Uluslararası Eğitimde Yenilikçi Yaklaşımlar Dergisi
International Journal of Innovative Approaches in Education, Vol. 10 (2026), e9790
https://doi.org/10.29329/ijiape.2026.1443.2

Original article

An Inquiry-Based Approach to Improving Mathematical Literacy in Gifted Students

Duygu Alyeşil Kabakçı [a,*] & Süha Yılmaz [b]

[a] İzmit Science and Art Center (BİLSEM), İzmit, Kocaeli, Türkiye
[b] Department of Mathematics Education, Buca Faculty of Education, Dokuz Eylül University, İzmir, Türkiye

Abstract

Mathematical literacy encompasses students' abilities to formulate mathematical problems encountered in real-life contexts, use mathematics in the problem-solving process, and interpret the results obtained. Furthermore, it is considered a multifaceted skill area involving higher-order cognitive processes that support an individual's ability to apply mathematics in various situations. The aim of this study is to examine the effect of inquiry-based mathematics teaching on the development of mathematics literacy performance in gifted Year 7 students. The research was derived from a doctoral thesis conducted by the first author under the supervision of the second author. The research was conducted using a teaching experiment design within the scope of qualitative methods. The study group consisted of eight gifted students selected through criterion sampling. The teaching process was structured based on the guided inquiry approach and used PISA-style open-ended problems that supported active student participation. Data were collected through pre-, mid-, and post-clinical interviews and audio recordings. The clinical interviews were analysed using content analysis, while the teaching experiment session data were analysed using descriptive analysis. The findings revealed that inquiry-based teaching improved students' mathematical literacy performance and led to significant developments in their ability to understand problems and relate data and concepts within the formulation process.

Keywords: Mathematical Literacy, PISA, Inquiry-Based Teaching, Gifted Student

Received: 06 February 2026 * **Accepted:** 30 April 2026 * **Published:** 08 June 2026

* **Corresponding author:**

Duygu Alyeşil Kabakçı is a specialist mathematics teacher at İzmit Science and Art Center (Bilim ve Sanat Merkezi), İzmit, Kocaeli, Türkiye. Her professional interests include gifted education, mathematics education, mathematical literacy, inquiry-based learning, and differentiated instruction for gifted students. She has worked extensively with gifted learners in science and mathematics-focused educational settings in Türkiye.
Email: geroglu@gazi.edu.tr

INTRODUCTION

Mathematical literacy (ML) refers to individuals' capacity to employ mathematical reasoning and thinking skills to produce solutions to problems encountered in everyday life across diverse contexts, as well as their competence to formulate, apply, and interpret mathematics through a critical lens (OECD, 2022). In parallel with rapid technological developments, the role of mathematical literacy has gained increasing importance as individuals are required to make sense of complex quantitative information in daily and professional settings. From this perspective, mathematical literacy may also be understood as the ability to comprehend mathematical knowledge, transfer it to real-life situations, and communicate effectively using the mathematical language (Uysal, 2009). Mathematics literacy is also a multifaceted skill area that includes higher-level cognitive processes that support an individual's ability to understand and use mathematics effectively (Pugalee, 1999). In assessments conducted within the framework of PISA 2022, students' performance is evaluated based on their ability to formulate, apply, and interpret mathematics in the problem-solving process (Ministry of National Education [MoNE],2024). Furthermore, within the PISA 2022 mathematics framework, mathematical literacy is defined as the ability of individuals to identify, solve, and interpret mathematical problems in real-life contexts in a rapidly changing world shaped by technology and digitalization, using mathematical reasoning skills (OECD, 2022).

The formulation process requires students to define or clarify mathematical problems, identify essential variables within a given model, determine the mathematical relationships embedded in a situation, and represent these problems using appropriate mathematical expressions, representations or algorithms. The application process involves employing mathematical knowledge and procedures to develop solution strategies and generate solutions to real-world problems. Finally, during the interpretation process, students are expected to critically examine both the solution processes and the results obtained, verify their accuracy, and draw well reasoned conclusions (OECD, 2018).

Recent assessments show that Turkey has made significant progress in mathematical literacy compared to previous years; however, its average score is below the OECD average. While the average mathematics literacy score for OECD countries is 472 points, Turkey's average score is 453. This indicates that Turkey lags 19 points behind the OECD average. However, according to the PISA 2022 results, students in Turkey with high-level mathematics performance demonstrated lower achievements than their international peers. Furthermore, an analysis of the PISA 2022 results shows that the success rate of students who performed at the highest level and ranked at the 5th or 6th achievement level is approximately 5% in Turkey, compared to 9% in OECD countries. (MoNE, 2024). The percentages of students achieving minimum and high performance levels in mathematics in the PISA assessments are presented in Figure 1.

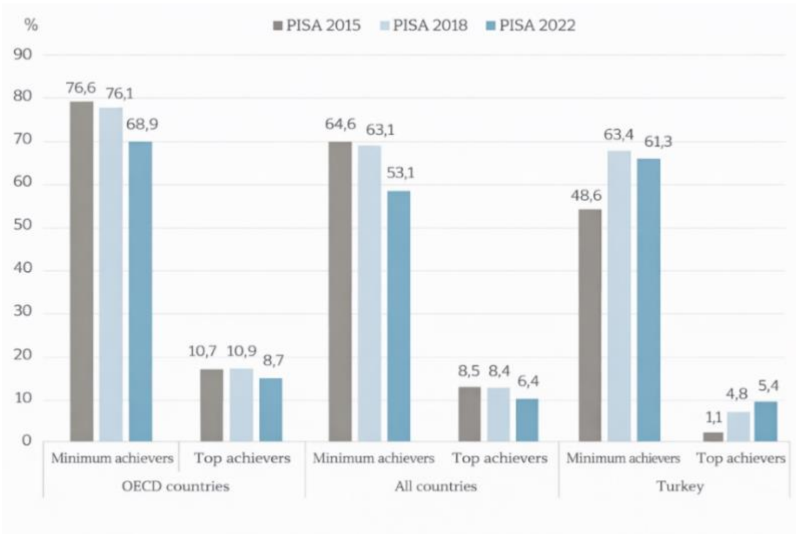


Figure 1. Percentage of students achieving minimum and maximum performance levels in mathematics in PISA assessments

Students with low and high performance levels in mathematical literacy skills are presented in Figure 2 (MoNE, 2024).

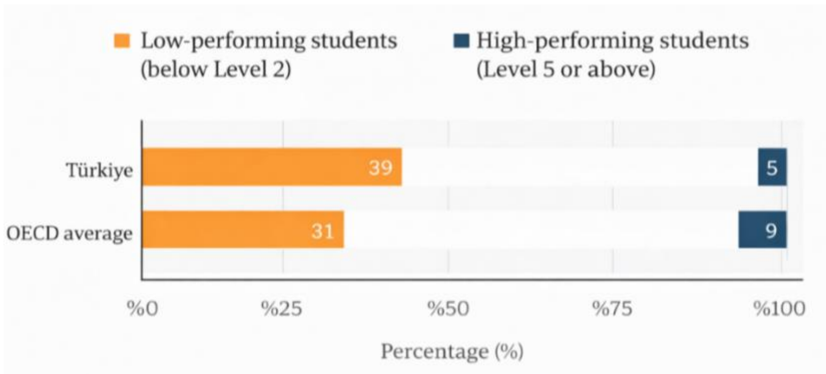


Figure 2. Percentages of students at lower and higher performance levels

The highest performance level represents the highest achievement level, where students demonstrate the ability to model complex mathematical situations, understand abstract concepts, select appropriate problem-solving strategies, and exhibit comparison and evaluation skills (OECD, 2023; Altun et al., 2022). The data in the graph highlight the need for studies aimed at developing the mathematical literacy competencies of students who demonstrate high-level performance.

Gifted students possess characteristics such as learning faster than their peers in certain areas, creative thinking, leadership, and high academic achievements. Therefore, they are generally considered high-achieving students (Bildiren, 2018). They also demonstrate distinct superiority, particularly in abstract thinking, problem-solving, and creative thinking skills (Renzulli, 2005). Furthermore, they play a critical role in the development of countries by generating innovative ideas, contributing to economic growth, and increasing social welfare. In this context, the development of mathematical literacy is particularly important for gifted students (Gagné, 2004). However, these students often fail to receive the support necessary to fully realize their potential and continue to be one of the groups overlooked in education systems (Cross, 2011). Therefore, to enable gifted individuals to realize their potential, it is important to implement effective and targeted interventions in educational settings, particularly in mathematical literacy.

