

GRADE 9 MATHEMATICS

Draft

IMPLEMENTATION SUPPORT RESOURCES:

- COURSE I (3013)
- COURSE II (3014)

LEARNING OUTCOMES AND MANIFESTATIONS



MATHEMATICAL PROCESSES

The seven mathematical processes play a vital role in learning, understanding, and applying mathematical concepts. These processes help students rephrase, organize, make connections, and create mental images to better make sense of their learning. They are integrated into the teaching and learning of mathematics: they are the means through which mathematical concepts are constructed. The descriptions below provide an overview of each process.

MENTAL MATH AND ESTIMATION [ME]

Mental math and estimation involve a combination of cognitive strategies that enhance flexibility in thinking and number sense.

Mental math is performed without the use of external memory aids. It relies on a set of calculation strategies and acquired knowledge. It requires students to be highly flexible in their use of numbers and operations.

Estimation, on the other hand, involves various strategies to determine approximate values or quantities, usually based on benchmarks or reference points. It allows students to judge whether a result is reasonable or plausible. Common in everyday life, estimation requires students to know when and how to use it, as well as to choose appropriate strategies depending on the context.

CONNECTIONS [CN]

Making connections is a key process in mathematics. It involves creating links between mathematical domains and concepts, between mathematics and real-life situations or other disciplines, as well as between various concrete, visual, and symbolic representations. This process helps students not only better understand mathematics, but also recognize its usefulness, relevance, and presence in the world around them.

To develop this skill, students must be encouraged to question, reason, and build bridges between their prior knowledge and new concepts being introduced. It is therefore essential to provide them with rich and varied learning opportunities that explicitly promote the making of these connections.

PROBLEM SOLVING [PS]

Problem solving, a key element of learning in mathematics, is a powerful instructional tool that fosters the development of creative and innovative solutions. It enables students to acquire and deepen their understanding of concepts and procedures, while making connections across domains, concepts, disciplines, and between mathematics and real-life situations.

When students are given a ready-made method to solve a problem, it is no longer a true problem but rather an exercise. A true problem requires students to draw on their knowledge and skills to enhance their mathematical reasoning and develop their understanding of concepts, while exploring various strategies that may lead to one or more possible solutions.

By collaborating and exchanging ideas with peers, students are encouraged to validate their problem-solving process and consider different approaches. A learning environment where they feel confident to try different strategies contributes to the development of self-esteem, encourages risk taking, and fosters enjoyment in doing mathematics. This helps them see themselves as mathematicians.

TECHNOLOGY [T]

Technology can support the learning of a wide range of learning outcomes and allow students to explore and create patterns, study relationships, test conjectures, and solve problems. It has the potential to enrich the teaching and learning of mathematics through a variety of tools, including calculators, computers, and mobile devices, which provide access to apps, statistical software, geometry software, math simulation tools, videos, and communication technologies.

Technology can help students deepen their understanding of concepts and communicate their thinking and learning. However, its use should not replace conceptual understanding, procedural thinking, or problem solving. The ability to represent situations concretely, visually, and symbolically, as well as to perform mental calculations, remains a fundamental aspect of learning mathematics.

Students must therefore learn to determine when to use technology and to choose the most appropriate tool for completing a mathematical task, studying concepts, or solving problems.

MATHEMATICAL PROCESSES (CONTINUED)

COMMUNICATION [C]

Communication plays an important role in clarifying, deepening, and correcting ideas, attitudes, and beliefs about mathematics. Students communicate mathematical ideas concretely, visually, and symbolically, both orally and in writing, in a variety of everyday contexts, while demonstrating active and respectful listening toward others.

Effective communication develops when students are in a safe, inclusive, and welcoming environment where everyone feels comfortable taking risks expressing their reasoning and responding to others.

This communication requires students to use mathematical terminology and symbols while respecting the conventions of the discipline. To achieve this, students need opportunities to read and write about mathematical concepts, to represent them, observe them, hear about them, and discuss them. These experiences allow them to reflect, validate, and clarify their thinking.

