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Students' Mathematical Connections in Circle Sector Learning Using the PMRI Approach with Bolu Kojo Context

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ABSTRACT
This study aimed to describe students' mathematical connection abilities in learning circle sectors through the Indonesian Realistic Mathematics Education (PMRI) approach using bolu kojo, a traditional Palembang cake, as a culturally relevant context. The study employed a descriptive mixed-method design involving 41 twelfth-grade students at SMA Negeri 10 Palembang. Quantitative data were obtained from a mathematical connection ability test, while qualitative data were collected through observations, written-response analysis, and semi-structured interviews. The research was conducted through preliminary, field-test, and teaching-experiment stages. During instruction, a PMRI-based student worksheet guided students in exploring the bolu kojo context, developing informal and formal mathematical models, participating in discussions, and progressively mathematizing contextual situations. After the learning session, students completed a test using a different context, namely a birthday cake, to examine their ability to transfer mathematical ideas beyond the instructional context. Mathematical connection ability was analyzed through four indicators: connecting concepts within the same mathematical topic, connecting concepts across different mathematical topics, applying mathematics to other disciplines, and relating mathematics to everyday life. The findings showed that students' mathematical connection ability was generally in the medium category. The highest achievement occurred in connecting concepts within the same topic and relating mathematics to everyday life, with 95.1% of students meeting each indicator. Connections across mathematical topics were demonstrated by 65.9% of students, while 75.6% successfully connected mathematics with other disciplines. Interview findings revealed that high-, medium-, and low-ability students differed in contextual interpretation, proportional reasoning, use of scientific units, calculation accuracy, and completeness of mathematical representations. These results indicate that PMRI learning using the culturally familiar bolu kojo context can facilitate meaningful mathematical connections, although students still require support in writing systematic solutions, interpreting contexts accurately, and consistently using mathematical and scientific units.

ABSTRAK
Penelitian ini bertujuan mendeskripsikan kemampuan koneksi matematis siswa dalam pembelajaran juring lingkaran melalui pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) dengan menggunakan bolu kojo, makanan tradisional Palembang, sebagai konteks budaya yang dekat dengan kehidupan siswa. Penelitian menggunakan desain deskriptif dengan pendekatan campuran yang melibatkan 41 siswa kelas XII SMA Negeri 10

Palembang. Data kuantitatif diperoleh melalui tes kemampuan koneksi matematis, sedangkan data kualitatif dikumpulkan melalui observasi, analisis jawaban tertulis, dan wawancara semi-terstruktur. Penelitian dilaksanakan melalui tahap pendahuluan, uji lapangan, dan eksperimen pembelajaran. Pada proses pembelajaran, lembar kerja peserta didik berbasis PMRI mengarahkan siswa untuk mengeksplorasi konteks bolu kojo, mengembangkan model matematika informal dan formal, berdiskusi secara interaktif, serta melakukan matematisasi progresif. Setelah pembelajaran, siswa mengerjakan tes dengan konteks berbeda, yaitu kue tart, untuk mengidentifikasi kemampuan mereka dalam mentransfer konsep yang telah dipelajari ke situasi baru. Kemampuan koneksi matematis dianalisis berdasarkan empat indikator, yaitu menghubungkan konsep dalam topik matematika yang sama, menghubungkan konsep antartopik matematika, menerapkan konsep matematika pada disiplin ilmu lain, dan menghubungkan matematika dengan kehidupan sehari-hari. Hasil penelitian menunjukkan bahwa kemampuan koneksi matematis siswa secara umum berada pada kategori sedang. Capaian tertinggi terdapat pada indikator koneksi dalam topik yang sama dan koneksi dengan kehidupan sehari-hari, yang masing-masing dipenuhi oleh 95,1% siswa. Indikator koneksi antartopik matematika dicapai oleh 65,9% siswa, sedangkan koneksi matematika dengan disiplin ilmu lain dicapai oleh 75,6% siswa. Hasil wawancara menunjukkan adanya perbedaan antara siswa berkemampuan tinggi, sedang, dan rendah dalam menafsirkan konteks, menggunakan penalaran proporsional, menuliskan satuan ilmiah, melakukan perhitungan, dan menyajikan representasi matematika secara lengkap. Temuan ini menunjukkan bahwa pembelajaran PMRI dengan konteks budaya bolu kojo dapat memfasilitasi koneksi matematis yang bermakna, meskipun siswa masih memerlukan penguatan dalam penulisan solusi yang sistematis, ketepatan interpretasi konteks, serta konsistensi penggunaan satuan matematika dan sains.

INTRODUCTION

Mathematical connection skills are the ability to connect mathematical concepts with other concepts in mathematics (Ahmad et al., 2023; Septian et al., 2020). These skills include systematically linking ideas and concepts to solve problems in various contexts, both within and outside the realm of mathematics (Aprilianda, 2022). In addition, mathematical connection skills enable students to integrate mathematics with the real world (Romiyansah et al., 2020). A similar view was expressed by Ostian (2023), who revealed in his research that mathematical connection skills connect mathematical concepts with everyday problems. Mathematical connection skills are important for students to master. Students who have mastered mathematical connection skills can understand and apply mathematical concepts more effectively without relying on memorization (Andriani et al., 2024). In fact, they will find it easier to solve mathematical problems, reason and prove theorems, and convey mathematical ideas clearly to others (Hidayati & Jahring, 2021).

However, the reality in the field shows that many students still have difficulty relating mathematical concepts, especially in circle material. They tend to be unable to connect procedures and conceptual understanding, and often misinterpret problem representations, resulting in most students achieving low learning outcomes and falling below the minimum passing criteria (Hidayati et al., 2020). Based on (Hidayati et al., 2020) research, mathematical connection errors still often occur when students solve geometry problems, especially those involving circles, causing students to have difficulty understanding concepts and solving problems effectively. Similar results were found by (Rahmi et al., 2020), who concluded that the mathematical connection abilities of seventh-grade students are still low, as only a small number of students are able to connect mathematics with real-life problems or other disciplines. Mariana (2024) also found that students are still predominantly at the basic stage of mathematical literacy, only able to write down the formula for a circle but not yet able to relate it to the context of science, such as the distance traveled by a vehicle's wheels. This difficulty is caused by a weak understanding of prerequisite material, which hinders students from connecting different mathematical concepts (Krisdamayanti, 2021).

This is in line with research conducted by Siagian (2021), which states that mathematical connection skills are greatly influenced by prior knowledge. Not only focused on students, ineffective teaching methods that often limit students' opportunities to explore and connect mathematical concepts independently cause students to lose interest in learning and have difficulty making these connections (Desthiani et al., 2024). This emphasizes the importance of educational strategies that encourage exploration and connection-making among students, involving more interactive and student-centered learning experiences that enable students to apply their knowledge in various contexts (Desthiani et al., 2024). Therefore, teachers have an obligation to design innovative approaches, models, and learning media that can facilitate student understanding (Jannah, 2023).

