

TRENDS AND STRATEGIES IN IMPLEMENTING RME AND PJBL FOR TEACHING CENTRAL TENDENCY: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

This study aims to examine current research trends and the most effective strategies to support students' critical thinking skills in the context of central tendency data. The method used is a Systematic Literature Review (SLR), collecting relevant articles from 2018 to 2025 that explore trends and strategies in teaching central tendency data. The relevant articles were gathered from leading academic databases such as Scopus and Google Scholar, using keywords related to Realistic Mathematics Education (RME), Project Based Learning (PjBL), and central tendency data. The inclusion selection process involved screening 1383 relevant articles, which were narrowed down to 175 articles. After further examination, 147 articles were excluded based on relevance criteria. Finally, 15 articles were selected for further analysis. The main findings of this study indicate that RME and PjBL have become increasingly popular approaches from 2018 to 2025 in teaching central tendency among researchers, with strategies focusing on the use of real-world contexts, project-based learning, and the integration of technology and ethnomathematics in supporting students' critical thinking skills.

Kata kunci : RME, PjBL, central tendency, critical thinking skills

ABSTRAK

Penelitian ini bertujuan untuk mengkaji tren penelitian terkini dan strategi yang paling efektif untuk mendukung kemampuan berpikir kritis siswa pada materi ukuran pemusatan data. Metode yang digunakan adalah Systematic Literature Review (SLR) dengan mengumpulkan artikel-artikel yang relevan dari tahun 2018 hingga 2025, yang mengkaji tren dan strategi dalam konteks pembelajaran ukuran pemusatan data. Artikel-artikel yang relevan dikumpulkan dari berbagai basis data akademik terkemuka, seperti Scopus dan Google Scholar, dengan menggunakan kata kunci yang berkaitan dengan Realistic Mathematics Education (RME), Project Based Learning (PjBL), dan ukuran pemusatan data. Proses seleksi inklusi dilakukan dengan menyaring 1383 artikel yang relevan menjadi 175 artikel, dan setelah pemeriksaan lebih lanjut, 147 artikel dieliminasi berdasarkan kriteria relevansi. Akhirnya, 15 artikel dipilih untuk analisis lebih lanjut. Hasil utama penelitian ini menunjukkan bahwa RME dan PjBL menjadi dua pendekatan yang semakin populer dari tahun 2018 hingga 2025 dalam pengajaran ukuran pemusatan di kalangan peneliti, dengan strategi penggunaan konteks dunia nyata, proyek berbasis pembelajaran, dan integrasi teknologi dan etnomatematika dalam mendukung kemampuan berpikir kritis siswa.

Kata kunci : RME, PjBL, statistik, ukuran pemusatan data, berpikir kritis

INTRODUCTION

Statistics education, particularly related to measures of central tendency such as mean, median, and mode, plays an important role in developing students' critical thinking skills. The concept of measures of central tendency serves as a foundation for students to understand how to describe, analyze, and draw conclusions from numerical data in a structured way (Armiati et al., 2022; Bayu et al., 2022).

However, various studies have shown that this concept is often perceived as abstract and difficult to understand, leading to misconceptions and a low level of mastery among students in basic statistical material (Armiati et al., 2022; Borovcnik & Terán, 2021; Sari & Nursyahidah, 2022). To address these challenges, several instructional approaches have been developed, one of which is Realistic Mathematics Education (RME). RME emphasizes the connection of mathematics learning with students' real-life contexts so that abstract concepts can be understood through concrete experiences (Bayu et al., 2022; Fauzan et al., 2018; Mubharokh et al., 2022; Rahayu & Putri, 2021; Zulkardi et al., 2020). Through this approach, students are encouraged to develop critical thinking skills within a contextual framework, by connecting mathematical theory to their everyday experiences (Fauzan et al., 2018; Hasanah et al., 2022).

In addition to RME, the Project-Based Learning (PjBL) model also offers great opportunities in statistics learning. PjBL emphasizes the application of concepts through real projects that engage students in the process of collecting, analyzing, and interpreting data (Fisher et al., 2020). This model not only enhances student engagement but also strengthens their critical thinking and problem-solving skills (Himmi et al., 2025; Trisnadati, 2018). When combined with the RME approach, PjBL enables students to apply statistical concepts in projects that are relevant to real life, thereby fostering a deeper and more meaningful understanding (Trisnadati, 2018).

