I S T I W A ' INTERDISCIPLINARY JOURNAL OF ISLAMIC STUDIES
Vol. 1, No. 2, Juli 2026
Print ISSN : 0854-4239 || Online ISSN : 3123-8289

Connections and Knowledge Integration in Math Trail Activities: A Gender Analysis of Elementary School Students from the Perspective of Islamic Education

Arif Rahman Hakim[a1]*, Slamet Panuntun[b2], Kamalun Ni'am[c3] Singgih Setiawan [d4], Abdul Karim[e5]
[abc] Sekolah Tinggi Agama Islam Walisembilan, Semarang, Indonesia; [d] UIN Abdurrahman Wahid, Pekalongan, Indonesia, [e] Hallym University, South Korea
[1] arif.rahman4696@gmail.com; [2] slametpanuntun@setiaws.ac.id; [3] kamalunniam@setiaws.ac.id;
[4] singgih.setiawan@uingusdur.ac.id; [5] abdullkarim@hallym.ac.kr.
*Correspondent Author

ARTICLE INFO

Article history
Received:
28-07-2026
Revised:
29-07-2026
Accepted:
31-07-2026

Keywords: Mathematical Connection Process, Math Trail, Realistic Mathematics Problem, Gender Perspective, Islamic Education Perspective

ABSTRACT

This study aims to explore the mathematical connection processes of elementary school students with high mathematical ability in solving real-world problems through math trail activities, analyze differences in these processes based on gender, and examine them from the perspective of Islamic education. The study employed a qualitative method with a descriptive approach. Data were collected through a mathematical connection test based on math trail activities and interviews with fourth-grade students who demonstrated high mathematical ability. Data analysis involved data reduction, data presentation, and conclusion drawing. The findings indicate that mathematical connections emerged from the problem-understanding stage through the looking-back stage, encompassing connections between problems and mathematical knowledge, relationships among mathematical concepts, and connections between mathematics and other fields of knowledge. Mathematical modeling played an important role in bridging abstract mathematical concepts and real-world situations while facilitating students' mathematical connection processes. In terms of gender, both male and female students demonstrated mathematical connection indicators at every stage of problem-solving, although differences were observed in how they constructed these connections. From the perspective of Islamic education, the findings emphasize the equitable development of students' intellectual potential, appreciation of diverse learning characteristics, and integration of knowledge with real-life contexts. However, students' mathematical connections remained limited to simple mathematical content and did not yet extend to relationships among more complex mathematical topics. These findings support the development of inclusive, meaningful, and context-based learning.

ABSTRAK

Penelitian ini bertujuan mengeksplorasi proses koneksi matematis siswa sekolah dasar berkemampuan matematika tinggi dalam menyelesaikan masalah nyata melalui kegiatan math trail, menganalisis perbedaan proses berdasarkan gender, serta meninjaunya dari perspektif Pendidikan Islam. Penelitian menggunakan metode kualitatif dengan pendekatan deskriptif. Data dikumpulkan melalui tes koneksi matematis berbasis math trail dan wawancara terhadap siswa kelas IV berkemampuan matematika tinggi. Analisis data meliputi reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa koneksi matematis muncul sejak tahap memahami masalah hingga looking back, mencakup hubungan masalah dengan pengetahuan matematika, antarkonsep matematika, serta matematika dengan bidang ilmu lain. Pemodelan berperan penting dalam menjembatani konsep abstrak dengan situasi nyata dan memfasilitasi koneksi matematis siswa. Berdasarkan gender, siswa laki-laki dan perempuan menunjukkan indikator koneksi matematis pada setiap tahap pemecahan masalah, meskipun terdapat perbedaan dalam proses mengonstruksi koneksi. Perspektif Pendidikan Islam menekankan pengembangan potensi intelektual secara adil, penghargaan terhadap keragaman karakteristik belajar, dan integrasi pengetahuan dengan kehidupan nyata. Namun, koneksi matematis siswa masih terbatas pada materi sederhana dan belum mencakup hubungan antarmateri matematika yang lebih kompleks. Temuan ini mendukung pengembangan pembelajaran kontekstual yang inklusif dan bermakna.Kata kunci**:** Proses Koneksi Matematis, Math Trail, Masalah Matematika Realistik, Perspektif Gender, Perspektif Pendidikan Islam.

Introduction

Mathematics education is essentially not merely a process of transferring abstract formulas to students, but rather an effort to optimize all aspects of human nature (*fitrah*) in understanding the order of the universe. Although mathematical connection ability has been extensively studied, most previous research has focused on measuring the outcomes of mathematical connection ability through written tests. Research examining how mathematical connections are formed when students solve real-world problems remains relatively limited. In addition, studies integrating the process of mathematical connections with outdoor learning activities such as *Math Trail*, particularly from a gender perspective among elementary school students, are still scarce. Therefore, this study seeks to address this research gap.

Islamic education views learning not merely as the mastery of cognitive competencies, but as a process of developing the entirety of human potential (*fitrah*) in an integrated manner. Therefore, the knowledge acquired by students should enable them to understand the relationship between knowledge, life, and their responsibilities as human beings. The Prophet Muhammad (peace be upon him) stated that every child is born in a state of *fitrah*, while the environment plays a role in shaping the child's development (HR. Bukhari) (Az-Zabidi, 2020). This is further reinforced by the Qur'an, Surah al-Nahl verse 78, which explains that Allah has endowed human beings with hearing, sight, intellect, talents, and abilities. After being born with guidance from Allah, these talents develop.

Mathematical ability, from the perspective of Islamic education, constitutes part of the intellectual potential bestowed by Allah upon human beings. QS al-Nahl [16]: 78 indicates that human beings are endowed with hearing, sight, and *af'idah* (hearts/intellectual faculties), which serve as instruments in the process of acquiring knowledge. Therefore, mathematics learning should not be positioned merely as the transfer of abstract concepts, but as a process of actualizing students' intellectual potential through learning experiences that enable them to observe, measure, connect, model, and reflect upon reality. In this context, *Math Trail* activities are relevant to the principles of Islamic education because they provide real objects and problems as sources of learning experiences.