A sector is a geometric concept that describes a part of a circle bounded by two radii and an arc of the circle on a flat plane (Earl, 2023). In the Merdeka Curriculum, the material on circular sectors is included in Phase F mathematics learning, where students are expected to be able to calculate the length of an arc and the area of a circular sector and apply this concept in everyday life (Kemdikbud, 2022). The competency for grades XI and XII is not only aimed at developing conceptual understanding, but also the students' ability to connect mathematics with the real world, such as in determining the location on the Earth's surface and the distance between two places on Earth.

However, the implementation in learning is not always as expected. Many students still have difficulty with circle material. Students find it difficult to apply the correct formulas, resulting in a high error rate related to circle topics (Brijlall & Abakah, 2022). Research conducted by Kristianti (2022) also states that high school students experience difficulties with circle material due to misunderstandings of the concepts of circles, radii, equations, and point positions influenced by teachers and students themselves. In line with this research, Kpotosu (2024) revealed that students had difficulty understanding circle theorems due to a lack of instructional concepts, complex topics, and ineffective teaching methods, which hindered their understanding of geometric concepts.

These difficulties are often caused by teaching that is too abstract and not connected to students' daily experiences, teaching methods that only focus on theoretical explanations without involving students in the active learning process, and teaching approaches that still focus on memorizing formulas without providing a deep understanding of the concepts (Nuralam & Maulidayani, 2020). This emphasizes the importance of the teacher's role in determining an in-depth and appropriate teaching approach so that these difficulties can be overcome. Therefore, a teaching approach is needed that can make this concept more contextual and interesting for students.

One effective solution is to apply the Indonesian Realistic Mathematics Education (PMRI) approach (Narotama et al., 2024). Indonesian Realistic Mathematics Education (PMRI) is an adaptation of Realistic Mathematics Education (RME), which was originally developed in the Netherlands (Zulkardi et al., 2020). PMRI aims to connect mathematics learning with everyday contexts(Purba, 2022). Thus, with PMRI, students can more easily understand mathematical concepts (Fitriani et al., 2023; Isamer et al., 2022; Septiana et al., 2022). PMRI emphasizes the use of real contexts and contextual problems in the learning process (Meitrilova & Putri, 2020; Van den Heuvel-Panhuizen & Drijvers, 2020). PMRI also encourages students to discover and develop mathematical understanding independently (Agusta, 2020). Therefore, PMRI can improve mathematical connection skills (Firdaus et al., 2022; Hutneriana et al., 2024). The PMRI approach can be developed in accordance with the local cultural conditions and context in Indonesia (Hutneriana et al., 2024).

Based on the above description, it is necessary to implement learning that can help students have good mathematical connection skills in circle sector material. Some previous research has shown that students' mathematical connection abilities still need attention. Rafiepour & Faramarzpour (2023) found that some students have not been able to connect mathematical concepts with other disciplines or daily lives. Fitri & Prahmana (2020) use the context of the Ferris Wheel for circle learning, but its focus is on parts of the circle in general, not exploring sector material or the local cultural context. Ostian (2023) examined students' mathematical connection ability using the Palembang tourism context in flat building materials, but they did not investigate sector circles or integrate culinary cultural contexts. This research fills that gap by examining the mathematical connection ability of grade XII students in circle sector material through the PMRI approach based on the local cultural context of bolu kojo.

METHOD

This study uses a descriptive design with a mixed-method approach (Creswell, 2018), combining quantitative and qualitative data to describe the ability of students' mathematical connections in learning the material of the circle sector through the PMRI approach in the context of sponge kojo. The research subjects were selected through purposive sampling from a class of 41 grade XII students at SMA Negeri 10 Palembang, with one student representing each category of high, medium, and low mathematical connection ability. Data collection included quantitative data from tests that measured mathematical connection skills and qualitative data from observations and interviews to explore students' thinking processes and learning behaviors. The research was carried out in three stages: preliminary (expert validation and one-to-one), field trials (small groups), and learning experiments (one PMRI-based learning session, tests, and interviews). During the learning experiment, the PMRI syntax was implemented through a student worksheet (LKPD) designed to guide students through contextual exploration, model development, interactive discussions, and progressive mathematization. The LKPD consistently utilized the previously introduced culturally relevant context of the traditional Palembang cake bolu kojo to promote student engagement and support the development of mathematical connection abilities through meaningful and realistic activities. Following the instructional session, students completed a test that employed a different real-world context, specifically a birthday cake (kue tart), to assess the transferability of the learned concepts beyond the instructional context and to evaluate students' mathematical connection ability in an independent setting. All collected data were analyzed using descriptive techniques, including data reduction, data presentation, and conclusion drawing, to ensure credibility and support the triangulation of findings.

The indicators of mathematical connection ability used in this study were adapted from NCTM modified by Prihadi (2023) into four indicators, namely: (1) connections between mathematical concepts within the same topic; (2) connections between mathematical concepts in different topics; (3) application of mathematical concepts in other disciplinesand; (4)

connections between mathematical concepts and everyday life. The students' mathematical connection ability levels were categorized into three categories: high (70–100), medium (50–69), and low (below 50) (Widiyawati et al., 2020).

RESULTS AND DISCUSSION

In the results and discussion of this study, the analysis of data on the results of student tests on mathematical connection ability and interviews of high, medium, and low ability students will be described. This research is a representation of the entire research subject. Before that, the researcher had checked the results of the mathematical connection ability test which was adjusted to the assessment rubric that had been prepared beforehand. Based on the examination of the results of the mathematical connection ability test, the researcher classifies them into three categories as shown in Table 1 below.

Table 1. Categories Mathematical Connection Ability Test Results

Average Score	Number of Students	Presentase (%)	Category
$70 - 100$	10	24	High
$50 - 69$	20	49	Medium
$0 - 49$	11	27	Low
Class Average	56.6		
Class Categories	Medium		

Based on Table 1, the average mathematical connection ability of students tested in the field of circle wide material test questions with the context of a tart cake is included in the medium category, with an average score of 56.6. The researcher also analyzed the indicators of students' mathematical connection ability that appeared in the answers to each question contained in Table 2.

Table 2. Number of Students Who Meet the Mathematical Connection Ability Indicator on Each Test Question

Indicators	Question Number	Students who meet the indicators	Presentase (%)
1	1	39	95.1
2	2a	27	65.9
3	3b	31	75.6
4	3	39	95.1

Based on Table 2, most of the students showed good mathematical connection ability on indicators 1 and 4 (95.1%), while indicators 2 and 3 were achieved by 65.9% and 75.6% of students, indicating the need for attention to the calculation process and consistency of writing. To get a more in-depth picture, the researcher analyzed the students' thinking process through test and interview answers, then selected three subjects representing low, medium, and high abilities, to explore strategies and how they solved problems in the circle of sector material. Each part of the students' responses was marked with color boxes to indicate the indicators of mathematical connection ability. A red box specifically donates errors made by students. The use of these color codes is applied consistently to Question 1, Question 2a, Question 2b and Question 3. The specific mapping of each question to its corresponding color code is presented in Table 3.