Polat and Turhan (2022), in their meta-analytic study on mathematical literacy, determined that students experienced significant difficulties in sub-skills such as problem formulation, mathematical modeling, and argumentation. Güler (2013), on the other hand, examined the difficulties experienced by students within the framework of PISA mathematics questions and emphasized that reading deficiencies, communication and reasoning difficulties, low self-confidence, insufficient knowledge, and difficulties in understanding the problem text were the main factors. In addition, Yıldız and Ezentaş (2020) categorized the difficulties encountered by seventh-grade students while solving mathematical literacy questions as "deficiencies in previous topics," "exam duration," "attention deficit," "reading comprehension difficulties," and "inability to relate to daily life."

Similarly, Wijaya et al. (2014) revealed that students mostly focused on procedural calculations in mathematical literacy tasks but experienced significant difficulties in the formulation phase, which involves understanding the problem holistically, representing the situation mathematically, and identifying appropriate variables. Furthermore, Stillman et al. (2013), in their study examining mathematical modeling and problem-solving processes, reported that students tended to focus on the mathematical steps in real-life contextual problems; however, they struggled in the formulation process, which requires transforming the problem into a mathematical structure and creating appropriate representations.

Karaduman et al. (2023), in their study on the mathematical literacy of gifted students, analyzed the problem-solving processes of gifted students in the fields of art, music, and numerical ability, identifying similarities and differences. The findings showed that students in the numerical ability field experienced difficulties in making mathematical inferences, whereas students in the art and music fields encountered difficulties in the problem-understanding stage. However, research on the mathematical literacy performance of gifted students is limited, and no studies have been conducted on improving the mathematical literacy performance of students in the general ability field. Today, educational programs prioritize learning through research, inquiry, and experience rather than simply providing information while considering individual differences. Mathematical literacy includes individuals' ability to analyze, solve, interpret, and understand mathematical problems in different situations (MoNE, 2024). When curricula are examined, the general aims of both mathematics courses and gifted education programs include developing students' mathematical literacy skills and enabling them to use higher-order thinking skills in problem-solving by relating mathematical concepts to daily life (Ministry of National Education [MoNE], 2024a, 2024b). Therefore, it is important that instruction aimed at developing mathematical literacy be structured using methods that consider students' mathematical processes and competencies, encourage inquiry, and establish connections between daily life and mathematics. Sheffield (2003) emphasizes that inquiry-based and problem-centered teaching approaches, in particular, increase the depth of gifted students' mathematical thinking and strengthen their interpretation, generalization, and reasoning skills, which are directly related to mathematical literacy.

When learning approaches are examined, inquiry-based instruction is defined as a teaching approach that enables students to construct knowledge actively through questioning, investigation, and problem-solving processes. Rather than encouraging rote memorization, this approach aims to promote deep understanding and the development of higher-order thinking skills (Martin, 2009). Inquiry-based learning is a model in which students engage in research to solve a problem or to understand content in depth by employing logical reasoning processes. It is characterized as a method in which students are positioned at the center of the learning process and instruction is conducted through inquiry and critical evaluation (Friesen & Scott, 2013).

This process supports students' active learning while significantly contributing to the development of critical thinking and problem-solving skills (Llewellyn, 2002). The activities carried out in this study were structured based on Llewellyn's (2002) inquiry cycle. In this cycle, students generally begin the learning process by observing an event or starting with a research question. The inquiry phase, the first stage of the process, involves generating questions based on an interesting event or problem. In the stage of uncovering existing knowledge, students relate their existing knowledge and experiences to new learning experiences. In the prediction phase, predictions of possible outcomes are developed based on observations and prior knowledge.

During the planning and implementation phases of the solution, students design and implement experiments, research, or problem-solving methods. In the evaluation phase, the data obtained are analyzed and the results are discussed; in the final phase, the presentation of findings, the results are shared through reports, presentations, or other means. In addition, the study adopted a guided inquiry approach, in which students actively shaped the teaching process and learning environment under the teacher's guidance and took responsibility for problem solving. This approach provides a structure in which the teacher guides the process, but the responsibility for learning lies with the students, which is consistent with the guided research inquiry model defined by Banchi and Bell (2008). Therefore, this study aims to examine the effect of inquiry-based mathematics teaching on the development of gifted students' mathematical literacy performance within the scope of the mathematical literacy process of formulation. To this end, answers were sought to the following sub-questions:

- What are the mathematics literacy scores of gifted students before, during, and after the application?
- What are the gifted students' mathematics literacy performances before, during, and after the inquiry-based teaching experiments within the scope of the formulation process?

- What is the mathematical literacy performance of students in the teaching experiment during the first session (Session 1) within the scope of the formulation process?
- What is the mathematical literacy performance of students in the teaching experiment during the final session (Session 10) within the scope of the formulation process?

MATERIALS and METHODS

Research Model

This research was derived from the doctoral thesis conducted by the first author under the supervision of the second author. This is an expanded version of a paper presented at the 2025 UBEST conference. The teaching experiment design, a qualitative research method, was used in this study. A teaching experiment is a research design that allows for the systematic examination of the effects of a specific teaching strategy or intervention on students' learning processes (Steffe & Thompson, 2000). In this context, the teaching experiments applied in this study were designed to evaluate the effect of strategies aimed at developing students' mathematical literacy skills. The study included both the initial and final teaching experiments.

Study Group

The study group consisted of eight gifted students in the 7th grade. Participants were selected using criterion sampling, a type of purposive sampling. Purposive sampling refers to a qualitative research approach in which individuals or situations with the most relevant information for the research objective are consciously selected. In this study, since the focus was on gifted students at the 7th grade level, the selection of participants was carried out using criterion sampling, which allows for the examination of individuals meeting specific criteria (Yıldırım & Şimşek, 2021).

Data Collection Tools

Activities were prepared for students to reveal their mathematical literacy processes and contribute to the development of their skills. Each teaching experiment was examined using audio recordings and worksheets distributed during the activities. To determine students' mathematical literacy performance, pre-, mid-, and post-clinical interview questions consisting of open-ended questions prepared by the researcher were used. The questions were asked to the students via Zoom and were recorded. Ethical committee approval was obtained from the Dokuz Eylu University Rectorate Ethics Committee for the use of data collection tools. Participants were informed prior to the application, and consent was obtained from the participants and students. No demographic or personal information was collected from the participants in this study. To ensure participant confidentiality, student names were coded as S1, S2, S3... and analyses were performed using these codes. In clinical interviews, an example of an interim clinical question prepared in accordance with the PISA 2022 mathematics literacy framework is presented in Figure 3.

PRACTICE EXAM EVALUATION

Answer questions 3, 4, and 5 according to the explanations below.

Mine took practice exams consisting of 20 math questions each. Based on her repeated practice exams, she calculated the percentages of her mistakes in the math questions and created a bargraph. She then categorized her mistakes by error causes, as shown in the table below.

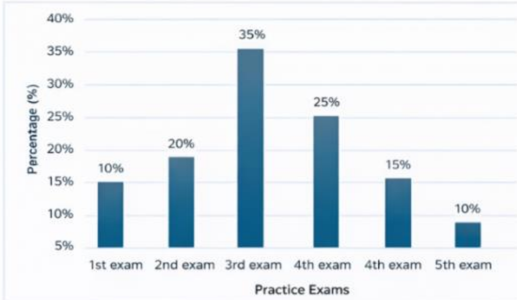


Figure 1. Distribution of Mistakes by Error Causes in Practice Exams

Error Causes	Number
Misreading the question	4
Failing to understand the question	5
Calculation errors	9
Lack of knowledge about the topic	3

Table 1. Distribution of Mistakes by Error Causes

3. Accordingly, what approximate percentage of Mine's total mistakes were due to distractibility? What should Mine primarily focus on to reduce her mistakes in the next practice exam? Explain.