Although both approaches are promising, their implementation in the classroom still faces several challenges, such as limited teacher readiness, lack of learning resources, and difficulties in adapting the approaches to diverse student conditions (Dewi et al., 2020; Rahayu & Putri, 2021). However, to date, there has been no systematic review that specifically examines the trends and strategies of implementing RME and PjBL in teaching measures of central tendency. This raises an important question: what are the recent research trends regarding the use of RME and PjBL in teaching measures of central tendency, and which strategies are most effective in supporting students' critical thinking skills?

Based on this background, the present study was conducted in the form of a systematic literature review (SLR). The main objectives of this study are (1) to examine recent research trends related to the implementation of RME and PjBL in teaching measures of central tendency, and (2) to identify effective strategies for supporting students' critical thinking skills. Thus, this study is expected to contribute to the development of more effective, contextual, and relevant strategies for teaching statistics in relation to students' real-life experiences.

METHODS

This study uses an SLR design to analyze, filter, and synthesize previous research (Calderón & Ruiz, 2015; Xiao & Watson, 2019) relevant to the application of RME and PjBL in statistics education, specifically in the teaching of measures of central tendency. SLR was chosen as the method because it allows for identifying

current trends and strategies used in the implementation of RME and PjBL in the context of statistics education based on prior studies. The SLR process begins with the search and selection of relevant articles published in Scopus and Google Scholar using relevant keywords such as “realistic mathematics education,” “RME in statistics,” “central tendency,” “critical thinking in statistics,” “project-based learning in mathematics,” “PjBL in statistics,” and “research in statistics.” The inclusion criteria used in this study are articles that discuss approaches to teaching mathematics with a focus on measures of central tendency. Exclusion criteria include articles that are not relevant to the main topic or do not provide empirical data on the application of RME and PjBL, as illustrated in the following Table 1.

Table 1. Inclusion and Exclusion Criteria

Criteria Name	Criteria Inclusion	Criteria Exclusion
Research Topic	A study that integrates RME and PjBL with the topic of central tendency	A study that are not relevant to the research topic
Literature type	A study includes Journal (research-based)	A study excludes literature reviews, meta analyses, bibliometric, books.
Indexing	Indexed by Scopus, and Google Scholar	Not indexed by Scopus and Google Scholar
Publication Year	Published between 2018-2025	Published before 2018
Language	Full text/ English	Non full text/ Non English

The initial search yielded 1383 relevant articles; however, after screening the titles and abstracts, articles that did not meet the inclusion criteria, such as those unrelated to the main topic, literature reviews, meta-analyses, bibliometric studies, and books, were excluded, leaving 175 articles for further processing. The screening process was based on two main criteria: relevance to statistics education and the use of RME and PjBL in instructional design. Feasibility assessment was conducted by reviewing the full text of 28 articles that were deemed to meet further criteria.

Subsequently, during the final evaluation and selection process, only 15 articles met the criteria to be included in the final review, based on methodological quality and significant contributions to understanding the use of RME and PjBL in statistics education. In the data collection procedure, the selected articles were analyzed to identify how RME and PjBL support students' critical thinking skills. The data collected through content analysis of these articles also considered strategies, research outcomes, as well as the challenges and limitations faced in implementing RME and PjBL approaches.

For the data analysis method, the researchers adopted a qualitative analysis technique with an in-depth review of each selected article. Data were identified to determine emerging research trends and how each study contributed to the understanding of RME and PjBL in teaching measures of central tendency. The findings from this analysis are then presented using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Chen et al., 2021; de Dieuleveult et al., 2017; Page et al., 2021), illustrated in the following PRISMA flowchart (Figure 1).