Mathematical reasoning helps students think logically and make sense of mathematics by developing their reasoning skills across different areas of the discipline. It relies on the ability to formulate and validate conjectures or hypotheses, particularly by drawing on an understanding of mathematical concepts, properties, and conventions to solve problems.

When faced with a problem situation, students are encouraged to build confidence in their ability to reason and communicate their mathematical thinking. In this process, it is important to ask questions that prompt them to draw on their knowledge to explain and justify their thinking.

REASONING [R]

Mathematical reasoning helps students think logically and make sense of mathematics by developing their reasoning skills across various areas of the discipline. It relies on the ability to formulate and validate conjectures or hypotheses, particularly by drawing on an understanding of mathematical concepts, properties, and conventions to solve problems.

When faced with a problem situation, students are encouraged to build confidence in their ability to reason and communicate their mathematical thinking. In this process, it is important to ask questions that prompt them to draw on their knowledge to explain and justify their thinking.

VISUALIZATION [V]

Visualization “involves the ability to think in images, to perceive, transform, and recreate different aspects of the visual and spatial world” (Armstrong, 1993, p. 10). Using visualization, or visual representation, in the study of mathematics supports the understanding of concepts and the creation of connections between them.

Although a mathematical situation or concept can be represented in various ways, such as with the use of manipulatives, models, or technological tools, students must be able to determine the most appropriate forms of visual representation depending on the situation or concept being explored. These representations help them create mental images, verbalize or model them, and make their thinking and reasoning visible.

Visualization is essential to problem solving, as it allows students to build a mental image of the situation, represent the problem, and communicate their solution using various means such as diagrams, graphs, tables, numbers, words, or symbols.

By collaborating and exchanging ideas with peers, students are better able to validate and refine their representations as needed during problem solving.

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COURSE I (3013)

LEARNING OUTCOMES AND MANIFESTATIONS



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[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

MAT.9.1.A.1.

Demonstrate an understanding of powers with integral bases (excluding base zero) and whole-number exponents by

- representing repeated multiplication using powers
- using patterns to show that a power with an exponent of zero is equal to one

[C, CN, ME, PS, R, V]

MANIFESTATION OF LEARNING

Students develop an understanding of powers as a structured form of repeated multiplication by focusing on the meaning of the base and exponent. By modelling powers concretely, students represent, compare, and explain exponential expressions such as 2^3 and 3^2 , allowing them to make connections [CN] between symbolic notation and visual structure [V]. These representations support the development of mental math strategies [ME] and help students reason about the magnitude of powers without relying solely on calculation. Through comparison and discussion, students communicate [C] how changing the base or the exponent affects the value of the power, reinforcing that powers describe multiplicative relation rather than repeated addition.

Through pattern based investigations, students explore how powers behave as exponents increase or decrease. By extending and comparing numerical sequences such as 3^3 , 3^2 , 3^1 , and 3^0 , students communicate [C] and justify [R] why any power with an exponent of zero is equal to one, provided the base is non zero. This generalization emerges naturally from observing consistent multiplicative patterns and reasoning about how the structure of repeated multiplication must be preserved.

Students also investigate the role of parentheses in powers by analyzing expressions such as $(-2)^4$ and -2^4 . Using visual or symbolic representations, they explain how grouping affects meaning and outcome, deepening their understanding of mathematical conventions and the order of operations. These explorations emphasize precision in exponential notation and reasoning [R] about structure rather than the memorization of rules.

Throughout this learning, students engage in problem solving tasks [PS] that connect powers to broader mathematical concepts, such as exponential growth, algebraic expressions, and financial contexts including compound interest. They make connections [CN] across representations and contexts, strengthening their conceptual understanding of powers as a meaningful mathematical structure.

STRAND A: NUMBER

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

[C]	Communication
[ME]	Mental Math and Estimation
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[T]	Technology
[V]	Visualization

MAT.9.1.A.2.

Demonstrate how prime factorization supports reasoning of number properties by

- expressing natural numbers using prime factorization with exponents
- determining the greatest common factor (GCF) and least common multiple (LCM) of two or more numbers using prime factorization
- applying prime factorization to determine divisibility of numbers.