One of the most important mathematical skills to be developed from an early age, particularly at the elementary school level, is mathematical connection ability (Kenedi, Ahmad, et al., 2019; Kenedi, Helsa, et al., 2019; Ndiung & Nendi, 2018). Mathematical connection refers to the ability to relate previously acquired knowledge to a particular situation (Pambudi et al., 2020; Quilang & Lazaro, 2022). The ability to connect mathematical objects with one another, mathematical objects with other fields of knowledge, and mathematics with everyday life constitutes the foundation of mathematical connections that support problem-solving processes (Dewi et al., 2020). Therefore, this ability needs to be developed, and the process through which it emerges needs to be understood in order to improve students' problem-solving skills in everyday life.

Mathematical connections play a very important role in problem solving (Diana et al., 2020). Providing students with experiences in connecting mathematics from an early age can develop the habit of understanding that mathematics is closely related to other fields of knowledge and everyday life, thereby producing deeper understanding and improving success in problem solving (Astari & Marsigit, 2019; García-García & Dolores-Flores, 2018; Samo, 2021). NCTM (2000) states that mathematical connection ability is necessary to broaden students' perspectives, enable them to view mathematics as an integrated whole rather than as separate parts, and understand the relevance and usefulness of mathematics both inside and outside school. There are three indicators of mathematical connection ability (Baiduri et al., 2020): (1) the ability to recognize and use relationships among mathematical ideas; (2) the ability to recognize and understand relationships between mathematics and other fields of knowledge; and (3) the ability to recognize and apply mathematical ideas in everyday life.

Students need to connect the problems they encounter with their existing mathematical knowledge in order to understand a problem. An appropriate connection between a problem and mathematical knowledge will help students determine the final form of a solution (García-

García & Dolores-Flores, 2018; Payton, 2019). Furthermore, when dealing with real-world problems, students often need to connect mathematics with other relevant fields of knowledge. Even when students possess good mathematical knowledge, if they experience difficulties connecting mathematics with relevant disciplines, the solutions they produce tend to be less accurate (Kenedi, Ahmad, et al., 2019).

Furthermore, in order to bridge real-life problems with the mathematical world, students need to construct a mathematical model of the problem they encounter. The mathematical model produced during the problem-understanding process can represent the logical thinking involved in connecting mathematical concepts (García-García & Dolores-Flores, 2018). After obtaining a mathematical model, the next step is to utilize relationships among mathematical objects to solve the problem based on the model that has been constructed (Blum & Borromeo, 2009; Cahyono et al., 2020). The final stage is to check the answer by examining the accuracy of the relationships established, the calculations performed, and the suitability of the solution to the real-world context of the problem (Baiduri et al., 2020; Jailani et al., 2020). Efforts to develop students' mathematical connection ability can be initiated from an early age, one of which is through the use of realistic problems implemented in outdoor environments for elementary school students (Haji et al., 2017).

Mathematical connection ability is also influenced by other factors, including gender (Maulida et al., 2022). Differences in mathematical connection outcomes between male and female students have been identified in problem-solving processes (Hotipah & Pujiastuti, 2020; Lianawati & Purwasih, 2018). Dewi et al. (2020) found that both male and female students possess their respective strengths and weaknesses in solving mathematical connection problems. Based on this description, it is important to examine how elementary school students construct mathematical connections when solving realistic problems through *Math Trail* activities from a gender perspective.

Based on the research gap described above, this study addresses the following research question: How do high-achieving male and female elementary school students construct mathematical connections during mathematical problem solving in *Math Trail* activities?

Methodology

Research Design

This study aims to explore the process of mathematical connections among elementary school students based on gender differences when solving realistic problems through *Math Trail* activities. This research employed an exploratory descriptive design with a qualitative approach (Moleong, 2016).

Participants and Data Collection

The participants in this study were six fourth-grade students from MI Jamiyatul Ulum, consisting of three male and three female students who obtained the highest rankings in their semester examinations and had also completed a pre-test to determine their mathematical abilities. The number of participants was intentionally limited because this study employed a qualitative exploratory approach that focused on an in-depth analysis of students' thinking processes rather than statistical generalization. Six participants were considered sufficient to obtain rich descriptions while allowing detailed observation, interviews, and cross-validation of the mathematical connection processes of each participant.

The selection of participants was based on several considerations, including students' rankings in the semester examination, recommendations from classroom teachers, and the results of the mathematical ability pre-test. The selected students were the three highest-ranked students of each gender, received recommendations from their teachers, obtained pre-test scores above 85, and were able to explain their answers clearly. Students with high mathematical ability were selected because they were expected to demonstrate a broader

range of mathematical connections while solving problems authentically. This allowed the researchers to examine the process of constructing these connections in greater depth.

The three male and three female students were subsequently divided into two groups based on gender: the female group was coded G1 and the male group G2. Individual students in the female group were coded P1, P2, and P3, while those in the male group were coded L1, L2, and L3; Q1 represented the researcher. Each group was provided with a school-location map containing numbered stops (see Figure 1). Each group was asked to solve two problems collaboratively according to its gender group. The mathematical problems were validated by two elementary school mathematics teachers who examined their relevance, contextual appropriateness, language clarity, and alignment with the mathematical connection indicators. Revisions were made based on the feedback from the two validators before data collection.

The mathematical connection ability test consisted of realistic problems involving two questions related to distance and the area of plane figures within the context of a *Math Trail* activity. Students were asked to locate the problem site and solve the problem at that location using one-meter and 60-centimeter rulers, pens, pencils, and prepared answer sheets.

Data were collected by presenting realistic mathematical problems during the *Math Trail* activity, followed by in-depth group interviews. All group members were given the freedom to add to and complement one another's answers to the questions posed.

