Infinity Journal of Mathematics Education
Volume 14, No. 3, 2025

p-ISSN 2089-6867
e–ISSN 2460-9285

https://doi.org/10.22460/infinity.v14i3.p633-654

Integrating technology, ethnomathematics, and realistic mathematics education in learning statistics: A learning trajectory

Farida Nursyahidah, Wardono*, Scolastika Mariani, Kristina Wijayanti
Department of Mathematics Education, Universitas Negeri Semarang, Central Java, Indonesia
*Correspondence: wardono@mail.unnes.ac.id

Received: Dec 8, 2024 | **Revised**: Jan 28, 2025 | **Accepted**: Mar 5, 2025 | **Published Online**: Jun 9, 2025

Abstract

Statistics is a critical subject for developing students' academic and career competencies, yet it remains challenging for many students due to its abstract nature. To address this issue, a study was conducted to design a learning trajectory for teaching statistical concepts by integrating technology, ethnomathematics, and realistic mathematics education (TE-RME) within the culturally relevant context of *pranata mangsa,* a traditional Javanese calendar system. Employing a design research methodology, the study involved 32 eighth-grade students from a junior high school in Semarang, Indonesia. It was conducted in three phases: preparation for the experiment, designing learning activities, and retrospective analysis. The resulting learning trajectory consisted of three structured activities: observing *pranata mangsa* videos to collect and present data, deriving formulas for measures of central tendency, and exploring methods for calculating data dispersion. Findings indicated that the integration of *pranata mangsa* in the TE-RME framework significantly enhanced students' understanding of statistical concepts by connecting abstract ideas to culturally meaningful contexts. This approach facilitated quicker and more meaningful learning, demonstrating the effectiveness of incorporating local wisdom into mathematics education. The study also highlights the potential for future research to explore other culturally relevant contexts to teach mathematical concepts, further advancing the field of culturally responsive education.

Keywords:
Animation video, Design research, Statistics, Techno-Ethno-Realistic Mathematics Education (TE-RME)

How to Cite:
Nursyahidah, F., Wardono, W., Mariani, S., & Wijayanti, K. (2025). Integrating technology, ethnomathematics, and realistic mathematics education in learning statistics: A learning trajectory. *Infinity Journal*, *14*(3), 633-654. https://doi.org/10.22460/infinity.v14i3.p633-654

1. INTRODUCTION

Statistics, as a branch of mathematics, holds a pivotal role in everyday life (Ben-Zvi et al., 2015), and professional lives to understand, interpret, and communicate statistics (Crisostomo & Chauhan, 2019). Studying statistics enables students to not only meet curriculum requirements but also acquire essential competencies for future success (Ruan et al., 2021; Zhang, 2018). Mastery of statistics fosters the ability to plan, design, analyze, and interpret the experimental data (Soe et al., 2021), interpret data effectively, enhance critical thinking, refine analytical skills, and reasoning (Ben-Zvi et al., 2015). Furthermore, statistics serves as a fundamental discipline underpinning advanced education and diverse scientific fields, such as economics, geology, and social sciences (Crisostomo & Chauhan, 2019). Therefore, it can be concluded that statistics is indispensable for developing critical thinking and analytical skills, enabling students to effectively interpret data, fulfill academic requirements, and establish a solid foundation for higher education and various scientific domains.

Although the study of statistics offers numerous benefits, students often encounter significant challenges in understanding statistical concepts (Borovcnik & Terán, 2021). These difficulties stem from an overwhelming number of formulas that students feel compelled to memorize, insufficient mastery of prerequisite knowledge, and the abstract nature of interpreting statistical results (Koparan, 2015; Rosli & Aliwee, 2021). Beyond theoretical challenges, students frequently struggle to apply statistical concepts to real-world situations, which diminishes their motivation and interest in learning (Silva et al., 2022). Thus, the study of statistics poses significant challenges for students, despite its benefits, including the complexity of formulas, lack of prerequisite knowledge, abstract interpretations, and difficulty in applying concepts to real-world situations, often leading to reduced motivation and interest.

Several key factors contribute to students' difficulties in learning statistics, including a lack of real-world applications that make the subject relevant (Silva et al., 2022), ineffective or incomplete teaching methods (Charles-Owaba, 2019), an absence of conceptual understanding in the learning process (Koparan, 2015), limited student engagement during instruction (Suarez-Rivera & Langan, 2022), and the inherent complexity of statistical material (Koparan, 2015). It means that students' difficulties in learning statistics stem from limited real-world applications, ineffective teaching methods, a lack of conceptual understanding, low engagement during instruction, and the inherent complexity of the subject matter. Therefore, it is necessary to design learning using an innovative approach, namely Techno-Ethno-Realistic Mathematics Education (TE-RME).

Techno-Ethno-Realistic Mathematics Education has emerged as a promising approach to address challenges in statistics education. TE-RME offers a comprehensive framework for innovative mathematics teaching that refines the integration approach between Ethnomathematics and Realistic Mathematics Education (E-RME) proposed by Prahmana (2022) and Prahmana et al. (2023) namely by integrating technology as a learning medium in the learning process. Technology-based learning media play a critical role in enhancing students' understanding and motivation in the learning process (Drijvers, 2019; Uchima-Marin et al., 2024). In TE-RME, technology is used to help visualize context as a starting point for learning obtained from ethnomathematics exploration results.

Ethnomathematics is an essential source of knowledge that can assist teachers establish effective pedagogical practices in the classroom (Rosa & Orey, 2023). Ethnomathematics emphasizes the integration of culturally based mathematical concepts, promoting learning experiences grounded in students' cultural contexts (D'Ambrosio, 2018; Rosa & Orey, 2021). Ethnomathematics studies boost students' interest, understanding, and creativity by contextualizing mathematics with real-life ideas and practices (D'Ambrosio, 1999). Incorporating cultural elements into daily learning not only supports more meaningful engagement but also fosters improved mathematical literacy (Rosa et al., 2016; Umbara et al., 2023). Meanwhile, RME focuses on the use of real-world contexts in teaching mathematics (Streefland, 1991). Its principles include didactic phenomenology, the development of independent models, student participation, interactive learning activities, and conceptual connections.

Moreover, RME has been shown to effectively enhance student involvement, motivation, understanding, and analytical problem-solving abilities (Nursyahidah et al., 2023; Papadakis et al., 2017). Combining realistic mathematics education with authentic learning methods improves and develops problem-solving, mathematical modeling competence, and mathematical communication ability (Da, 2023). Additionally, it strengthens literacy and numeracy skills (Fauzan et al., 2024) while developing higher-order thinking skills and overall mathematical proficiency (Sutarni et al., 2024). By combining these elements, TE-RME provides a holistic approach to fostering meaningful, culturally relevant, and effective learning experiences in mathematics and statistics education.

In RME, context refers to problem situations derived from students' real-life experiences or environments that are familiar, relevant, and serve as entry points for developing activities and understanding mathematical concepts (Putri et al., 2021; Zulkardi & Setiawan, 2020). Context problems are meant to facilitate a reinvention process that allows students to come to terms with formal mathematics (Gravemeijer & Doorman, 1999). In this study, the chosen context stems from an exploration of Javanese ethnomathematics, specifically the *pranata mangsa* system.

The *pranata mangsa* is a form of local knowledge based on a 12-season calendar traditionally used by Javanese farmers and fishermen to guide their agricultural and fishing activities (Prahmana et al., 2021). In Hawaii, there is the Hawaiian moon calendar, which is similar to the lunar calendar-pranatamangsa in Indonesia. This system has been used effectively to teach mathematics based on past, present, and future mathematics in order to prepare leaders who are knowledgeable about their ancestors' cultures and can use mathematical modeling (Luneta, 2021). This culturally significant system was utilized as a starting point for the learning process, presented to students through an animated video.

Furthermore, animated videos were selected as the instructional medium because they combine visual and auditory elements, enabling dynamic and interactive engagement with students (Feeley et al., 2023). Research has demonstrated that animated videos enhance learning outcomes, increase student engagement and interest, and stimulate creativity during the educational process (Ridha et al., 2022; Songkhro et al., 2022). By leveraging this approach, the study integrates cultural context and innovative technology to create an engaging and effective learning environment.

Previous studies have explored statistical learning designs using RME in various contexts, such as traditional markets (Sari & Nursyahidah, 2022) and sports (Uyen et al., 2021). These studies demonstrated that contextual approaches improve students' conceptual understanding and learning outcomes. In addition, *pranata mangsa* has been explore as a context in learning modulo (Prahmana et al., 2021) and has not been used in mathematics learning practices. The novelty of the present study lies in its integration of technology through animated videos, ethnomathematics, and RME—collectively termed the TE-RME approach. This innovative framework is applied within the unique context of the *pranata mangsa*, a traditional Javanese calendar system, which has not been previously utilized in statistical learning.

