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Integrating Local Wisdom with Technology: Designing Learning Trajectory of Cylinder through Realistic Mathematics Education Approach

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Abstract

The study of cylindrical geometry is a fundamental component of mathematics education, yet many students face challenges in grasping the concepts of surface area and volume. To address this issue, it is imperative to design a structured learning trajectory that leverages innovative approaches and integrates suitable contextual elements with technological assistance. This study explores the implementation of Realistic Mathematics Education (RME) supported by animated videos and Adobe Animate, to facilitate understanding of these concepts. The research focuses on the design of instructional activities centered on the Semarang *Nyadran* tradition as a contextual framework. Employing a design research methodology, this study was conducted in three stages: preliminary design, design experimentation, and retrospective analysis. The participants were seventh-grade students at a state junior high school in Semarang. The resulting learning trajectory comprises four key activities: observing animated videos depicting the *Nyadran* tradition to identify cylindrical characteristics, determining the cylinder's surface area through cardboard modeling, calculating the cylinder's volume using styrofoam and 2D geometry formulae, and solving contextual problems related to cylindrical geometry. The incorporation of the *Nyadran* tradition, animated videos, and Adobe Animate provided a culturally relevant and technologically enriched learning experience, enhancing students' comprehension of cylindrical concepts and their ability to solve contextual problems effectively. This study highlights the potential of integrating local cultural wisdom and technology in mathematics education to create engaging, meaningful, and contextually grounded learning experiences. The findings offer insights for future research to explore other forms of local wisdom as entry points for teaching diverse mathematical topics in innovative and technology-integrated ways.

Keywords: Cylinder, Design Research, Learning Trajectory, *Nyadran* Tradition Context, RME

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INTRODUCTION

Geometry is a fundamental branch of mathematics that integrates concepts, reasoning processes, and axiomatic representations to model spatial objects, relationships, and transformations mathematically (Crompton & Ferguson, 2024). Its study equips students with the skills to solve problems related to measurement and spatial configurations (Alghadari & Noor, 2021). As a mathematical discipline, geometry is pervasive in everyday life and fosters the development of higher-order thinking skills, encouraging students to approach problems critically, logically, and systematically (Deshpande et al., 2021; Malalina et al., 2023).

Despite its importance, numerous studies highlight persistent challenges faced by students in learning geometry, particularly in mastering cylindrical structures and calculating their volume and surface area (Lelinge & Svensson, 2020; Sudirman et al., 2023). These difficulties extend to grasping the conceptual foundations of curved-sided three-dimensional shapes and identifying appropriate solutions to problems involving their area and volume (Lelinge & Svensson, 2020). Students often

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struggle to recall and apply formulas for the surface area and volume of cylinders, reflecting broader challenges in employing mathematical principles effectively (Marasabessy et al., 2021). Furthermore, a lack of interest in curved-sided three-dimensional shapes, coupled with difficulties in naming their components and applying relevant formulas, exacerbates these challenges (Huang & Wu, 2019).

Several factors contribute to students' difficulties in understanding geometry, including the lack of lesson preparation by teachers prior to classroom instruction (Nursyahidah et al., 2021), the abstract nature of the material that requires students to rely on imagination for visual representation (Suseno et al., 2020), and the insufficient use of innovative learning media (Fendiyanto, 2023). These challenges significantly hinder students' ability to grasp the fundamental concepts of the material. The inherent abstractness of mathematics necessitates the support of clear visual aids and more effective learning media to facilitate comprehension (Sudirman et al., 2023).

To address these issues, a potential solution lies in designing instructional strategies that incorporate innovative approaches, appropriate contextualization, and technology-integrated learning media (Gübbük et al., 2024; Nursyahidah & Albab, 2021). One such approach is the Realistic Mathematics Education (RME) model, which emphasizes experiential learning and real-life applications through the integration of technology. This approach aims to create more meaningful and engaging learning experiences while enhancing students' understanding of curved-sided three-dimensional shapes (Nursyahidah & Albab, 2021; Nursyahidah, Albab, & Rubowo, 2023). By leveraging technology-enhanced learning media, it is anticipated that cylindrical material can be effectively represented within the context of Indonesian traditions, providing a culturally relevant and pedagogically robust framework.

Research has shown that RME effectively enhances students' motivation, comprehension, analytical problem-solving skills, and active participation in learning (Andzin et al., 2024; Nursyahidah, Albab, & Rubowo, 2023). Additionally, it improves overall mathematical competency and fosters higher-order cognitive abilities (Hardiyanto et al., 2024; Sutarni et al., 2024). By integrating these elements, RME integrated with technology provides a holistic framework for designing engaging and effective learning experiences in topics such as cylinders and other mathematical concepts.

In the RME framework, context plays a critical role as it involves problem scenarios derived from students' familiar and meaningful real-life experiences (Putri et al., 2021; Zulkardi & Setiawan, 2020). These contexts serve as the foundation for developing activities and facilitating the understanding of mathematical concepts. For this study, the chosen context is the *Nyadran* tradition of Semarang, a culturally significant practice. To introduce this context, an animated video depicting the tradition was presented to students, serving as the entry point for the learning process and connecting the abstract mathematical concepts to a culturally relevant and tangible experience.