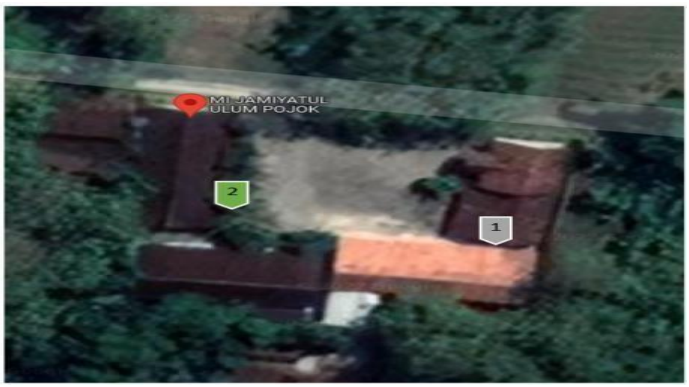


Figure 1. Math Trail Activity Map

The first form of data triangulation involved collecting data at different times and through different questions. Second, two different methods were employed: tests and interviews. Thus, data triangulation was conducted to obtain valid findings. In addition to collecting the answer sheets from each group, the problem-solving process and in-depth interviews were recorded using a video recorder. To ensure data trustworthiness, credibility was established through triangulation among observations, students' written work, and interviews. Peer debriefing was conducted among the researchers during the coding process, while all interpretations were repeatedly compared with the original data to ensure consistency.

Data Analysis

The data analysis process consisted of three stages: (1) data reduction, (2) data presentation, and (3) conclusion drawing (Miles & Huberman, 1994). The *Math Trail* activity was conducted within the MI Jamiyatul Ulum environment while taking students' safety into consideration. The realistic mathematical problems consisted of two problems located at two different sites. Interview transcripts and students' written work were analyzed thematically through a thematic analysis process. Initial coding focused on identifying evidence of mathematical connections at each stage of problem solving. Similar codes were then grouped

into categories representing indicators of mathematical connection. At the final stage, the emerging themes were interpreted by comparing the two gender groups. The problems presented were adapted to the components and indicators of the mathematical connection process based on the following problem-solving stages.

Table 2. Components and Indicators of the Mathematical Connection Process in Realistic Problem Solving

Problem-Solving Stage	Components and Indicators
1. Understanding the problem	1a. Connecting the realistic problem with prior mathematical knowledge; 1b. Connecting the mathematical domain with other fields of knowledge; 1c. Understanding the form of the final solution
2. Planning the solution	2a. Constructing a mathematical model as a representation of the relationship between the real-world problem and mathematical ideas; 2b. Identifying information known from the problem; 2c. Determining facts, principles, concepts, or procedures based on the model to be used
3. Carrying out the plan	3a. Collecting the data required to solve the problem; 3b. Using relationships among mathematical objects to solve the problem
4. Looking back	4a. Checking the application of the solution to the problem; 4b. Checking the accuracy of the mathematical domain connected in the solution; 4c. Checking the correctness of the calculations

Results

The Mathematical Connection Process for Problem Number 1

Problem number 1 involved connecting the concepts of surface area and numerical operations with the real world. The problem was as follows:

> "Observe the southern exterior wall of the building in front of the MI Jamiyatul Ulum Hall. If the school intends to cover the part of the wall that still has a rough surface with ceramic tiles of the same size as the hall floor tiles, how many boxes of ceramic tiles should be purchased? (1 box of ceramic tiles = 10 tiles)."

Understanding the Problem

The first question concerned calculating the number of ceramic tiles required to cover a wall. As is characteristic of problems in a *Math Trail* activity, the question did not contain specific information about the measurements. Therefore, students first needed to formulate questions to determine what they should do.

Students in G1 began understanding the problem by connecting the problem they were facing with their existing mathematical knowledge. This was evident in the following interview:

Q1: "How did you begin solving the first problem?"
P3: "We started by reading the problem several times and directly observing the location of the problem."
P2: "It needed to be read twice to understand what the problem meant."
Q1: "What did you understand after that?"

P2: "We understood that the problem was related to plane figures and things like that because the tiles are square."
P1: "Yes, and it must also be related to area."
Q1: "Okay, there are various ways of installing tiles. However, in the picture you made, you arranged the tiles neatly starting from the left. Have you encountered a problem like this before?"
P1: "Not exactly, sir, but I have seen a worker installing tiles at my house, and he started from one side first."
P3: "Me too. At that time, our house was being renovated and a bathroom was being built."
Q1: "Why do you think they did not start from the middle?"
P1: "If we start from the middle, it might not fit properly at the edges."

Based on the interview, students in G1 understood the problem by reading it and connecting it with their existing mathematical knowledge, particularly the relationship between the shapes of objects in the problem and plane figures such as squares and rectangles. In addition, G1 connected the way tiles are arranged with their mathematical knowledge and construction techniques, thereby connecting mathematical knowledge with another field of practical knowledge.

G2 demonstrated a process that was broadly similar to G1 in understanding the problem. G2 began by reading the problem and directly observing the location. They connected the shapes of the objects described in the problem with plane figures. They also appeared to have previous experience observing construction workers installing tiles and demonstrated their understanding of appropriate tile-installation techniques through the diagrams they produced.

Planning a Problem Resolution

G1 and G2 both drew models of the first realistic problem they encountered in the *Math Trail* activity. G1 initially planned to solve the problem using the abstract concept of surface area, as reflected in the length and width of the wall and the dimensions of the ceramic tiles shown in Figure 2.