[C, CN, ME, PS, R, V]

MANIFESTATION OF LEARNING

Students explore prime factorization as a way to reveal the underlying structure and properties of natural numbers. By expressing numbers using prime factorization with exponents, students reason [R] about how numbers are composed. They use tools such as factor trees and symbolic notation to visualize [V] and communicate [C] this structure. For example, a number such as 60 may be expressed as $2^2 \times 3 \times 5$, allowing students to see how prime factors and their exponents describe the number's composition and support mental math strategies [ME].

Students build on their understanding of number structure by using prime factorization as a reasoning tool to examine relationships among numbers. They compare prime factorizations, identify shared and distinct factors, and explain how these patterns support determining the greatest common factor (GCF) and least common multiple (LCM) of two or more numbers. Students justify their understanding by reasoning about common prime factors and the role of exponents, making connections [CN] between number structure and number relationships so that procedures are grounded in an understanding of the underlying concepts.

Students also use prime factorization to deepen their understanding of divisibility and to make connections [C] among factors, multiples, and number structure. They analyze how the presence or absence of specific prime factors determines whether one number is divisible by another. For example, students explore how the prime factorization of 84 can be used to determine whether it is divisible by 6 or 12, explaining what the inclusion or omission of prime factors reveals about divisibility. Through problem solving tasks [PS], students communicate [C] and justify [R] their reasoning using symbolic representations and mathematical language.

Throughout this learning, students communicate [C] their thinking using symbolic notation, explanations, and visual models, making connections [CN] between prime factorization and broader mathematical ideas such as number properties, operations, and algebraic reasoning. These experiences lead students to view prime factorization as a powerful tool for understanding the structure of numbers, making sense of the procedures they use, and supporting mathematical reasoning.

STRAND A: NUMBER

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

[C]	Communication
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MAT.9.1.A.3.

Demonstrate an understanding of operations on powers with integral bases (excluding base 0) and whole-number exponents by determining and applying the laws of exponents to simplify and evaluate expressions:

- $a^m \cdot a^n = a^{m+n}$
- $\frac{a^m}{a^n} = a^{m-n}, m \geq n$
- $(a^m)^n = a^{mn}$
- $(ab)^m = a^m \cdot b^m$
- $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$
- $a^0 = 1$

where a and b are non-zero integers and m and n are whole numbers.

[C, CN, ME, PS, R]

MANIFESTATION OF LEARNING

Students explore how the laws of exponents emerge from the structure of repeated multiplication. They expand and compare expressions such as $2^3 \cdot 2^4$, $(3 \cdot 2)^3$ and $(2 \cdot 3)^4$, and reason [R] about how powers with the same base can be expressed as products of identical factors. Through these explorations, students recognize that regrouping factors preserves the value of an expression, allowing them to generalize patterns that explain how exponents behave when expressions are multiplied, divided, or raised to a power.

Students build on this structural reasoning to examine how consistent patterns across repeated multiplication, lead to generalized exponent laws. Students communicate [C] and justify [R] why operations such as multiplying powers with the same base result in adding exponents, or why a power of a power, results in multiplying exponents, understanding these relationships as natural extensions of repeated multiplication making connections [CN] to their prior knowledge of operations.

Students apply this reasoning to simplify and evaluate exponential expressions, integrating it into their mental math strategies [ME] to anticipate and compare results. For example, students may reason whether $5^3 \cdot 5^2$ is greater than 5^4 , by analyzing the structure of each expression before calculating its value. Through problem solving tasks [PS], students use exponent laws to rewrite expressions in equivalent forms and explain how different representations can describe the same value.

Throughout this learning, students make connections [CN] between exponent laws and broader mathematical concepts, such as the distributive property and the order of operations. These connections enable students to develop a conceptual understanding of powers as coherent relationships, grounded in the structure of numbers and applied to support mathematical reasoning.

STRAND A: NUMBER

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

[C]	Communication
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[V]	Visualization

MAT.9.1.A.4.