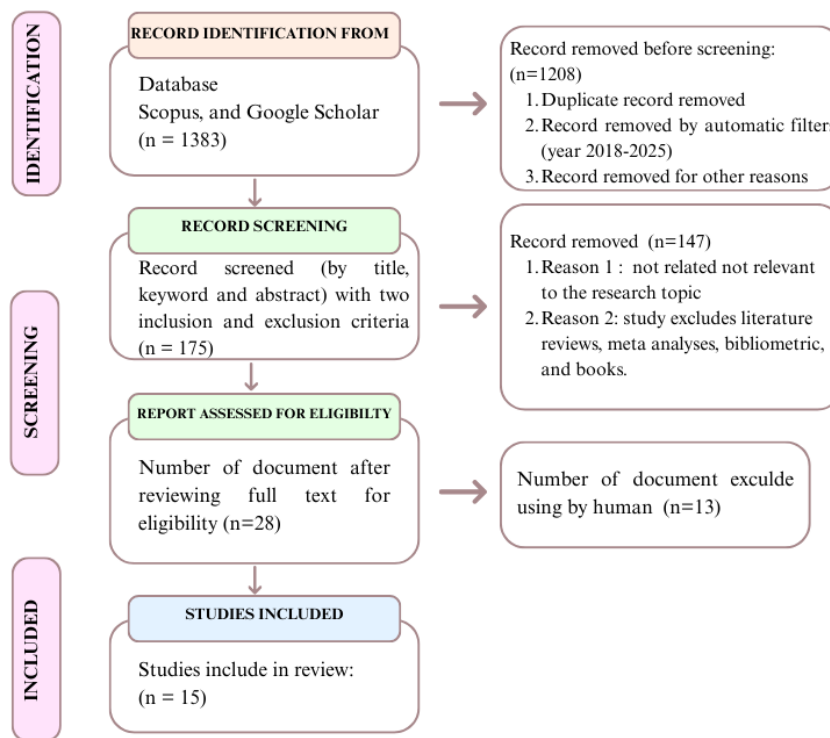


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

RESULTS AND DISCUSSION

The results of the selected articles are presented in Table 2, which synthesizes the 15 relevant articles related to the application of RME and PjBL in statistics education, focusing on measures of central tendency. The table includes the research title, strategies, and findings of the studies. The purpose of this synthesis is to provide a clear overview of the current research trends related to teaching measures of central tendency and the most effective strategies for supporting students' critical thinking skills in the topic of measures of central tendency.

Table 2. Synthesis of Research on the Application of RME and PjBL in Teaching Measures of Central Tendency"

Research Title	Jounal Name	Strategy	Research findings
Developing Learning Trajectory for Teaching Statistics at Junior High School Using RME Approach (Fauzan et al., 2018)	Journal on Mathematics Education	Design-based research using RME to develop a learning trajectory for teaching statistics	Learning trajectory for teaching statistics based on RME improved students' statistical reasoning and understanding of central tendency.

Research Title	Jounal Name	Strategy	Research findings
Learning design using PMRI to teach central tendency Materials (Meitrilova & Putri, 2020)	Journal of Physics: Conference Series	LSLC, RME using the context of the victims of natural disasters	The design of learning provided has helped students understand the concept of central tendency.
The Effectiveness of Applying Realistic Mathematics Education Approach in Teaching Statistics in Grade 7 to Students' Mathematical Skills (Uyen et al., 2021)	Journal of Education and e-Learning Research	Using RME for teaching statistics	RME positively impacts students' statistical skills, especially in data collection, classification, and representation.
The Data Package in Learning Mean Using LSLC and RME (Rahayu & Putri, 2021)	Mathematics Education Journal	LSLC, RME using the context of the data package	the design of learning provided has helped students understand the concept of mean.
How the Project Method Contributes to the Construction of Meaning in Statistics – Also in a Hybrid Learning Environment (Borovcnik & Terán, 2021)	Journal of Physics: Conference Series	Project method in statistics learning	Project-based statistics learning helps build a better understanding of statistical concepts.
Local Instructional Theory of Probability Topics Based on Realistic Mathematics Education for Eight-Grade Students (Armiati et al., 2022)	Journal on Mathematics Education	Developing Local Instructional Theory (LIT) for teaching probability topics using RME, combining Plomp and Gravemeijer and Cobb models	Students improved mathematical communication skills and understanding of probability through RME-based teaching design.
Learning design for statistics materials using the context of traditional market assisted by interactive videos (Sari & Nursyahidah, 2022)	Journal on elemen	Design Research, RME, Interactive Video with traditional market context	The context of traditional markets and interactive videos helped students understand the concept of data presentation material
Students' Ability in Solving Statistical Problem Using the Context of the COVID-19 Pandemic (Hasanah et al., 2022)	Mathematics Education Journal	RME, LSLC Using the Context of the COVID-19 Pandemic	The Context of the COVID-19 Pandemic helped students' problem-solving skills for central tendency in a good category with an average 68,5.