Adobe Animate and animated videos were selected as the instructional media for this study due to their ability to integrate audio and visual elements, facilitating dynamic and interactive engagement with students (Feeley et al., 2023). Interactive multimedia offers significant advantages in educational settings, including the capacity to vividly represent objects or phenomena that cannot be directly observed in the classroom (Hasyim & Ahmad, 2021). By leveraging this approach, the study combines advanced technology with cultural context to create an engaging and effective learning environment.

Previous studies have explored cylinder learning designs using RME within various contexts, such as traditional cuisine (Nursyahidah et al., 2021; Nursyahidah & Albab, 2021). These studies demonstrated that contextual strategies enhance students' learning outcomes and deepen their conceptual understanding. The present study introduces an innovative approach by employing the RME integrated with technology, which integrates RME with Adobe Animate and animated videos. This novel application, unique in its use for cylinder learning, is contextualized within the *Nyadran* tradition of Semarang, a Central Javanese cultural practice observed prior to Ramadan (Muhyiddin, 2019). Specifically, the study uses the *Besek Sajen*, a cylindrical container utilized for carrying offerings during the *Nyadran* celebration, as a representation of the cylinder concept.

Building on this cultural foundation, the study designs a learning trajectory for seventh-grade students using the RME approach, guided by the Hypothetical Learning Trajectory (HLT) model and supported by animated video content created with Adobe Animate. The primary objective is to develop a learning framework that enhances student engagement, integrates contextual relevance, and facilitates a clearer understanding of the cylinder concept.

METHODS

The research employed a design research methodology to develop instructional instruments for use in educational settings. Design research facilitates the creation of Local Instructional Theory (LIT) through collaboration between researchers and practitioners (Gravemeijer & van Eerde, 2009). The methodological framework consisted of three distinct phases: preparation for the experiment, implementation of the experimental design, and retrospective analysis (Akker, 2006). Data collection was conducted between May and June 2024, involving seventh-grade students from a junior high school in Semarang as the study participants.

Data collection in this study was conducted through observations, documentation of activities, video recordings, and interviews. Following the learning activities, discussions were held between the researchers and model teachers to analyze data obtained from the pilot and teaching experiments. These discussions aimed to evaluate students' progress in understanding the material presented. This article specifically emphasizes the three stages of the research design: preparation for the experiment, implementation of the experimental design, and retrospective analysis. The primary focus of the study is the development and description of the HLT within the context of the *Nyadran* tradition, supported by interactive videos on cylindrical concepts in curved-surface three-dimensional geometry.

Preparing for the Experiment

The primary objective of the preparation phase is to develop a HLT, which is subsequently refined and expanded during the experimental phase. The HLT comprises three key components: the activities, the objectives, and the anticipated student responses to the planned activities. It serves as the central focus of the study and provides a foundational framework for guiding the research process.

To construct the HLT, the researcher conducted an extensive literature review encompassing cylindrical geometry, RME, and relevant educational technologies such as animated videos and Adobe Animate, specifically tailored to seventh-grade students. Based on this review, an initial learning trajectory and instructional theory were formulated to guide the subsequent experimental stages.

Design Experiment

The design experiment phase comprised two stages: the pilot experiment and the instructional experiment. During the pilot experiment, the initial learning design was implemented in an authentic classroom setting to evaluate the proposed instructional theory and assess the feasibility of the learning trajectory. This phase involved six seventh-grade students from Class VII-H and provided valuable feedback for refining the learning design and improving the HLT.

In the subsequent teaching experiment phase, the revised learning trajectory was tested in a larger, authentic classroom setting. This phase involved 35 seventh-grade students from Class VII-G and was conducted with the collaboration of a model teacher. The study was carried out at a junior high school in Semarang during the 2024/2025 academic year.

Data collection focused on students’ strategies for completing four designed learning activities. A variety of research instruments were employed, including classroom observation sheets, field notes, student activity sheets, and interviews with both students and teachers. The instruments were validated by mathematics teachers and university lecturers to ensure reliability.

The collected data, which included students’ problem-solving strategies and encountered challenges, was instrumental in further refining the HLT. Data collection methods included focus group observations, video recordings, and document analysis to provide a comprehensive understanding of the instructional outcomes and student learning processes.

Retrospective Analysis

In the retrospective analysis phase, the data collected during the design experiment was meticulously analyzed by comparing the initial conjectures formulated in the HLT with the actual implementation of the learning trajectory. This comparative analysis aimed to assess the alignment between the designed instructional activities and students' observed responses and learning progress.

Furthermore, students' problem-solving strategies and encountered challenges were systematically evaluated to identify patterns and areas for improvement. This phase provided critical insights into the effectiveness of the instructional design and its alignment with the intended learning objectives.

Finally, the research questions were addressed by examining the consistency between the expected student responses, as hypothesized in the HLT, and the actual outcomes observed during the teaching sessions. This evaluation helped validate the instructional approach and refine the learning trajectory for future applications.

