Areas of Strengths and Growth Opportunities for Students Who Achieved Level 2 on the Mathematics Component of the 2022–2023 EQAO Assessment of Reading, Writing and Mathematics, Primary Division

Introduction

This study provides detailed information regarding students' mathematical strengths and growth opportunities from the mathematics component of the 2022–2023 EQAO Assessment of Reading, Writing and Mathematics, Primary Division, with a focus on students achieving Level 2.

This work expands on EQAO's previously released Student Achievement on Mathematics Curriculum Strands (Education Quality and Accountability Office [EQAO], 2023b) by analyzing student responses to single-selection questions (commonly known as multiple-choice questions) to identify strengths and potential growth opportunities in mathematical understanding. Detailed examples are provided to illustrate student misunderstandings as well as instructional implications and recommendations that educators can use to move student achievement from Level 2 to the provincial standard. Although the analysis provided in this report focuses on students achieving Level 2, the themes and instructional implications that emerge are useful for all students, as they highlight areas required for strong mathematical understanding.

Method

The data used for this study include responses from all participating students at public school boards in Ontario who received an assessment level outcome from the mathematics component of EQAO's primary-division assessment in the 2022–2023 school year.

In the primary-division mathematics component, each student is presented with 40 operational and four field-test questions. These questions assess student knowledge and skills across the Number, Algebra, Data, Spatial Sense and Financial Literacy strands.[1] As outlined in the Assessment of Reading, Writing and Mathematics, Primary Division (Grades 1–3), Framework (EQAO, 2025a), 35% of the 40 operational questions are allocated to the Number and Financial Literacy strands, 20% to the Algebra strand, 20% to the Data strand and 25% to the Spatial Sense strand. Each question is also mapped to one of three of the categories of knowledge and skills: Knowledge and Understanding, Application or Thinking.

The mathematics component of the primary-division assessment uses a multi-stage computer adaptive testing model (EQAO, 2020) that adapts to student performance as the student progresses through the assessment sessions. The assessment is composed of different types of selected-response questions such as drag and drop, checklist, ordering, and single- and multiple-selection questions (EQAO, 2025a). For this study, only single-selection questions were included in the analysis from the five assessed strands and three knowledge and skills categories. Field-test questions were not included. This resulted in the selection of 83 operational questions for an item-by-item analysis as outlined below.

The item-by-item analysis was conducted by calculating the percentage of students at each achievement level who selected each option for each question. Response patterns were then examined to understand the potential mathematical misunderstandings and misconceptions that led students to select incorrect answers.

Table 1 provides an example of the analysis process for one question, in which the percentage of students who selected each option is calculated for students at each achievement level. In Table 1, 20% of students achieving Level 2 selected option A as opposed to the correct option C. Option A was then analyzed to determine why students might have selected it and what this selection revealed about potential mathematical misunderstandings and misconceptions.

Students achieving below Level 1 were not included in the analysis due to small sample sizes. Responses for students in English- and French-language schools were analyzed separately, and major differences are described in detail in this report where applicable.

Table 1. Percentage of students who chose each option, by achievement level

Level	A	B	C	D	No Response	Total
Level 1	24%	27%	33%	15%	1%	100%
Level 2	20%	13%	59%	7%	1%	100%
Level 3	7%	2%	89%	2%	–	100%
Level 4	1%	–	99%	–	–	100%

Findings

Classification of Mathematical Themes

Through the analysis of item level performance, patterns of students' mathematical understanding were grouped under four themes: Proportional Reasoning, Algebraic Reasoning, Computational Thinking and Mathematical Language. By grouping mathematical understanding into these four areas, student strengths and areas for growth were identified. Each of these themes will be explored in detail in the following sections by using examples from Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division (EQAO, 2023a). As well, instructional implications and recommendations for improving student performance are provided for each theme.

Theme 1. Proportional Reasoning

One of the most prevalent and noticeable themes that appeared during the analysis of student responses was proportional reasoning, which “permeates mathematics and is often considered the foundation to abstract mathematical understanding” (Ontario Ministry of Education, 2012, p. 2). As such, proportional reasoning appears across the Ontario mathematics curriculum. It is defined as “reasoning that is based on equal ratios and that involves an understanding of the multiplicative relationship in the size of one quantity compared with another” (Ontario Ministry of Education, 2020b, p. 567).