Building on this background, the study focuses on designing statistical learning for eighth-grade students using the *pranata mangsa* as the contextual foundation. The learning design follows a Hypothetical Learning Trajectory (HLT) model, supported by animated video media and guided by the principles of the TE-RME approach. The primary objective of this research is to develop a learning trajectory that simplifies the process of understanding statistics for students while enhancing their engagement and contextual relevance.

2. METHOD

The research employs a design research methodology, which focuses on developing and refining learning strategies and instructional materials to address complex educational challenges while contributing to the theoretical understanding of these strategies and materials (Van den Akker et al., 2006). This approach is characterized by several key elements, including its interventionist nature, process orientation, reflective components, cyclical design, and strong theoretical grounding (Van den Akker et al., 2012).

Design research typically unfolds in three distinct phases: preparation for the experiment, which involves identifying problems and establishing a theoretical framework; designing the experiment, where the instructional materials and strategies are implemented and tested; and retrospective analysis, which involves analyzing and refining the results to enhance understanding and improve future practices (Gravemeijer & Cobb, 2006). This structured methodology ensures both practical relevance and theoretical rigor in addressing educational challenges.

2.1. Preparing for the Experiment

The preparation stage focuses on developing a HLT, which is refined and elaborated during the experiment's implementation. The HLT comprises three main components: activities, objectives, and anticipated student responses to the designed activities. It serves as a foundational guide and the primary focus of the research.

To create the HLT, the researcher conducted a comprehensive literature review on statistical materials, Ethnomathematics, RME, educational technology such as animated videos, and statistical content for eighth-grade students. This review informed the development of an initial instructional theory and the design of an initial learning trajectory to guide the subsequent experiment phases.

2.2. Design Experiment

The design experiment stage consists of two phases: the pilot experiment and the teaching experiment. In the Pilot Experiment phase, the initial learning design was piloted in an authentic classroom setting to evaluate the instructional theory and test the feasibility of the learning trajectory. A total of 32 eighth-grade students from Class VIII B participated in this phase. The pilot experiment provided valuable feedback, which was used to improve the learning design and refine the HLT. Furthermore, in the Teaching Experiment phase, the revised learning trajectory was implemented in a real classroom setting during the teaching experiment phase. This phase involved another group of 32 eighth-grade students from Class VIII F and was conducted with the support of a model teacher.

This research was carried out in a junior high school in Semarang during the 2024/2025 academic year. Data collection focused on students' strategies for completing three designed activities. Research instruments included classroom observation sheets, field notes, student activity sheets, and interviews with both students and teachers. The instruments were validated by lecturers and mathematics educators.

The data collected—comprising students’ strategies and difficulties in problem-solving—was used to refine the HLT. Techniques employed for data collection included focus group observations, video recordings, and document analysis.

2.3. Retrospective Analysis

In the retrospective analysis stage, the data collected during the design experiment was meticulously examined by comparing the initial conjectures outlined in the HLT with the actual implementation of the learning trajectory. This comparison aimed to assess how well the designed activities aligned with students' responses and learning progress. Additionally, students' strategies for solving problems and the difficulties they encountered were thoroughly analyzed to identify patterns and areas for improvement. The analysis provided critical insights into the effectiveness of the instructional design and its alignment with the intended learning outcomes. Finally, research questions were addressed by evaluating the consistency between students' anticipated responses (as conjectured in the HLT) and their actual outcomes observed during the teaching experiments. This process allowed for a deeper understanding of the learning process and informed refinements to the instructional theory and learning design.

3. RESULTS AND DISCUSSION

3.1. Results

The findings of this study present a detailed description of the learning trajectory for statistical material, developed using the context of *pranata mangsa* and supported by animated video technology. The results are organized into three distinct stages, as follow.

3.1.1. Preparing for the Experiment

At this stage, the researcher implements the initial idea of integrating the *pranata mangsa* systems as a context for teaching statistics. The season structure was selected because it effectively represents real-world data suitable for statistical learning. Additionally, the twelve seasons in the system have varying numbers of days, providing an intriguing and meaningful dataset for statistical exploration.

The subsequent step involves developing the HLT, which serves as a conceptual framework and roadmap for the learning process. To create the HLT, the researcher undertakes the following actions: (1) Literature Review: Examines existing studies and theories on statistical education, Ethnomathematics, and RME; (2) Observations: Collects contextual insights into the application of the season structure in statistical learning; (3) Design of Learning Trajectories: Plans and sequences the activities to align with the educational objectives; and (4) Curriculum Review: Evaluates the curriculum to identify appropriate learning materials, objectives, and expected outcomes for eighth-grade statistical education.

The HLT developed for this study comprises three main activities, as summarized in Table 1, which outlines the activities, objectives, and anticipated student responses. These activities form the foundation of the instructional approach, guiding students through a meaningful and contextually relevant exploration of statistical concepts.

Table 1. HLT statistics material

Activity	Goals	Conjectures
Observing the context video of *pranata mangsa*	To collect and present data	- Students can collect and present data - Students can solve contextual problems related to data collection and presentation
Determining the size of the data center	To find the formulas of mean, medians, and modes	- Students can find the formulas of mean, medians, and modes - Students can solve contextual problems related to averages, medians, and modes
Determining the size of the data distribution	To find the formula for range, quartile, quartile range, and quartile divergence	- Students can find the formula for range, quartile, quartile range, and quartile divergence - Students can solve contextual problems related to range, quartile, quartile range, and quartile deviation

3.1.2. Design Experiment

The learning activities in this stage are divided into three tasks aligned with the HLT for statistical material. The first activity focuses on observing the *pranata mangsa* context and involves data collection and presentation.

Activity 1. Observing video of pranata mangsa context to collect and present data

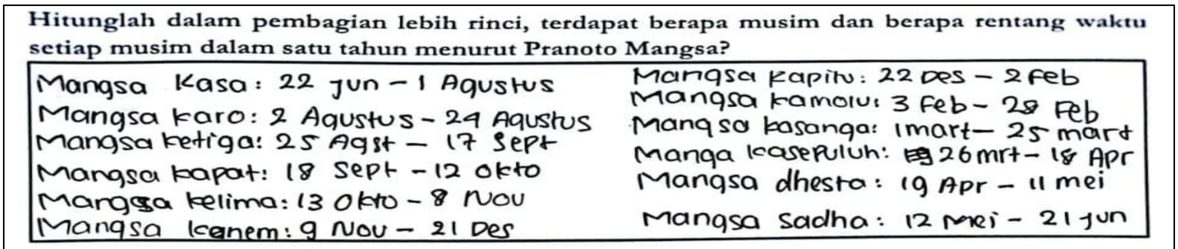
Students are divided into eight groups, each consisting of four members, to encourage collaboration and discussion during the activity. Furthermore, the teacher begins by showing a video about the *pranata mangsa*, which explains the definition, description, and historical background of the seasonal system. Students attentively observe the video to extract key information as shown in Figure 1.

Figure 1. Students observe a video of the *pranata mangsa*

After observing the video, students are tasked with collecting data related to the seasons in the *pranata mangsa*, including the names of the seasons and the number of days in each in the students' worksheet. More details can be seen in Figure 2.

Figure 2. Activity 1 in the students' worksheet

Moreover, their responses are summarized in Figure 3, which lists the twelve seasons along with their respective time spans.



Hitunglah dalam pembagian lebih rinci, terdapat berapa musim dan berapa rentang waktu setiap musim dalam satu tahun menurut Pranoto Mangsa?

Mangsa Kasa : 22 Jun – 1 Agustus
Mangsa Karo : 2 Agustus – 24 Agustus
Mangsa Ketiga : 25 Agst – 17 Sept
Mangsa Kapat : 18 Sept – 12 Okto
Mangsa Kelima : 13 Okto – 8 Nov
Mangsa Kenem : 9 Nov – 21 Des
Mangsa Kapitu : 22 Des – 2 Feb
Mangsa Kamolu : 3 Feb – 28 Feb
Mangsa Kasanga : 1 mart – 25 mart
Manga Kasepuluh : 26 mrt – 18 Apr
Mangsa dhesta : 19 Apr – 11 mei
Mangsa Sadha : 12 Mei – 21 Jun

Translate:

Calculate in more detail how many seasons there are and how long the span of each season in a year of Pranata mangsa structure is.

Mangsa Kasa : 22 June - 1August 1
Mangsa Karo : 2 August - 24 August
Mangsa ketiga : 25 August – 17 September
Mangsa Kapat : 18 September - 12 October
Mangsa Kelima : 13 October - 8 November
Mangsa Kanem : 9 November – 21 December
Mangsa Kapitu : 22 December – 2 February
Mangsa Kamolu : 3 February - 28 February
Mangsa Kasanga : 1 March – 25 March
Mangsa Kasepuluh : 26 March - 18 April
Mangsa Dhesta : 19 April - 11 May
Mangsa Sadha : 12 May – 21 June

Figure 3. Student answers regarding data collection

Using the collected data, students are then instructed to present their findings in a table to organize the information clearly and make it more comprehensible. An example of their output is shown in Figure 4.