Explain and apply the order of operations on integers, including exponents (limited to whole numbers), with and without technology. [ME, PS, R, T]

MANIFESTATION OF LEARNING

Students reason about the structure of numerical expressions involving integers, including whole number exponents, in order to explain and apply the order of operations. They analyze expressions by identifying the roles of exponents, multiplication, division, addition, and subtraction, and reason [R] about how these operations work together to determine meaning and value. By focusing on integer-based expressions, students focus on structure and conventions independent of the added complexity of rational numbers.

Students use mental math strategies [ME] to recognize how each component of an expression influences its value. They verify intermediate results, considering the order of operations, and explain how each operation affects the value of the expression. Through discussion and reasoning, students demonstrate that understanding the order of operations supports efficiency, accuracy, and flexibility in computation rather than a reliance on acronyms without an understanding of the underlying mathematical reasoning. Students use technology [T] to explore how the order of operations is handled by digital tools and to understand how and when to use technology appropriately.

Students engage in problem solving tasks [PS] that require them to analyze and compare expressions whose values depend on structure rather than appearance. They reason about how features such as exponents, parentheses, and the interaction of operations can change results, even when the same numbers are used. These tasks deepen students' understanding of mathematical conventions and reinforce the idea that expressions must be viewed as structured objects, not sequences of independent calculations.

Throughout this learning, students build confidence in applying the order of operations consistently and accurately, using reasoning [R] and estimation [ME] to validate their results and solve problems [PS]. Through these experiences, students strengthen their understanding of the order of operations as a mathematical convention that ensures the accuracy and consistency of results.

STRAND A: **NUMBER**

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

MAT.9.1.A.5.

Demonstrate an understanding of rational numbers by comparing and ordering rational numbers.

[C, CN, ME, R, V]

MANIFESTATION OF LEARNING

Students reason [R] about the relative magnitude of rational numbers by using benchmarks such as -1 , $-\frac{1}{2}$, 0 , $\frac{1}{2}$ and 1 to support comparison and ordering. Building on prior learning, students extend their understanding to include negative rational numbers and examine how values are ordered based on their position relative to these benchmarks. Students reason that opposite rational numbers have equal magnitude and are located the same distance from zero on the number line, but in opposite directions.

Students rely on visual representations [V], particularly horizontal and vertical number lines, to develop and justify their reasoning about rational numbers. Through these representations, students identify rational numbers between two given values and communicate [C] how their position on the number line supports comparison and ordering.

Students apply mental math strategies [ME] to compare and order rational numbers with flexibility and accuracy. They consider distance from zero, the effect of negative signs, and proximity to benchmarks when reasoning about magnitude. Students communicate [C] their thinking using mathematical language and representations, justifying comparisons by referring to magnitude and position rather than relying solely on computation.

Throughout this learning, students make connections [CN] among different representations of rational numbers and number sense. By focusing on relative magnitude and symmetry about zero, students develop an understanding of rational numbers and flexibility in their reasoning when comparing and ordering them.

STRAND A: NUMBER

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

MAT.9.1.A.6.

Demonstrate an understanding of operations on rational numbers.

[C, CN, PS, R, V]

MANIFESTATION OF LEARNING

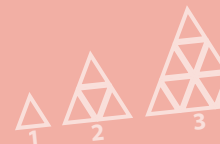
Students extend their understanding of operations to include all rational numbers by reasoning about the meaning of each operation, particularly when positive and negative values are involved. For example, they compare expressions such as $\frac{3}{4} + \left(-\frac{1}{2}\right)$, $\frac{3}{4} - \left(-\frac{1}{2}\right)$ and $\frac{3}{4} - \frac{1}{2}$ to explain how operations and signs influence the resulting value. Building on prior learning, students focus on how operations affect value rather than on procedures alone, and reason [R] about how signs influence results.

Students reason about the role of positive and negative signs across operations, addressing common sources of difficulty through sense making rather than memorization. They examine the meaning of adding a negative and subtracting a positive, explain how subtraction can be represented as adding its opposite, and reason why operations with negative rational numbers result in predictable sign patterns. Through discussion and justification, students deepen their understanding and communicate [C] their reasoning about the effect of positive and negative values in operations.