When examining the options selected by Grade 3 students achieving Level 2 within the context of proportional reasoning, both strengths and areas for improvement became apparent. In terms of strengths, students achieving Level 2 were able to add and subtract accurately with explicit instructions. Areas of improvement for students achieving Level 2 were apparent in questions involving skip counting on a number line, area, and multiplication and division. The examples below explore each of these findings in detail.

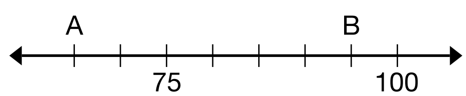
Skip Counting on a Number Line

Students achieving Level 2 experienced some difficulty with problems involving proportional reasoning when skip counting on a number line. When presented with a question that asked students to identify numbers on a number line where the tick marks represented increments of five units, only about one third of students achieving Level 2 answered correctly, compared to over half of students achieving Level 3. Example 1, taken from the [Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division] (EQAO, 2023a), illustrates this finding.

Example 1

(Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division, Question 3)

What numbers are represented by the letters A and B on this number line?



A 60 and 90

B 65 and 90

C 65 and 95

D 70 and 95

Objective: Students were asked what numbers are represented by the letters A and B on the given number line.

Overall Curriculum Expectation: B1, Number Sense. To answer correctly, students need to "demonstrate an understanding of numbers and make connections to the way numbers are used in everyday life" (Ontario Ministry of Education, 2020b, p. 178).

Mathematical Misunderstanding: When answering questions of this type, students achieving Level 2 often selected incorrect options such as B, indicating that they either had difficulty determining the correct scale used on the number line or lacked the understanding that the scale on the number line must be consistent. To answer the question correctly, students had to accurately determine the scale used on the number line and determine the missing values to arrive at the correct answer (option C). They needed to understand that the proportional values underlying the number line represent a consistent scale.

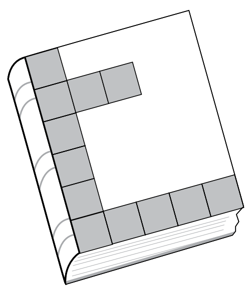
Area

Students achieving Level 2 experienced some difficulty in understanding problems involving proportional reasoning related to area. When presented with a problem that involved the use of non-standard units to measure an area, such as Example 2 below, only one quarter of students achieving Level 2 were able to answer correctly, compared to just over half of students achieving Level 3.

Example 2

(Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division, Question 25)

Riley starts to cover the front of this book with square tiles. All the tiles are the same size.



How many **more** tiles are needed to cover the front of this book, with no gaps or overlaps?

A 12 tiles

B 16 tiles

C 18 tiles

D 30 tiles

Objective: Students were presented with a picture of a book partially covered by tiles and asked how many more tiles would be needed to cover the front of the book without gaps or overlaps.

Overall Curriculum Expectation: E2, Measurement. To answer correctly, students need to "compare, estimate, and determine measurements in various contexts" (Ontario Ministry of Education, 2020b, p. 213).

Mathematical Misunderstanding: Students may find the correct answer to this question, option C, in two different ways. One way involves counting the missing tiles on the front of the book. Another way involves multiplication (6 × 5) to find the total area of the book cover and then subtraction of the existing tiles from the total area (30 – 12). However, students achieving Level 2 often chose option A, indicating that they only completed part of the question, i.e., determining the number of existing tiles on the front of the book. They did not find the number of missing tiles either by performing the above-mentioned calculations or by counting the missing tiles.

Multiplication and Division

Students achieving Level 2 often relied on additive and subtractive thinking instead of multiplicative and divisional thinking when presented with questions requiring the use of multiplication and division. For example, when students were presented with questions requiring the use of multiplication that asked them to calculate the total number in a group, students achieving Level 2 often selected options that indicated they had added the given numbers in the question. When asked how many bananas are in a box that contains four times as many bananas as there are apples, given there are six apples, students achieving Level 2 tended to choose "10 bananas." This indicated that they had known a "growth" solution was appropriate, but opted for addition instead of multiplication as the operation. Similarly, when asked to identify the number of groups of five in 45, students who experienced difficulty with divisional thinking tended to choose "40," indicating that they knew a "reduction" solution was appropriate, but opted for subtraction instead of division as the operation. Mathematical errors of this type highlight the importance of the development of proportional reasoning skills and the distinction between additive and multiplicative thinking (Lamon 2012; Ontario Ministry of Education, 2012).