Nama Musim	Rentan Waktu
Mangsa Kasa	22 juni - 1 agustus
Mangsa Karo	2 Agustus - 24 agustus
Mangsa Katiga	25 Agustus - 17 September
Mangsa Kapat	18 September - 12 oktober
Mangsa Kalima	13 oktober - 8 November
Mangsa Kanem	9 November - 21 Desember
Mangsa Kapitu	22 Desember - 2 februari
Mangsa Kawolu	3 februari - 28 februari
Mangsa Kasanga	1 Maret - 25 Maret
Mangsa Kasepuluh	26 Maret - 18 April
Mangsa dhesta	19 April - 11 Mei
Mangsa Sadha	12 Mei - 21 juni

Translate:

Season Name	*Time Range*
Mangsa 1	*22 June - 1 August*
Mangsa 2	*2 August - 24 August*
Mangsa 3	*25 August - 17 September*
Mangsa 4	*18 September - 12 October*
Mangsa 5	*13 October – 8 November*
Mangsa 6	*9 November - 21 December*
Mangsa 7	*22 December - 2 February*
Mangsa 8	*3 February - 28 February*
Mangsa 9	*1 March - 25 March*
Mangsa 10	*26 March - 18 April*
Mangsa 11	*19 April - 11 May*
Mangsa 12	*12 May - 21 June*

Figure 4. Student's answer related to data presentation

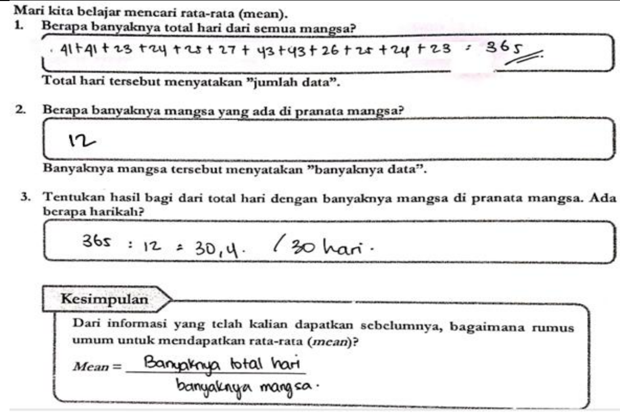
Figure 1 shows the students activity in observing learning video of *pranata mangsa* to identify data given. Figure 3 explain that students successfully gathered data related to the *pranata mangsa*, identifying time intervals for each season and the corresponding days. Furthermore, Figure 4 shows the students also demonstrated their ability to present data in a structured tabular format, facilitating easier analysis and understanding of the seasonal patterns. This method is supported by the following interview excerpt with the student.

Research : How did you determine how many seasons in pranata mangsa?
Student : I learned it from the video context given by the teacher
Researcher : How did you calculate how long the span of each season in a year of pranata mangsa?
Student : By observing and identifying seasons in video of pranata mangsa
Researcher : How did your present data collect?
Student : I make it into table with two columns, first column is season name and the second column is for time range.

The interview confirms that students successfully identify, collect, and present data using the *pranata mangsa* context into table. Finally, this activity establishes a foundation for statistical learning by providing students with real-world data in a culturally relevant context, promoting engagement and practical understanding of data collection and presentation.

Activity 2. Determining the size of the data center

This activity began with students grouped according to their previous arrangements. The teacher introduced the topic by showing a video explaining seasonal structures, highlighting the number of days in each season. Students were tasked with calculating the total number of days across six seasons and then dividing this total by six to determine the average number of days per season. The students' calculations are presented in Figure 5.


Mari kita belajar mencari rata-rata (mean).
1. Berapa banyaknya total hari dari semua mangsa?
41+41+23+24+25+27+43+43+26+25+24+23 = 365
Total hari tersebut menyatakan "jumlah data".
2. Berapa banyaknya mangsa yang ada di pranata mangsa?
12
Banyaknya mangsa tersebut menyatakan "banyaknya data".
3. Tentukan hasil bagi dari total hari dengan banyaknya mangsa di pranata mangsa. Ada berapa harikah?
365 : 12 = 30,4. / 30 hari.
Kesimpulan
Dari informasi yang telah kalian dapatkan sebelumnya, bagaimana rumus umum untuk mendapatkan rata-rata (*mean*)?
Mean = Banyaknya total hari / banyaknya mangsa.

Translate:
Let's learn to look for averages.
How many days are there in total from all seasons?
41 + 41 + 23 + 24 + 25 + 27 + 43 + 43 + 26 + 25 + 24 + 23 = 365
The total number of days states the "amount of data".
How many seasons are there in the pranata mangsa?
12
The large number of seasons indicates a "lot of data."
Determine the total days' quotient by the season system's number of seasons. How many days are there?
$365: 12 = 30{,}4 \ or \ day 30$
Conclusion
What is the general formula to get the mean from the information you have obtained before?
Mean $= \frac{the\ number\ of\ days}{the\ number\ of\ seasons}$

Figure 5. Students' answers are related to the mean

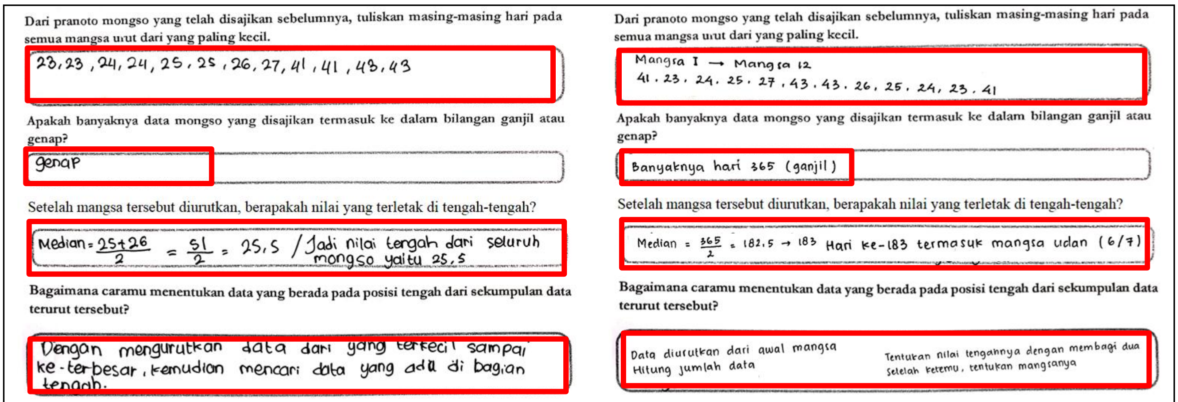
Figure 5 shows that students calculated the total number of days as follows: 41 + 41 + 23 + 24 + 25 + 27 + 43 + 43 + 26 + 25 + 24 + 23 = 365. The total number of days represents the amount of data, and the 12 seasons in the "*pranata mangsa*" system represent the number of data points. Furthermore, the mean was calculated using the formula, mean $= \frac{\text{total number of days}}{\text{number of seasons}} = \frac{365}{12} = 30.4\ days$. Students were guided to generalize the formula for calculating the mean as mean $= \frac{\text{total number of data}}{\text{number of data points}}$. Although some students struggled with generalization, the teacher assisted them in understanding and applying the mean formula effectively. This method is supported by the following interview excerpt with the student.

Research : *How did you determine the mean?*
Student : *I calculated the total number of days in pranata mangsa system. Then divided it with the total seasons.*
Researcher : *How many total numbers of days in pranata mangsa and how many season there?*
Student : *41 + 41 + 23 + 24 + 25 + 27 + 43 + 43 + 26 + 25 + 24 + 23 = 365 days and there are 12 seasons. So, I divide* $\frac{365}{12} = 30.4$ *days.*

The interview confirms that students successfully calculated the total number of days and the seasons using *pranata mangsa* context. This calculation involved summing the number of days and seasons and dividing the number, demonstrating their ability to apply theoretical knowledge to practical contexts.

Furthermore, the lesson progressed with students being tasked to identify the middle value (median) during the twelve seasons. The students provided two distinct approaches to this task. In the first method, students sorted the data based on the number of days in each season, arranging the values from smallest to largest. Next, in the second method, students organized the data sequentially, starting from the beginning of the seasons through to the end. Despite these differing methods, the students successfully grasped the concept of the median, demonstrating an understanding of how to locate the central value in a data set. The outcomes of their work are illustrated in Figure 5. On the other hands, based on the students' responses in Figure 6, it is also evident that they have comprehended the concept of the median as the middle value of a data set once it is sorted. However, variations in their answers emerged due to differing interpretations of the context provided by the *pranata mangsa*.