Students use visual representations [V] to interpret and justify the results of operations with rational numbers. These representations help students explain how operations change position, direction, or magnitude, particularly when reasoning about negative values. Through problem solving tasks [PS], students solve contextualized situations using operations with rational numbers, apply their reasoning to compare strategies and to assess the reasonableness of their results.

Throughout this learning, students make connections [CN] between operations on rational numbers and broader mathematical ideas related to number sense and structure. They communicate [C] their reasoning using mathematical language, representations, and explanations, developing confidence and flexibility when operating with rational numbers. These experiences support students in viewing operations as meaningful tools for reasoning, rather than isolated procedures, across both mathematical and contextualized situations.

STRAND B: PATTERNS AND RELATIONS



Patterns: Recognizing and representing patterns helps us understand the world, formulate generalizations, and solve problems.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.B.1.

Generalize a pattern arising from a problem-solving context using linear equations, and verify by substitution.

[C, CN, PS, R, V]

MANIFESTATION OF LEARNING

Students, through the use of manipulatives and visual models [V], deepen their understanding of linear patterns that arise from pictorial, oral, and written problem solving contexts. They analyze patterns by representing them first visually and then using tables of values and algebraic expressions. Students then identify the quantities that vary together and describe the relationship between them [C]. By examining how each term in a pattern changes in relation to the previous term, students formulate an algebraic expression that represents its structure. They reason [R] about the relationships observed within the pattern in order to represent them using a linear equation.

Students extend their representations by constructing and interpreting tables of values, looking for patterns that reveal constant rates of change. Through these investigations, they formulate linear equations [C] that model the relationship between variables and justify their equations by referring to the structure of the pattern. Students verify their equations by substituting values from a table or the original pattern, explaining [CN] how these substitutions confirm the correctness of the linear equation.

Students also engage in problem solving [PS] by creating their own meaningful contexts for a given linear equation, such as designing scenarios involving cost, perimeter, or consistent growth, and demonstrating how the equation represents their chosen situation. These experiences help them make connections [CN] between patterns and linear equations.

Throughout these learning experiences, students communicate [C] their thinking through algebraic equations, verbal explanations, and visual representations [V], demonstrating and understanding [CN] of how linear equations can be used to generalize and verify patterns arising from authentic mathematical contexts.

STRAND B: PATTERNS AND RELATIONS

Patterns: Recognizing and representing patterns helps us understand the world, make generalizations, and solve problems.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.B.2.

Graph linear relations ($y = mx + b$) and analyse the graph, by

- understanding slope as the rate of change and its relation to the coefficient m
- recognizing the y -intercept as the value of y when $x = 0$ and its relation to the constant b
- identifying the pattern in the graph that demonstrates the relationship between the independent and dependent variables
- using patterns to make predictions through interpolation and extrapolation.

[C, CN, ME, PS, R, T, V]

MANIFESTATION OF LEARNING

Students model linear relations of the form $y = mx + b$ by constructing and analyzing tables of values and graphs that represent them. They analyze the role of slope (m) as a rate of change by examining the vertical change associated with horizontal change, and reason [R] about what a positive, negative, zero, or undefined slope means in a given context. Students relate slope to the coefficient m in the linear equation and perform calculations to determine additional points on the line [ME]. They also examine the y intercept (b) as the value of y when $x = 0$, identifying it in a table of values and visually on the graph, and connecting it to the constant b in the linear equation. These explorations help students match contextual situations to linear relations and graphs, clearly recognizing how slope and y -intercept describe features of real scenarios.

Students describe patterns found in graphs and table of values [C], noticing that while equal horizontal intervals produce equal vertical changes, different horizontal intervals produce proportional vertical changes [V]. As they plot points and draw lines, students make connections [CN] between the table of values and the resulting graph, strengthening their understanding of how numerical patterns translate into visual patterns.