Implications and Recommendations for Proportional Reasoning

Proportional reasoning appears across the Ontario mathematics curriculum and "is often considered the foundation to abstract mathematical understanding" (Ontario Ministry of Education, 2012, p. 2). This widespread nature is evident in the examples provided above, which detailed student difficulties in questions mapped to different strands across the curriculum. A key aspect that appeared in the analysis was the tendency for students who experienced difficulty with proportional reasoning to use counting or additive methods for questions that required multiplicative thinking, which "requires thinking about situations in relative rather than absolute terms" (Ontario Ministry of Education, 2012, p. 5). Developing multiplicative thinking is not only important for answering mathematical problems that require multiplication and division, but also has implications for learning in the Algebra, Spatial Sense, Data and Financial Literacy strands.

Recommendations

- Make use of multiple assessment types and opportunities to determine which aspects of proportional reasoning students already know, and what next steps are needed to reach each student's learning goals. This could include the use of EQAO's released questions from the Released Questions with Provincial Data: Mathematics (EQAO, 2025b) that involve proportional reasoning as part of a pre- and post-assessment.
- Consider tasks that involve classifying additive and multiplicative problems followed by classroom discussion (Van Dooren et al., 2010). This practice could start with providing students with a set of word problems, some involving addition and others multiplication, and then having students classify each problem as either additive or multiplicative and justify their classifications.
- Consider activities with manipulatives (including virtual manipulatives) that allow students to explore different proportional and non-proportional problems. For example, have students use fraction strips to compare different fractions and determine if they are equivalent.
- Allow students to practise with a variety of proportional tasks in multiple contexts across strands that foster connections across mathematical topics. This practice could include providing students with various tasks involving the use of number lines or axes on graphs with scales 1 to 2, 1 to 5, or 1 to 10.

Theme 2. Algebraic Reasoning

Algebraic reasoning appeared as an important theme during the analysis of student responses. The Ontario Ministry of Education defines algebraic reasoning as "our ability to notice patterns and generalize from them. Algebra is the language that allows us to express these generalizations in a mathematical way (Ontario Ministry of Education, 2013, p. 3).

When examining the options selected by Grade 3 students achieving Level 2 within the context of algebraic reasoning, both strengths and areas for improvement became apparent. In terms of strengths, students achieving Level 2 could identify patterns when it involved skip counting by 10s. For example, when presented with a set of numbers such as "90, 80, 70, 60," students could correctly identify the next two numbers as "50, 40." Areas for potential growth for students achieving Level 2 were also found within the theme of algebraic reasoning. These include working with equalities, determining unknown values, identifying patterns and determining the total value of equal-sized groups. The examples below illustrate each of these growth areas.

Equalities

Students achieving Level 2 experienced some difficulty with the identification of equivalent relationships. For example, when presented with questions that required students to select an expression that is equivalent to 4 × 2, students who experienced difficulty in this area tended to select options like 4 ÷ 2, indicating their confusion with inverse operations. Additionally, when asked to select an expression that was equal to a given number (e.g., 345), students achieving Level 2 tended to select options that featured addition (e.g., 255 + 95), rather than the correct expression (e.g., 500 – 155).

Unknown Values

Students achieving Level 2 had difficulty determining unknown values when presented with questions that asked them to find a missing value. When given two equivalent expressions or a number sentence with a missing value, about one third of students achieving Level 2 answered correctly, compared to over half of students at Level 3. Example 3 illustrates where the options selected by students reveal this difficulty.

Example 3

(Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division, Question 6)

What two numbers make this subtraction problem correct?

$$\begin{array}{r} 7\ \square\ \text{⬡} \\ -\ 2\ \ 5\ \ 6 \\ \hline 4\ \ 7\ \ 4 \end{array}$$

A $\boxed{2}$ ⬡2

B $\boxed{2}$ ⬡0

C $\boxed{3}$ ⬡0

D $\boxed{4}$ ⬡2

Objective: Students were asked to identify which two numbers would make the subtraction problem correct.

Overall Curriculum Expectation: B2, Operations. To answer correctly, students need to “use knowledge of numbers and operations to solve mathematical problems encountered in everyday life” (Ontario Ministry of Education, 2020b, p. 185).