Table 3. Mapping of Questions to Mathematical Connection Indicators and Color Codes Box

Color Code Box	Question	Indicator
Yellow box	1	1
Green box	2a	2
Blue box	2b	3
Purple box	3	4

Based on Table 3, the analysis of students' mathematical connection skills is described through three questions presented in Figure 1. Question 1 focuses on understanding the relationship between the number of pieces of pie and the central angle of each slice. This question requires students to determine the number of pieces of pie to be distributed, describe the shape of the slice as a representation of a piece of pie, and calculate the central angle based on the number of pieces. This question represents the indicator of mathematical connection skills in identifying connections between mathematical concepts, namely central angles.

Question 2 focuses on the application of the concept of sectors in the context of comparing the size and material requirements of mini tarts decorated with chocolate cream. This question consists of two sub-questions (a–b) that reflect different indicators of mathematical connection skills. Sub-question (a) assesses students' ability to identify and apply the relationship between mathematical concepts of circle area and sector area. Sub question (b) assesses students' ability to connect mathematical concepts with other disciplines, namely calculating the amount of chocolate cream needed based on the surface area and arc length of the sector associated with the unit of mass (grams).

Question 3 focuses on the application of the concepts of ratios and proportions in social arithmetic, particularly in determining the selling price of a cake based on production costs and the desired profit. In this question, students are asked to determine the appropriate selling price per slice when the total production cost of one medium-sized tart cake with topping is IDR 140,000, the cake is cut into 15 equal slices, and the seller expects a profit of IDR 3,000 from each slice sold. This question assesses students' ability to connect mathematical concepts with real-life and interdisciplinary contexts, as well as to evaluate mathematical relationships in order to make decisions that are appropriate to the problem situation.

Original Version	English Version

Gambar 1. Kue Tart ukuran Sedang

Andi membuat sebuah kue tart ukuran sedang untuk perayaan ulang tahunnya bersama teman-temannya, seperti Gambar 1. Kue tart tersebut akan dipotong sama rata dan dihias sebelum Andi membagikannya.

1. Jika Andi memiliki 6 orang teman, kue tart tersebut akan terbagi menjadi berapa potongan? Gambarkan bentuk sepotong kue tart yang diterima 1 teman Andi. Jika satu potongan disebut juring, kira-kira berapa besar sudut pusat tiap juring?
2. Karena banyak yang suka, Andi membuat satu kue tart mini yang diameternya lebih kecil 7 kali lipat dari kue tart sebelumnya. Satu juring kue tart tersebut akan diberi topping cream choco dengan ukuran 0,2 *gram* cream per 1 cm² permukaan dan 1,5 *gram* cream per 1 cm panjang busur.
   a. Hitunglah luas satu juring kue tart mini jika diketahui memiliki sudut pusat 180°.
   b. Lalu hitung berapa gram cream choco yang dibutuhkan untuk menghias satu juring kue tart mini tersebut.
3. Biaya membuat satu kue tart ukuran sedang beserta topping adalah Rp140.000. Jika Andi menjual kue tart dalam bentuk 15 potongan dengan target keuntungan per potong Rp3000. Tentukan harga jual yang sesuai untuk satu potongan kue tart yang sesuai dengan target Andi.

(a)

Figure 1. Medium size Tart Cake

Andi made a medium-sized tart for his birthday celebration with his friends, as shown in Figure 1. The tart will be cut evenly and decorated before Andi distributes it.

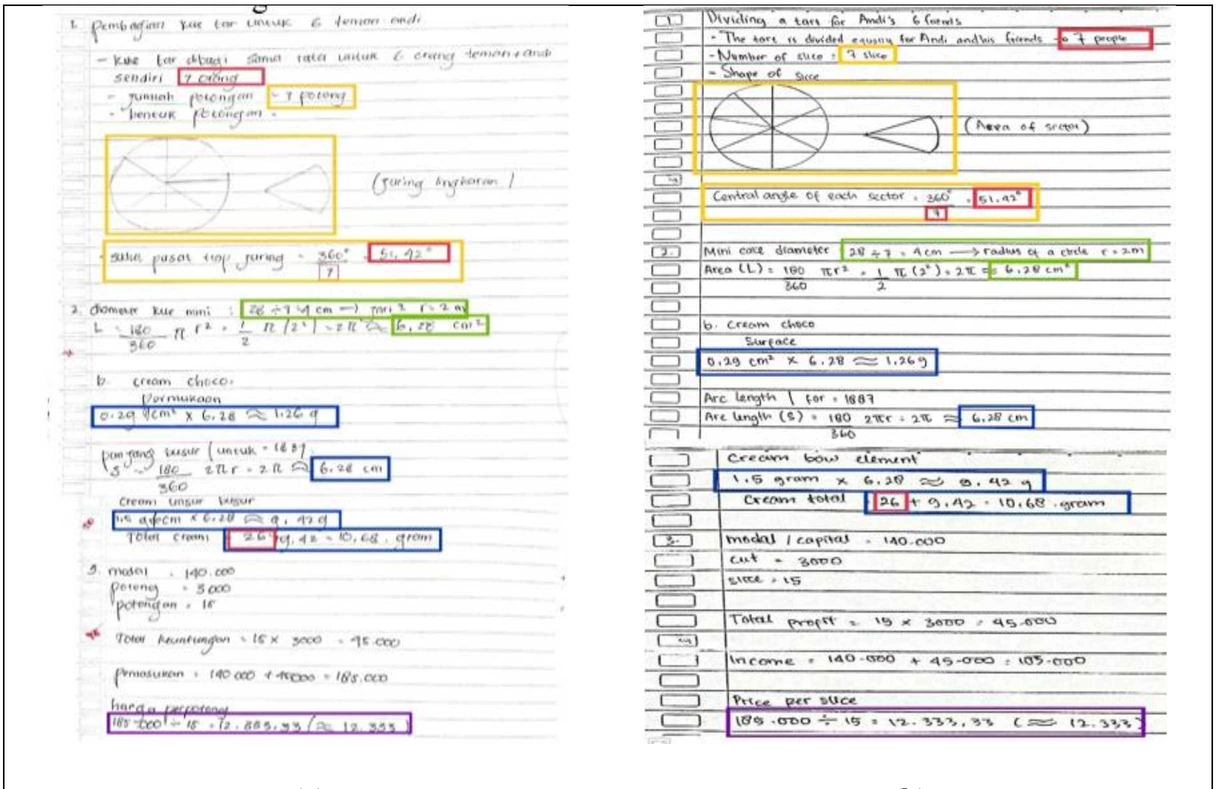
1. If Andi has 6 friends, how many pieces will the tart be divided into? Describe the shape of a piece of tart that 1 of Andi's friends received. If one piece is called a juring, what is the size of the center angle of each juring?
2. Because many people like it, Andi makes one mini tart cake that is 7 times smaller in diameter than the previous tart. One of the tart cakes will be topped with choco cream with a size of 0.2 grams of cream per 1 cm² of surface and 1.5 grams of cream per 1 cm of bow length.
   a. Calculate the area of one mini tart bar if it is known to have a center angle of 180.°
   b. Then calculate how many grams of cream choco are needed to decorate one of the mini tarts.
3. The cost of making one medium-sized tart cake with toppings is IDR 140,000. If Andi sells tart in the form of 15 pieces with a profit target per piece of IDR 3,000. Determine the appropriate selling price for one piece of tart that matches Andi's target.