RESULTS AND DISCUSSION

The findings of this study present a comprehensive account of the learning trajectory for cylinder-related content, contextualized within the *Nyadran* tradition and supported by the use of animated videos and Adobe Animate. The results are structured into three distinct stages, as outlined below.

Preparing for the Experiment

This initial phase involved operationalizing the concept of utilizing the *Nyadran* tradition as a contextual basis for teaching cylinder-related concepts. The *Nyadran* tradition was selected due to its inherent properties, which closely align with the geometrical attributes of a cylinder, thereby offering a relevant and meaningful context for learning. Additionally, the *besek sesaji* (offering containers) employed in the tradition vary in size, providing an engaging and contextually rich problem-setting for the analysis of cylinder properties.

To guide the instructional process, a HLT was developed. The HLT serves as both a conceptual framework and a roadmap for the learning activities. The formulation of the HLT was carried out through the following systematic steps:

1. Literature Review: Examination of theoretical and practical studies on cylinder-related content, RME, and educational technologies, including animated videos and Adobe Animate.
2. Observations: Collection of contextual data to support the integration of the *Nyadran* tradition into learning activities focused on the cylinder.
3. Learning Trajectory Design: Structuring activities to align with the desired educational outcomes.
4. Curriculum Review: Analysis of curriculum guidelines to ensure alignment with appropriate learning objectives, materials, and outcomes for seventh-grade students studying cylinder-related content.
5. Media Development: Creation of technology-enhanced learning media, leveraging animated videos and Adobe Animate to effectively incorporate the *Nyadran* tradition into the instructional design.

The resulting HLT comprises four primary activities, detailed in Table 1, which outlines the activities, objectives, and expected student responses. These activities constitute the core of the instructional approach, facilitating a meaningful and contextually relevant exploration of cylinder-related topics.

The HLT provides a structured approach to teaching cylinder-related content, guiding students through an exploration of mathematical concepts rooted in a culturally meaningful context. This strategy not only enhances the relevance of the material but also fosters deeper conceptual understanding and problem-solving skills.

Table 1. HLT for cylinder content

Activity	Objective	Conjectures (Expected Student Outcomes)
Observing the contextual video of the *Nyadran* tradition	Identify the characteristics of a cylinder	• Students identify the defining characteristics of a cylinder. • Students solve problems related to the cylinder's characteristics.
Determining the formula for the surface area of a cylinder	Derive the formula for the surface area	• Students derive and understand the formula for the surface area of a cylinder. • Students solve surface area-related problems.
Determining the formula for the volume of a cylinder	Derive the formula for the volume of a cylinder	• Students derive and understand the formula for the volume of a cylinder. • Students solve problems involving the volume of a cylinder.
Solving contextual problems related to the cylinder	Apply concepts to real-world problems	• Students solve real-world problems involving the surface area of a cylinder. • Students solve real-world problems involving the volume of a cylinder.

Design Experiment

The learning activities at this stage are systematically structured into four phases, aligned with the HLT for cylinder material. In the first phase, students observed an animated video contextualized within the Semarang *Nyadran* tradition to explore and identify the concept and elements of a cylinder. In the second phase, students engaged in hands-on activities using cardboard to derive the concept of the cylinder's surface area. The third phase directed students to determine the concept of cylinder volume through an exploration of flat-sided three-dimensional shapes. Finally, in the fourth phase, students applied their understanding to solve contextual problems related to cylinders. The outcomes of these activities are presented in detail below.

Activity 1: Observing the Video of the Semarang Nyadran Tradition to Identify Characteristics of Curved-Faced Three-Dimensional Shapes

At the start of the lesson, students were introduced to an animated video contextualized within the Semarang *Nyadran* tradition. The video, developed using Adobe Animate and validated by mathematics educators and lecturers, depicted the cultural procession of the *Nyadran* tradition as observed in the community. Figure 1 captures students' engagement and enthusiasm while observing the video.

Figure 1. Students observing the contextual video of the Semarang *Nyadran* tradition

Upon completing the observation of the animated video of the Semarang *Nyadran* Tradition, students were instructed to begin working on Worksheet 1. The initial task involved completing their group identity information. Subsequently, students were asked to draw objects depicted in the *Nyadran* tradition, identify the curved-sided three-dimensional shapes associated with these objects, and create illustrations of the corresponding shapes based on the forms observed in the *Nyadran* tradition series. Following the illustrations, students analyzed the properties of cylinders and engaged in discussions about the nets of cylinders. The responses provided by students during this activity are presented in Figure 2.