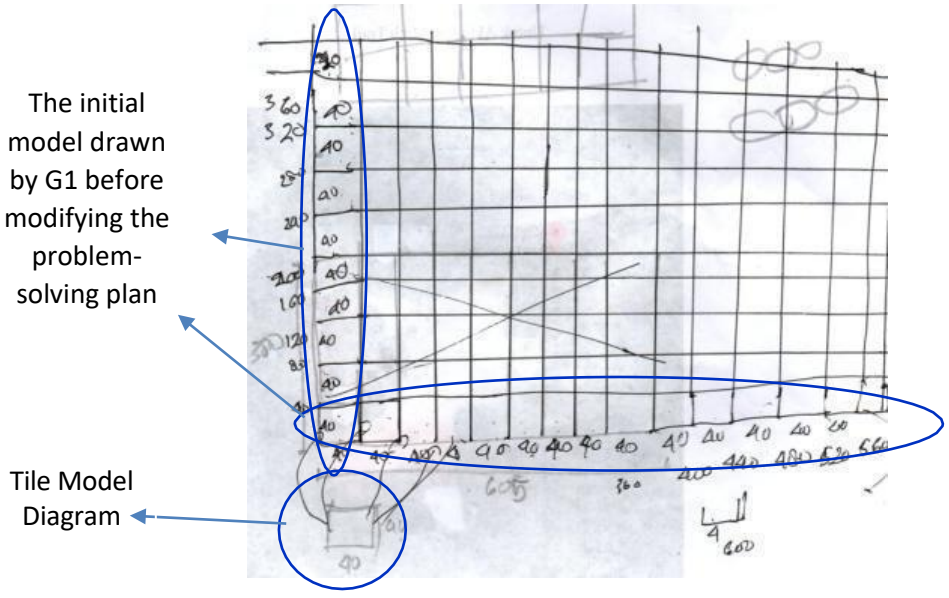


Figure 2. G1 Model at the Problem-Solving Planning Stage

However, their initial plan was interrupted because they experienced difficulty connecting the problem they were trying to solve with abstract concepts, as shown in Figure 3.

G1 subsequently discussed the problem and decided to modify its solution strategy by using a simpler approach while still relying on a similar concept. This was expressed in the following interview:

Q1: "What was your plan for solving the first problem?"
P1: "We started by determining the length and height, and then it was related to division."
P2: "First, we needed to know the length and width of the tiles and the wall."
P3: "Once we knew everything, we just had to calculate it using division, I think."

Based on the interview, G1 modified its plan by using a visual representation and working with a pictorial model to determine the number of tiles required. In contrast, G2 planned from the beginning to use a pictorial representation to solve the problem and perform mathematical operations based on the model. This indicates that both groups connected mathematical concepts with real life by constructing mathematical models of the problem they encountered.

Carrying Out Problem Resolution

As shown in Figure 4, G1 implemented its plan by measuring the information needed from the problem. G1 was able to identify the necessary information through direct measurement using a ruler. G1 also recorded the information requested in the question on its answer sheet.

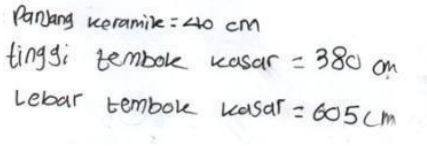
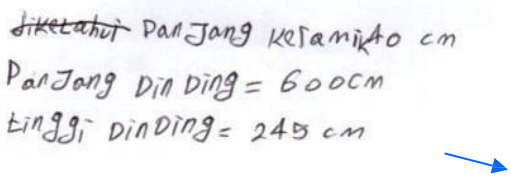


Figure 4. Understanding the problem oleh G1

The measurements demonstrated that G1 had connected the problem with mathematical measurement and the correct procedures for measuring, thereby establishing a connection between mathematical concepts and the real world.



Obtained through direct measurement after understanding the problem

Figure 5. The measure of things to know from the problem by G2

Similar to G1, G2 began the problem-solving process by accurately measuring the important information needed. However, the two groups showed a significant difference in their measurements of the wall height. This occurred because G1 measured beyond the area specified in the problem, which only concerned the portion of the wall with a rough surface. This resulted in a difference in measurements between the two groups. G2 demonstrated an understanding of the connection between the mathematical problem and the real-world situation, as well as between measurement and appropriate measurement procedures.

After obtaining the required measurements, G1 carried out its plan by drawing small squares and assigning each a measurement of 40, repeatedly extending them to the right until they reached the height and length of the wall, as shown in Figure 6.

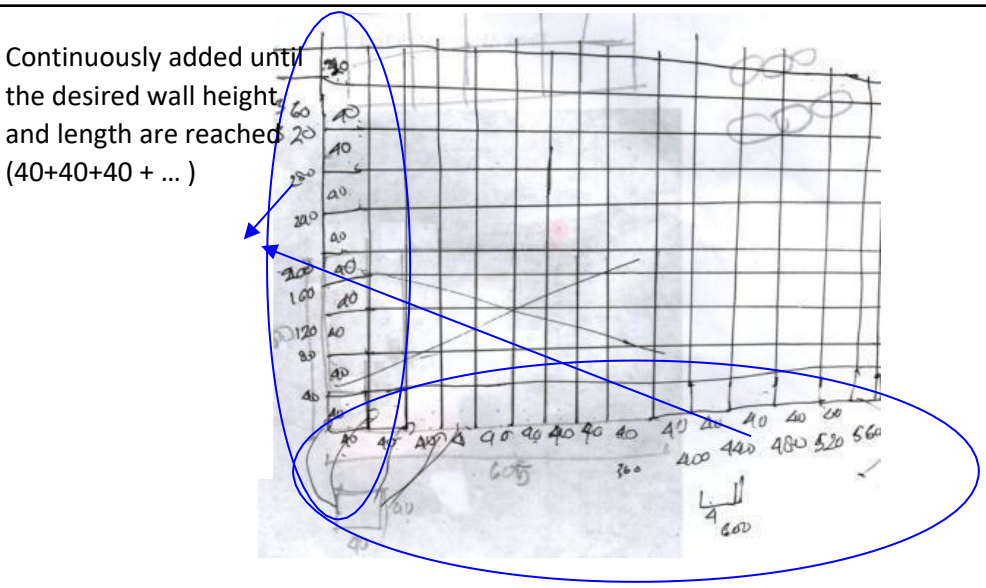


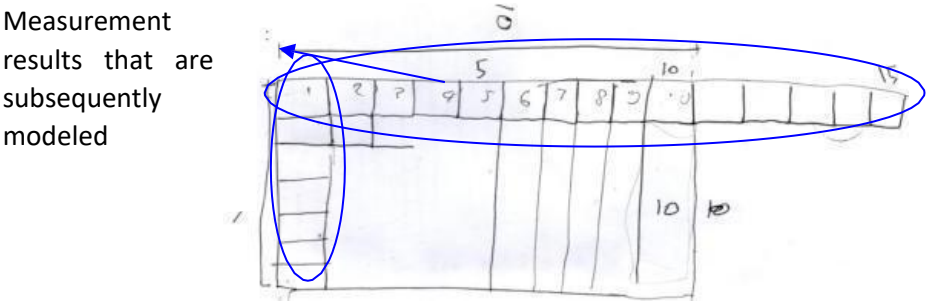
Figure 6. G1 Problem Solving Using the Model Diagram in the "Carry Out Problem" Step