Mathematical Misunderstanding: In the example shown above, the correct answer is 3 and 0 (option C); however, students who experienced difficulty in this area tended to select option A, which shows that they may have been subtracting (6 – 4 = 2), instead of adding (6 + 4 = 10). Students may not have understood the relationship between the given values and how addition relates to the question.

Patterning

The identification of patterns of repeating operations was also an area for growth for students achieving Level 2. For example, when students were presented with a set of numbers (e.g., 316, 366, 416, 466) and asked to identify the pattern, approximately half of the students achieving Level 2 answered the question correctly, compared to more than 80% of students achieving Level 3. Students achieving Level 2 also experienced difficulty with shrinking patterns (e.g., involving subtraction). For example, when presented with a question that asked students to identify a pattern in which 6 was subtracted each time (e.g., 96, 90, 84, 78, 72), approximately half of the students achieving Level 2 answered the question correctly, compared to more than 80% of students achieving Level 3. This shows that students achieving Level 2 had difficulty applying the pattern rule to each set of numbers to determine the correct answer, even though they could access a calculator. They tended to select incorrect patterns such as “96, 90, 85, 81, 78,” indicating that they correctly determined only the second number in the pattern.

Determining the Total Value of Equal-Sized Groups

Students achieving Level 2 had difficulty using multiplication to determine the total value of equal-sized groups. As Example 4 illustrates, when students were presented with a question that required multiplication using the key to determine the total number of paper items recycled, only about 40% of students achieving Level 2 answered correctly, compared to 85% of students achieving Level 3.

Example 4

(Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division, Question 16)

This pictograph shows information about recycled items.

Recycled Items

Type	Number of items recycled
Paper	
Plastic	
Glass	

Key
Each  represents 4 items.

How many paper items have been recycled?

A 5

B 14

C 20

D 24

Objective: Students were given a pictograph and asked to determine the number of paper items recycled.

Overall Curriculum Expectation: D1, Data Literacy. To answer correctly, students need to "manage, analyse, and use data to make convincing arguments and informed decisions, in various contexts drawn from real life" (Ontario Ministry of Education, 2020b, p. 202).

Mathematical Misunderstanding: Instead of the correct option (C), students who had difficulty in this area tended to use a one-to-one correspondence instead of using the key, and selected option A. To answer correctly, students must connect the symbol used (recycling box) to the value given in the key (four items) and then connect this value to the number of symbols in the row in the pictograph. Students had to either correctly multiply these values (5 × 4) or use repeated addition to determine their answer. However, students who had difficulty in this area did not connect the relationship between the symbol and the number of items recycled, indicating their difficulty in applying algebraic reasoning.

Implications and Recommendations for Algebraic Reasoning

By exploring the properties of numbers and then developing an understanding of patterns, students build the generalization rules of algebra (Ontario Ministry of Education, 2013). In addition to generalization, algebraic reasoning also includes an understanding of unknowns expressed as variables, as well as a conceptual understanding of formulas and equivalence (Ontario Ministry of Education, 2013). The examples explored above illustrate the difficulties students had in these areas and highlight the importance of developing algebraic reasoning as students progress in their learning of mathematical concepts. Without consistent skills in algebraic reasoning, solving algebra problems becomes increasingly difficult. These skills are needed to later build equations and to solve an equation for an unknown or missing value.

Recommendations

- Develop students' conceptual understanding in algebra by engaging them with mathematical ideas and the relationships between these ideas. This can include tasks in making conjectures, justifying or proving, and predicting (Ontario Ministry of Education, 2013). For example, develop students' skills in multiplication to determine the total value of equal-sized groups by providing exercises that require students to interpret and use keys to determine quantities in pictographs, make predictions based on patterns observed in pictographs, justify their answers and predict the results of changes in the keys.
- Use manipulatives such as number lines, relational rods and pan balances to allow students to develop a concrete representation of algebraic ideas. For example, educators can consider using a pan balance to explore equality by working on both sides of an equation. With manipulatives, students can first apply operations concretely, then transfer their concrete skills to pictorial representations and, finally, move to more abstract representations by using algebraic symbols (Fyfe et al., 2014). This three-step progression allows students to build a repository of memorable images to reference when abstract concepts become more difficult to understand (Fyfe et al., 2014).
- Consider providing opportunities for students to discuss and analyze algebraic problems that have already been solved so they can compare different solution strategies and the mathematical reasoning involved (Star et al., 2015).