Figure 3. Example of an intermediate clinical question

Data Analysis

Content and descriptive analyses were used to analyze the data. During the analysis, the formulation process defined within the framework of PISA 2022 mathematical literacy was considered. In this process, how gifted students structured and expressed problems mathematically was examined. Each student's response was analyzed and interpreted in the context of the formulation process, and the mathematical thinking structures possessed by the students were revealed. When examining the data related to the formulation process, a complete and accurate understanding of the information, interpretation of the problem situation, and identification of appropriate variables were considered. In addition, the correct expression of mathematical statements with appropriate symbols, the creation of variables or statements appropriate to the problem context, and the accurate definition and application of concepts and operations were evaluated. Within the scope of the study's validity and reliability, the data were independently evaluated by both the researcher and an external expert, and consensus was reached with a field expert in determining the codes. To support internal reliability, the agreement between coders was calculated according to Miles and Huberman's model, and the reliability coefficient was determined to be 91.5%. The data obtained were analysed through prospective and retrospective examinations. The internal validity of the research was ensured through long-term interactions and in-depth data collection. Codes and themes were created based on the data obtained from the clinical interviews, and the students' responses were classified according to these codes and themes. The themes and codes presented in the table below were obtained from the clinical interview coding. The coding work revealed that the errors that emerged during the formulation stage were in the dimensions of 'understanding the problem' and 'relating data and concepts.' The codes and themes identified during the formulation process are presented in the visual maps in Figure 4.

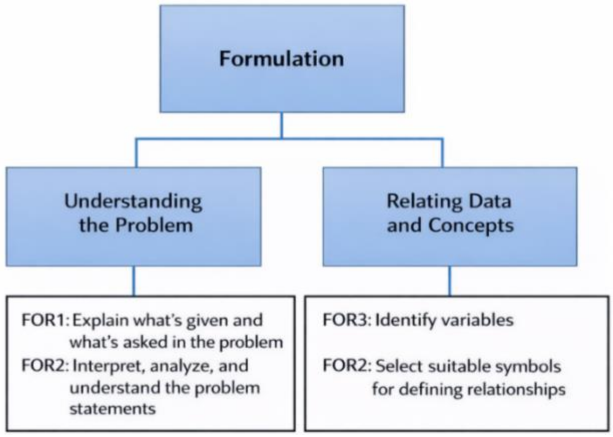


Figure 4. Codes and themes derived from student responses during the formulation process

In evaluating the answer sheets, answer keys were created based on the scoring criteria used in the PISA exams. Accordingly, completely correct solutions were scored as 2 points, partially correct solutions as 1 point, and incorrect or blank answers as 0 points. The answers given by the students to the questions asked during the pre-clinical interviews were converted into text and scored according to the answer key. The maximum score that can be obtained by answering all pre-clinical interview questions correctly was 28. In line with this scoring system, students' achievement levels were classified as 'low' for the 0–9 point range, "medium" for the 10–19 point range, and 'high' for the 20–28 point range. The maximum score that can be obtained if all the mid-clinical interview questions are answered correctly, is 16. Accordingly, students' achievement levels are determined as 'low' for the 0–5 point range, "medium" for the 6–10 point range, and 'high' for the 11–16 point range. The maximum score that can be obtained if all the final clinical interview questions are answered correctly is 18. Based on this scoring, students' achievement levels are classified as 'low' for the 0–6 point range, "medium" for the 7–12 point range, and 'high' for the 13–18 point range.

In this study, teaching experiments and activities were designed to reveal students' mathematical literacy processes and contribute to the development of their skills in these processes. The audio recordings of the initial and final teaching experiments and activities were transcribed and analyzed descriptively. In Teaching Experiment–1, students were asked to express the areas in which they use mathematics in their daily lives; subsequently, evaluation activities were conducted based on graphs showing Türkiye's mathematics literacy scores in PISA across different years. Students examined Türkiye's performance between 2003 and 2015 in terms of achievement rankings and, supported by videos related to the OECD–PISA 2022 Education Report, engaged in discussions involving year-by-year comparisons, percentage calculations, and comparisons with the OECD average.

The final teaching experiment, Session 10, began with the question, ‘Where do we encounter tables and graphs in real life?’ and students' opinions were gathered. Students were also given problems aimed at understanding data, making comparisons, establishing ratios and proportions, and interpreting distributions through tables and graphs. Students discussed these problems among themselves and drew their own conclusions. Graphs containing information about the tour schedules and earnings of four different theatre groups were presented to the students via the smart board; questions based on the graphs were asked to create a discussion environment. Later in the activity, students were asked questions about their weekly study hours and the distribution of these hours across subjects. Furthermore, as part of the sample application, students were given the opportunity to individually experience the process of creating and analysing graphs using an online tool (https://tr.mathigon.org/polypad).

RESULTS and DISCUSSION

Findings

Findings related to the first sub-problem

Within the scope of the sub-problem, ‘What are the mathematics literacy scores of gifted students before, during, and after the application?’ The changes in the gifted students’ mathematics literacy performance before, during the application process, and after inquiry-based mathematics teaching were examined based on the scores obtained from clinical interviews. The findings are presented in a comparative manner, showing the score distributions obtained from pre-, mid-, and post-clinical interviews.Pre-clinical interviews were conducted to determine students' mathematics literacy performance prior to the application. Based on the responses to the pre-clinical interview questions, where a student who answered all questions correctly could score a maximum of 28 points, the distribution of scores ranging from 0 to 10 is presented in Table 1.

Table 1. Distribution of Scores Obtained from Pre-Clinical Interview Questions

Students	S1	S2	S3	S4	S5	S6	S7	S8
Score	13	14	18	16	18	9	12	10

When examining the student scores, it was observed that the students generally achieved mid-level scores (S1, S2, S3, S5, S6, S7, and S8). Only one student S6 was at a low level, and no students were at a high level. However, students with codes S3 and S5 achieved the highest success with 18 points. Interim clinical interviews were conducted during the application process to monitor changes in students' mathematical literacy performance. The distribution of scores obtained based on the answers given to the interim clinical interview questions, where a student who answered all questions correctly could score a maximum of 16 points, is shown in Table 2.

Table 2. Distribution of Scores Obtained from Interim Clinical Interview Questions

Students	S1	S2	S3	S4	S5	S6	S7	S8
Score	8	11	12	12	16	14	11	10

When the findings in Table 2 are examined, it is seen that students generally had medium-level and above-average scores during the intervention process. While no student was found to be at a low level, student coded Ö5 was determined to have shown the highest achievement with 16 points. In order to monitor the change in students' mathematical literacy performance after the intervention, final clinical interviews were conducted.

The distribution of the scores obtained according to the answers given to the final clinical interview questions, where a student who answered all questions correctly could receive a maximum of 18 points, is presented in Table 3.

Table 3. Distribution of Scores Obtained From The Last Clinical Interview Questions.

Students	S1	S2	S3	S4	S5	S6	S7	S8
Score	16	17	18	15	18	15	18	16

Table 3 shows that all students achieved scores of 15 points or above. Accordingly, it was determined that there were no students at the intermediate or low levels; students with codes S3, S5, and S7 achieved full marks and demonstrated the highest level of success.

Findings related to the second sub-problem.

The findings regarding the sub-problem, "How does the mathematical literacy performance of gifted students differ before, during, and after inquiry-based teaching experiments within the context of the formulation process?", were examined using data obtained from pre-, mid- and post-clinical interviews within the context of the formulation process.

When the data obtained in the pre-clinical interviews were examined within the framework of the theme of understanding the problem, it was found that the majority of students (S1, S2, S4, S5, S6, S7, and S8) could comprehend what was given and required in the problems (FOR1). However, most students (S1, S2, S4, S5, S6, S7, and S8) experienced difficulties reading, analyzing, and interpreting the statements (FOR2), failing to understand some of the questions or misreading them. For example, in question 1, student S4 missed the phrase ‘as a percentage’ in the first reading. Student S8 misread the question, stating, ‘Teacher, I thought it was city B. But it's city A, I misread it’ (FOR2). In question 2, student S8 struggled to distinguish between “result” and ‘last digit,’ and was therefore uncertain about what the question was asking (FOR2).

In question 3, specifically in option e, which asked whether a plant sown as a seed could be at least half as long as its length 10 years later, it was determined that some students (S1, S4, and S5) misinterpreted the given situation and failed to understand the context of the question. In question 4, concerning the mosaic tiling problem created using patterns and designs, the vast majority of students understood the problem correctly and proceeded directly to the solution. In Question 5, which asked about the rule of the given pattern, it was found that some students (S2, S6, and S8) did not grasp what the question was asking on first reading, but were able to understand the problem after an explanation and used expressions of uncertainty in response. In question 6, which asked about finding the missing pattern, it was determined that some students in particular (S1, S4, and S6) had difficulty distinguishing what the question was asking and were uncertain about how to express the solution. Below are the responses to the first question from Student S3 and to the fourth question from Student S5, both of whom were able to correctly express what was given and what was required (FOR1).