After the model had been clearly constructed, the squares were counted individually along the bottom row and the leftmost column. G1 then multiplied the two resulting quantities to determine the number of ceramic tiles required. This shows that G1 connected the concepts of tiling and surface area, thereby establishing connections among mathematical concepts. Through modeling, G1 also connected mathematics with real life. The students applied a procedure equivalent to the concept of area, although they could not explicitly identify the mathematical concept underlying their strategy. This was evident in the interview:

Q1: "How did you calculate the number of ceramic tiles required?"
P1: "We counted the bottom row and the leftmost column, then multiplied them."
Q1: "Is there a similar concept that you have learned in class before?"
P2: "Hmm... [thinking] we just thought it was the fastest way, that's all."

This indicates that the G1 students had connected the concept of surface area with a real-world problem but did not understand the appropriate terminology to describe what they were doing.

A similar process was demonstrated by G2. However, the G2 students did not fully rely on a pictorial model. Instead, they marked the wall directly using writing instruments according to the previously measured length of the ceramic tiles. They then calculated based on the markings made on the wall and constructed the corresponding model on their worksheet, as shown in Figure 7.



Gambar 7. G2 Problem Solving Using the Model Diagram in the "Carry Out Problem" Step

Looking Back Process

After obtaining the desired solution, both G1 and G2 rechecked their calculations and the pictorial models they had constructed. The mathematical connection indicators observed in both groups during the *looking back* stage involved connecting mathematics through reviewing numerical operations and connecting mathematics with real-world problems by examining the models and calculation details.

The mathematical connection process for Problem 1 in both G1 and G2 involved connections among mathematical concepts as well as connections between mathematics and everyday life. Indicators of mathematical connections were observed at every stage of problem solving. Connections among mathematical concepts were evident in the students' understanding and use of measurement, surface area, and numerical operations. Meanwhile, connections between mathematics and everyday life were demonstrated through the application of mathematics to determine the number of ceramic tiles required.

The Mathematical Connection Process for Problem Number 2

Problem number 2 involved connecting the concepts of distance and mathematical patterns with biology. The problem was as follows:
"Observe the trees in front of Grades 4, 5, and 6. If the school wants to replace these trees with sapodilla trees, and if the sapodilla trees eventually grow as large as the tree in front of Grade 2, will the branches of the sapodilla trees collide with one another? If so, determine the distance between the trees so that their branches will not collide when they become fully grown."

Understanding the Problem

G2 began the problem-understanding stage by discussing the problem within the group. Based on the worksheet produced, G2 understood the problem by connecting it with the concepts of measurement and distance. This was also evident in the following interview:
Q1: "What did you do to begin understanding the problem?"
L1: "We read the problem several times until we understood it."
L3: "Yes, we read it about three times."
Q1: "What did you understand from it?"
L2: "We knew that the problem was not too complicated and that it only required distance, addition, and multiplication."
L3: "Then we also measured the branches of the sapodilla tree in front of Grade 2 to estimate the space needed when the tree grows to that size."

G2 began by connecting the real-world problem with mathematical knowledge involving distance, measurement, and numerical operations. In addition, G2 connected mathematical objects with another field of knowledge, namely biology, through estimation based on tree growth. G2 also indicated in its worksheet that solving the problem required determining the appropriate dimensions of each tree to be planted.

Unlike G2, which tended to understand the problem directly and conduct measurements within a relatively short period, G1 spent more time discussing the problem. This was evident in the interview:
Q1: "How did you understand Problem 2?"
P3: "We read the problem repeatedly, perhaps around five times."
Q1: "Was there anything confusing?"
P3: "We were confused about how to measure the distance."
P1: "Yes, we were unsure whether to measure directly from the trees or from the tree enclosures."

The problem-solving process and worksheet showed that G1 measured the distance starting from the tree enclosure. Based on the interview, G1 chose to measure from the enclosure because they believed that the trees would continue to grow and therefore could not

be measured directly from the trees themselves. Thus, G1 connected mathematics with another field of knowledge, namely biology, by connecting the concepts of measurement and distance with biological growth. G1 also determined that the final solution should be the minimum distance between the enclosures of the sapodilla trees to be planted.

Planning a Problem Resolution

The plans used by G1 and G2 were broadly similar. Both groups determined the space required by a single sapodilla tree and then constructed a pattern based on that space. To determine the required space, both G1 and G2 measured the length of the branches of a sapodilla tree, represented the measurements in a model, and solved the problem using the pictorial model. Thus, both groups constructed solution plans by connecting measurement concepts with the field of biology.

Carrying Out Problem Resolution

G2 began implementing its problem-solving plan by measuring the distance between the trees located in front of Grades 3, 4, and 5 to complete the data required for the model, as shown in Figure 8. This indicates that G2 understood the connection between the problem and measurement.