(b)

Figure 1. Questionss

The following section presents an analysis of the research subject's responses in solving the contextual mathematics problem. The analysis aims to identify how the subject interpreted the problem situation, selected appropriate mathematical concepts, carried out the solution process, and arrived at a conclusion. The subject's work was examined based on the indicators of mathematical literacy, including formulating, employing, and interpreting mathematics in a real-world context. To provide a comprehensive description of the subject's mathematical thinking, the written responses were analyzed and supported by interview data. The discussion begins with Subject MO, who was categorized as a high-ability student based on the results of the mathematical ability test. Figure 2 presents the written responses of Subject MO to the given problem.

Original Version	English Version



(a) (b)

Figure 2. MO's Answers

MO student demonstrated a strong conceptual understanding of the relationship between the number of cake slices and the size of the central angle of a circle. MO student was able to correctly apply the formula $\theta = \frac{360°}{n}$, which reflects a solid grasp of the geometric principles underlying circular divisions. Despite this, a notable error emerged in the contextual interpretation of the problem. Specifically, MO student included Andi as an additional recipient of the cake, increasing the total number of slices from six to seven. As a result, the circle depicted in the diagram was divided into seven sectors, each with a central angle of $51.42°$, instead of the mathematically accurate $60°$. Although this calculation was incorrect, the step-by-step reasoning presented by MO student indicates a clear understanding of the internal connection between the number of slices and the central angle of the circle. This observation suggests that MO student has achieved competence in linking mathematical concepts internally but has not yet fully developed the ability to integrate these concepts accurately within real-life contexts.

In addition to the geometric understanding, MO student demonstrated strong proficiency in applying the concept of ratios to solve problems involving circle segments. MO student began by determining the radius of a mini tart through a proportional relationship derived from the given diameters, accurately calculating $r = 2$. Even though part (a) question 2 was not explicitly labeled, the solution process clearly delineated the logical steps taken to determine the area of a mini tart slice. These steps were performed systematically and correctly, providing evidence that MO student successfully achieved the indicator of connecting mathematical concepts across different topics, particularly linking the concepts of ratio and geometry in the context of calculating the area of a circle sector. The systematic approach also indicates that

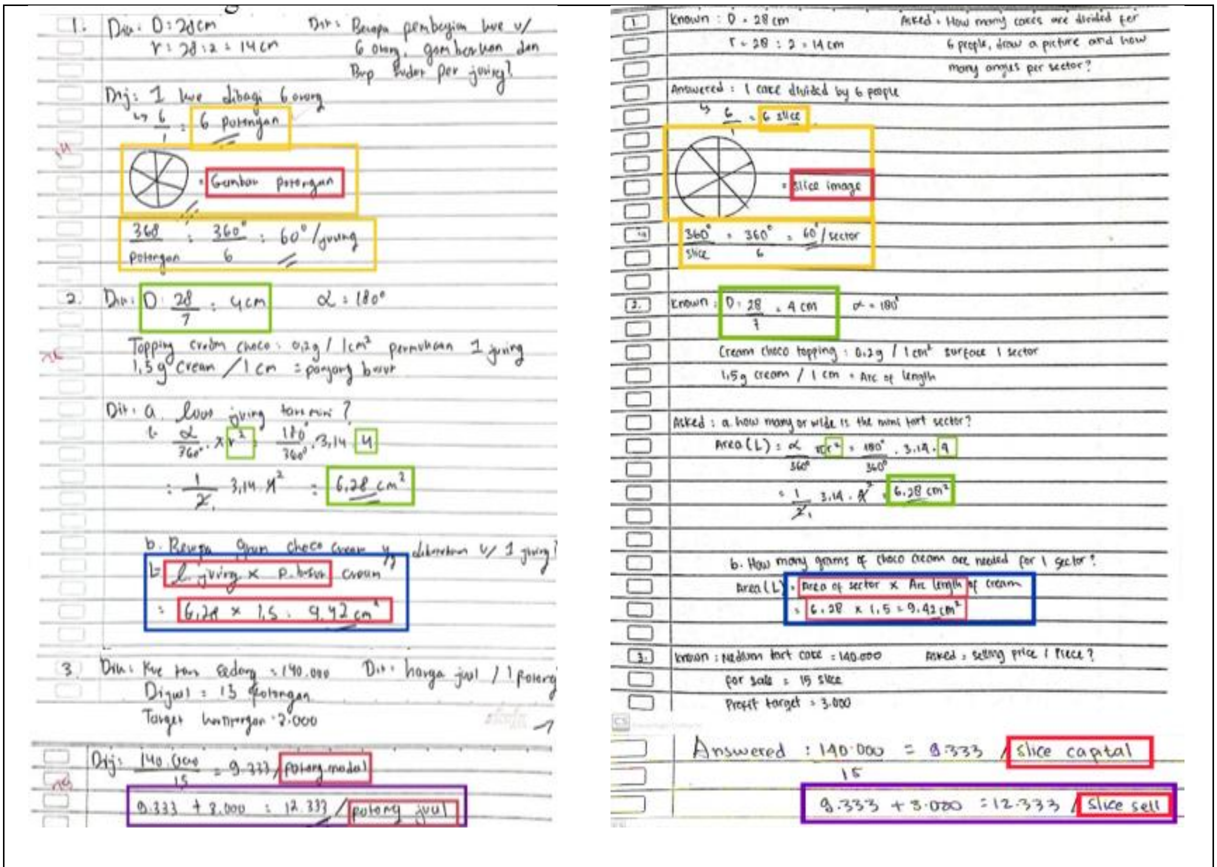
MO student is capable of following a structured problem-solving strategy, demonstrating both procedural fluency and conceptual understanding.