Students graph linear relations [PS] from tables of values, equations, or contextual information, and extend their graphs (extrapolate) to determine unknown values. They use interpolation to estimate values between known points, justifying their reasoning [R] based on the structure of the line and the constant rate of change. Students engage with problem-solving tasks that require them to use graphs of linear relations to make predictions, extend patterns, or verify solutions, strengthening their ability to analyze the relationship between independent (x) and dependent (y) variables.

Students use technology [T] to facilitate the visualization [V] and exploration of linear relations. Students may use digital graphing tools or spreadsheets to explore changes to the slope and y intercept dynamically or compare multiple linear relations on the same set of axes [V].

Throughout their learning, students communicate [C] their thinking using a variety of representations and make connections [L] among tables of values, linear equations, graphs, and real world contexts, demonstrating an understanding of relationships between two variables.

STRAND B: PATTERNS AND RELATIONS

Variables and equations: Symbols, expressions, and equations are used to represent patterns and describe relationships between quantities.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.B.3.

Model and solve problems using linear equations of the form

- $ax = b$
- $\frac{x}{a} = b, a \neq 0$
- $ax + b = c$
- $a(x + b) = c$

where a , b , and c are rational numbers.
[C, CN, ME, PS, V]

MANIFESTATION OF LEARNING

Students, through the use of concrete and pictorial representations [V], explore linear equations by using models to represent and understand each step of the solving process. Building on prior experiences with integer coefficients, then extend and refine their strategies to include equations with rational-number coefficients. They use equality models, algebra tiles as well as visual and symbolic representations, to represent equations and illustrate how maintaining equality guides the solving process by making connections among the different representations. By manipulating these models, students communicate [C] their thinking, describing how the steps in the problem-solving process lead to isolating the unknown value.

Students solve linear equations symbolically by applying the principle of the preservation of equality, estimating the plausibility of the expected result [ME] before confirming it through algebraic steps. They verify their solution by substituting their answer into the original equation. When the answer does not satisfy the original equation, students identify the error, determine where the process failed to preserve equality, and make the necessary corrections to obtain a valid solution.

Students represent problems using linear equations [PS], creating or interpreting contexts that naturally lead to equations with rational coefficients. They solve problems using these equations and show the steps they followed to reach their solution.

Throughout these learning experiences, students communicate [C] their understanding using explanations, visual models, and symbolic notation. They make connections [CN] among concrete, visual, and symbolic representations as well as contextualized situations, demonstrating a growing ability to model and solve linear equations with flexibility and precision.

STRAND B: PATTERNS AND RELATIONS

Variables and equations: Symbols, expressions, and equations are used to represent patterns and describe relationships between quantities.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.B.4.

Demonstrate an understanding of polynomials (limited to polynomials of degree less than or equal to 2).
[C, CN, R, V]

MANIFESTATION OF LEARNING

Students use concrete and pictorial representations [V], such as algebra tiles or rectangular array models to model polynomial expressions of degree one and two. They describe how each part of the model corresponds to components of the algebraic expression, communicating [C] how variables, coefficients, exponents, and constant terms are represented.

Students identify and describe the structural elements of simplified polynomial expressions, including the number of terms, the coefficients associated with each variable, and the role of the exponents. They reason [R] how array models can be used to represent certain polynomial expressions. Students make connections [C] between visual [V] and symbolic representations by writing expressions that correspond to given models.

Through these learning experiences, students come to view polynomials as a mathematical language, interpreting how terms, coefficients, and exponents communicate information about quantities and relationships. They communicate [C] their reasoning and make connections [CN] between concrete, pictorial, and symbolic forms, developing a clear understanding of polynomial structure up to degree two.

STRAND B: PATTERNS AND RELATIONS

Variables and equations: Symbols, expressions, and equations are used to represent patterns and describe relationships between quantities.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.B.5.

Model, record, and explain the operations of addition and subtraction of polynomial expressions, concretely, pictorially, and symbolically (limited to polynomials of degree less than or equal to 2).
[C, CN, ME, PS, R, V]

MANIFESTATION OF LEARNING

Students use concrete and visual representations [V], such as algebra tiles and array models, to demonstrate the addition and subtraction of polynomial expressions of degree one and two. By combining or removing tiles, including forming and removing zero pairs, to model the addition or subtraction of like terms, they communicate [C] how the visual representation corresponds to the symbolic expression.