1. Question
S3: *It says to write the approximate values of the percentage of social media users in each city to two decimal places in the last column (FOR1).*
4. Question
S5: *The top row is entirely covered with A tiles, the row below that is entirely covered with B tiles (FOR1). The bottom row will have one A tile, one B tile, one A tile, and one B tile. Therefore, the last tile is a B tile.*

In addition, dialogue excerpts from student S8, who misread the question, and students S2, S4, and S6, who had difficulty understanding the question, as well as students S1, S4, and S6, who were uncertain about what the question required, are presented below.

1. Question
S8: *Teacher, I thought it was city B. But it's city A, I misread it (FOR2).*
S4: *Is there an answer in the question, or am I just understanding it that way? That's why I got so stuck on it (FOR2).*
2. Question
S4: *Is it the last digits of these numbers' results? Or is it the results? Oh, so do we need numbers? (FOR2)*
3. Question
Option e
S1: *So, if it grows healthily, are we to assume it grows at the same rate every year? (FOR2)*
S4: *Does it have to be an odd number? Oh, so does it have to be a number? (FOR1)*
5. Question
S2: *So how? (FOR2)*
S6: *I didn't quite understand what exactly was being asked. (FOR2).*
S8: *Teacher, I didn't understand (FOR2).*

S8: *So you'll fill in the rows and columns with spaces again.*

S8: *I understand.*

6. Question

S6: *I don't quite understand, they've given two, should I do one? (FOR2)*

S1: *First, I want to find these, should I write the thing for the tiles that will go in these rows below?*

6. Question

S6: *I didn't quite understand. They gave two, should I do one? (FOR2)*

S1: *First, I want to find these places. Should I write the letters of the tiles that will come in the following lines? (FOR2)*

When the data obtained from the pre-clinical interviews were examined within the framework of the theme of relating data and concepts, it was determined that some of the students who answered the first question correctly (S1, S3, S5, and S7) used the percentage symbols correctly, while some students (S2, S4, and S8) did not use the symbols (FOR4). Figure 5 and Figure 6 show the response of student S5, who used the symbols correctly, and the visual representation of the operations of student S4, who did not use the symbols.

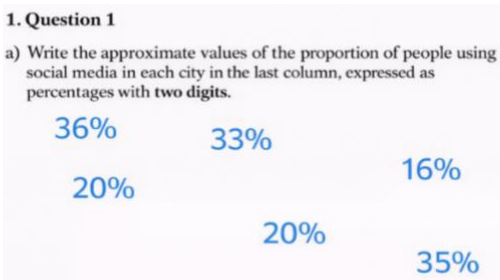
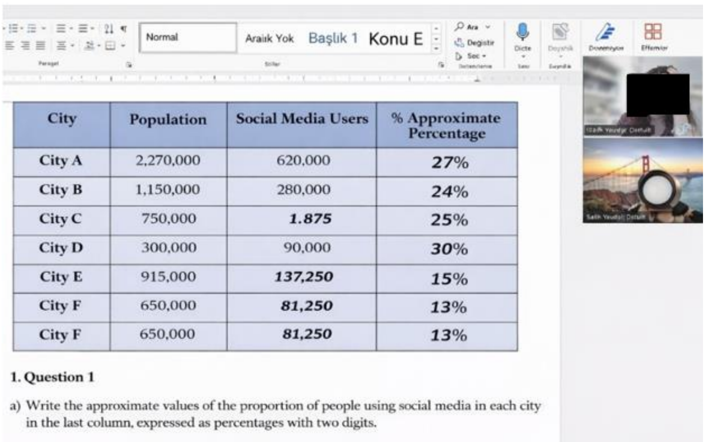


Figure 5. Indicator of student S5 selecting the correct symbols (FOR4)



City	Population	Social Media Users	% Approximate Percentage
City A	2,270,000	620,000	27%
City B	1,150,000	280,000	24%
City C	750,000	1.875	25%
City D	300,000	90,000	30%
City E	915,000	137,250	15%
City F	650,000	81,250	13%
City F	650,000	81,250	13%

1. Question 1

a) Write the approximate values of the proportion of people using social media in each city in the last column, expressed as percentages with two digits.

Figure 6. Indicator of selecting appropriate symbols for student with code S4 (FOR4)

However, it was observed that all students were able to identify the variables given in the questions. In particular, it was determined that variables such as odd numbers, even numbers, and prime numbers in the third question were correctly defined by the students and that the result was calculated according to the values given to these variables (FOR3). An example dialogue excerpt from student S6, who was successful in identifying the variables in Question 3, is presented below.

Question 3

S6: *One even, one odd, 1 and 2 add up to 3. This is an odd natural number. But when we add 2 and 3, we get 5. This is 2 and 7, 9, actually, if we try 24 and 35, we get 39. (FOR3)*

When the data obtained from the interim clinical interviews was examined within the framework of understanding the problem, it was observed that the students were generally able to explain the information given and requested in the problems (FOR1). Indeed, in questions 1 and 2, it was determined that all students were able to correctly express the information given regarding operations with exponential numbers. Similarly, in questions 3, 4, and 5, it was determined that they could read and understand the data presented in the table, and in questions 6, 7, and 8, they could place the data related to body mass index in the appropriate sections (FOR1). However, it was observed that some students (S1, S2, S4, S5, S6, and S8) struggled with reading, analysing, and comprehending the question (FOR2). Specifically, they initially misinterpreted the data in Questions 3 and 4, but some of these students (S1, S2, S4, and S5) recognised their errors during the process and corrected them.

For example, in question 1, it was determined that the student coded as S8 did not fully comprehend the question; in question 3, it was determined that the students coded as S1, S4 and S6 interpreted the total number of incorrect answers in the entire test as the number of questions in a single attempt and evaluated it based on 20 questions. However, it was observed that these students later realised their misunderstanding through subsequent checks and made corrections (FOR2). Similarly, in question 4, it was found that the student with code S2 misread the phrase ‘in five attempts’ as ‘in the fifth attempt’ and therefore reached an incorrect conclusion (FOR1). It was determined that students with codes S4 and S5, who made the same mistake, realised their misunderstanding after a while and made corrections (FOR2). In question 5, it was found that all students understood that the question required a comparison of the errors in the first two and last three attempts; however, it was determined that the student with code S1 overlooked the information that the average should be taken in this comparison (FOR1). In questions 6.7.8, all students were able to comprehend and interpret the given values such as height, mass, and body mass index, and explain what was required. Below is a dialogue excerpt from question 3 involving student S8, one of the students who correctly understood the concepts given and required in the problem (FOR1).

Question 3

S8: *He categorised the reasons for his mistakes as percentages (FOR1)....*

Teacher: So what does this table show?

S8: *The number of mistakes, for example, misreading the question 4 (FOR1).*

Teacher: *Good, what does it ask us to do?*

S8: *Approximately what percentage were due to carelessness? Also, how can they correct their mistakes? What measures can they take? (FOR2), (FOR1).*

Teacher: *What do you think?*

S8: *First, the teacher says here what percentage was due to carelessness (FOR1).*

Below are sample dialogues reflecting the process of students who made mistakes or struggled in reading, understanding, and solving the problem (FOR2).

Question 1

S8: *Teacher, now, are they multiples of 7? Like 7 to the power of 17, for example (FOR2).*

Teacher: *What does 7 to the power of 17 mean according to the example above?*

S8: *Ah, I see. Not multiples. Because there is no relationship between them. So. (FOR2)*

Teacher: *What does 7 to the power of 17 mean? What is its expanded form?...*

S8: *Teacher, I don't quite understand, the question (FOR2)*

Question 3

S4: *There are 20 questions in total. There are 21 wrong answers. These are wrong (FOR1).*

Teacher: How did you get 21 wrong out of 20 questions?