One group of students interpreted the task as requiring the ordering of the number of days for each season in the *pranata mangsa* system. Conversely, another group understood it as requiring the ordering of the seasons chronologically, from season 1 to season 12. These differing approaches led to distinct methods and results, reflecting how context influences problem-solving strategies. This variation highlights the effectiveness of using the *pranata mangsa* context in stimulating diverse thought processes and encouraging creative problem-solving among students.


Dari pranoto mongso yang telah disajikan sebelumnya, tuliskan masing-masing hari pada semua mangsa urut dari yang paling kecil.

23, 23, 24, 24, 25, 25, 26, 27, 41, 41, 43, 43

Apakah banyaknya data mongso yang disajikan termasuk ke dalam bilangan ganjil atau genap?

genap

Setelah mangsa tersebut diurutkan, berapakah nilai yang terletak di tengah-tengah?

Median = $\frac{25+26}{2} = \frac{51}{2} = 25,5$ / Jadi nilai tengah dari seluruh mongso yaitu 25,5

Bagaimana caramu menentukan data yang berada pada posisi tengah dari sekumpulan data terurut tersebut?

Dengan mengurutkan data dari yang terkecil sampai ke-terbesar, kemudian mencari data yang ada di bagian tengah.

Dari pranoto mongso yang telah disajikan sebelumnya, tuliskan masing-masing hari pada semua mangsa urut dari yang paling kecil.

Mangsa I → Mangsa 12
41. 23. 24. 25. 27. 43. 43. 26. 25. 24. 23. 41

Apakah banyaknya data mongso yang disajikan termasuk ke dalam bilangan ganjil atau genap?

Banyaknya hari 365 (ganjil)

Setelah mangsa tersebut diurutkan, berapakah nilai yang terletak di tengah-tengah?

Median = $\frac{365}{2}$ = 182,5 → 183 Hari ke-183 termasuk mangsa udan (6/7)

Bagaimana caramu menentukan data yang berada pada posisi tengah dari sekumpulan data terurut tersebut?

Data diurutkan dari awal mangsa
Hitung jumlah data
Tentukan nilai tengahnya dengan membagi dua
Setelah ketemu, tentukan mangsanya

Translate:

The season structure data that has been presented season, written each day on all seasons in order from the smallest.
23, 23, 24, 24, 25, 25, 26, 27, 41, 41, 43, 43
Does the amount of season data present fall into odd or even numbers?
Complete
Once the season is sorted, what value lies in the middle?
Median = $\frac{25+26}{2}$ = 25,5
How do you determine which data season is in the middle of the ordered data set?
Sorting the data from the smallest to the largest and then looking for the data in the middle.

The season structure data that has been presented season, written each day on all seasons in order from the smallest.
season 1 to season 12
41, 23, 24, 25, 27, 43, 43, 26, 25, 24, 23, 41
Does the amount of season data present fall into odd or even numbers?
Number of days 365 (odd)
Once the season is sorted, what value lies in the middle?
Median or (rainy season) = $\frac{365}{2}$ = 182,5183
How do you determine which data season is in the middle of the ordered data set?
Data sorted from smallest
Count the amount of data
Determine the middle value by dividing by 2
Once found, determine the season

Figure 6. Student answers related to the median

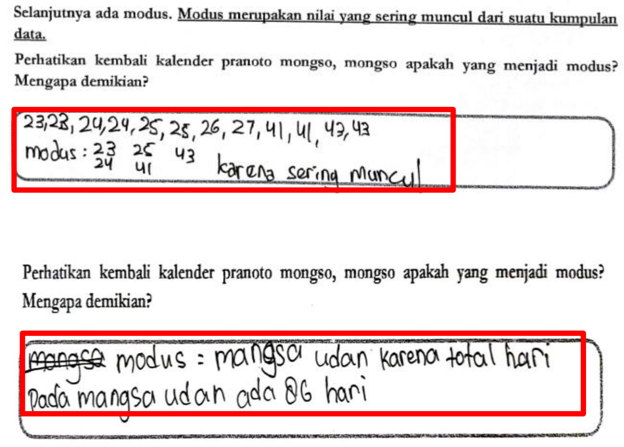
This approach is supported by the following interview excerpt with student 1 and student 2 as follows.

Research : *How did you determine the median?*
Student 1 : *Firstly, I write the day for each season data from the smallest, namely 23, 23, 24, 24, 25, 25, 26, 27, 41, 41, 43, 43*
Researcher : *Does the amount of season data present fall into odd or even number?*
Student 1 : *even number*
Researcher : *why it should be even number?*
Student 1 : *because there are 12 seasons*
Researcher : *So, how did you determine the median?*
Student 1 : *Sorting the data from the smallest to the largest and then looking for the data in the middle. Because there are 12 data, even, so I find the middle data is the average from data 6 and 7, that is (25+26)/2=25.5.*

Research : *How did you determine the median?*
Student 2 : *Firstly, I write the day from season 1 to 12, that is 41,23,24,25,27,43,43,26,25,24,23,41*
Researcher : *So, do you mean that the smallest to the largest data is season 1, 2, to 12?*
Student 2 : *Yes Mam.*
Researcher : *Does the amount of season data present fall into odd or even number?*
Student 2 : *because the total number of days in pranata mangsa is 365, so it is odd number*
Researcher : *So, how did you determine the median?*
Student 2 : *Sorting the data season from the smallest (season 1) to the largest (season 12), then I count the amount of data, that is 365 days, determine the middle value by dividing by 2, so I get 365/2=182.5183, then determine the season on that day.*

The interview confirms that students successfully determine the median using the *pranata mangsa*, although they have different strategies. This calculation involved ordering numbers, summing the numbers, and dividing the numbers, demonstrating their ability to apply theoretical knowledge to practical contexts and using it to solve given problems.

Subsequently, students were instructed to explore the concept of the mode by identifying the season with the most days. Two distinct versions of student responses emerged. In the first version, students identified the mode based on the most frequently occurring number of days in each season. Furthermore, in the second version, students determined the mode by calculating the total number of days across all seasons and identifying the season with the highest total. Finally, these variations in approaches demonstrate different interpretations of the mode concept within the context of the *pranata mangsa*. The students' answers illustrating these methods are presented in Figure 7.


Selanjutnya ada modus. Modus merupakan nilai yang sering muncul dari suatu kumpulan data.
Perhatikan kembali kalender pranoto mongso, mongso apakah yang menjadi modus? Mengapa demikian?

23,23, 24,24, 25, 25, 26, 27, 41, 41, 43, 43
modus : 23 24 25 41 43 karena sering muncul

Perhatikan kembali kalender pranoto mongso, mongso apakah yang menjadi modus? Mengapa demikian?

~~Mangsa~~ modus : mangsa udan karena total hari pada mangsa udan ada 86 hari

Translate:
Next, there is a mode. Mode is a value that often appears from a data set. Pay attention to the calendar of the season system; what season is the mode?
Why is that?
Mode = 23,24,25,41,43
Because it often appears

Translate:
Look back at the *pranata mangsa* calendar; which season is the mode?
Mode = rainy season because the total days in the rainy season are 86 days

Figure 7. Student answers related to the mode

This approach is supported by the following interview excerpt with student 1.

Research : *How did you determine the mode?*
Student : *Firstly, I write the day for each season data from pranata mangsa context, namely 23, 23, 24, 24, 25, 25, 26, 27, 41, 41, 43, 43, then I determine the mode from the value that often appears, namely 23, 24, 25, 41, 43.*

In addition, the interview excerpt with student 2 is follows.

Research : *How did you determine the mode?*
Student : *Firstly, I calculate the number of the days for each season in pranata mangsa, and the rainy season is the season with the most days, namely 86 days, so, the mode is the rainy season, 86 days.*

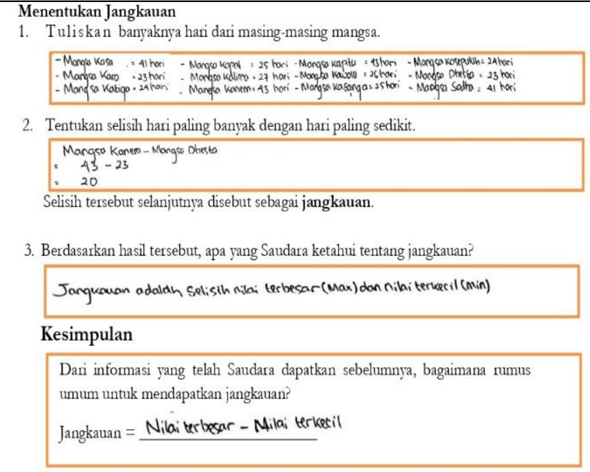
The interview confirms that students successfully determine the mode using the *pranata mangsa*, although they have different strategies. This calculation involved comparing numbers, summing the numbers, demonstrating their ability to apply theoretical knowledge to practical contexts, and using it to solve given problems and make decisions.