Furthermore, in part (b) question 2, MO student extended mathematical reasoning to determine the amount of cream required for the mini tart. MO student accurately multiplied the surface area of the tart by the specified quantity of cream per unit area and correctly calculated the arc length to account for the cream along the edge. A minor error occurred in the final summation, where “1.26” was written instead of “26.” Despite this computational oversight, the process reflects a coherent connection between mathematical calculations and scientific contexts, demonstrating an understanding of how geometric measures such as area and arc length relate to real-world quantities expressed in grams. Moreover, MO student attempted to apply the mathematical results to a practical scenario by estimating the ideal price of a piece of cake. Although the final answer did not include the currency unit (rupiah), the approach exemplifies an emerging ability to translate mathematical reasoning into everyday applications.

In addition, the work of MO student illustrates the capacity to integrate multiple mathematical concepts within a single problem, combining geometric reasoning, ratio analysis, and proportional calculations. This multi-conceptual approach is indicative of higher-order thinking skills and reflects the potential for advanced mathematical modeling. However, the minor errors in contextual interpretation and arithmetic calculations suggest that MO student may benefit from additional guidance in applying abstract mathematical knowledge to realistic situations. The observed strengths also highlight the importance of scaffolding in teaching, as structured prompts and guided questions could further enhance MO student’s ability to link theory with practice. Furthermore, the findings provide insight into the cognitive processes involved in mathematical problem-solving, particularly in tasks that require simultaneous attention to geometric, proportional, and applied contexts. This case reinforces the pedagogical principle that conceptual understanding alone is not sufficient; students must also be able to contextualize and operationalize their knowledge in practical scenarios. Overall, MO student demonstrates a promising ability to make internal mathematical connections and to attempt real-world applications, offering valuable evidence for curriculum developers and educators seeking to strengthen mathematical reasoning and application skills among learners.

The following section presents an analysis of the responses provided by Subject SAA, who was categorized as a medium-ability student based on the results of the mathematical ability test. The purpose of this analysis is to examine how Subject SAA understood the contextual problem, identified the relevant mathematical concepts, and implemented problem-solving strategies to obtain a solution. Particular attention is given to the subject's ability to formulate the mathematical model, perform the necessary calculations, and interpret the results within the context of the problem. In addition, the analysis explores the strengths and limitations demonstrated by the subject during the problem-solving process. To obtain a more comprehensive understanding of the subject's mathematical thinking, the analysis is based on both the written responses and the interview data. Figure 3 presents the written responses of Subject SAA to the given problem, which serve as the primary data for the subsequent analysis.

Original Version	English Version



(a) (b)

Figure 3. SAA's Answers

SAA student showed an adequate understanding of the relationship between the number of slices and the central angle of a circle. These SAA students correctly identified that the pie should be divided into six equal slices and accurately calculated the central angle as $60° per\ juring$. This shows that SAA student understand the mathematical relationship between the number of slices and the size of the central angle. In the visual representation, SAA student drew a whole cake divided into six equal slices and labeled it as a "slice diagram." However, this diagram did not clearly represent the shape of the slice received by one person according to the requirements of the question. Although the illustration was incomplete, the written explanation showed that student showed to think mathematically and connect the context of the question with the correct mathematical concepts. Overall, SAA student successfully identified and connected mathematical concepts with the same topic, but were unable to provide a completely accurate visual representation based on the question given.

In question number 2, SAA student showed to determine the diameter of the circle using the concept of proportion and comparison, but did not explicitly write the radius. In the quadratic operation involving r, the student entered the value 4, indicating that he actually understood the radius of the cake slice but omitted writing its length. This was confirmed through the interview, where the student explained that he forgot to write the radius because he was in a hurry, although he knew that the value of r was 2.

In the third indicator, SAA was unable to connect mathematical calculations with the concept of mass, and based on interviews he stated that he had forgotten the completion step even though he had previously been able to work on similar problems. In the fourth indicator, SAA showed to complete the price calculation but did not include rupiah units, similar to other students.

The following section presents an analysis of the responses provided by Subject KAS, who was classified as a low-ability student based on the results of the mathematical ability test. This analysis aims to examine how the subject understood the contextual mathematics problem, identified the relevant information, and attempted to formulate and solve the problem using mathematical concepts. Special attention is given to the difficulties encountered by the subject throughout the problem-solving process, including misconceptions, procedural errors, and limitations in interpreting the contextual information. The analysis also explores the extent to which the subject was able to formulate, employ, and interpret mathematics when solving the given task. To obtain a comprehensive understanding of the subject's mathematical thinking, both the written responses and interview data were analyzed. Figure 4 presents the written responses of Subject KAS, which serve as the basis for the following discussion.