Theme 3. Computational Thinking

Our next theme explores computational thinking, which can be defined as “the thought process involved in expressing problems in such a way that their solutions can be reached using computational steps and algorithms” (Ontario Ministry of Education, 2020b, p. 513).

When examining the options selected by students achieving Level 2, it became clear that students had difficulties with multi-step questions in general, particularly those that involved location and movement, and calculating change. The examples below explore these findings in more detail.

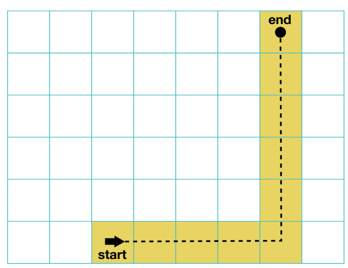
Location and Movement

Students achieving Level 2 faced challenges with questions involving multiple steps with movement on a grid, such as sequences of movement from one location to another, including half- and quarter-turns. For example, when presented with a question like the one in Example 5, students achieving Level 2 tended to make a counting error. Only two thirds of students at Level 2 selected the correct answer, compared to more than 80% of students achieving Level 3.

Example 5

(Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division, Question 22)

Which option describes the movement of the arrow from the **start** square to the **end** square?



A Move forward 4 squares, make a quarter-turn clockwise, and move forward 4 squares.

B Move forward 4 squares, make a quarter-turn counterclockwise, and move forward 5 squares.

C Move forward 5 squares, make a quarter-turn clockwise, and move forward 5 squares.

D Move forward 5 squares, make a quarter-turn counterclockwise, and move forward 6 squares.

Objective: Students were asked to describe how the arrow moves from the start square to the end square in the grid.

Overall Curriculum Expectation: E1, Geometric and Spatial Reasoning. To answer correctly, students need to be able to “describe and represent shape, location, and movement by applying geometric properties and spatial relationships in order to navigate the world around them” (Ontario Ministry of Education, 2020b, p. 208).

Mathematical Misunderstanding: The correct option for this question (B) required students to use their computational thinking to break down the problem into smaller steps, recognize the pattern in the movement, and follow a sequence of instructions to solve the problem. They needed to begin on the square labelled “start,” move forward four squares in the direction of the arrow, where they would land on the square with the turn, make a counterclockwise turn and finally move forward five squares so they would land on the “end” square. However, students achieving Level 2 tended to choose option C, showing that they may have mistakenly included the square labelled “start” in their counting, and also mixed up the meaning of the words “clockwise” and “counterclockwise.”

Calculating Change

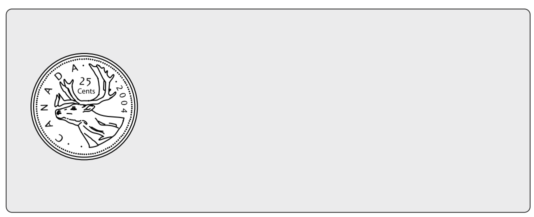
Students achieving Level 2 often struggled with questions involving multiple steps when asked to calculate change. For example, when presented with questions like the one in Example 6, students must calculate the difference between the payment and the cost to determine the amount of change and then find which option represents this amount. Only one third of students achieving Level 2 could determine the correct answer, compared to three quarters of students achieving Level 3.

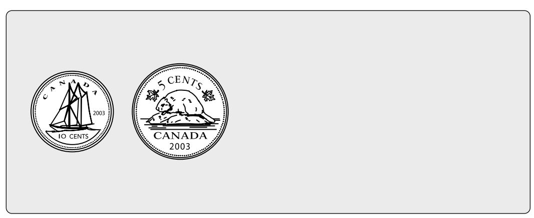
Example 6

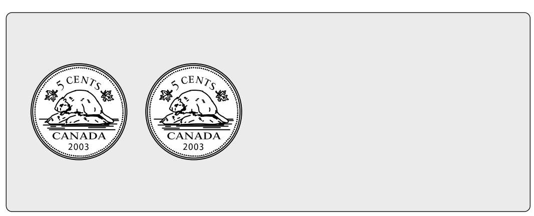
(Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division, Question 28)

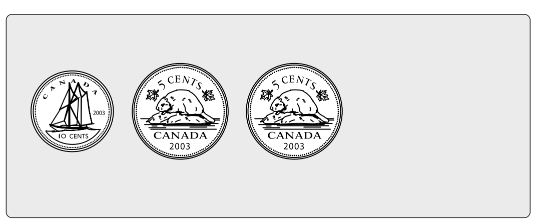
Hana buys an item that costs 55¢. She pays with 75¢.