S4: *Aren't these wrong, or is everything here wrong? (FOR2)*

Question 4

Teacher: *So how many questions are there in total?*

S4: *There are 20 questions in total, so... (FOR1), (FOR2)*

Teacher: *The questions in the 5th attempt. What percentage of all questions are incorrect? (FOR1)*

S4: *There are 20 questions in total. There are 21 incorrect answers in total. These are incorrect. 100 in total.*

Teacher: *Well, why did you think it was 20 at first?*

S4: *I thought it was the 5th attempt.*

Teacher: *Then what shall we do?*

S4: *There are 21 incorrect answers out of 100. In 5 attempts in total. (FOR2).*

Question 5

S1: *Teacher, he made 15% errors in the first attempt. He made 35% errors in the second attempt. Adding these together makes 50%. Adding the other three makes 65%. Therefore, he was more successful in the first two attempts. (FOR1), (FOR2).*

When examining the findings obtained within the framework of the theme of relating data and concepts, it was determined that all students were able to correctly identify the variables (FOR3) and select the appropriate symbols corresponding to these variables (FOR3). For example, student S1 expressed the unknown in question 7 with an appropriate symbol (x) and used this symbol effectively in the solution process. Similarly, in question 3, it was determined that all students correctly used fraction and percentage symbols when calculating error rates. Furthermore, in questions 6, 7, and 8, it was observed that students correctly defined variables such as weight, mass index, and height (FOR3), used appropriate symbols for unknowns, and correctly placed the obtained data in the table (FOR4). Regarding correct applications, a dialogue excerpt related to student S8's identification of variables (FOR3) in question 8 and a visual and process related to student S7's use of appropriate symbols (FOR4) in question 3 are presented in Figure 7.

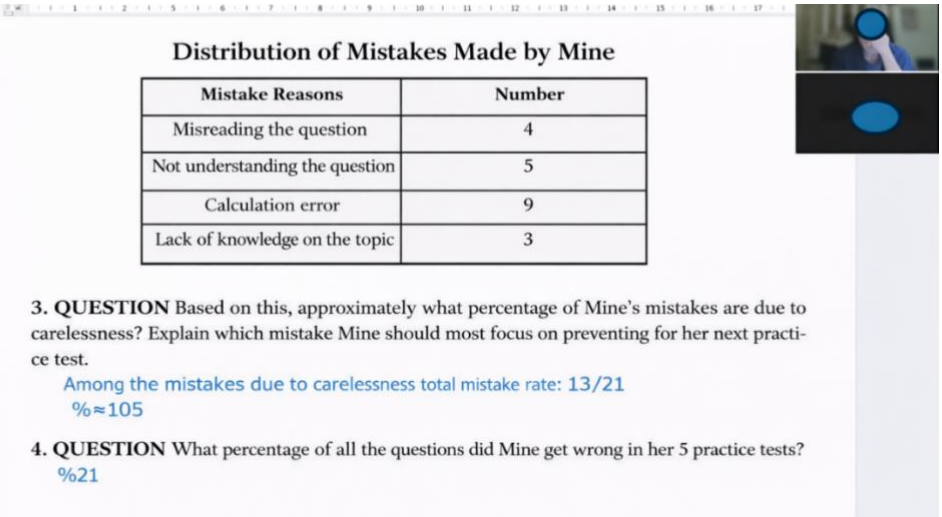
Question 8

Teacher: *So what are the variables in this question?*

S8: *The variables are weight (75), body mass index (24), and the intention to be at an ideal weight (FOR1).*

Teacher: *Which ones are the variables?*

S8: *Body mass index can vary according to height. It can also vary according to weight. According to height and weight (FOR3).*



Distribution of Mistakes Made by Mine

Mistake Reasons	Number
Misreading the question	4
Not understanding the question	5
Calculation error	9
Lack of knowledge on the topic	3

3. QUESTION Based on this, approximately what percentage of Mine's mistakes are due to carelessness? Explain which mistake Mine should most focus on preventing for her next practice test.

Among the mistakes due to carelessness total mistake rate: 13/21

%≈105

4. QUESTION What percentage of all the questions did Mine get wrong in her 5 practice tests?

%21

Figure 7. Data processing indicator (FOR4) for student with code S7

The data obtained from the final clinical interviews, when examined within the framework of understanding the problem, showed that all students generally understood the question and were able to explain what was given and what was required (FOR1). They were also able to read and understand the problems correctly. For example, in question 1, all students were able to explain that the graph showed the relationship between family income and school violence rates and the relationship between education levels and school violence; they correctly expressed the values of these rates from the graph. They were also able to understand that the question asked how school violence rates changed according to school enrolment and family income (FOR2). In option (a) of question 2, students correctly interpreted the information provided (FOR2) and stated that the question asked what the new percentage would be if the number of violent incidents remained unchanged despite an increase in school enrolment at School D (FOR1). In option (b) of question 2, students correctly understood the question by stating that it asked what change in school enrolment would be required for the percentage to be 20% while the number of violent incidents remained constant (FOR2). Excerpts from student dialogues demonstrating successful performance on questions 1 and 2 under the theme of understanding the problem are provided below.

1. Question

Teacher: *Take a look at both the first and second ones. What is being asked in the question? Can you explain?*

S3: *Teacher, this is what it wants. Families' income status and this according to school violence rates (FOR2).*

Teacher: *What based on these?*

S3: *He wants us to compare. Here is the income status and the violence rate (FOR2).*

Teacher: What is the question asking for?

Question 2

Part a

Teacher: *So what won't change?*

S2: *The number of violence rates (FOR2).*

Teacher: *What is it?*

S2: *30% (FOR1).*

Section b

S7: *120 people are committing acts of violence.*

Teacher: What does he want from us?

S7: *He says, if the number of violent incidents remains unchanged, what will the school's current situation be? Like this, teacher. The number of violent incidents, okay. One moment. He doesn't even mention the number of violent incidents (FOR2).*

When questions 3, 4, and 5 are evaluated together, it is seen that all students generally understood the questions correctly and were able to express what was given and what was asked (FOR1), (FOR2). However, it was determined that some students (S1, S3, S4, and S8) initially hesitated about the number of lines to be drawn regarding the shortest routes and understood the question by rereading it (FOR2). For example, student S4 stated that when they first read the question, they thought the routes could also pass over railways, but later understood it correctly.

Furthermore, it was observed that the students correctly explained that the stops were to be placed at equal distances in question 4 (FOR1) and were able to justify this situation by interpreting it in their own words (FOR2). Nearly all students easily understood Question 5 (S1, S2, S3, S5, S7, and S8) and stated what the stops would be (FOR1), (FOR2). However, students coded S4, S5, and S6 were able to understand what was required by questioning the problem. Regarding questions 3, 4, and 5, excerpts from the dialogues of students who demonstrated successful performance in understanding the problem are provided below. Furthermore, dialogue excerpts from student coded S1 who correctly understood the question when they re-evaluated it in determining the shortest route to be drawn in Question 3, are also presented in relation to their explanations of what was given and what was required.

Question 3

S5: *The shortest route. It says to draw different paths in the two lower and upper regions where it can go. (FOR2)*

Teacher: *Okay, continue. Can you explain the question? What does it want?*

S1: *It wants us to draw one more path (FOR1).*

Arch: *What are the given conditions? Can you explain that?*

S1: *The white squares are buildings. That blue area is a railroad. Bus routes will be organized from the locations on the right and upper regions of this railroad line (FOR2).*

Teacher: *So what do A and B represent?*

S1: *A and B are subway stations (FOR2).*

... returned to the question

Teacher: *Where does it want you to draw the route from and to?*

S1: *It says from station A and station B, from the upper and lower areas (FOR1).*

Question 4

S8: *Bus stops at equal distances are to be built. It asks where they can be built. (FOR2).*

Question 5

Teacher: *Did you understand the question? Can you explain it?*

S3: *These gray lines connect the corner points, and the distance between each pair of corners is 1 unit. The length of the diagonal roads is approximately 1.4 units. (FOR1).*

Teacher: *So what does it want from us here, for example?*

S3: *The shortest route they can take. Like this, when it stops at stop C (FOR1)(FOR2).*

Teacher: Yes, now when we look here, how many units does it take when stopping at C? Can you draw it and write it in units?

All students modeled how the small squares cut from the corners and sides of the squares were formed in parts (a), (b), and (c) of question 6; they were able to verbally express what was given and what was asked in the question correctly. The dialogue of student coded Ö8, who successfully completed question 6, is given below as an example. Additionally, the drawing of student coded Ö8, who correctly placed the given information in the visual, is shown in Figure 8 as an example.