Research Title	Jounal Name	Strategy	Research findings
Improve Critical Thinking by Developing Teaching Materials Based on Realistic Mathematics Learning (Nasrulloh & Amin, 2022)	Journal of Physics: Conference Series	Development of teaching materials based on RME	RME-based teaching statistics materials are valid, practical, and effective in improving students' critical thinking skills.
The Development of Teacher and Student's Book Based on Realistic Mathematics Education in Statistics for A Package Program (Bayu et al., 2022)	European Journal of Educational Research,	Development of teacher and student books using RME approach for Package A program, focusing on content validity and reliability	Development of teacher and student books for teaching statistics with RME, validated for content and feasible to use.
Designing Learning Materials Oriented Towards Project-based Learning on Statistic (Kurniasari & Salshabilla, 2023)	Journal of Physics: Conference Series	Development type study using PjBL	Developed PjBL-based learning materials for statistics that are valid, practical, and effective, and enhance understanding of statistical concepts.
Integrating Traditional Food and Technology in Statistical Learning: A Learning Trajectory (Ramadhani et al., 2024)	Journal on Mathematics Education	Design Research using Lemang Batok context	The learning trajectory developed significantly improved students' numeracy skills in descriptive statistics, as showned by increased critical thinking and enhanced abilities to analyze variability.
Enhancing students' attitudes towards statistics through innovative technology-enhanced, collaborative, and data-driven project-based learning (Cujba & Pifarré, 2024)	Humanities and Social Sciences Communications Journal	Technology and data driven Project Based Learning (PjBL)	Students showed an improvement in positive attitudes toward statistics, a decrease in anxiety, and an increased interest in using technology to learn statistics."
Enhancing Critical Thinking in Junior High School through Project-Based Learning (Ningsih & Yusof, 2025)	International Journal of Educational Insights and Innovations (IJEDINS)	PjBL focusing Ecosystems and Environmental Pollution	PjBL is a highly effective strategy for developing critical thinking.

Research Title	Jounal Name	Strategy	Research findings
Integrating Technology, Ethnomathematics, and Realistic Mathematics Education in Learning Statistics: A Learning Trajectory (Nursyahidah et al., 2025)	Infinity Journal	Integration of technology, ethnomathematics, and RME in teaching statistics with a learning trajectory based on pranata mangsa context	Students' understanding of statistical concepts significantly improved by integrating ethnomathematics and technology, and RME based on pranata mangsa context.

Based on the synthesis in Table 2, there are two main focuses discussed in this article, namely research trends and the most effective strategies in supporting students' critical thinking skills, which are explained in detail as follows:

Current Research Trends in Teaching Measures of Central Tendency

The results of the analysis show that research on the implementation of Realistic Mathematics Education (RME) and Project-Based Learning (PjBL) in teaching measures of central tendency has developed significantly from 2018 to 2025. In general, the majority of studies emphasize the importance of using real-world contexts as a bridge between theory and students' practical experiences (Armiati et al., 2022; Bayu et al., 2022)

In the early phase, particularly in 2018, research was still limited. One study at the junior high school level employed an RME-based learning trajectory and found that this strategy successfully improved students' understanding of mean, median, and mode (Fauzan et al., 2018). More studies began to emerge in the following years, with four publications recorded. For instance, in 2021 several publications demonstrated the effectiveness of RME in helping Grade 7 students understand measures of central tendency through contexts that are closely related to their daily lives (Uyen et al., 2021).

A more rapid development was observed in 2022, when the number of publications increased sharply. Beyond focusing on the classroom application of RME, several studies began to explore the integration of technology with RME. With five published articles, this marked significant progress in the combined use of RME and PjBL (Sari & Nursyahidah, 2022), along with their impact on enhancing students' critical thinking skills in solving statistical problems (Nasrulloh & Amin, 2022).

Although the number of publications decreased in 2023, the research focus became more specific. One study developed interactive learning tools based on RME, which proved effective in improving students' critical thinking skills in understanding statistical data (Ramadhani et al., 2024). Meanwhile, in 2024 and 2025, research once again highlighted the role of RME in strengthening conceptual understanding of measures of central tendency while simultaneously fostering critical thinking skills (Nursyahidah et al., 2025).

