the contextual approach in PMRI is able to increase students' active involvement in the learning process. However, there are not many studies that directly compare Indonesian textbooks with textbooks from other education systems such as the Netherlands, especially in relation to the use of learning facilitators and contextual tasks.

This study is novel in its approach that combines content analysis of the curriculum and textbooks from two different education systems. Not only comparing in terms of content, this study also examines how mathematics tasks are structured and facilitated in the learning context. In addition, the qualitative approach to identifying learning facilitators and contextual tasks provides new insights into the extent to which textbooks support meaningful and student-centered learning.

Although providing important findings, this study has several limitations, such as the scope which is only limited to grade 1 of elementary school and focuses on three specific textbooks. Therefore, further research is needed to explore other grades and books from different publishers. The urgency of this study lies in the importance of textbook design that not only delivers material, but also facilitates students' thinking processes actively and contextually. Implementatively, the results of this study can be used by curriculum developers and textbook writers to improve the quality of textbooks by emphasizing the integration of context, models, and students' exploratory strategies to support more meaningful and effective mathematics learning.

4. CONCLUSION

Based on the analysis results, it can be concluded that the DWiG and PMRI books are more consistent in implementing the principles of Realistic Mathematics Education (RME) than the BSE books. This can be seen from the use of contextual problems in the DWiG books (62%) and PMRI (78%) which are much higher than the BSE books (15% contextual, 85% simple number problems). In addition, DWiG and PMRI also provide space for students to develop their own strategies (own productions), while the BSE books are more procedural and teacher-centric. Therefore, it is recommended that curriculum developers and textbook writers pay attention to the integration of context, visual models, and students' exploratory strategies in compiling teaching materials. This approach can strengthen students' conceptual understanding and active involvement in mathematics learning from an early age, as well as enrich the design of more meaningful and student-centered learning.

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