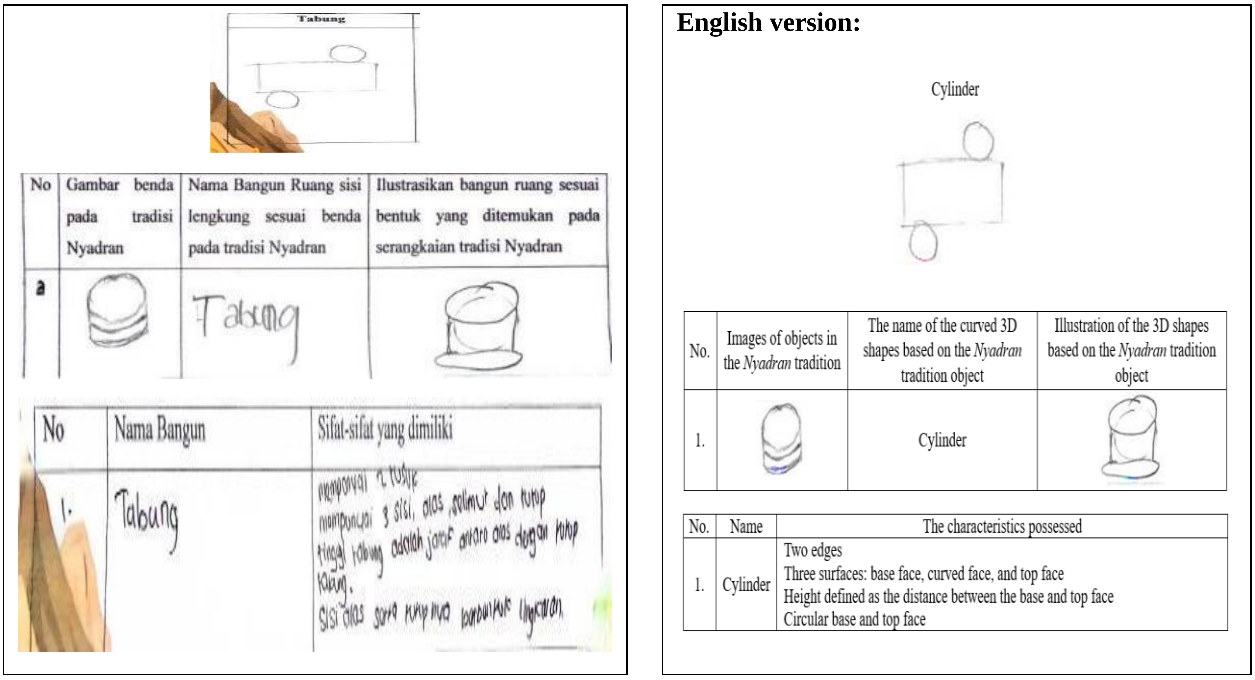


Figure 2. Examples of student responses on worksheet 1

Figure 2 demonstrates that students successfully illustrated the offering basket as a representation of a cylinder and accurately identified its elements. However, an exploration of students' reasoning, conducted through interviews, revealed a conceptual misunderstanding regarding the cylinder's net. While most students correctly identified the net as comprising a rectangular face, some erroneously perceived it as square. Despite this, the activity outcomes indicate that students effectively identified and articulated the defining characteristics of a cylinder.

Activity 2: Determining the Surface Area of a Cylinder using Cardboard

In the second activity, students were tasked with determining the surface area of a cylinder. The teacher provided the necessary materials and tools for constructing teaching aids, including pieces of pipe, stationery, rulers, cardboard, and scissors. As part of the activity, students created a replica of the offering basket from the Semarang *Nyadran* tradition. Through this hands-on process, students identified the individual shapes that comprise the cylinder by assembling the replica. They engaged creatively in constructing the cylinder, iterating their designs as needed to achieve an accurate and well-formed cylinder. This activity facilitated an experiential understanding of the geometric structure and surface area of a cylinder.