Overall, these findings indicate that both RME and PjBL are increasingly popular in teaching measures of central tendency. The main emerging trends include a focus on real-world contexts, the integration of project-based activities, and the use of technology to reinforce students' critical thinking skills. With these developments,

RME and PjBL hold great potential to become increasingly relevant and adaptive instructional strategies to meet the demands of 21st-century education, as presented in Figure 2 below.

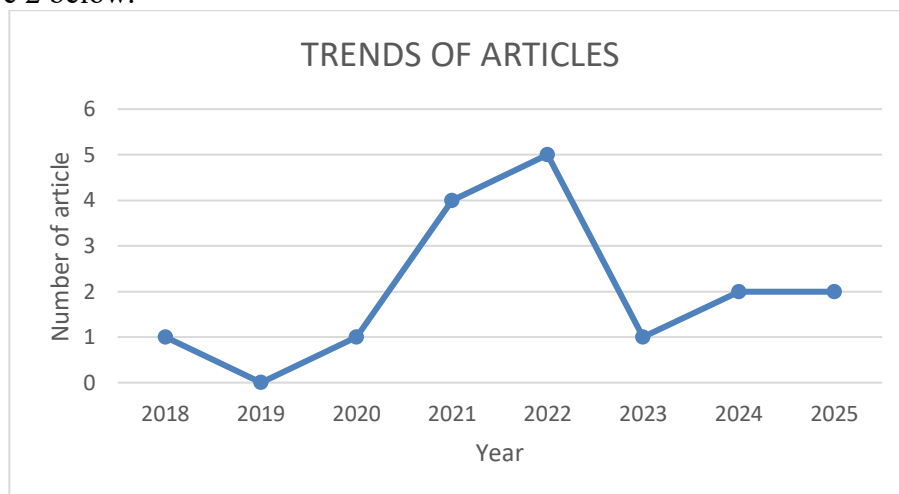


Figure 2. Trends of article on RME and PjBL in Teaching Measures of Central Tendency

However, the challenges faced include student engagement, difficulties in implementation across diverse classroom contexts, and teacher readiness to effectively use these two approaches. Additionally, the use of ethnomathematics to link local culture with statistics education has gained increasing attention as a way to enhance the relevance of learning material for students.

Strategies Most Effective in Supporting Students' Critical Thinking Skills

In research related to Instructional Design Theory to support critical thinking in teaching measures of central tendency, several key strategies are used to enhance students' understanding and support the development of critical thinking skills. Figure 3 illustrates various strategies employed to support the development of students' critical thinking skills.

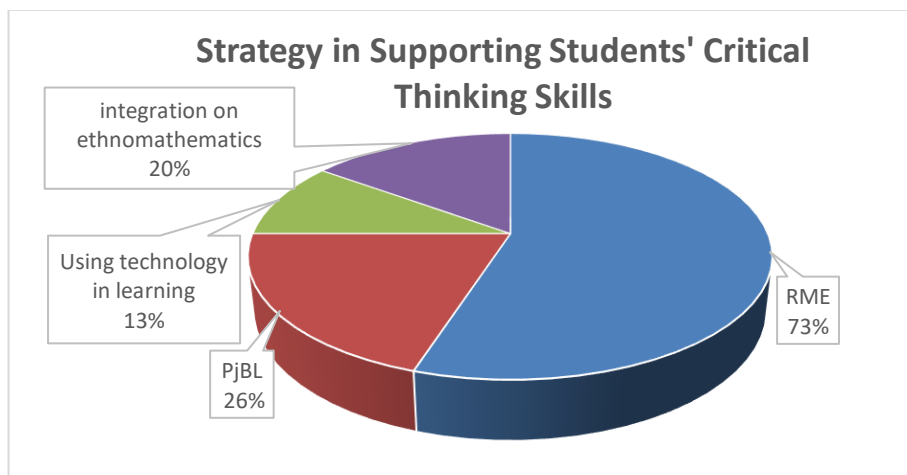


Figure 3. Strategy in Supporting Students' Critical Thinking Skills

Based on Figure 3 presents a pie chart illustrating various strategies used to support students' critical thinking skills. Four main strategies are displayed, each with different percentage contributions. Realistic Mathematics Education (RME) dominates with 73%, indicating that this contextual learning approach is considered the most effective in enhancing students' critical thinking skills. The second largest portion is Project-Based Learning (PjBL) with 26%, emphasizing the importance of project-oriented learning in fostering critical thinking skills. Meanwhile, the integration of ethnomathematics accounts for 20%, reflecting the role of cultural and local contexts in strengthening students' understanding while simultaneously building their critical thinking competence. Lastly, the use of technology in learning contributes 13%, highlighting that technology also plays an important role, although to a lesser extent compared to the other strategies.