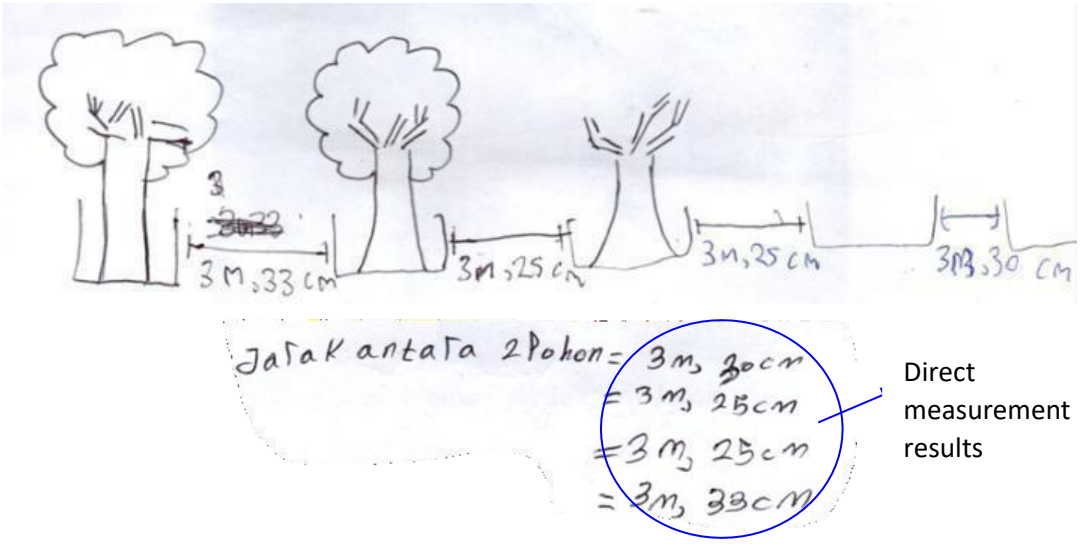


Figure 8. The measure of things to know from problem 2 by G2

G1 relied heavily on a pictorial model in solving Problem 2. It began by understanding the problem through drawing the distances between trees, although the measurements were taken between the enclosures surrounding the trees, as shown in Figure 9. This resulted in measurements that differed considerably from those obtained by G2. The selection of measurement points indicates that G1 connected mathematical concepts with the real-world problem, particularly the concepts of distance and measurement and the context of the problem.

The problem-solving processes of G1 and G2 were based on the plans they had developed. Overall, there was no substantial difference in the way G1 and G2 carried out the problem because both followed similar plans. However, there was a difference in the measurements of the sapodilla branches obtained by the two groups. This occurred because G1 selected the longest branch, whereas G2 did not. The work of G1 and G2 showed that both

groups understood that if the distance between the trees remained the same as that of the existing trees, their branches would collide. Both groups focused on the second question, namely the distance required between two sapodilla trees once they reached the size of the tree in front of Grade 2. Based on their measurements, both groups added the areas required by two trees, although G1 used addition while G2 used multiplication (see Figure 10).

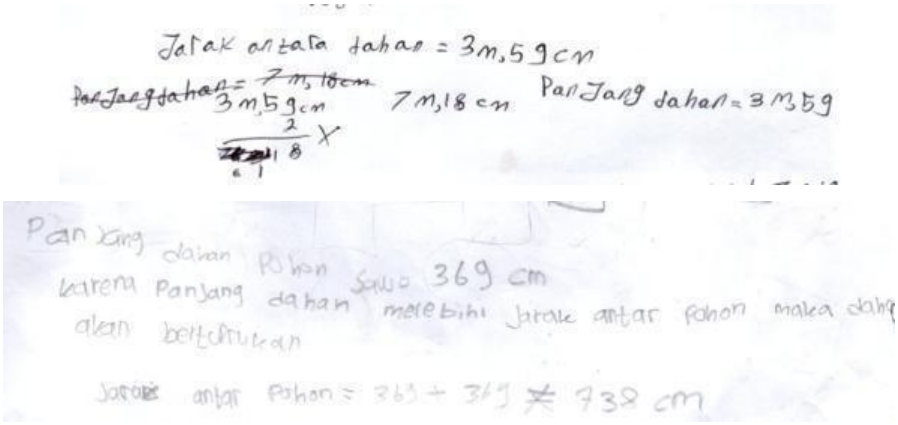


Figure 10. Carry out the problem process of G2

Looking Back Process

After obtaining the desired solutions, both G1 and G2 reviewed their calculations and pictorial models. The *looking back* processes of both groups demonstrated connections among mathematical concepts through calculations and connections between mathematical concepts and real-world problems through checking the pictorial models they had constructed.

Discussion

Overall, there were no substantial differences in the mathematical connection processes of students in the male and female groups. This finding is consistent with Baiduri et al. (2020), who found that differences occurred in the processes through which male and female students constructed mathematical connections, while all indicators of mathematical connection ability were demonstrated by both genders. Mathematical connection ability has a significant influence on how students solve problems (Jailani et al., 2020; Mardiyana et al., 2020; Rahmi et al., 2020).

The finding that both male and female students demonstrated mathematical connection indicators has important implications for Islamic education. Differences in learning-process characteristics should not serve as a basis for limiting students' opportunities to develop their intellectual potential. Islamic education places human potential development as an educational responsibility; therefore, learning should provide equitable opportunities for all students to develop according to their individual characteristics and learning needs. Accordingly, gender differences are more appropriately understood as variations in learning processes rather than as a basis for establishing a hierarchy of intellectual abilities.

At the problem-understanding stage, both groups demonstrated mathematical connection processes by relating real-world problems to their existing mathematical knowledge through connections with mathematical objects. Connections between mathematics and other fields of knowledge were also established through *Math Trail* activities that utilized real problems in an outdoor environment. The use of contextual outdoor problems has been shown to facilitate students' ability to connect mathematics with other disciplines (Haji et al., 2017). The findings also indicate that at this stage students were able to determine the form of the final result required by the problem. This may indicate that female students

tended to allocate greater cognitive resources to understanding the problem before carrying out mathematical procedures. Similar behavior was reported by Sari et al. (2020), who argued that female students generally demonstrate more careful reasoning during mathematical problem solving and therefore require more time to understand problems.

Although mathematical connection processes were evident during the planning stage, several errors were still identified due to the elementary school students' limited mathematical connection ability. The work of both groups showed that students had not yet been able to connect more abstract mathematical concepts to the first problem. Limited understanding of the mathematical material being studied also contributed to weaknesses in both internal and external mathematical connections and resulted in inappropriate use of concepts (García-García & Dolores-Flores, 2021; Jailani et al., 2020). Both groups tended to use only basic mathematical objects, such as direct measurement and simple numerical operations. Fourth-grade mathematics includes area, perimeter, and comparison, but students had not yet fully connected these concepts with real-world contexts (Jannah et al., 2017; Payton, 2019). If both groups were able to apply higher-level concepts, they might produce solutions more quickly and accurately.