Figure 5 demonstrates the students' work in determine the mean based on the *pranata mangsa* context. Figure 6 shows the students could determine the median using *pranata mangsa* context with a different strategy. Figure 7 demonstrates that the student could find the mode also in different strategy. It can be concluded that students successfully identified and understood the concepts of mean, median, and mode within the context of *pranata mangsa*. The activity revealed multiple versions of students' responses, reflecting diverse interpretations and approaches to solving the problems as shown in Figures 6 and 7.

The use of the *pranata mangsa* context proved to be an effective strategy, as it stimulated students' creativity and encouraged them to explore various methods for discovering and solving mathematical problems. This contextual approach not only enhanced their comprehension of statistical concepts but also fostered critical thinking and problem-solving skills.

Activity 3. Determining the size of the data distribution

Like the previous activity, the teacher introduced the concept of data distribution by presenting a video about the *pranata mangsa* system, students were instructed to determine the maximum and minimum values of the data to understand the concept of range. The results of the students' analyses are displayed in Figure 8.


Menentukan Jangkauan

1. Tuliskan banyaknya hari dari masing-masing mangsa.

- Mangsa Kasa : 41 hari - Mangsa Karo : 23 hari - Mangsa Katiga : 24 hari - Mangsa Kapat : 25 hari - Mangsa Kalima : 27 hari - Mangsa Kanem : 43 hari - Mangsa Kapitu : 43 hari - Mangsa Kawolu : 26 hari - Mangsa Kasanga : 25 hari - Mangsa Kasepuluh : 24 hari - Mangsa Dhesta : 23 hari - Mangsa Sadha : 41 hari

2. Tentukan selisih hari paling banyak dengan hari paling sedikit.

Mangsa Kanem – Mangsa Dhesta
= 43 – 23
= 20

Selisih tersebut selanjutnya disebut sebagai **jangkauan**.

3. Berdasarkan hasil tersebut, apa yang Saudara ketahui tentang jangkauan?

Jangkauan adalah selisih nilai terbesar (Max) dan nilai terkecil (Min)

Kesimpulan

Dari informasi yang telah Saudara dapatkan sebelumnya, bagaimana rumus umum untuk mendapatkan jangkauan?

Jangkauan = Nilai terbesar – Nilai terkecil

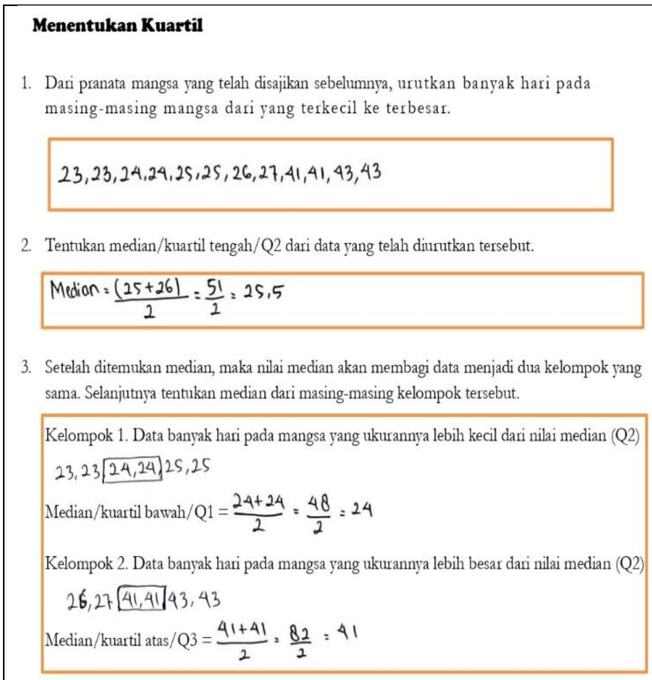
Translate:

Determining Range

1. Write down the number of days for each season
   - *Mangsa kasa* = 41 days - *Mangsa kapitu* = 43 days
   - *Mangsa karo* = 23 days - *Mangsa kawolu* = 26 days
   - *Mangsa katiga* = 24 days - *Mangsa kasanga* = 25 days
   - *Mangsa kapat* = 25 days - *Mangsa kasepuluh* = 24 days
   - *Mangsa kalima* = 27 days - *Mangsa dhesta* = 23 days
   - *Mangsa kanem* = 43 days - *Mangsa sadha* = 41 days
2. Determine the difference between the most days and the fewest days
   mangsa kanem – mangsa dhesta = 43 – 23 = 20
   This difference is referred to as **range**
3. Based on these results, what do you know about range?
   Conclusion
   From the information you have previously obtained, what is the general formula for getting a range?
   Range = largest value – smallest value

Figure 8. Student answers related to range

Next, students were instructed to organize the data in ascending order. Building upon their understanding of the median concept introduced in Activity 2, they divided the dataset into two groups to identify the middle quartile. The first group comprised data values smaller than the median, while the second group included values larger than the median. Students were then tasked with calculating the median of each group to conceptualize the lower and upper quartiles. The students' responses are presented in Figure 9.


Menentukan Kuartil

1. Dari pranata mangsa yang telah disajikan sebelumnya, urutkan banyak hari pada masing-masing mangsa dari yang terkecil ke terbesar.

23, 23, 24, 24, 25, 25, 26, 27, 41, 41, 43, 43

2. Tentukan median/kuartil tengah/Q2 dari data yang telah diurutkan tersebut.

Median = $\frac{(25+26)}{2} = \frac{51}{2} = 25,5$

3. Setelah ditemukan median, maka nilai median akan membagi data menjadi dua kelompok yang sama. Selanjutnya tentukan median dari masing-masing kelompok tersebut.

Kelompok 1. Data banyak hari pada mangsa yang ukurannya lebih kecil dari nilai median (Q2)

23, 23, $\boxed{24, 24}$ 25, 25

Median/kuartil bawah/Q1 = $\frac{24+24}{2} = \frac{48}{2} = 24$

Kelompok 2. Data banyak hari pada mangsa yang ukurannya lebih besar dari nilai median (Q2)

26, 27, $\boxed{41, 41}$ 43, 43

Median/kuartil atas/Q3 = $\frac{41+41}{2} = \frac{82}{2} = 41$

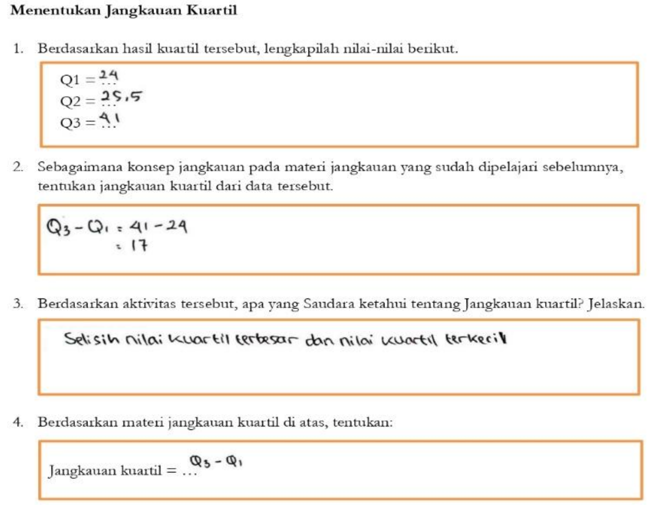
Translate:

Determining Quartiles

1. From the *pranata mangsa* system that has been presented previously, sort the number of days in each season from the smallest to the largest.
   23, 23, 24, 24, 25, 25, 26, 27, 41, 41, 43, 43
2. Determine the median/middle quartile/Q2 from the sorted data.
   Median = $\frac{(25+26)}{2} = \frac{51}{2} = 25,5$
3. After finding the median, the median value will divide the data into two equal groups. Next, determine the median of each group.
   Group 1. Data on the number of *pranata mangsa* whose size is smaller than the median value (Q2)
   23, 23, 24, 24, 25, 25
   Median/lower quartile/Q1 = $\frac{24+24}{2} = \frac{48}{2} = 24$
   Group 2. Data on the number of days in *pranata mangsa* whose size is larger than the median value (Q2)
   26, 27, 41, 41, 43, 43
   Median/upper quartile/Q3 = $\frac{41+41}{2} = \frac{82}{2} = 41$

Figure 9. Student answers related to quartiles

In the subsequent activity, students explored the concept of the quartile range. Building on their prior understanding of the range and quartile concepts from the previous activity, they combined these ideas to derive the quartile range. The students' responses, illustrating their comprehension and calculations, are shown in Figure 10.