Which option shows the change she should get back?

A


B


C


D


Objective: Students were asked to calculate the change in a cash transaction in which the buyer pays 75¢ for an item that costs 55¢.

Overall Curriculum Expectation: F1, Money and Finances. To answer correctly, students need to "demonstrate an understanding of the value and use of Canadian currency" (Ontario Ministry of Education, 2020b, p. 220).

Mathematical Misunderstanding: Students achieving Level 2 seemed to have trouble understanding the sequence of operations needed to solve the problem. To find the correct answer, they needed to subtract the cost of the item (55¢) from the payment (75¢) to arrive at the correct amount of change (20¢). Alternatively, they may have found the change by counting up from 55¢ to 75¢. After this, the students needed to add up the values of the coins shown in the options to find the correct option, D. However, students achieving Level 2 tended to choose option A, 25¢, which is close to the answer 20¢.

Implications and Recommendations for Computational Thinking

Students develop computational thinking skills by analyzing problems, identifying patterns, designing algorithms and testing solutions (Aho, 2012; Grover & Pea, 2013; Weintrop et al., 2016; Wing, 2006). These skills have many instructional implications since they are essential for success in science, technology, engineering and mathematics (STEM) and related fields (Aho, 2012; Grover & Pea, 2013; Weintrop et al., 2016; Wing, 2006). One of these computational thinking skills is problem solving, which allows students to break down more complex mathematical problems into smaller and more manageable parts, which is referred to as decomposition (Wu et al., 2024). The examples explored above indicate that these decomposition skills are a growth area for students achieving Level 2.

Recommendations

- Make the process of problem solving explicit by discussing the thinking process with students (Ontario Ministry of Education, 2020a). Encourage students to share their thinking process by exploring the structure of a multi-step problem to determine what information has been provided and what information is needed, and to compare different solution strategies (Ontario Ministry of Education, 2020a).
- Regularly review and offer practice on difficult concepts such as inverse operations. This practice should not only revisit students' prior knowledge but allow students to make connections between the skills, concepts and processes (Ontario Ministry of Education, 2020a).
- Support students to reflect on mistakes and the revision of their solutions (Ontario Ministry of Education, 2020b). For example, provide students with practice problems that involve sequences of operations for calculating change. Encourage them to reflect on why they chose incorrect options and guide them on how to revise their solutions to arrive at the correct answers.

Theme 4. Mathematical Language

The final theme explored in this report is mathematical language, which can be defined as "the conventions, vocabulary, and terminology of mathematics" (Ontario Ministry of Education, 2020b, p. 548). When examining the options selected by students achieving Level 2, strengths were identified in mathematical language. This included an understanding of the concepts of "certain" and "impossible" when students were asked to determine the likelihood of events happening.

It also became apparent through the analysis that students achieving Level 2 had difficulty with questions that required knowledge and understanding of the mathematical content and associated mathematical language within some questions. This occurred across strands and was found for certain concepts and terminology involving probability, coding, geometric properties and data analysis. Each of these is explored below in more detail.

Probability

Students achieving Level 2 often demonstrated a misunderstanding of the terms “likely” and “unlikely,” which are important aspects of probability in the Data strand in the curriculum. Analysis of option selections revealed that only about 55% of these students answered these types of questions correctly, compared to 85% of students achieving Level 3. Example 7 illustrates the incorrect option that students achieving Level 2 often selected.

Example 7

(Resource: Released Questions, Assessment of Reading, Writing and Mathematics, Primary Division, Question 19)

A coin with heads on one side and tails on the other side is tossed 5 times.

Choose the likelihood of the coin landing on tails 5 times in a row.

A certain

B impossible

C likely

D unlikely

Objective: Students were presented with a scenario in which a coin is tossed five times. Students were then asked to choose the likelihood of the coin landing on tails five times in a row.

Overall Curriculum Expectation: D2, Probability. To answer correctly, students need to “describe the likelihood that events will happen, and use that information to make predictions” (Ontario Ministry of Education, 2020b, p. 255).