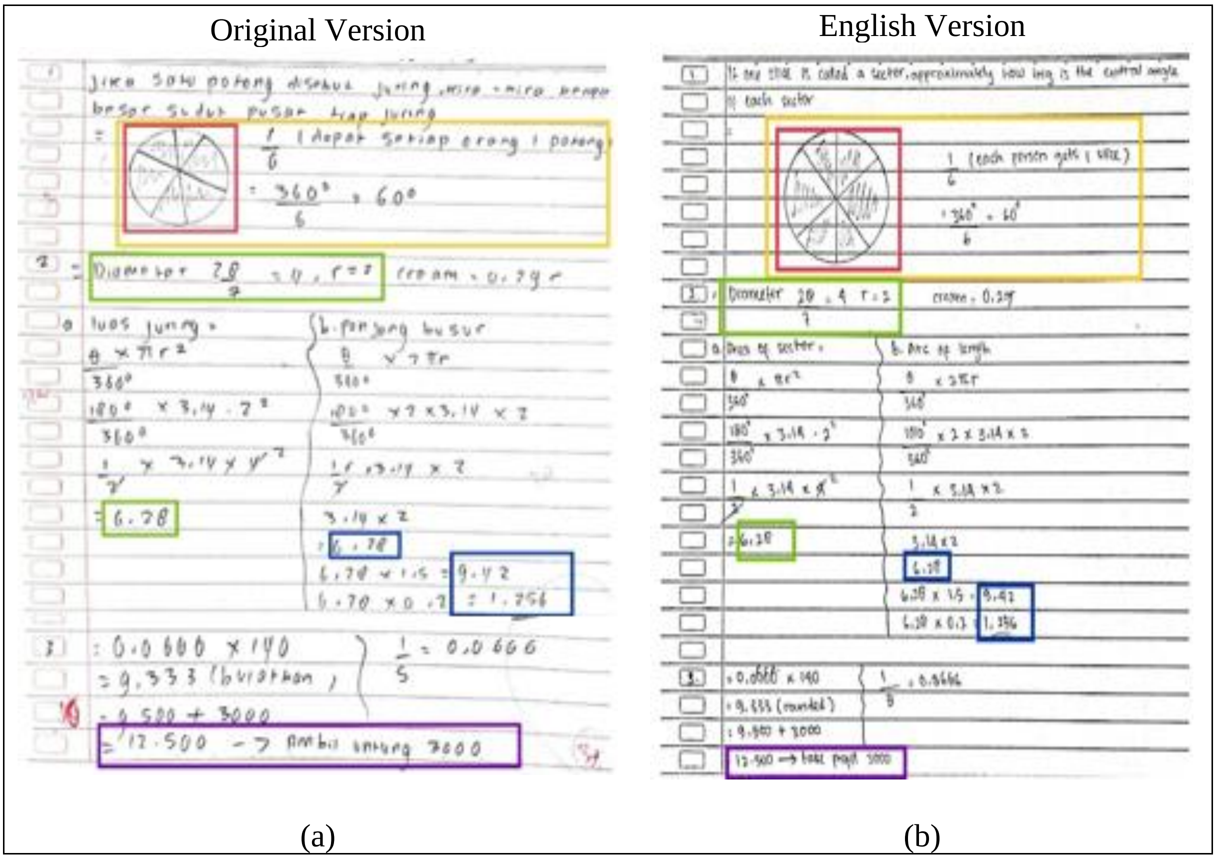


Figure 4. KAS's Answers

The KAS student showed an understanding of the relationship between the number of slices and the central angle of a circle. During the interview, KAS stated that her deliberately did not write the total number of slices of cake, but instead drew a whole cake divided into six equal parts and wrote "$\frac{1}{6}$ (each person gets one slice)," meaning that in a cake divided into six parts, each person would receive one slice. The calculation of the central angle is correct, using the formula $\frac{360°}{6} = 60°$, showing an understanding of the relationship between the concept of central angle and the number of pieces. However, KAS did not explicitly write down the number of pieces and the visual representation was inaccurate because all the slices were shaded, making it unclear which slice represented an individual portion. This shows that KAS understands the mathematical concept but lacks precision in representing the concept procedurally and visually, resulting in low mathematical connection skills.

In Question 2, the KAS student demonstrated the indicator of connecting mathematical concepts across different topics, particularly by integrating proportional reasoning and comparison with the concepts of sector area and arc length. KAS student correctly identified the radius as $r = 2$, although minor inaccuracies were observed, including the omission of units in the arc length and sector area calculations. In Question 2b, the student was also able to relate the concepts of sector area and arc length to the scientific concept of mass, successfully determining the required amount of cream but failing to combine the results of the two portions. The omission of units likewise appeared in the arc length and measurement values. However, the interview confirmed that the student possessed accurate conceptual understanding, as he correctly stated that the unit for sector area is cm^2, for arc length is cm, and that mass should be expressed in grams. In the fourth indicator, KAS is able to relate arithmetic operations to the price context, but makes minor mistakes such as mistakenly changing the value of $\frac{1}{15}$ to $\frac{1}{5}$ and writing incorrect units.

Based on the results of the analysis, the first indicator, namely *connecting mathematical concepts in one topic*, can generally be achieved by all students. However, there is a difference in accuracy between the ability categories. Medium and low category students are not appropriate in describing the shape of one sector. Even though they understood that what was asked was a picture of the sector, both still depicted a whole baking sheet that did not match the question request. These findings are in line with Hidayati (2020) and (Fatimah, 2021) who found that students often misinterpret circle representations and have difficulty relating mathematical concepts internally in real contexts. High-category students misinterpret the questions because they are in a hurry, according to Maulyda et al., 2022). These findings also support previous results Nurlaela (2023) which emphasized that inthoroughness and rush are the causes of student error.

The second indicator, namely *connecting mathematical concepts with other mathematical topics*, also appeared in the three students. All students from each category showed to associate the concepts of proportions and comparisons to determine the length of the radius and the diameter of the mini tart. However, students in the medium category did not write down the complete calculation process and did not directly write down the value of the radius because they felt that the step was unnecessary and would be operated again at the next stage. These findings are in line with the research Mustaghisa (2024) and Khofifah (2022) who found that some students tend to ignore the link between procedures and concepts when solving fraction problems.

In the third indicator, namely *connecting the concept of mathematics with other* disciplines, the context used is the concept of mass in science subjects. Of the three students interviewed, only the medium category students did not show the appearance of these indicators. The high category student showed to give complete and accurate answers, but there were minor errors in the form of mistakes in writing numbers because he worked on the problem in a hurry. The category student is experiencing conceptual errors, although during previous observations and exercises he showed to solve similar problems correctly. Based on the interview, the student in the medium category stated that he forgot the completion step. Meanwhile, the low-category student did not write down the total mass of the cream as a whole because he stopped in the medium of the calculation process and did not list the unit in his answer, even though the results of the interview showed that he actually understood the unit that was supposed to be used. These findings show that students with medium or low mathematical connection skills often experience conceptual, procedural, and comprehension/transformation errors when connecting mathematics with other disciplines, so that connection indicators appear even if the completion steps are incomplete (Aritonang & Pujiastuti, 2023; Hamid, 2023; Kurniawati et al., 2021).

The fourth indicator, which is *to connect mathematical concepts with the real-world context*, is analyzed through students' ability to understand arithmetic operations related to prices in rupiah units. The three students showed the appearance of this indicator in their completion. However, none of the students wrote rupiah units on their answers. In low-category students, minor errors arise and the use of improper units. These findings show that there is an inaccuracy in writing information and presenting final results in line with Susilawati (2023) who found that encoding errors often appear in contextual problems, including inaccuracy in unit writing Ratna (2023) also emphasized that students with low abilities tend to make "careless mistakes" or application errors when solving real-world problems.

CONCLUSION

The conclusion of this study indicates that students' mathematical connection ability is at a medium to high level, with an average score of 56.6. In general, students are able to connect mathematical concepts within a single topic and relate them to real-world contexts, with a percentage of 95.1%. However, students still face difficulties in systematically writing calculation processes and in comprehensively linking concepts across different topics, with a percentage of 65.9%. The analysis of interviews with representative subjects showed differences in strategies and ways of thinking between students with low, medium, and high abilities, which became the basis for consideration for learning improvement. This study is limited by its small sample size and its specific focus on sector-of-circle material, which means that the findings may not fully represent students' mathematical connection abilities across broader mathematical domains. Even so, the study contributes to mathematics education by showing that the integration of local cultural contexts, particularly the use of sponge kojo, within PMRI-based learning supported by interactive technology can strengthen students' mathematical connection skills, enhance the quality of contextual learning, and increase learning motivation because the food-based context is familiar and engaging for students. This culturally grounded context makes mathematical tasks more meaningful and encourages deeper involvement in problem solving. The findings also highlight the need for interactive learning strategies that incorporate technology, emphasize students' reasoning processes, promote consistency in mathematical writing, and make use of everyday contexts rooted in the cultural practices of Palembang. Based on these implications, future research is recommended to involve larger and more diverse samples, examine a wider range of mathematical topics, and explore additional cultural contexts to more comprehensively evaluate the effectiveness and adaptability of contextual and technology-enhanced mathematics learning.