Menentukan Jangkauan Kuartil

1. Berdasarkan hasil kuartil tersebut, lengkapilah nilai-nilai berikut.
   Q1 = 24
   Q2 = 25,5
   Q3 = 41
2. Sebagaimana konsep jangkauan pada materi jangkauan yang sudah dipelajari sebelumnya, tentukan jangkauan kuartil dari data tersebut.
   $Q_3 - Q_1 = 41 - 24 = 17$
3. Berdasarkan aktivitas tersebut, apa yang Saudara ketahui tentang Jangkauan kuartil? Jelaskan.
   Selisih nilai kuartil terbesar dan nilai kuartil terkecil
4. Berdasarkan materi jangkauan kuartil di atas, tentukan:
   Jangkauan kuartil = ... $Q_3 - Q_1$

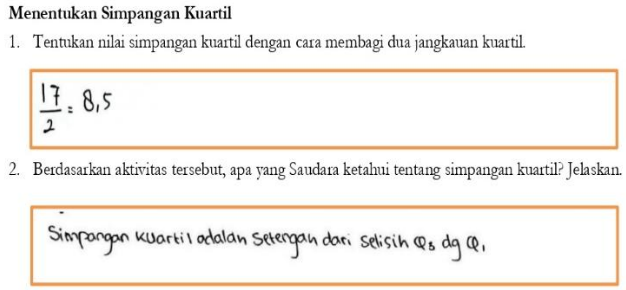
Translate:

Determining Quartile Range

1. Based on the quartile results, complete the following values.
   Q1 = lower quartile (24)
   Q2 = middle quartile (25,5)
   Q3 = upper quartile (41)
2. As the concept of range in the range material that has been studied previously, determine the quartile range of the data.
   Q3 - Q1 = 41 – 24 = 17
3. Based on the activity, what do you know about quartile range?
   The difference between the largest quartile value and the smallest quartile value
4. Based on the quartile range material above, determine
   Quartile range = Q3 – Q1

Figure 10. Students answer related to quartile range

Students were able to understand the concept of quartile deviation by dividing the quartile range value by two. This calculation allowed them to quantify the dispersion of the dataset around the median more precisely. The students' responses, demonstrating their understanding and computations, are displayed in Figure 11.


Menentukan Simpangan Kuartil

1. Tentukan nilai simpangan kuartil dengan cara membagi dua jangkauan kuartil.
   $\frac{17}{2} = 8{,}5$
2. Berdasarkan aktivitas tersebut, apa yang Saudara ketahui tentang simpangan kuartil? Jelaskan.
   Simpangan kuartil adalah setengah dari selisih Q_3 dg Q_1

Translate:

Determining Quartile Deviation

1. Determine the quartile deviation value by dividing the quartile range by two
   $\frac{17}{2} = 8{,}5$
2. Based on the activity, what do you know about quartile deviation? Explain.
   Quartile deviation is half of the difference Q3 – Q1

Figure 11. Students' answers related to quartile deviations

Figure 9 shows students' work in the determined quartile. Figure 10 demonstrates the students' answers in determined quartile reach. Figure 11 shows students' work in determined quartile deviation. It can be concluded that students successfully grasped the concepts of range, quartiles, quartile range, and quartile deviation. This activity revealed the context used could stimulate and help students in grasping the concept learned.

3.1.3. Retrospective Analysis

The HLT outlined in Table 1 serves as a framework for achieving the learning objectives. It also functions as a tool to identify and address potential challenges that students might encounter during the learning process. Moreover, the HLT was compared with the data collected to analyze how students comprehended and applied statistical concepts within the context of *pranata mangsa* using TE-RME.

The outcomes of the students' responses aligned with the researcher's expectations. From the first activity, students demonstrated their ability to collect and present data through video observations related to the *pranata mangsa* system. Students were able to identify the names of the seasons and the number of days in each season in *pranata mangsa* as shown in Figure 3. Furthermore, students were also able to present the data in the form of a table as shown in Figure 4. The students' abilities have also been demonstrated through interviews. This shows that through activity 1 which was designed using the help of a *pranata mangsa* context video with the aim of students being able to understand, identify, collect, and present data correctly.

In the second activity, students could understand the concept of data centralization measures. They could determine the mean, median, and mode. Even students could come up with various interpretations of problem-solving strategies and solutions using the context of *pranata mangsa* system in determining the median. Students were able to find the mean through the *pranata mangsa* context by recording the number of days in each season and dividing it by the number of seasons as shown in Figure 4. Students were able to find the concept of the median with various strategies that emerged through various interpretations of the *pranata mangsa* context as shown in Figure 5. Furthermore, students were able to find the concept of mode through the *pranata mangsa* context by finding the largest number of days as shown in Figure 6. From this activity 2, the objectives designed by the researcher in HLT can be achieved.

Lastly, in the third activity, students could grasp the idea of data distribution measures. They could determine the range, quartile, quartile range, and quartile deviation using *pranata mangsa* context. Students were able to determine the range by finding the difference between the largest and smallest number of days of the *pranata mangsa* as shown in Figure 8. Students determine the quartile by determining the median of the data on the number of days for each season in the *pranata mangsa* as Q2, then determining Q1 and Q2 as shown in Figure 9. Students were also able to find the quartile range by finding the difference between Q3 and Q1 as described in Figure 10. Students were then able to find the quartile deviation which is half of the quartile range as shown in Figure 11. From this activity 3, it can be seen that the objectives designed in HLT can be achieved.

Based on activities 1, 2, and 3, it is clear that students can comprehend statistical content within the context of *pranata mangsa* by studying with TE-RME. The utilization of context and technology can inspire students to be motivated and learn the subject more simply, enjoyably, and meaningfully, as well as promote problem-solving skills with diverse strategies through various interpretations of the *pranata mangsa* context. The three activities were designed in HLT run in by actual learning and can achieve the expected learning objectives, as well as offer insights on the range of student responses that emerge as a result of the context intervention and the new TE-RME approach applied.

3.2. Discussion

TE-RME is instrumental in facilitating students' comprehension of statistical material with greater enthusiasm and deeper understanding. The integration of technology, particularly through the use of animated videos, plays a crucial role in this approach. Animated videos are effective tools for helping students visualize abstract statistical concepts by connecting them to concrete and familiar contexts, such as the *pranata mangsa* system. This aligns with Timotheou et al. (2023), who found that videos engage students more effectively than traditional teaching methods by providing visual stimulation, making complex concepts more accessible and relatable. Additionally, Uchima-Marin et al. (2024) emphasized that videos enhance engagement and foster a collaborative learning environment, catering to diverse learning preferences and improving overall learning outcomes, as also noted by Haleem et al. (2022). Moreover, using animated video could improve critical thinking ability (Pratiwi et al., 2022).

Using ethnomathematics as a contextual framework, such as the *pranata mangsa* system (Nursyahidah et al., 2024; Prahmana et al., 2021), provides a culturally relevant approach to teaching statistics. This method contextualizes mathematical concepts within students' cultural experiences, enhancing their understanding and engagement while fostering an appreciation for diverse mathematical practices (Nursyahidah & Albab, 2021; Prahmana & D'Ambrosio, 2020). Imswatama and Lukman (2018) demonstrated that culturally relevant contexts lead to improved learning outcomes by enabling deeper understanding. Similarly, Rosa and Orey (2023) found that integrating ethnomathematics into instruction enhances students' mathematical skills and fosters higher-order thinking abilities. Moreover, using ethnomathematics could emergence of mathematical knowledge, created the identification of specific mathematical concepts (Meeran et al., 2024).

Realistic Mathematics Education complements this approach by making mathematical concepts more accessible and relevant to students' daily lives. RME promotes student engagement and understanding, as highlighted by Nursyahidah and Albab (2021) and Putri et al. (2021), who noted its positive impact on problem-solving skills. Moreover, Andzin et al. (2024) and Hardiyanto et al. (2024) emphasized that RME-based learning improves conceptual comprehension, making statistical concepts easier to grasp.

Furthermore, the learning process includes a series of structured activities designed to enhance students' statistical understanding. Each activity begins with a contextual video, such as one depicting the *pranata mangsa* system, to spark student interest and provide a foundation for learning. These videos help students collect and present data effectively, as demonstrated in this study. Yakubova et al. (2020) found that contextual videos increase students' learning interest, while Wirth and Greefrath (2024) observed that such videos enhance critical thinking skills and encourage diverse responses. In addition, learning video can improve students motivation and concept understanding (Nursyahidah et al., 2023) and also enriched learning experience, enhancing students' comprehension of concepts and their ability to solve contextual problems effectively (Nursyahidah et al., 2025).

In addition, students collaborate in groups to discuss students worksheets with guidance from their teacher. This interaction promotes the exchange of ideas and helps students navigate challenging concepts. Sofroniou and Poutos (2016) reported that group learning improves critical thinking and analytical skills, while Knopika and Oszwab (2021) highlighted its role in fostering competitiveness and reducing anxiety.