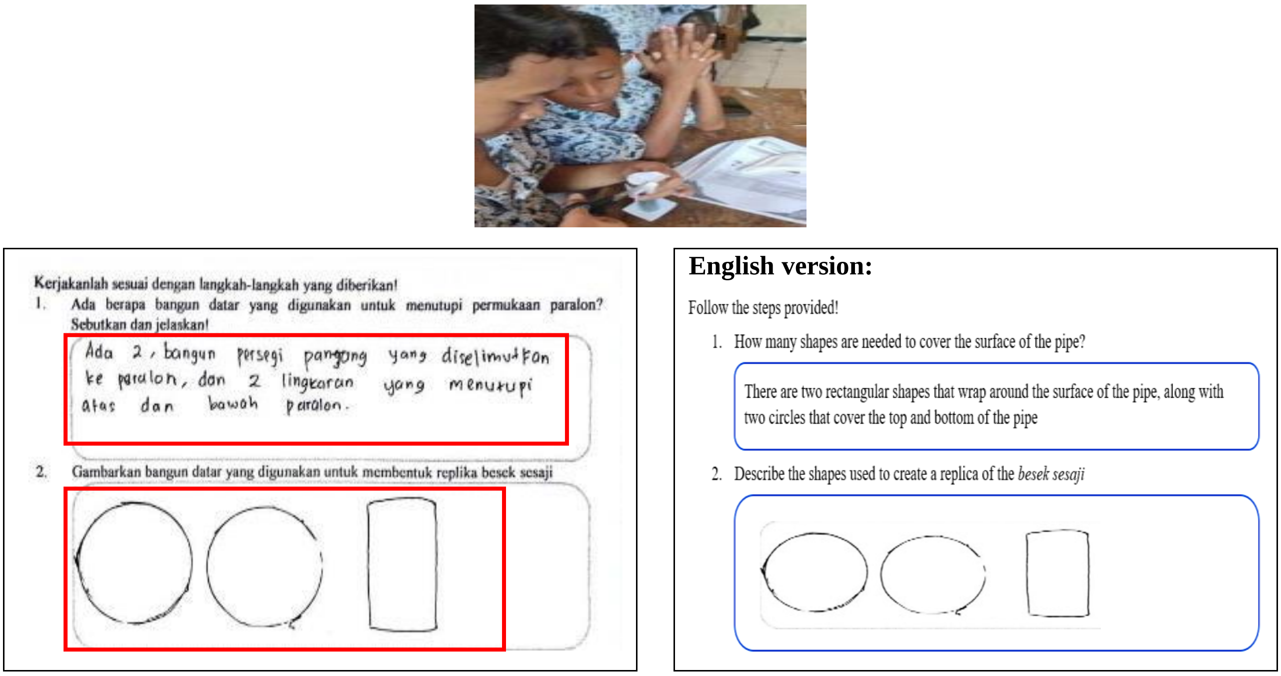


Figure 3. Student activity to find the surface area of a cylinder using cardboard and worksheet 2 students answer results

Figure 3 illustrates students' active engagement and enthusiasm in solving the problems presented in Activity 2, facilitated by the use of cardboard. The analysis of student responses indicates that they successfully derived the concept of the cylinder's surface area by constructing and examining the nets of a cylinder in the previous activity. Students then identified and annotated the formulas for the flat shapes that constitute the cylinder, demonstrating a clear understanding of the relationship between the cylinder's nets and its surface area.

Through this process, students were able to deduce the formula for the surface area of a cylinder. By connecting the geometric properties of the nets with the areas of the constituent shapes, they derived the correct formula. The outcomes of their work are presented in Figure 4.