Question 6

Option a

Teacher: *How many units is one side of the square?*

S8: *10 units (FOR1).*

Teacher: *What are we removing from the square? It says when removed. So what are we cutting out of the square?*

S8: *Square (FOR1)*

Teacher: *How many squares?*

S8: *2 (FOR1)*

Teacher: *How many units are the sides?*

S8: *1 unit (FOR1)...*

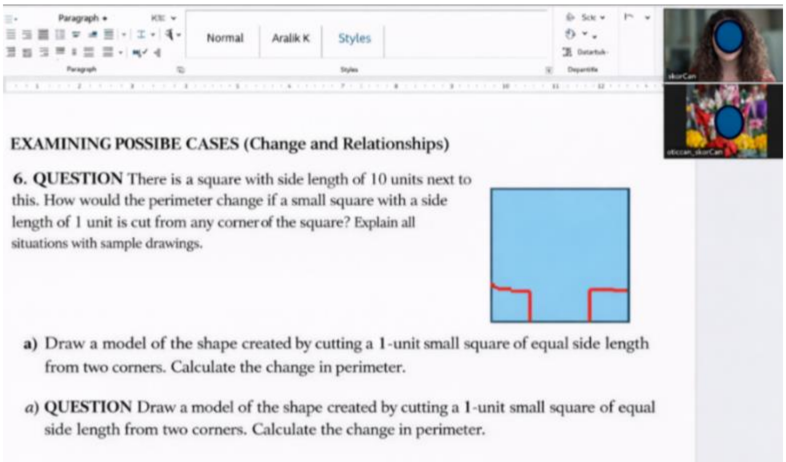


Figure 8. Visual representation of the drawing made by student S8 regarding the information given in the problem (FOR1)

All students were able to correctly identify the variables of school enrollment, violence rates, and family income in the graphs in question 1 within the theme of relating data and concepts (FOR3). In question 2, students stated that the number of violence incidents had not changed; they expressed the variables by indicating in item (a) the change in school enrollment and in item (b) what change in school enrollment would be necessary for violence incidents to decrease (FOR3). Furthermore, in questions 1 and 2, all students were able to use mathematical symbols such as the percent (%) symbol and fraction line appropriately (FOR4). Below are sample dialogue excerpts from students who correctly identified the variables and used mathematical symbols appropriately in questions 1 and 2. In addition, Figure 9 shows the correct and appropriate use of symbols by student S1 (FOR4).

Question 1

S1: *As income increases, violence decreases (FOR3).*

Teacher: *Is there a relationship between them?*

S1: *So, if family income increases, the percentage of violence decreases (FOR3).*

Teacher: *If we only evaluate this graph, can we say that there is a relationship between income and the rate of violence as income increases? For example, what happened to the rates of violence as income increased?*

S6: *As income increases, for example, School B was 50,000, while School C was 10,000, but School B was 25, and School C was between 30 and 35. So it varies according to income (FOR3).*

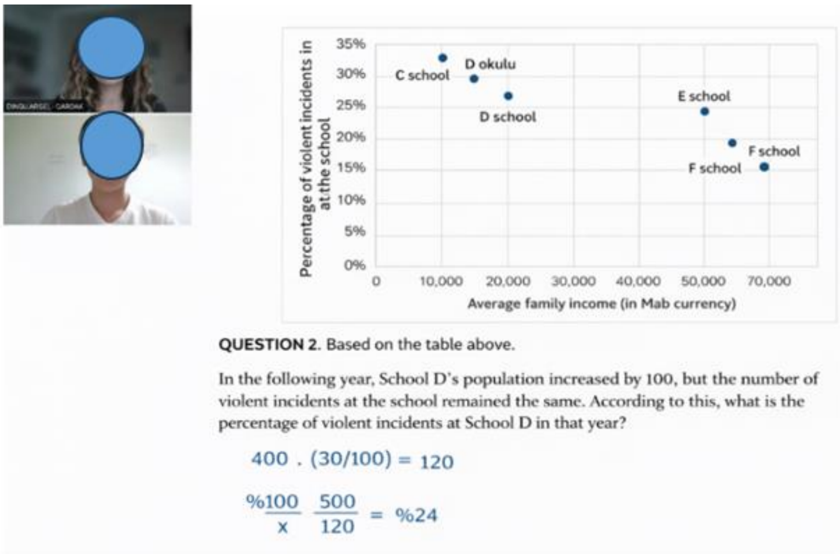


Figure 9. Student S1's indicator of selecting appropriate symbols in the problem (FOR4)

Question 2

S3: *Teacher, the school enrollment is 400, it increases by 100 people, it becomes 500. But he still wants the number of violent incidents to remain at 120 (KUL2) (FOR2).**S3: Teacher, the school enrollment is 400, it increases by 100 people, it becomes 500. But he still wants the number of violent incidents to remain at 120 (KUL2) (FOR2).*

Findings related to the third sub-problem

How do students' mathematics literacy performances in the first teaching experiment (1st teaching experiment) relate to the sub-problem of how their mathematics literacy performances are within the scope of the formulation process? The findings obtained regarding the levels of students' mathematics literacy performances within the scope of the formulation process in the first teaching experiment (1st teaching experiment) are presented below.

An examination of the students' responses revealed that they mostly perceived mathematical literacy as a structure focused on lessons, operations, and exams; they limited examples from daily life mainly to basic applications such as calculation, measurement, geometric shapes, and time. It was determined that a large proportion of students could not relate mathematical literacy to professions (S1, S2, S6, S7, and S8), and only students coded as S3, S4, and S5 stated that mathematical literacy could be used in fields such as health, software, engineering, and architecture, beyond classic examples such as market calculations. These findings show that at the beginning of the teaching process, students approached the concept of mathematical literacy in a narrower, more operation-based framework; their awareness of real-life contexts and professional applications was limited. When examining the findings related to the formulation process, it was observed that some students (S4, S5, S6, S7) experienced difficulties in the stage of formulating problem situations mathematically. For example, when student S5 was asked how Turkey's mathematics literacy performance changed over the years, instead of focusing solely on mathematics literacy data, they evaluated science, mathematics, and reading comprehension scores together and asked, "Is it the average?" This situation showed that the student did not fully understand the problem context. Similarly, when asked, "Let's say you ranked 10th out of 25 people on an exam. What percentage would that be?", student S7 stated that they did not understand the question and requested further clarification. When the teacher asked, "Did our performance increase or decrease in 2022?" to compare the 2018 and 2022 PISA data, it was determined that some students did not understand the meaning of the given scores. Student S6 interpreted success in terms of the number of people rather than the average score and gave the reason, "because the number of people is greater."

Additionally, in the question regarding the calculation of the score increase required to reach the average of OECD countries in the last seven exams, the responses of students coded as S6 and S7, who stated "I did not understand," revealed that they struggled with the formulation process. In contrast, it was observed that some students (S4, S5, S7) were relatively successful in establishing relationships between data and making comparisons. For example, in their answers to the question "In which year was our ranking better?", students evaluated the number of countries and the ranking together. Similarly, students coded S5 and S4 also made contextual assessments by considering the ranking and the number of countries together according to the years. The student coded S7 made a comparative assessment by taking the number of countries into account. In contrast, the student coded S6 perceived the ranking as a ranking rather than a percentage, stating that "Turkey's ranking is lower." Students with codes S1, S2, S3, and S8 refrained from commenting because they had difficulty fully understanding the problem. Below are selected excerpts from the student-teacher dialogues obtained in the first session regarding the formulation process.