The final stage involves solving real-world statistical problems, leveraging the meaningfulness of RME. Students actively engage in the learning process, applying concepts to practical situations. Silva et al. (2022) found that RME makes learning more relevant and meaningful, while Van den Heuvel-Panhuizen (2020) demonstrated its effectiveness in improving critical thinking and problem-solving skills.

Finally, the integration of Technology, Ethnomathematics, and RME offers a comprehensive approach to teaching statistics. By combining technology, cultural contexts, and realistic scenarios, this methodology not only enhances students' conceptual understanding but also fosters critical thinking, engagement, and the ability to apply knowledge to real-world problems. These findings are supported by prior research, affirming the effectiveness of TE-RME, an innovative pedagogical approach.

4. CONCLUSION

This study has successfully developed a learning trajectory for statistical material using the context of *pranata mangsa* through the TE-RME approach. The trajectory integrates contextual videos to enhance students' conceptual understanding of statistical topics. The learning trajectory comprises three well-structured activities, such as observing videos of *pranata mangsa* to collect and present data, deriving formulas for measuring the data center, and deriving formulas for measuring data dispersion. These activities guide students progressively in understanding statistical concepts while fostering meaningful connections between mathematics and local cultural wisdom. The findings affirm the potential of integrating local wisdom with technology-enhanced learning approaches to improve the teaching and learning of statistical material.

Despite its promising results, this study has certain limitations. First, the scope of implementation was limited to a specific cultural context, namely *pranata mangsa*, which might not be universally applicable or relatable to students in other regions. Second, the study primarily focuses on conceptual understanding and does not comprehensively evaluate other aspects of learning, such as problem-solving skills or collaborative competencies. Additionally, the sample size and duration of the intervention were limited, which may affect the generalizability and long-term applicability of the findings. Addressing these limitations in future studies could provide a more holistic understanding of the approach's effectiveness.

Building on these findings, future research should explore the integration of other culturally relevant contexts to develop diverse learning trajectories that accommodate varied cultural and regional backgrounds. Expanding the scope of the TE-RME approach to other mathematical topics and conducting long-term studies with larger and more diverse populations would also enhance the robustness of this educational model. Further, the use of advanced technological tools, such as interactive simulations or augmented reality, could provide deeper engagement and improve the scalability of context-based learning. By embracing such advancements, researchers and educators can continue to enrich mathematics education through innovative, culturally grounded, and technology-integrated pedagogical strategies.

Acknowledgments

The authors would like to thank the Universitas PGRI Semarang, SMP 6 Semarang, and the reviewers for their valuable feedback and support for this research paper.

Declarations

Author Contribution	: FN: Conceptualization, Visualization, Writing - original draft, and Writing - review & editing; W: Writing - review & editing; SM: Formal analysis, and Methodology; KW: Supervision, and Validation.
Funding Statement	: This research was funded by Universitas PGRI Semarang.
Conflict of Interest	: The authors declare no conflict of interest.
Additional Information	: Additional information is available for this paper.

REFERENCES

Andzin, N. S., Sari, P. Y. P., Widodo, R. C., Sukowati, D. I., Indriastuti, S., & Nursyahidah, F. (2024). Arithmetic sequences and series learning using realistic mathematics education assisted by augmented reality. *Mathematics Education Journal*, *18*(1), 139–148. https://doi.org/10.22342/jpm.v18i1.pp139-148

Ben-Zvi, D., Bakker, A., & Makar, K. (2015). Learning to reason from samples. *Educational Studies in Mathematics*, *88*(3), 291–303. https://doi.org/10.1007/s10649-015-9593-3

Borovcnik, M., & Terán, T. E. (2021). How the project method contributes to the construction of meaning in statistics–also in a hybrid learning environment. In *Satellite conference of the International Association for Statistical Education (IASE)*.

Charles-Owaba, T. (2019). Assessing areas of students' difficulties in the learning of statistics content in secondary school mathematics curriculum in Bayelsa. *Abacus (Mathematics Education Series)*, *44*(1), 321–332.

Crisostomo, M. E., & Chauhan, R. S. (2019). Using the occupational information network (O*NET) to demonstrate the importance of understanding statistics for undergraduate students. *Teaching Statistics*, *41*(3), 89–93. https://doi.org/10.1111/test.12188

D'Ambrosio, U. (1999). Literacy, matheracy, and technocracy: A trivium for today. *Mathematical thinking and learning*, *1*(2), 131–153. https://doi.org/10.1207/s15327833mtl0102_3

D'Ambrosio, U. (2018). Etnomatemática, justiça social e sustentabilidade. *Estudos avançados*, *32*, 189–204. https://doi.org/10.1590/s0103-40142018.3294.0014

Da, N. T. (2023). Realistic mathematics education and authentic learning: A combination of teaching mathematics in high schools. *Journal of Mathematics and Science Teacher*, *3*(1), 1–9. https://doi.org/10.29333/mathsciteacher/13061

Drijvers, P. (2019). Head in the clouds, feet on the ground – A realistic view on using digital tools in mathematics education. In A. Büchter, M. Glade, R. Herold-Blasius, M. Klinger, F. Schacht, & P. Scherer (Eds.), *Vielfältige Zugänge zum*

Mathematikunterricht: Konzepte und Beispiele aus Forschung und Praxis (pp. 163–176). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-24292-3_12

Fauzan, A., Harisman, Y., Yerizon, Y., Suherman, S., Tasman, F., Nisa, S., Sumarwati, S., Hafizatunnisa, H., & Syaputra, H. (2024). Realistic mathematics education (RME) to improve literacy and numeracy skills of elementary school students based on teachers' experience. *Infinity Journal*, *13*(2), 301–316. https://doi.org/10.22460/infinity.v13i2.p301-316

Feeley, T. H., Keller, M., & Kayler, L. (2023). Using animated videos to increase patient knowledge: A meta-analytic review. *Health Education & Behavior*, *50*(2), 240–249. https://doi.org/10.1177/10901981221116791

Gravemeijer, K., & Cobb, P. (2006). Design research from a learning design perspective. In J. Van den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational design research* (pp. 29–63). Routledge.

Gravemeijer, K., & Doorman, M. (1999). Context problems in realistic mathematics education: A calculus course as an example. *Educational Studies in Mathematics*, *39*(1), 111–129. https://doi.org/10.1023/A:1003749919816

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Hardiyanto, D., Asokawati, I., Majid, P. M., Maesaroh, A. T., & Nursyahidah, F. (2024). Learning reflection using realistic mathematics education assisted by GeoGebra software. *Jurnal Pendidikan Matematika*, *18*(1), 15–26. https://doi.org/10.22342/jpm.v18i1.pp15-26

Imswatama, A., & Lukman, H. S. (2018). The effectiveness of mathematics teaching material based on ethnomathematics. *International Journal of Trends in Mathematics Education Research*, *1*(1), 35–38. https://doi.org/10.33122/ijtmer.v1i1.11

Knopika, T., & Oszwab, U. (2021). La resolución de problemas e-cooperativo como estrategia para el aprendizaje de las matemáticas durante la pandemia de la COVID-19. *Education in the Knowledge Society (EKS)*, *22*, e25176. https://doi.org/10.14201/eks.25176

Koparan, T. (2015). Difficulties in learning and teaching statistics: teacher views. *International Journal of Mathematical Education in Science and Technology*, *46*(1), 94–104. https://doi.org/10.1080/0020739X.2014.941425

Luneta, K. (2021). Living culturally responsive mathematics education with/in indigenous communities. *Research in Mathematics Education*, *23*(3), 338–342. https://doi.org/10.1080/14794802.2021.1899970

Meeran, S., Mamanyena, K. S., Merriam, M. M., Noor, D. M., & and Makokotlela, M. V. (2024). Ethnomathematics in Intermediate Phase: Reflections on the Morabaraba Game as Indigenous Mathematical knowledge. *African Journal of Research in Mathematics, Science and Technology Education*, *28*(2), 171–184. https://doi.org/10.1080/18117295.2024.2340095

Nursyahidah, F., & Albab, I. U. (2021). Learning design on surface area and volume of cylinder using indonesian ethno-mathematics of traditional cookie maker assisted by geogebra. *Mathematics Teaching Research Journal*, *13*(4), 79–98.

Nursyahidah, F., Albab, I. U., & Rubowo, M. R. (2023). Learning design of sphere using realistic mathematics education assisted by interactive video. *Jurnal Pendidikan Matematika*, *17*(3), 297–312.