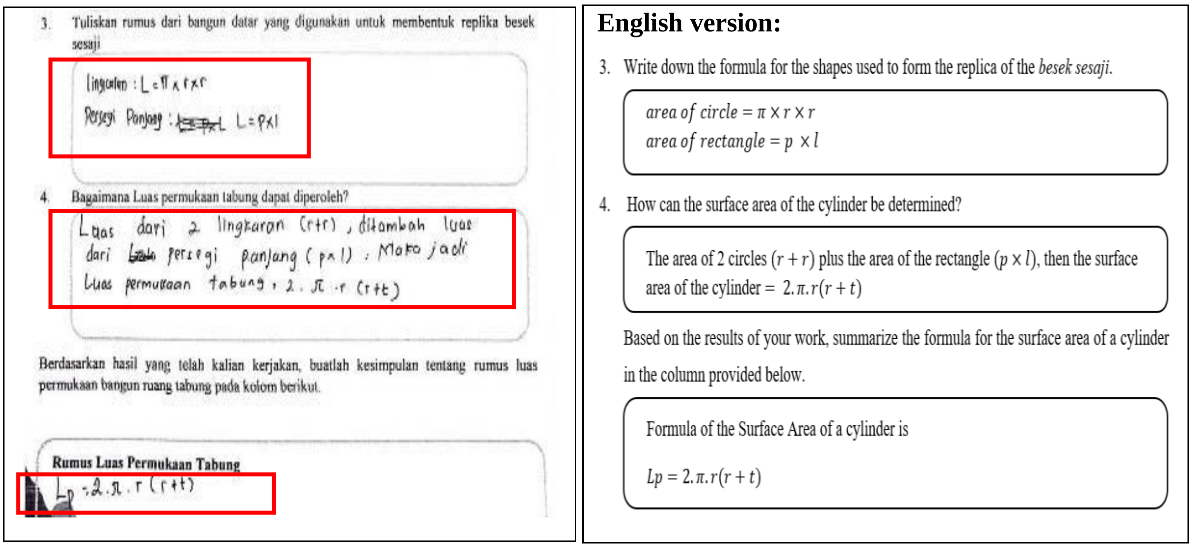


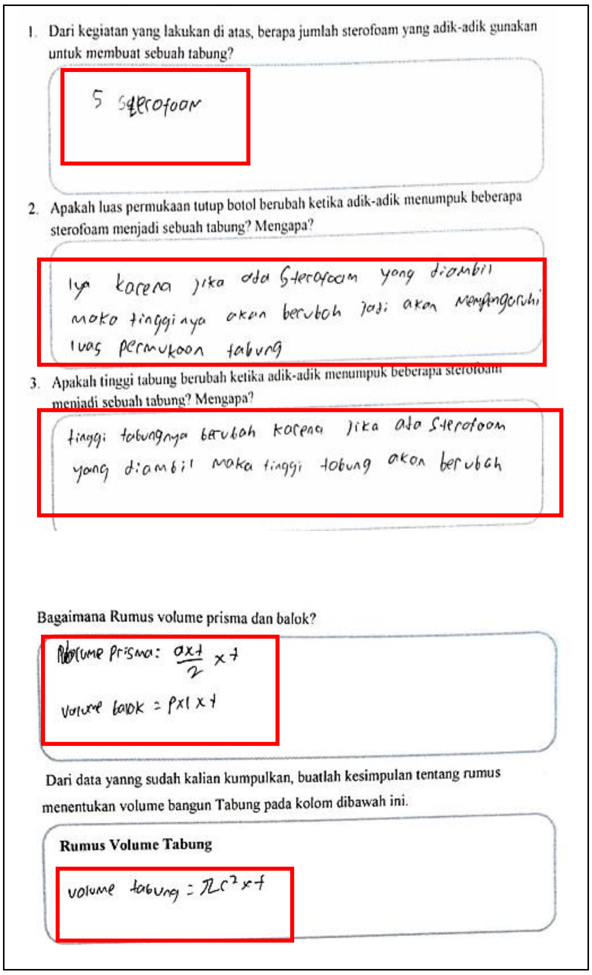
Figure 4. Results of students' answers to determine the surface area of the cylinder

Activity 3: Determining the Volume of a Cylinder Using Styrofoam and the 2D Geometry Formula Approach

In the third activity, students explored the concept of the volume of a cylinder. Initially, they observed objects used in the *Nyadran* tradition, such as the offering basket, and identified its representation as a cylinder. Students then sketched the net of a cylinder, drawing from the illustration of the offering basket observed in the animated video presented by the teacher.

To investigate the concept of cylinder volume, students conducted hands-on observations using a stack of styrofoam coins and two-dimensional geometric shapes. This practical approach allowed students to intuitively understand the composition and dimensions of the cylinder. They were subsequently tasked with deriving the volume formula for the cylinder by analyzing and identifying relationships between its geometric components.

Students connected the elements of two-dimensional geometric shapes, such as rectangles and circles, to the corresponding features of the cylinder. Finally, they established connections between the volume formulas of different three-dimensional geometric shapes, including prisms, cuboids, and cylinders, to better understand the mathematical derivation of the cylinder's volume formula (see Figure 5).


1. Dari kegiatan yang lakukan di atas, berapa jumlah sterofoam yang adik-adik gunakan untuk membuat sebuah tabung?

5 sterofoam

2. Apakah luas permukaan tutup botol berubah ketika adik-adik menumpuk beberapa sterofoam menjadi sebuah tabung? Mengapa?

Iya karena jika ada sterofoam yang diambil maka tinggi nya akan berubah jadi akan mengaruhi luas permukaan tabung

3. Apakah tinggi tabung berubah ketika adik-adik menumpuk beberapa sterofoam menjadi sebuah tabung? Mengapa?

tinggi tabungnya berubah karena jika ada sterofoam yang diambil maka tinggi tabung akan berubah

Bagaimana Rumus volume prisma dan balok?

Volume prisma: $\frac{a \times t}{2} \times t$

Volume balok = $p \times l \times t$

Dari data yanng sudah kalian kumpulkan, buatlah kesimpulan tentang rumus menentukan volume bangun Tabung pada kolom dibawah ini.

Rumus Volume Tabung

volume tabung = $\pi r^2 \times t$

English version:

1. Based on the activities conducted above, how many pieces of styrofoam are required to construct the cylinder?

5 Styrofoams

2. Does the surface area of the cylinder change when multiple pieces of styrofoam are stacked to form a cylinder? Explain your reasoning.

Yes, because removing or adding Styrofoam layers changes the height of the cylinder, which in turn affects the surface area.

3. Does the height of the cylinder change when multiple pieces of styrofoam are stacked to form a cylinder? Provide an explanation for your answer.

The height of the cylinder changes because removing or adding styrofoam layers directly affects the total height of the cylinder.

What is the formula for the volume of a prism and a cuboid?

$volume\ of\ prism = \frac{a \times t}{2} \times t$

$volume\ of\ cuboid = p \times l \times t$

Based on the data you have gathered, summarize the formula for determining the volume of a cylinder in the column below.

Cylinder Volume Formula

$volume\ of\ cylinder = \pi r^2 \times t$

Figure 5. Student identification results for determining the volume of a cylinder

As part of this activity, excerpts from interviews with students regarding their completion of the task are presented below:

Researcher	:	*"How did you find the experimental activities earlier?"*
Student	:	*"They were exciting and required creative thinking, ma'am."*
Researcher	:	*"How did you fill the cylinder with styrofoam coins until it was full?"*
Student	:	*"We stacked the styrofoam coins that we had, ma'am."*
Researcher	:	*"How did you formulate the volume of the cylinder?"*
Student	:	*"We observed the shapes of cuboids and prisms, ma'am. Upon closer examination, we noticed that the elements of these shapes—specifically the base and the height—directly influenced their structure. We applied the same reasoning to develop the formula for cylinders."*
Researcher	:	*"Good. What did you learn and conclude from the experiments and observations?"*
Student	:	*"The volume of a cylinder is calculated by multiplying the area of its base by its height. Therefore, we derived the formula for the volume of a cylinder as V= $\pi r^2 t$."*

From the student interviews, it can be concluded that the participants successfully identified the relationship between the volumes of flat-sided three-dimensional shapes (such as cuboids and prisms) and the volume of a cylinder. Through the styrofoam coin experiment and comparisons with flat-sided geometric figures, students deduced that the volume of a cylinder is determined by multiplying the area of its circular base by its height, yielding the formula $V = \pi r^2 t$. The learning objective for Activity 3 was effectively achieved based on these results and observations.