At the stage of carrying out the plan, although students had connected mathematics with real life, limitations remained due to insufficient accuracy in observing field conditions, which was related to their limited experience in solving contextual problems (Samo, 2021). In the first problem involving ceramic tiles, both groups assumed that one complete tile was required even when only half of the tile was needed because they reasoned that tiles could not be purchased in half units. This argument demonstrates a connection between mathematics and real-life facts. However, if students had been more careful, one complete tile could actually have been divided into two parts, thereby reducing the number of tiles required. A similar situation occurred on the right side of the wall.

In addition, in the second problem, both groups used pictorial models to assist in solving the problem. However, the male group demonstrated an inaccuracy in its visual representation based on the interview and the model produced. The measurement was taken from tree to tree, but the drawing indicated that the measurement had been taken from enclosure to enclosure. In contrast, the female group demonstrated consistency between the work recorded on the answer sheet and the interview results. Although both groups had similar work plans, their implementation showed that both had connected mathematics with biology, for example, through estimating branch length based on tree age. The female group measured the longest branch and therefore produced a more accurate estimate. This accuracy was one factor contributing to the stronger mathematical connection ability demonstrated by the female students (Yuniawatika, 2018).

At the *looking back* stage, both groups established mathematical connections by reviewing calculations using numerical operations as well as the concepts of distance and area. In addition, students reconnected their calculations with the real-world context by checking the suitability of the measurements modeled from the given problems. These findings imply that teachers should not assess only the final answer but should also facilitate students' mathematical connection processes through authentic contextual activities such as *Math Trail*. Activities requiring students to construct mathematical models can strengthen the relationship between mathematical concepts and real-world situations.

The findings indicate that *Math Trail* not only develops intra-mathematical connections but also creates opportunities for interconnections between mathematics and other disciplines. When students connect the concepts of distance and measurement with tree growth, for example, they practically integrate mathematical knowledge with biological knowledge. From the perspective of Islamic education, such experiences are important because knowledge is not understood as consisting of isolated fields, but rather as a means of understanding reality holistically. Thus, mathematics learning can become part of an integrated knowledge paradigm that connects rational-empirical knowledge with awareness of the reality of Allah's creation.

The *looking back* stage in problem solving is also relevant to the principle of scientific *adab* in Islamic education. Students do not stop after obtaining an answer but re-examine their calculations, models, and their suitability to reality. This act of reviewing can be understood as a means of developing habits of accuracy, caution, and intellectual responsibility. Accordingly, mathematical activities do not merely produce procedurally correct answers but also cultivate an epistemic habit of not accepting conclusions hastily.

Conclusion

The mathematical connection process of students with high mathematical ability during *Math Trail* activities emerged from the stage of understanding the problem through the *looking back* stage. Students were able to connect real-world problems with their existing mathematical knowledge, establish connections among mathematical concepts, and relate mathematics to other fields of knowledge and everyday life. Mathematical modeling played an important role as a bridge between real-world problems and mathematical concepts, enabling students to identify the necessary data, construct models, perform calculations, and re-examine the suitability of their solutions within the context of the problems.

From a gender perspective, both male and female students demonstrated mathematical connection indicators at every stage of problem solving, although differences existed in the ways they constructed these connections. Female students tended to require more time to understand problems but demonstrated deeper understanding and greater accuracy, whereas male students tended to begin the problem-solving process more quickly. Therefore, gender differences are more appropriately understood as variations in learning-process characteristics rather than as a basis for distinguishing students' intellectual abilities. This finding is consistent with the Islamic education perspective, which emphasizes the importance of providing equal opportunities for every student to develop their intellectual potential.

Although all mathematical connection indicators emerged, the students' abilities had not yet fully developed at a complex level. Both groups still tended to use basic mathematical concepts and experienced limitations in optimally connecting more abstract mathematical concepts with real-life contexts. Therefore, mathematics learning should continue to be directed toward contextual and authentic experiences such as *Math Trail*, which not only strengthen intra-mathematical connections but also connect mathematics with other disciplines. From the perspective of Islamic education, such an approach supports knowledge integration, the development of intellectual potential, and the cultivation of attitudes of accuracy, carefulness, and responsibility in acquiring and verifying knowledge.

Research Limitations

This study is limited to elementary school students with high mathematical ability and gender differences. However, the problems used in this study were realistic problems presented within *Math Trail* activities. Therefore, research on the process of mathematical connections remains open for further development by selecting participants with different characteristics, such as students with moderate or low mathematical ability, differences in reasoning ability, or diverse types of intelligence, as well as by employing different types of problems, such as open-ended problems, PISA tasks, and other types of mathematical problems.

References

Astari, E., & Marsigit. (2019). Mathematical Connections Process For Elementary School Students In Problem Solving Of Statistics. *Journal Of Physics: Conference Series*, *1280*(4). Https://Doi.Org/10.1088/1742-6596/1280/4/042008

Az-Zabidi, I. (2020). *Ringkasan Shahih Bukhori*. Hikam Pustaka.

Baiduri, Putri, O. R. U., & Alfani, I. (2020). Mathematical Connection Process Of Students With

High Mathematics Ability In Solving PISA Problems. *European Journal Of Educational Research*, *9*(4), 1527–1537. Https://Doi.Org/10.12973/EU-JER.9.4.1527

Blum, W., & Borromeo, R. (2009). Mathematical Modelling: Can It Be Taught And Learnt? *Journal Of Mathematical Modelling And Application*, *1*(1), 45–58.