Nursyahidah, F., Albab, I. U., Rubowo, M. R., Tuni'mah, L., Febriansyah, M. A., Hardiyanto, D., & Atmaja, S. A. A. (2024). Development hypothetical learning trajectory on statistics material in grade VIII using realistic mathematics education at the preliminary stage with pranata mangsa context. *Jurnal Pendidikan Matematika (Kudus)*, *7*(2), 249–264. https://doi.org/10.21043/jpmk.v7i2.29180

Nursyahidah, F., Anindya, F. M., Yulianti, M. A., Prisanto, Z. I., & Rosario, M. A. R. (2025). Integrating local wisdom with technology: Designing learning trajectory of cylinder through realistic mathematics education approach. *Mathematics Education Journal*, *19*(1), 81–98. https://doi.org/10.22342/jpm.v19i1.pp81-98

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2017). Improving mathematics teaching in kindergarten with realistic mathematical education. *Early Childhood Education Journal*, *45*(3), 369–378. https://doi.org/10.1007/s10643-015-0768-4

Prahmana, R. C. I. (2022). Ethno-realistic mathematics education: The promising learning approach in the city of culture. *SN Social Sciences*, *2*(257). https://doi.org/10.1007/s43545-022-00571-w

Prahmana, R. C. I., & D'Ambrosio, U. (2020). Learning geometry and values from patterns: Ethnomathematics on the batik patterns of Yogyakarta, Indonesia. *Journal on Mathematics Education*, *11*(3), 439–456. https://doi.org/10.22342/jme.11.3.12949.439-456

Prahmana, R. C. I., Ramadhani, R., Arnal-Palacián, M., & Risdiyanti, I. (2023). Trivium curriculum in ethno-RME approach: An impactful insight from ethnomathematics and realistic mathematics education. *Jurnal Elemen*, *9*(1), 298–316. https://doi.org/10.29408/jel.v9i1.7262

Prahmana, R. C. I., Yunianto, W., Rosa, M., & Orey, D. C. (2021). Ethnomathematics: "Pranatamangsa" system and the birth-death ceremonial in Yogyakarta. *Journal on Mathematics Education*, *12*(1), 93–112. https://doi.org/10.22342/jme.12.1.11745.93-112

Pratiwi, M. D., Putri, R. I. I., & Zulkardi, Z. (2022). Mathematics critical thinking ability materials social arrithmatic class VII assisted video animation in the era of COVID-19. *Infinity Journal*, *11*(2), 297–310. https://doi.org/10.22460/infinity.v11i2.p297-310

Putri, R. I. I., Setyorini, N. P., Meitrilova, A., Permatasari, R., Saskiyah, S. A., & Nusantara, D. S. (2021). Designing a healthy menu project for Indonesian junior high school students. *Journal on Mathematics Education*, *12*(1), 133–146. https://doi.org/10.22342/jme.12.1.13239.133-146

Ridha, S. K., Bostanci, H. B., & Kurt, M. (2022). Using animated videos to enhance vocabulary learning at the noble private technical institute (NPTI) in Northern Iraq/Erbil. *Sustainability*, *14*(12), 7002. https://doi.org/10.3390/su14127002

Rosa, M., D'Ambrosio, U., Orey, D. C., Shirley, L., Alangui, W. V., Palhares, P., & Gavarrete, M. E. (2016). *Current and future perspectives of ethnomathematics as a program*. Springer Nature. https://doi.org/10.1007/978-3-319-30120-4

Rosa, M., & Orey, D. C. (2021). An ethnomathematical perspective of STEM education in a glocalized world. *Bolema: Boletim de Educação Matemática*, *35*(70), 840–876. https://doi.org/10.1590/1980-4415v35n70a14

Rosa, M., & Orey, D. C. (2023). Considerations about ethnomathematics, the culturally relevant pedagogy and social justice in mathematical education. *Educação Matemática Pesquisa*, *25*(2), 145–165. https://doi.org/10.23925/1983-3156.2023v25i2p145-165

Rosli, R., & Aliwee, M. F. (2021). Professional Development of Mathematics Teacher: A Systematic Literature Review. *Contemporary Educational Researches Journal*, *11*(2), 43–54. https://doi.org/10.18844/cerj.v11i2.5415

Ruan, L., Jiang, R., & Dong, K. (2021). Exploration on teaching reform of applied statistics in economics and management based on ability improvement. *Advances in Educational Technology and Psychology*, *5*(9), 203–209.

Sari, D. L., & Nursyahidah, F. (2022). Learning design for statistics materials using the context of traditional market assisted by interactive videos. *Jurnal Elemen*, *8*(1), 29–42. https://doi.org/10.29408/jel.v8i1.4067

Silva, A. C., Viseu, F., Aires, A. P., & Neto, T. B. (2022). Investigative activities for statistics learning with 1st grade portuguese students. *Education Sciences*, *12*(10), 665. https://doi.org/10.3390/educsci12100665

Soe, H. H. K., Khobragade, S., Lwin, H., Htay, M. N. N., Than, N. N., Phyu, K. L., & Abas, A. L. (2021). Learning statistics: Interprofessional survey of attitudes toward statistics using SATS-36. *Dentistry and Medical Research*, *9*(2), 121–125. https://doi.org/10.4103/dmr.dmr_68_20

Sofroniou, A., & Poutos, K. (2016). Investigating the effectiveness of group work in mathematics. *Education Sciences*, *6*(3), 30. https://doi.org/10.3390/educsci6030030

Songkhro, J., Dequiña, L. S., Dominguez, R. R., & Khathayut, P. (2022). Effectiveness of using animated videos via Google Sites in enhancing socio-culture of native English-speaking countries. *Education Quarterly Reviews*, *5*(2), 371–380. https://doi.org/10.31014/aior.1993.05.02.497

Streefland, L. (1991). *Realistic mathematics education in primary school : on the occasion of the opening of the Freudenthal Institute*. CD-β Press. https://cir.nii.ac.jp/crid/1130000795504500608

Suarez-Rivera, C., & Langan, D. (2022). Teaching statistics in context: Effects of statistics history on student learning. In *Proceedings of the 11th International Conference on Teaching Statistics (ICOTS112022), Rosario, Argentina.* https://doi.org/10.52041/iase.icots11.T8F2

Sutarni, S., Sutama, S., Prayitno, H. J., Sutopo, A., & Laksmiwati, P. A. (2024). The development of realistic mathematics education-based student worksheets to enhance higher-order thinking skills and mathematical ability. *Infinity Journal*, *13*(2), 285–300. https://doi.org/10.22460/infinity.v13i2.p285-300

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., Monés, A. M., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. *Education and Information Technologies*, *28*(6), 6695–6726. https://doi.org/10.1007/s10639-022-11431-8

Uchima-Marin, C., Murillo, J., Salvador-Acosta, L., & Acosta-Vargas, P. (2024). Integration of technological tools in teaching statistics: Innovations in educational technology for sustainable education. *Sustainability*, *16*(19), 8344. https://doi.org/10.3390/su16198344

Umbara, U., Prabawanto, S., & Jatisunda, M. G. (2023). Combination of mathematical literacy with ethnomathematics: How to perspective sundanese culture. *Infinity Journal*, *12*(2), 393–414. https://doi.org/10.22460/infinity.v12i2.p393-414

Uyen, B. P., Tong, D. H., Loc, N. P., & Thanh, L. N. P. (2021). The effectiveness of applying realistic mathematics education approach in teaching statistics in grade 7 to students' mathematical skills. *Journal of Education and e-Learning Research*, *8*(2), 185–197. https://doi.org/10.20448/journal.509.2021.82.185.197

Van den Akker, J., Branch, R. M., Gustafson, K., Nieveen, N., & Plomp, T. (2012). *Prototyping to reach product quality*. Springer Science & Business Media.

Van den Akker, J., Gravemeijer, K., McKenney, S., & Nieveen, N. (2006). *Educational design research*. Routledge London.

Van den Heuvel-Panhuizen, M. (2020). *National reflections on the Netherlands didactics of mathematics: Teaching and learning in the context of realistic mathematics education*. Springer Nature. https://doi.org/10.1007/978-3-030-33824-4

Wirth, L., & Greefrath, G. (2024). Working with an instructional video on mathematical modeling: upper-secondary students' perceived advantages and challenges. *ZDM – Mathematics Education*, *56*(4), 573–587. https://doi.org/10.1007/s11858-024-01546-2

Yakubova, G., M., H. E., & Baer, B. L. (2020). Supporting students with ASD in mathematics learning using video-based concrete-representational-abstract sequencing instruction. *Preventing School Failure: Alternative Education for Children and Youth*, *64*(1), 12–18. https://doi.org/10.1080/1045988X.2019.1627999

Zhang, Y. (2018). Application of project teaching method on statistical analysis teaching *Proceedings of the 6th International Conference on Social Science, Education and Humanities Research (SSEHR 2017)*,

Zulkardi, Z., & Setiawan, M. B. T. (2020). Javanese calendar as context to learn number pattern and least common multiple. *Journal of Physics: Conference Series*, *1470*(1), 012094. https://doi.org/10.1088/1742-6596/1470/1/012094