Teacher: *Do you think our success increased or decreased in 2022? Why?*

S6: *I think it increased. It's lower than 454, 489, but...*

Teacher: *Why do you think that?*

S6: *Because there are more people.*

Teacher: *It's not the number of people, it's the average of these countries.*

S6: *Oh, okay then.*

Teacher: *In order to catch up with the average of OECD countries in the last seven PISA exams, by how many points does our country's score need to increase?*

S6: *I don't understand, teacher.*

S7: *I don't understand either.*

The dialogue example below shows that students coded as S6 had difficulty relating the concepts of ranking, percentile, and number of countries:

Teacher: *Which year did we rank better? Let's compare the percentiles.*

S6: *2003.*

Teacher: *Why do you think so?*

S6: *Turkey's rank is higher. Oh, it's lower.*

Teacher: *Why do you think so?*

S6: *I mean, now we're better than 65 countries.*

Findings related to the fourth sub-problem

How do students' mathematics literacy performances within the formulation process relate to the fourth sub-problem in the final session (10th session) of the teaching experiment? The findings obtained regarding the levels of students' mathematics literacy performances within the formulation process are presented below. It was observed that students were generally aware of the areas of use and functions of graphs in daily life when asked about the areas of use of graphs in daily life. In the final teaching experiment, it was observed that students had a general awareness of the areas of use and functions of graphs in daily life when asked about the graphs presented to them. In addition, students stated that graphs facilitate comparing data and examining multiple data sets together. Students mentioned that they also encountered graphs in television broadcasts and mock exams, emphasizing that success graphs are frequently used in this context. Furthermore, it was stated that graphs are more practical and understandable from a visual perspective. Within the scope of the problem-understanding theme of the formulation process, it was determined that all students generally understood the data in the problem situations, which included graphs belonging to theater groups and the number of questions solved weekly, correctly. It was observed that students could explain the values in the given tables and graphs and correctly express the information presented in the problem. For example, upon the teacher's request to summarize the given information, student S2 correctly stated the theater groups in the graphs and the number of questions solved by Şeyma. Similarly, student S6 stated the earnings of the theater group in the first graph by reading it from the graph and indicated that the data in the table showed the number of questions solved weekly. Student S5 stated that the total of the percentages should be checked to ensure the accuracy of the given information. While student S1 stated that the numerical data in the problem represented 30 questions, student S8 explained that the table showed the distribution of the math questions solved by Şeyma according to themes. Excerpts from student-teacher dialogues based on the data obtained regarding the theme of understanding the problem are provided below. An example of a dialogue showing that the student with code S8 correctly expressed what the table presented in the problem represented within the scope of the theme of understanding the problem is given below:

Teacher: *What is the table about?*

S8: *The table is a distribution table according to math themes, teacher.*

Teacher: *Okay, the distribution of what? Can you summarize the sentence?*

S8: *The distribution of the math questions Şeyma solved according to topics.*

Within the theme of relating data and concepts, it was observed that all students were able to establish relationships between the variables of earnings and number of performances by identifying these variables. For example, student S2 drew attention to the relationship between earnings and number of performances with the statement, "They performed fewer shows but were still the second highest earners." Similarly, student S5 correctly interpreted the relationship between the variables by stating that Mahşer-i Gürbüz Theater earned the least despite performing many shows. Below are excerpts from student-teacher dialogues obtained from the data collected on the theme of linking data and concepts. Within the scope of the theme of linking data and concepts, an example of a dialogue by student S2 linking data and variables to the relationship between earnings and number of performances is presented below:

Teacher: *Why did you make that comment?*

S2: *They performed fewer shows but were still the second highest earning group.*

RESULTS and DISCUSSION

When the findings were examined within the theme of relating data and concepts, it was observed that prior to the application, students could generally identify variables (FOR3), but experienced limitations in using mathematical symbols consistently and functionally. In the mid-term and final clinical interviews, it was determined that students expressed unknowns with letters in ratio and proportion problems, established equations, and used mathematical symbols such as the percentage symbol and fraction line more consciously and correctly. These findings show that students achieved meaningful development in their data-linking skills. In particular in questions involving graphs and ratios, it was observed that variables were correctly identified (FOR3) and that students used mathematical symbols such as percentage ratios, fraction lines, and letter expressions appropriately and functionally (FOR4). During the interim clinical sessions, it was observed that students read the problems more carefully, some recognized and corrected their previous mistakes, and they approached the problem context more consciously. In the final clinical sessions, all students were able to correctly explain what was given and what was required in the problem within the scope of understanding the problem (FOR1) and showed significant improvement in the processes of reading and comprehending the problem. The fact that some students tried to make sense of the problem by rereading the question (FOR2) when they were unsure of the problem context indicates that they developed a more conscious and controlled approach to the problem-solving process. This situation reveals that the students made progress in their problem comprehension skills.

When the findings were examined within the theme of relating data and concepts, it was observed that prior to the application, students could generally identify variables (FOR3), but experienced limitations in using mathematical symbols consistently and functionally. In the mid-term and final clinical interviews, it was determined that students expressed unknowns with letters in ratio and proportion problems, established equations, and used mathematical symbols such as the percentage symbol and fraction line more consciously and correctly. These findings show that students achieved meaningful development in their data-linking skills. Particularly in questions involving graphs and ratios, it was observed that variables were correctly identified (FOR3) and that students used mathematical symbols such as percentage ratios, fraction lines, and letter expressions appropriately and functionally (FOR4). The findings of the study revealed that students' mathematical literacy showed significant improvements, particularly in understanding problems and relating given and requested information. These results are consistent with previous studies showing that different teaching approaches strengthen students' abilities to understand real-life problems and establish relationships between mathematical representations. Indeed, Demirci (2018) stated that the mathematical modeling method significantly improves students' abilities to analyze problem situations, identify variables, and structure mathematical relationships. Similarly, Erol (2015) emphasized that modeling activities led to meaningful increases in students' mathematical literacy levels and beliefs about mathematics, particularly in their ability to correctly understand the problem context and justify the solution process. When the scores obtained from the pre-, mid-, and post-clinical interviews are evaluated together, inquiry-based mathematics instruction has a positive and increasing effect on the mathematics literacy performance of gifted students. Before the application, most students performed at an intermediate level, one student at a low level, and none at a high level. In the mid-term clinical interviews conducted during the implementation process, it was observed that all students achieved mid-level and above scores, and there were no students at the low level. In the final clinical interviews conducted after the implementation, it was determined that all students performed at a high level, there were no students at the mid-level or low level, and more than one student achieved a perfect score. This situation reveals that inquiry-based mathematics teaching gradually develops students' mathematical literacy skills during the process. Similarly, Akıllı (2020) revealed that mathematics literacy-based teaching positively affected the academic achievements of 7th grade students. The dual-focus teaching model and mathematics literacy framework developed by Altun (2022) and Altun, Kozaklı Ülger, and Bozkurt (2022) emphasize that supporting students' understanding of mathematics in everyday contexts is effective in developing these skills.When the findings from the 1st and 10th teaching experiments on inquiry-based mathematics education are evaluated together, it can be said that students showed significant progress, particularly in understanding the problem and relating data within the context of the formulation process. At the beginning of the process, it was observed that students perceived mathematical literacy as being more focused on lessons and exams, related real-life contexts with limited examples, and struggled to analyze the information provided in PISA-style graph questions. In contrast, at the end of the process, students could explain the functional uses of tables and graphs in daily life more effectively, correctly identify and relate the data presented in problem situations, and interpret the relationships between variables in a reasoned manner. Furthermore, students' use of monitoring strategies while making sense of problems indicates that they have reached a more systematic and relational level of thinking in the formulation process. The findings indicate that inquiry-based mathematics instruction positively contributes to students' formulation performance. This is thought to be related to the inclusion of PISA-style questions in the teaching process and the creation of learning environments that allow students to question and correct their mistakes in their writing. Indeed, the literature emphasizes that inquiry-, problem-, and modeling-based teaching approaches develop students' mathematical thinking and reasoning skills (Artigue & Blomhøj, 2013; Hmelo-Silver et al., 2007; Stillman et al., 2013).

The findings of this study are consistent with research showing that inquiry-based teaching is effective in developing mathematical-literacy skills. Indeed, an experimental study conducted by Doz (2025) at the 9th grade level indicated that students taught using an inquiry-based learning approach showed significantly greater development in conceptual understanding and problem-solving in mathematics compared to traditional teaching practices. Studies conducted in the context of gifted students also show that these students develop their mathematical reasoning and higher-order thinking skills more effectively in open-ended and cognitively challenging learning environments (Sheffield 2003). In conclusion, this study found that inquiry-based mathematics instruction significantly improved the mathematics literacy performance of gifted students, particularly demonstrating significant progress in their ability to understand problems and relate data within the context of the formulation process. Accordingly, the use of inquiry-based teaching approaches that deepen mathematical thinking in mathematics instruction for gifted students will make important contributions to developing their mathematical literacy.

Author Contributions

In this study, the contribution of the authors was equal; both authors contributed equally to the development of the research idea, data analysis, writing and proofreading stages.

Funding

This study was not funded by any institution or organization.

Responsible Artificial Intelligence Statement

In this study, artificial intelligence tools were used in language editing, data analysis and literature review stages. The artificial intelligence tool was used to correct language errors, to check the data analysis made by the author, and to provide the colophon information of current related resources in the literature review. We declare that we, as the authors, take full responsibility for the problems that may arise from the content produced by artificial intelligence.

Conflicts of Interest

The authors declare that there are no conflicts of interest related to the publication of this study.