Cahyono, A. N., Sukestiyarno, Y. L., Asikin, M., Miftahudin, Ahsan, M. G. K., & Ludwig, M. (2020). Learning Mathematical Modelling With Augmented Reality Mobile Math Trails Program: How Can It Work? *Journal On Mathematics Education*, *11*(2), 181–192. Https://Doi.Org/10.22342/Jme.11.2.10729.181-192

Dewi, N. R., Mulyono, Pratama, M. F. R., Amidi, Azmi, K. U., & Munahefi, D. N. (2020). Gender Perspectives On Mathematical Connection Ability In PACE Learning Model. *Journal Of Physics: Conference Series*, *1567*(3). Https://Doi.Org/10.1088/1742-6596/1567/3/032010

Diana, N., Suryadi, D., & Dahlan, J. A. (2020). Analysis Of Students' Mathematical Connection Abilities In Solving Problem Of Circle Material: Transposition Study. *Journal For The Education Of Gifted Young Scientists*, *8*(2), 829–842. Https://Doi.Org/10.17478/JEGYS.689673

García-García, J., & Dolores-Flores, C. (2018). Intra-Mathematical Connections Made By High School Students In Performing Calculus Tasks. *International Journal Of Mathematical Education In Science And Technology*, *49*(2), 227–252. Https://Doi.Org/10.1080/0020739X.2017.1355994

García-García, J., & Dolores-Flores, C. (2021). Exploring Pre-University Students' Mathematical Connections When Solving Calculus Application Problems. *International Journal Of Mathematical Education In Science And Technology*, *52*(6), 912–936. Https://Doi.Org/10.1080/0020739X.2020.1729429

Haji, S., Abdullah, M. I., Maizora, S., & Yumiati, Y. (2017). DEVELOPING STUDENTS' ABILITY OF MATHEMATICAL CONNECTION THROUGH USING OUTDOOR MATHEMATICS LEARNING. *Infinity Journal*, *6*(1), 11. Https://Doi.Org/10.22460/Infinity.V6i1.234

Hotipah, P., & Pujiastuti, H. (2020). An Analysis Of Mathematical Connection Ability In Cubes And Cuboids Learning Materials Based On Gender Differences. *Desimal: Jurnal Matematika*, *3*(2), 137–142. Https://Doi.Org/10.24042/Djm.V3i2.6118

Jailani, Retnawati, H., Apino, E., & Santoso, A. (2020). High School Students' Difficulties In Making Mathematical Connections When Solving Problems. *International Journal Of Learning, Teaching And Educational Research*, *19*(8), 255–277. Https://Doi.Org/10.26803/Ijlter.19.8.14

Jannah, R. R., Apriliya, S., & Karlimah. (2017). Didactical Design Material Units Of Distance And Speed To Developed Mathematical Connection In Elementary School. *IOP Conference Series: Materials Science And Engineering*, (1), 012022.

Https://Doi.Org/10.1088/1757-899X/180/1/012022

Kenedi, A. K., Ahmad, S., Sofiyan, Ningrum, T. A., & Helsa, Y. (2019). The Mathematical Connection Ability Of Elementary School Students In The 4.0 Industrial Revolution Era. *International Journal Of Innovation, Creativity And Change*, *5*(5), 458–472.

Kenedi, A. K., Helsa, Y., Ariani, Y., Zainil, M., & Hendri, S. (2019). Mathematical Connection Of Elementary School Students To Solve Mathematical Problems. *Journal On Mathematics*

Education, *10*(1), 69–79. Https://Doi.Org/10.22342/Jme.10.1.5416.69-80

Lianawati, I., & Purwasih, R. (2018). Analysis Ability Of Mathematical Connection Of SMP Students In Comparative Material In Review Of Gender Differences. *Jurnal Daya Matematis*, *6*(1), 14. Https://Doi.Org/10.26858/Jds.V6i1.5592

Mardiyana, Usodo, B., Budiyono, Jingga, A. A., & Fahrudin, D. (2020). Analysis Of Students' Mathematical Connection Errors In Trigonometric Identity Problem Solving. *Periodico Tche Quimica*, *17*(35), 825–836. Https://Doi.Org/10.52571/Ptq.V17.N35.2020.70_Mardiyana_Pgs_825_836.Pdf

Maulida, A. R., Suyitno, H., Asih, T. S. N., Purwoyoso, J., Purwoyoso, K., Ngaliyan, K., & Semarang, J. (2022). Mathematical Connection Ability Viewed From Cognitive Style And Gender In The CONINCON Learning (Constructivism, Integrative & Contextual). *Unnes Journal Of Mathematics Education Research Azwida Rosana Maulida*, *11*(2), 2022–2127.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis* (Second). SAGE Publications.

Moleong, L. J. (2016). *Metodologi Penelitian Kualitatif (Revisi)*. Rosda.

NCTM. (2000). *Principles And Standards For School Mathematics*. NCTM.

Ndiung, S., & Nendi, F. (2018). Mathematics Connection Ability And Students Mathematics Learning Achievement At Elementary School. *SHS Web Of Conferences*, *42*, 00009. Https://Doi.Org/10.1051/Shsconf/20184200009

Pambudi, D. S., Budayasa, I. K., & Lukito, A. (2020). The Role Of Mathematical Connections In Mathematical Problem Solving. *Mathematics Education Journal*, *14*(2), 129–144. Https://Doi.Org/10.22342/Jpm.14.2.10985.129-144

Payton, S. (2019). Fostering Mathematical Connections In Introductory Linear Algebra Through Adapted Inquiry. *ZDM - Mathematics Education*, *51*(7), 1239–1252. Https://Doi.Org/10.1007/S11858-019-01029-9

Quilang, L. J. L., & Lazaro, L. L. (2022). Mathematical Connections Made During Investigative Tasks In Statistics And Probability. *International Journal Of Evaluation And Research In Education (IJERE)*, *11*(1), 239. Https://Doi.Org/10.11591/Ijere.V11i1.21730

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

Samo, D. D. (2021). Analysis Of Mathematical Connections Ability On Junior High School Students. *International Journal Of Educational Management And Innovation*, *2*(3), 261. Https://Doi.Org/10.12928/Ijemi.V2i3.3785

Sari, D. N. O., Mardiyana, & Pramudya, I. (2020). Gender Differences In Junior High School Students' Mathematical Connection In Geometry. *Journal Of Physics: Conference Series*, *1613*(1), 012069. Https://Doi.Org/10.1088/1742-6596/1613/1/012069

Syarif, M. I. (2023). *Media Dan Sumber Belajar IPA Terintegrasi Nilai Islam Dan Tokoh-Tokoh Islam*. Rajawali Pers.

Yuniawatika. (2018). Kemampuan Koneksi Matematik Mahasiswa PGSD Ditinjau Dari Perbedaan Gender. *Eduhumaniora: Jurnal Pendidikan Dasar*, *10*(2), 72–77.