REFFERENCES

Agusta, E. S. (2020). Peningkatan kemampuan matematis siswa melalui pendekatan pendidikan matematika realistik. *Algoritma: Journal of Mathematics Education*, *2*(2), 145–165. https://doi.org/10.15408/ajme.v2i2.17819

Ahmad, R., Bahar, E. E., & Nursakiah, N. (2023). Deskripsi Kemampuan Koneksi Matematis pada Materi Sistem Persamaan Linear Dua Variabel ditinjau dari Self-Confidence di Kelas X SMA. *Proximal: Jurnal Penelitian Matematika Dan Pendidikan Matematika*, *6*(2), 141–149. https://doi.org/10.30605/proximal.v6i2.2589

Andriani, F. S. A., Inganah, S., & Khusna, A. H. (2024). Analysis of Mathematical Connection Ability in Minimum Competency Assessment Algebra Test Viewed From Students' Intrapersonal and Interpersonal Intelligence. *AL-ISHLAH: Jurnal Pendidikan*, *16*(1), 476–488. https://doi.org/10.35445/alishlah.v16i1.4398

Aprilianda, N., Susanah. (2022). Profile Of Students' Mathematical Connection Ability In Solving Mathematics Problems Based On Visualizer And Verbalizer Cognitive Style. *Jurnal Ilmiah Pendidikan Matematika*, *11*(2).

Aritonang, T. D., & Pujiastuti, H. (2023). SLR: Kesalahan Siswa dalam Memecahkan Masalah Geometri Berdasarkan Teori Newman. *Gammath : Jurnal Ilmiah Program Studi Pendidikan Matematika*, *8*(2), 83–93. https://doi.org/10.32528/gammath.v8i2.544

Brijlall, D., & Abakah, F. (2022). High school learners' challenges in solving circle geometry problems. *PONTE International Journal of Sciences and Research; Vol. 78, Issue 12 (1)*. https://doi.org/10.21506/j.ponte.2022.12.9

Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative and Mixed Methods Appproaches*.

Desthiani, W., Febrian, & Fera, M. (2024). Analysis Of The Matanalysis Of The Mathematical Connection Ability Of Class VIII Students Of SMP Negeri 11 Tanjung Pinang On Social Arithmetic Material. *Jurnal THEOREMS (The Original Research of Mathematics)*, *9*(1), 34–44. https://doi.org/10.31949/th.v9i1.8638

Earl L, W. (2023). *Geometry* (Subject Sector Area, pp. 106–106). www.mathguy.us

Fatimah, A. T. (2021). Koneksi Matematis Siswa pada Tugas Matematis Berbasis Hasil Pertanian: Konteks, Konsep, dan Prosedur Matematis. *Jurnal Elemen*, *7*(2), 295–309. https://doi.org/10.29408/jel.v7i2.3176

Firdaus, F. M., Afani, A. S., Utami, N. N., & Mega, R. Al. (2022). Pengaruh model realistic mathematics education terhadap kemampuan koneksi matematis siswa. *JMIE: Journal of Madrasah Ibtidaiyah Education*, *6*(1), 32–49. http://dx.doi.org/10.32934/jmie.v6i1.399

Fitri, N. L., & Prahmana, R. C. I. (2020). Designing Learning Trajectory of Circle Using the Context of Ferris Wheel. *Journal of Research and Advances in Mathematics Education*, *5*(3), 247–261. https://doi.org/10.23917/jramathedu.v5i3.10961

Fitriani, L., Refianti, R., & Yanto, Y. (2023). Systematic Literature Review: Desain Modul Dengan Pendekatan PMRI Pada Kurikulum Merdeka. *Polinomial: Jurnal Pendidikan Matematika*, *2*(1), 1–10. https://doi.org/10.56916/jp.v2i1.397

Hamid, H. (2023). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Geometri Berdasarkan Kriteria Newman pada Siswa Kelas VIII. *Linear : Jurnal Ilmu Pendidikan*, *7*(1), 30–39. https://doi.org/10.53090/jlinear.v7i1.423

Hasanah, U., Putri, R. I. I., & Zulkardi, Z. (2024). Development of learning video rotation using Palembang tanjak context to determine students' mathematical reasoning. *Jurnal Elemen*, *10*(1), 135–157. https://doi.org/https:/doi.org/10.29408/jel.v10i1.23988

Hidayati, U., & Jahring, J. (2021). Analisis Kemampuan Koneksi Matematis Siswa Ditinjau dari Gaya Belajar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(4), 2890–2900. https://doi.org/https://doi.org/10.24127/ajpm.v10i4.4417

Hidayati, V. R., Subanji, S., & Sisworo, S. (2020). Students' Mathematical Connection Error in Solving PISA Circle Problem. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *8*(2), 76. https://doi.org/10.25273/jipm.v8i2.5588

Hutneriana, R., Hidayah, I., Isnarto, I., Dwijanto, D., & Wardono, W. (2024). Meningkatkan Kemampuan Koneksi Matematis melalui Pembelajaran Matematika Realistik. *PRISMA, Prosiding Seminar Nasional Matematika*, 529–538. https://proceeding.unnes.ac.id/prisma/issue/view/58

Isamer, N. P., Ilma, R., & Susanti, E. (2022). Eksplorasi Penalaran Siswa Dalam Pembelajaran Menggunakan Soal Berkonsep PMRI Tentang Aritmatika Sosial Di SMP. *Jurnal Karya Pendidikan Matematika*, *9*(1), 8–14. https://doi.org/10.26714/jkpm.9.1.2022.8-14

Jannah, M. (2023). *Kemampuan Numerasi Siswa Pada Pembelajaran Aljabar Menggunakan Pendekatan PMRI dengan Konteks Taman Wisata Alam Punti Kayu di Kelas VII SMP*.

Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. (2022). CP & ATP: Matematika Fase F. https://guru.kemdikbud.go.id/kurikulum/referensi-penerapan/capaian-pembelajaran/sd-sma/matematika/fase-f/

Khofifah, R., Ernawati, E., & Halim, St. N. H. (2022). Deskripsi Kemampuan Koneksi Matematis Siswa Dalam Menyelesaikan Masalah Operasi Hitung Pecahan. *LINEAR: Journal of Mathematics Education*, *3*(2), 105. https://doi.org/10.32332/linear.v3i2.4845

Kpotosu, C. K., Amegbor, S., Mifetu, B., & Ezah, R. B. K. (2024). *Senior High School Students' difficulties with Geometry Topics*. https://doi.org/10.20944/preprints202405.0126.v1

Krisdamayanti, B. (2021). *Analysis Of Mathematical Connection Ability In Linear Equalies And Inequality One Variable Of Class Vii Students Of Smp Domicili Village Nanowa Learning Year*. https://doi.org/10.57094/afore.v2i1.762

Kristianti, R., Muchyidin, A., & Manfaat, B. (2022). Exploration of Vocational School Students' Misconceptions of Circle Material. *Journal of General Education and Humanities*, *1*(2), 95–106. https://doi.org/10.58421/gehu.v1i2.19

Kurniawati, E., Dwijayanti, I., & Aini, A. N. (2021). Profil Kesalahan Siswa Dalam Penyelesaian Masalah Matematika Berdasarkan Newman's Error Analysis (Nea) Ditinjau Dari Kemampuan Koneksi Matematis MATEMATIS. *JURNAL SILOGISME : Kajian Ilmu Matematika Dan Pembelajarannya*, *6*(1), 48–57. https://doi.org/10.24269/silogisme.v6i1.3335

Mariana, N., Kholiqul Amin, A., Matematika, P., & PGRI Bojonegoro Jalan Panglima Polin No, I. (2024). Profil Level Literasi Matematis Siswa Berdasarkan Kemampuan Koneksi Matematis. *Prosiding Seminar Nasional Pendidikan Fakultas Pendidikan Matematika Dan Ilmu Pengetahuan Alam IKIP PGRI Bojonegoro*.