Activity 4: Solving Contextual Problems Related to Cylinders

Activity 4 involves solving contextual problems related to cylinders. Working in groups, students engaged in discussions to solve the problems provided and arrive at accurate solutions. The results of students' work from Activity 4 are presented in Figure 6.

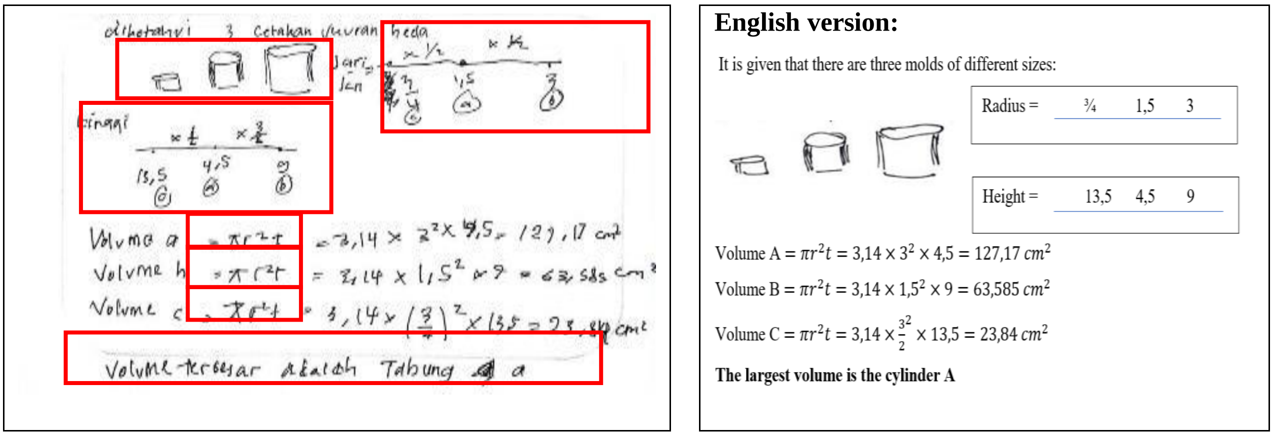


Figure 6. Student work results in activity 4

The student responses shown in Figure 6 demonstrate their ability to apply the concepts of volume and surface area to solve contextual problems involving cylinders. Students represented the three cylinders (A, B, and C) as offering baskets of varying sizes. They followed the problem's instructions to rank the baskets by size, identifying the one capable of holding the largest volume of offerings. By correctly applying the volume formula, students determined that Cylinder A had the largest volume.

This activity highlights students' ability to utilize the principles learned in previous activities to solve practical, real-world problems effectively. The successful completion of this task indicates that the designed learning trajectory has achieved its intended objectives.

Retrospective Analysis

The HLT developed in this study serves as a comprehensive framework for achieving the intended learning objectives. It also functions as a diagnostic tool to identify and address potential challenges encountered by students during the learning process. Additionally, the HLT was evaluated against the collected data to assess how well students comprehended and applied cylinder concepts within the context of the Semarang *Nyadran* tradition, facilitated by the use of an animated video and Adobe Animate.

The outcomes of the students' responses aligned with the researcher's expectations. Students successfully demonstrated their abilities to identify the properties of a cylinder through observations of the *Nyadran* tradition, derive the surface area formula of a cylinder, calculate the volume formula of a cylinder, and solve contextual problems involving cylinders. These activities guided students' progression from informal to formal understanding, effectively contextualizing mathematical concepts within their everyday experiences.

Figures 2 to Figure 6 provide evidence of students' conceptual development, illustrating their journey from initial informal comprehension to a more structured and formalized understanding. This approach, rooted in the culturally relevant context of the *Nyadran* tradition, enhanced students' engagement and connected mathematical learning to their daily lives.

RME is a teaching approach designed to enhance students' engagement and deepen their understanding of cylinder-related concepts. This methodology emphasizes the integration of technology, particularly the use of animated videos and tools such as Adobe Animate. Animated videos bridge the gap between abstract mathematical concepts and tangible, familiar contexts, such as the Semarang *Nyadran* tradition, enabling students to visualize and relate to the subject matter. This aligns with the findings of (Pratiwi et al., 2022), who reported that videos effectively engage students and improve their critical thinking skills in mathematics. Similarly, (Albert et al., 2021) highlighted that videos not only enhance mathematical competence but also boost student motivation, a conclusion further supported by (Cisneros et al., 2023).