Overall, this diagram shows that RME is the most dominant strategy, while the other approaches serve as complementary methods that reinforce each other in supporting the development of students' critical thinking skills. The details of these strategies are as follows.

1. Realistic Mathematics Education (RME)

Almost all of the analyzed articles employed RME in statistics learning, particularly in teaching measures of central tendency. This approach emphasizes linking mathematical concepts with real-life contexts that are familiar to students (Fauzan et al., 2018; Hung & Thuy Dieu, 2024; Zulkardi et al., 2020). One of the main principles of RME is the provision of contextual problems that encourage students to discover concepts independently. In the context of statistics, RME allows students to collect data, analyze it, and interpret the results through projects related to their daily lives (Rahayu & Putri, 2021).

2. Project-Based Learning (PjBL)

PjBL is another popular strategy in this research, often used in conjunction with RME to enhance students' critical thinking (Trisnadati, 2018). PjBL is an approach that focuses on developing students' skills through working on real-world projects that involve applying the theories they have learned. In the context of statistics, PjBL gives students the opportunity to use statistical concepts in projects that involve data collection, analysis, and presentation.

The implementation of PjBL allows students to work in groups, tackle more complex tasks, and develop better critical thinking skills (Fisher et al., 2020). RME-based projects can involve students in creating surveys to collect data on topics relevant to their lives, which are then analyzed using measures of central tendency (Fauzan et al., 2018). Research shows that PjBL strengthens students' understanding of statistical concepts and helps them see the direct connection between mathematics and their real-world experiences.

3. Use of Technology in Learning

Several articles highlight the importance of using technology to support RME and PjBL in teaching measures of central tendency. Technology is used in various forms, from animated videos to interactive software, to assist students in visualizing statistical data (Nursyahidah et al., 2025; Sari & Nursyahidah, 2022). One of the main benefits of using technology is that it can clarify abstract concepts, making them more accessible and understandable for students.

4. Integration on Ethnomathematics

Ethnomathematics is an approach that integrates students' local culture into mathematics learning, including teaching measures of central tendency. Research indicates that integrating local culture into RME helps students connect mathematical learning with their cultural experiences (Ramadhani et al., 2024). This approach enhances student motivation because the material becomes more relevant and easier to understand.

CONCLUSION

Based on the results of the analysis, it can be concluded that the RME approach has proven effective in enhancing students' understanding of statistical concepts, particularly in learning measures of central tendency. This approach provides contexts that are relevant to students' daily lives, which help them connect abstract concepts with real-world situations. In addition, the application of PjBL combined with RME encourages students to think critically, collect data, and apply statistical concepts in real projects. The integration of technology also plays an important supporting role, as it helps clarify complex statistical concepts while simultaneously strengthening students' critical thinking skills.

Overall, this study highlights the importance of contextualizing learning through RME and PjBL in the teaching of statistics. By linking the material to real-life experiences and engaging students in project-based learning, students' understanding of measures of central tendency can be enhanced in a more meaningful way. This contribution is significant because the relevance of mathematics learning to everyday life has been shown to improve both motivation and student engagement.

However, this study also identifies several challenges in the implementation of these two approaches. Some of the main challenges include teacher readiness, limited resources, and difficulties in adapting project-based learning in classrooms with a large number of students. Therefore, it is essential to continue strengthening teacher training and to provide adequate support for the implementation of RME and PjBL within a broader educational context.

For future research, it is recommended to focus on a deeper exploration of the role of technology in supporting RME and PjBL learning, particularly in teaching measures of central tendency. The use of statistical analysis software or interactive applications can serve as a strategic innovation to enrich students' learning experiences. In addition, further studies that incorporate cultural diversity through the integration of ethnomathematics are also important, so that the teaching of statistics becomes more inclusive, relevant, and contextualized within diverse cultural backgrounds.

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