Maulyda, M. A., Rosyidah, A. N. K., & Hidayati, V. R. (2022). Elementary school students' mathematical connection in problem-posing activities. *Jurnal Elemen*, *8*(1), 99–116. https://doi.org/10.29408/jel.v8i1.4364

Meitrilova, A., & Putri, R. I. I. (2020). Learning design using PMRI to teach central tendency materials. *Journal of Physics: Conference Series*, *1470*(1), 012086. https://doi.org/10.1088/1742-6596/1470/1/012086

Mustaghisa, A., & Chandra, T. D. (2024). Analisis Kesalahan Siswa Berdasarkan Teori Newman dalam Menyelesaikan Soal Cerita Materi Lingkaran. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, *4*(3). https://doi.org/10.51574/kognitif.v4i3.2025

Narotama, A., Ismail, B. N., & Zuliana, E. (2024). Lintasan Belajar Kelas 5 Materi Jaring-Jaring Kubus Dengan Permainan Engklek. *Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS)*, *8*(1), 119–124. https://doi.org/https://doi.org/10.33369/jp2ms.8.1.119-124

Nuralam, N., & Maulidayani, M. (2020). Capaian kemampuan penalaran matematis siswa dengan model air. *Numeracy*, *7*(1), 35–48. https://doi.org/10.46244/numeracy.v7i1.997

Nurlaela, R., Sofa, N. M., & Prabawanto, S. (2023). Jurnal Pembelajaran Matematika Inovatif Kesalahan Dalam Menyelesaikan Soal Koneksi Matematis Materi Sistem Pertidaksamaan Linear Dua Variabel. *6*(6). https://doi.org/10.22460/jpmi.v6i6.20072

Ostian, D., Zulkardi, Z., & Susanti, E. (2023). Kemampuan Koneksi Matematis Siswa Pada Materi Bangun Datar Dengan Konteks Wisata Palembang. *Indiktika : Jurnal Inovasi Pendidikan Matematika*, *5*(2), 211–221. https://doi.org/10.31851/indiktika.v5i2.11391

Prihadi, B. (2023). Pengembangan modul pembelajaran matematika terintegrasi keislaman berbasis QR code untuk kemampuan koneksi matematis pada materi trigonometri kelas X SMA Islam Al-Azhar 14 Semarang.

Purba, G. F. (2022). Implementasi Pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) Pada konsep Merdeka Belajar. *Sepren*, *4*(01), 23–33. https://doi.org/10.36655/sepren.v4i01.732

Rafiepour, A., & Faramarzpour, N. (2023). Investigation of The Mathematical Connection's Ability of 9th Grade Students. *Journal on Mathematics Education*, *14*(2), 339–352. https://doi.org/10.22342/jme.v14i2.pp339-352

Rahmi, M., Usman, & Subianto, M. (2020). First-Grade Junior High School Students' Mathematical Connection Ability. *Journal of Physics: Conference Series*, *1460*(1). https://doi.org/10.1088/1742-6596/1460/1/012003

Ratna, M. T., Mei, A., & Meke, K. D. P. (2023). Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Kontekstual Materi Barisan Aritmetika Ditinjau Dari Kemampuan Matematis. *JUPIKA: Jurnal Pendidikan Matematika*, *6*(1), 75–85. https://doi.org/10.37478/jupika.v6i1.2036

Romiyansah, R., Karim, K., & Mawaddah, S. (2020). Analisis Kemampuan Koneksi Matematis Siswa Pada Pembelajaran Matematika Dengan Menggunakan Model Pembelajaran Inkuiri Terbimbing. *EDU-MAT: Jurnal Pendidikan Matematika*, *8*(1). https://doi.org/10.20527/edumat.v8i1.8342

Septian, A., Inayah Program Studi Pendidikan matematika, S., Keguruan dan Ilmu Pendidikan Universitas Suryakancana, F., & Muwardi Kompleks Pasir Gede Raya Cianjur, J. (2020). Analisis Kemampuan Koneksi Matematis Siswa SMK Pada Materi Trigonometri. *Jurnal Analisa*, *6*(1), 28–39. http://journal.uinsgd.ac.id/index.php/analisa/index

Septiana, A., Amin, I. I., Soebagyo, J., & Nuriadin, I. (2022). Studi Literatur: Pendekatan Pendidikan Matematika Realistik Dalam Pembelajaan Matematika. *Teorema: Teori Dan Riset Matematika*, *7*(2), 343. https://doi.org/10.25157/teorema.v7i2.7090

Siagian, M. D., Suwanto, S., & Siregar, R. (2021). The Relationship Of Students' Prior Knowledge And Emotional Intelligence To Mathematical Connection Ability . *Jurnal Riset Pendidikan Matematika*, *8*(1), 61–72. https://doi.org/10.21831/jrpm.v8i1.39182

Susilawati, B. N., Sridana, N., Novitasari, D., & Subarinah, S. (2023). Analisis Kesalahan dalam Menyelesaikan Soal Cerita Ditinjau dari Kemampuan Matematika Siswa. *Jurnal Ilmiah Profesi Pendidikan*, *8*(4), 2256–2263. https://doi.org/10.29303/jipp.v8i4.1759

Van den Heuvel-Panhuizen, M., & Drijvers, P. (2020). Realistic mathematics education. *Encyclopedia of Mathematics Education*, 713–717.

Widiyawati, W., Septian, A., & Inayah, S. (2020). Analisis kemampuan koneksi matematis siswa SMK pada materi trigonometri. *Jurnal Analisa*, *6*(1), 28–39. https://doi.org/10.15575/ja.v6i1.8566

Zulkardi, Z., Putri, R. I. I., & Wijaya, A. (2020). Two decades of realistic mathematics education in Indonesia. *International Reflections on the Netherlands Didactics of Mathematics: Visions on and Experiences with Realistic Mathematics Education*, 325–340. https://doi.org/10.22460/infinity.v9i2.p223-246