RME leverages this approach by making mathematical topics more accessible and relatable to students' everyday experiences. By connecting learning to real-world contexts, RME fosters greater engagement, strengthens understanding, and enhances problem-solving abilities (Nursyahidah, Albab, & Rubowo, 2023). Additionally, (Andzin et al., 2024) emphasized that RME-based instruction significantly improves conceptual comprehension, particularly in understanding curved three-dimensional shapes, making these concepts more intuitive for students.

In addition, the learning process incorporates a series of structured tasks designed to enhance students' comprehension of curved three-dimensional shapes, particularly cylinders. These tasks are grounded in cultural context, technological integration, and collaborative learning strategies:

1. Cultural Context: Utilizing the Semarang *Nyadran* tradition as a contextual basis helps students understand cylinder concepts by connecting them to tangible, real-world examples, as depicted in the animated video. This approach aligns with previous research, which highlights that incorporating cultural context can simplify and deepen students' understanding of mathematical concepts (Aisyah et al., 2021; Malalina et al., 2023; Nursyahidah, Albab, & Rubowo, 2023; Prahmana, 2020; Putri et al., 2021; Zulkardi & Setiawan, 2020).

2. Video-Based Learning with Adobe Animate: The learning session begins with a contextual video created using Adobe Animate, such as one illustrating the Semarang *Nyadran* tradition, to capture students' interest and establish a foundation for further exploration. This study reveals that such videos effectively help students visualize abstract cylinder concepts through concrete examples. Similarly, (Hardiyanto et al., 2024; Nursyahidah, Albab, & Rubowo, 2023; Yakubova et al., 2020) found that contextual animated videos enhance student engagement and improve learning outcomes.
3. Experimentation and Group Discussions: Under teacher guidance, students engage in experiments and group discussions to derive formulas for the surface area and volume of a cylinder. These hands-on activities promote the discovery of key mathematical concepts and encourage deeper understanding. Research by (Nursyahidah, Albab, & Mulyaningrum, 2023; Nursyahidah, Albab, & Rubowo, 2023) supports the notion that hands-on activities increase student engagement and facilitate comprehension. Additionally, group discussions foster idea exchange and help students navigate complex concepts. Collaborative learning has also been shown to reduce anxiety and foster healthy competition among peers (Knopik & Oszwa, 2021).
4. Addressing Contextual Problems: In the final stage, students solve real-world problems related to cylinders by applying concepts learned through the RME framework. This step actively involves students in the learning process, connecting abstract mathematical ideas to practical applications. Research indicates that RME enhances the relevance of learning, fosters critical problem-solving skills, and makes learning more meaningful (Meryansumayeka et al., 2022; Nursyahidah, Albab, & Rubowo, 2023; Nursyahidah & Albab, 2021).

By combining technology with RME principles, this teaching approach offers a comprehensive method for understanding cylinder concepts. Integrating cultural contexts, realistic scenarios, and collaborative learning strategies not only strengthens students' conceptual knowledge but also promotes engagement and problem-solving in real-world contexts. These findings align with earlier research, which validates the effectiveness of RME integrated with technology as an innovative and impactful teaching strategy.

CONCLUSION

This study successfully developed a structured learning trajectory for the cylinder material using the RME integrated with technology approach, contextualized within the Semarang *Nyadran* tradition. The trajectory integrates Adobe Animate and culturally relevant videos to enhance students' conceptual understanding of cylinder-related topics. It comprises four sequential activities: observing videos to identify the characteristics of a cylinder within the *Nyadran* tradition; deriving formulas for the surface area of a cylinder; formulating the volume calculation; and applying these concepts to solve real-world problems. These activities not only reinforce students' grasp of cylinder-related mathematical principles but also foster meaningful connections between mathematical knowledge and cultural heritage.

Despite the promising outcomes, the study has notable limitations that warrant attention. First, its scope is confined to the cultural context of the Semarang *Nyadran* tradition, potentially limiting its applicability to diverse student populations in other cultural settings. Second, the study primarily emphasizes conceptual understanding, without addressing other critical dimensions of learning such as procedural fluency or affective engagement. Additionally, the small sample size and limited duration of the intervention may affect the findings' generalizability and the long-term impact of the approach. These constraints underline the need for further exploration to refine and broaden the application of this methodology.

Future research should aim to address these limitations to advance the understanding of culturally responsive mathematics education. Expanding the study to include diverse cultural contexts could provide insights into the adaptability and effectiveness of the RME integrated with technology approach across different traditions. Investigating additional aspects of learning, such as students' problem-solving skills, attitudes toward mathematics, and collaborative learning outcomes, would offer a more holistic perspective. Moreover, extending the duration of the intervention and increasing the sample size would enhance the validity and generalizability of the results, paving the way for more robust applications of this educational strategy.

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DECLARATIONS

Author Contribution	:	FN: Conceptualization, Writing - Original Draft-Review and Editing.
		FMA: Writing – Original Draft.
		MAY: Formal analysis, and Methodology.
		ZIP: Validation and Supervision.
		MARR: Software.

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