Mathematical Misunderstanding: When answering questions of this type, students achieving Level 2 often selected “likely” (option C) instead of the correct answer, “unlikely” (option D). Students struggling with questions of this type may not have a good understanding of the terms “likely” and “unlikely” and how the likelihood of an event can be represented along a continuum from “impossible” to “certain.” They might interpret the term “likely” as anything that has a likelihood of happening, regardless of how small that likelihood is. This can lead to confusion with the term “unlikely” when dealing with events that have very low likelihoods.

Coding Terminology

Students achieving Level 2 also had difficulty with the terminology needed for coding within the Algebra strand. For example, when presented with different lines of code and asked to identify which line was a loop (repeating an action), students achieving Level 2 tended to have difficulty in selecting the correct option, possibly due to limited understanding of what a loop is. Likewise, in another question that asked students to identify which line of code would create a loop to perform the given instruction, students at Level 2 faced challenges in choosing the correct option.

Geometric Properties

The terminology used for the geometric properties of three-dimensional objects was another growth area for students. Students at Level 2 often had difficulty with understanding terms such as face, edge and vertices, and correctly solving related problems. For instance, about half of students achieving Level 2 had difficulty identifying the correct number of vertices, faces and edges in a given three-dimensional object.

Data Analysis

Students achieving Level 2 had difficulty with questions that involved identification of the mode for various data sets. For example, when presented with questions that asked students to determine the mode from a frequency table, students achieving Level 2 often selected the maximum value.

Implications and Recommendations for Mathematical Language

As mentioned above, students achieving Level 2 had difficulty with terms related to probability, coding terminology, geometric properties and data analysis. Mathematical language and vocabulary are an important component of student understanding of mathematical concepts and the connections between them (Riccomini et al., 2008). Mathematical vocabulary has been linked to mathematical performance (Lin et al., 2021) and is emphasized in the mathematics curriculum as "students learn the vocabulary and terminology that are unique to a particular subject area and must be able to interpret symbols, charts and diagrams" (Ontario Ministry of Education, 2020b, p. 32).

Recommendations

- Encourage students to use mathematical language in class and provide feedback on its use in written and oral forms. This can provide opportunities for students to build connections to mathematical terms through classroom discourse.
- Use word walls, which can be effective in supporting students as new mathematical concepts and words are introduced (Hattie et al., 2017). For example, consider posting images of various three-dimensional objects with their names and associated attributes that can be referenced during instruction.
- Introduce new vocabulary via direct instruction in ways that activate students' prior knowledge (Ontario Ministry of Education, 2020a). For example, students' prior knowledge in patterning within the Algebra strand could be used to connect to new learning about loops, which are similar to patterns that repeat a set of instructions.

Conclusion

Through the analysis of question responses on the mathematics component of the 2022–2023 EQAO Assessment of Reading, Writing and Mathematics for the Primary Division, patterns of students' mathematical understanding and misconceptions were discovered and categorized into four themes: Proportional Reasoning, Algebraic Reasoning, Computational Thinking and Mathematical Language. By grouping mathematical understanding into these four areas, student strengths and areas for growth were identified across the different mathematical curriculum strands. The themes identified in this study reveal opportunities for growth in mathematical understanding and offer recommendations that can be applied systematically, as the skills and concepts discussed are closely connected. For example, improving student ability to solve multi-step problems should not be approached without also addressing difficulties in proportional and algebraic reasoning. Likewise, building mathematical vocabulary is an important activity that can be reinforced across strands.

Other important factors, such as knowing the learner and the curriculum, providing a positive and safe learning environment, using various assessment methods and fostering perseverance in mathematical learning, are also essential aspects of effective mathematical instruction (Ontario Ministry of Education, 2020a). These elements should be included in a systematic approach to improving mathematical proficiency. This report supports educators in getting to know their learners by providing a detailed analysis of the mathematical strengths and growth opportunities for students achieving Level 2. Educators can further tailor this analysis by using EQAO's released questions within their classrooms to assess current student understanding. Examining student answers to the released questions can uncover possible misconceptions at the student level and inform instructional approaches that address the specific needs of students.

Notes

[1] The assessment does not measure curriculum content from the Social Emotional Learning (SEL) Skills in Mathematics and the Mathematical Processes strand.

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