Ethics Approval

All procedures conducted in this study were carried out in accordance with the principles of the Pen Academic Publishing Research Ethics Policy, and ethical approval was obtained from the Dokuz

Eylul University Social and Human Sciences Scientific Research and Publication Ethics Committee on November 8, 2024 (Decision No: 2).

REFERENCES

Akıllı, E. (2020). *Matematik okuryazarlık eğitiminin 7. sınıf öğrencilerinde akademik başarıya ve epistemolojik inanç düzeyine etkisi* (Master's thesis, Bursa Uludağ University).

Altun, M. (2022). *Çift odaklı öğretim modeli ile matematik okuryazarlığı düzeyinin artırılması*. Stüdyo Star Yayınları.

Altun, M., Kozaklı Ülger, T., & Bozkurt, I. (2022). *Matematik okuryazarlığı el kitabı* (2nd ed.). Ekin Basım Yayın.

Artigue, M., & Blomhøj, M. (2013). Conceptualizing inquiry-based education in mathematics. *ZDM–The International Journal on Mathematics Education, 45*(6), 797–810. https://doi.org/10.1007/s11858-013-0506-6

Banchi, H., & Bell, R. (2008). The many levels of inquiry. *Science and Children, 46*(2), 26–29.

Bildiren, A. (2018). Üstün yetenekli çocuklar. Doğan Kitap.

Bozkurt, I. (2019). *Matematik okuryazarlığı bağlamında öğrencilerin yaşadığı güçlüklerin incelenmesi* (Doctoral dissertation, Bursa Uludağ University).

Cross, T. L. (2011). *On the social and emotional lives of gifted children* (4th ed.). Prufrock Press.

Demirci, G. (2018). *Matematiksel modelleme yönteminin matematik okuryazarlığına etkisi* (Master's thesis, Atatürk University).

Doz, I. (2025). The impact of inquiry-based learning on students' conceptual understanding and problem-solving skills in mathematics. *Educational Studies in Mathematics, 109*(2). https://doi.org/10.1007/s10649-025-10417-w

Erol, M. (2015). *Modelleme etkinliklerinin 9. sınıf öğrencilerinin matematiksel okuryazarlıkları ve inançları üzerine etkisi* (Doctoral dissertation, Balıkesir University).

Friesen, S., & Scott, D. (2013). *Inquiry-based learning: A review of the research literature*. Galileo Educational Network. https://galileo.org/focus-on-inquiry-lit-review.pdf

Gagné, F. (2004). Transforming gifts into talents: The DMGT as a developmental theory. *High Ability Studies, 15*(2), 119–147. https://doi.org/10.1080/1359813042000314682

Güler, H. K. (2013). Türk öğrencilerin PISA'da karşılaştıkları güçlüklerin analizi. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 26*(2), 501–522. https://dergipark.org.tr/tr/pub/uefad/article/173591

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning. *Educational Psychologist, 42*(2), 99–107. https://doi.org/10.1080/00461520701263368

Karaduman, B., Arslan, Ç., Tapan Broutın, M. S., & Ezentaş, R. (2023). Özel yetenekli öğrencilerin resim, müzik ve sayısal yeteneklerine göre matematiksel okuryazarlık problemlerini çözüm süreçlerinin irdelenmesi. *Turkish Journal of Educational Studies, 10*(2), 193–220. https://doi.org/10.33907/turkjes.1150966

Llewellyn, D. (2002). *Inquire within: Implementing inquiry-based science standards*. Corwin Press.

Martin, D. J. (2009). *Elementary science methods: A constructivist approach*. Delmar.

Mayan, T. (2019). *Problem çözme ve problem kurma uygulamalarının ortaokul 7. sınıf öğrencilerinin matematik okuryazarlığına etkisinin incelenmesi* (Master's thesis, Dokuz Eylül University).

Ministry of National Education. (2022). *BİLSEM primary school mathematics curriculum*. https://orgm.meb.gov.tr/meb_iys_dosyalar/2022_03/28171823_BILSEM_ILKOGRETIM_MATEMATIK_ALANI.pdf

Ministry of National Education. (2024). *PISA 2022 Türkiye report* [Report]. https://pisa.meb.gov.tr/meb_iys_dosyalar/2024_03/21120745_26152640_pisa2022_rapor.pdf

Ministry of National Education. (2024a). *Middle school mathematics curriculum* (Grades 5–8): Türkiye Century Maarif Model. https://tymm.meb.gov.tr/upload/program/2024programmat5678Onayli.pdf

Ministry of National Education. (2024b). *Learning-teaching experiences: Türkiye Century Maarif Model*. https://tymm.meb.gov.tr/ogrenme-ogretme-yasantilari

OECD. (2018). *PISA 2018 assessment and analytical framework: Mathematics, reading, science and global competence*. OECD Publishing. https://doi.org/10.1787/b25efab8-en

OECD. (2019). *PISA 2018 results (Volume I): What students know and can do*. OECD Publishing. https://doi.org/10.1787/5f07c754-en

OECD. (2022). *PISA 2022 mathematics framework* (Draft). https://pisa2022-maths.oecd.org/files/PISA%202022%20Mathematics%20Framework%20Draft.pdf

OECD. (2023). *PISA 2022 results* (Volume I & II): Country notes – Türkiye. https://www.oecd.org/en/publications/pisa-2022-results-volume-i-and-ii-country-notes_ed6fbcc5-en/turkiye_d67e6c05-en.html

Polat, M., & Turhan, N. S. (2022). PISA testlerinde matematik okuryazarlığı ile matematik başarısı arasındaki ilişkiye ilişkin bir meta-analiz çalışması. *Uluslararası Çevrimiçi Eğitim ve Öğretim Dergisi, 9*(2), 661–676. https://files.eric.ed.gov/fulltext/EJ1343127.pdf

Pugalee, D. K. (1999). Constructing a model of mathematical literacy. *The Clearing House, 73*(1), 19–22. https://doi.org/10.1080/00098659909599606

Renzulli, J. S. (2005). The three-ring conception of giftedness: A developmental model for promoting creative productivity. In R. J. Sternberg & J. E. Davidson (Eds.), *Conceptions of giftedness* (2nd ed., pp. 246–279). Cambridge University Press.

Sheffield, L. J. (2003). Extending the challenge in mathematics: Developing mathematical promise in K–8 students. Corwin Press.

Steffe, L. P., & Thompson, P. W. (2000). Teaching experiment methodology: Underlying principles and essential elements. *Educational Psychologist, 35*(3), 135–146. https://doi.org/10.1207/S15326985EP3503_1

Stillman, G., Brown, J., & Galbraith, P. (2013). Research into mathematical modelling and problem solving. In G. Stillman, G. Kaiser, W. Blum, & J. P. Brown (Eds.), *Teaching mathematical modelling* (pp. 237–248). Springer. https://doi.org/10.1007/978-94-007-6540-5_21

Taşkın, E. (2017). *Altıncı sınıf öğrencilerine verilen matematik okuryazarlığı eğitiminin öğrencilerin matematik okuryazarlığı başarısına etkisi* (Master's thesis, Bursa Uludağ University).

Uysal, E. (2009). *İlköğretim sekizinci sınıf öğrencilerinin matematik okuryazarlık düzeyleri* (Master's thesis, Eskişehir Osmangazi University).

Ülger, T. K. (2021). *Matematik okuryazarlık yeterliklerinin gelişimine dayalı bir modüler programın tasarlanması, uygulanması ve değerlendirilmesi* (Doctoral dissertation, Bursa Uludağ University).

Wijaya, A., van den Heuvel-Panhuizen, M., Doorman, M., & Robitzsch, A. (2014). Difficulties in solving context-based PISA mathematics tasks: An analysis of students' errors. *The Mathematics Enthusiast, 11*(3), 555–584. https://scholarworks.umt.edu/tme/

Yıldırım, A., & Şimşek, H. (2021). *Qualitative research methods in the social sciences* (Sosyal bilimlerde nitel araştırma yöntemleri) (12th ed.). Seçkin Yayıncılık.

Yıldız, H., & Ezentaş, R. (2020). Yedinci sınıf öğrencilerinin matematik okuryazarlığı sorularının çözümünde karşılaştıkları zorlukların incelenmesi. *Fen Matematik Girişimcilik ve Teknoloji Eğitimi Dergisi, 3*(2), 98–112. https://doi.org/10.17522/balikesirnef.801665