Students represent their work symbolically as they determine the results of combining like terms [ME]. They engage in problem-solving [PS] by comparing different strategies for simplifying polynomial expressions, determining which are most efficient or appropriate in a given situation, and explaining [C] how these strategies adhere to mathematical conventions. Students reason [R] about the structure of the expressions and make connections [CN] among pictorial and symbolic representations to show why their simplifications are valid.

Throughout this learning, students identify errors in simplification by comparing symbolic or visual steps and use visualization [V] to verify equivalence between models and expressions. They communicate [C] their thinking and develop connections [CN] across representations as they model, record, and explain the addition and subtraction of polynomial expressions up to degree two.

STRAND B: PATTERNS AND RELATIONS

Variables and equations: Symbols, expressions, and equations are used to represent patterns and describe relationships between quantities.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.B.6.

Model and solve problems using linear equations of the form:

- $ax = b + cx$
- $ax + b = cx + d$
- $a(x + b) = cx + d$
- $a(bx + c) = d(ex + f)$
- $\frac{a}{x} = b, x \neq 0$

where a, b, c, d, e and f are integers.

[C, CN, ME, PS, V]

MANIFESTATION OF LEARNING

Students use concrete and pictorial representations [V], such as equality models or algebra tiles to model linear equations and the preservation of equality as they work toward isolating the variable. They show how operations performed on one side of the equation must be mirrored on the other and record the steps symbolically. As they work, students communicate [C] how each representation corresponds to the equation and how their actions preserve equality.

Students engage in problem solving [PS] by representing situations using linear equations and then developing and applying strategies to determine and interpret unknown values. They compare different approaches, such as using inverse operations, applying the distributive property, or combining like terms, and explain [C] why a chosen strategy is appropriate for a particular equation. Students verify their solution by substituting their answer into the original equation. They estimate the value and anticipate the sign of their answer [ME]. When their answer does not satisfy the original equation, they identify the error, determine where the process failed to preserve equality, and make the necessary corrections to obtain the correct solution.

Throughout these learning experiences, students communicate [C] their understanding using explanations, visual models, and symbolic notation. They make connections [C] between concrete, visual, and symbolic representations to deepen their understanding of linear equations and the strategies used to solve them.



STRAND C: SHAPE AND SPACE

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Measurement: Measurement is a useful process for comparing the dimensions of certain attributes of two-dimensional shapes and three-dimensional objects, whether through direct or indirect methods, in order to solve problems in real-world contexts.

MAT.9.1.C.1.

Solve problems and justify the solution strategy using circle properties, including

- the perpendicular from the centre of a circle to a chord bisects the chord
- the measure of the central angle is equal to twice the measure of the inscribed angle subtended by the same arc
- the inscribed angles subtended by the same arc are congruent
- a tangent to a circle is perpendicular to the radius at the point of tangency.

[C, CN, PS, R, T, V]

MANIFESTATION OF LEARNING

Students develop an understanding of geometry of circles by representing and analyzing their properties using accurate diagrams, constructions, and visual models [V]. When appropriate, students use technology [T], including dynamic geometry software, to trace circles, manipulate points, and test conjectures, observing that angle relationships remain constant despite changes to the diagram.

Students observe and analyze a variety of geometric situations to understand and apply the geometric relationships of circles. They analyze [R] the relationships among certain lines and angles, identify patterns, and progressively make connections [CN] among the centre, chords, radii, tangents, and arcs in order to understand and justify the properties of circles.

Students apply these circle properties in problem solving contexts [PS], such as determining unknown angle measures, explaining the relationship between a tangent line and the radius of a circle, or explaining why inscribed angles subtended by the same arc are congruent [C]. More specifically, students determine the measure of an inscribed angle subtended by a diameter by recognizing that it forms a right angle and by validating this reasoning using relationships between central and inscribed angles. They reason [R] about which properties are relevant in a given situation and explain why a chosen strategy leads to a valid solution. In doing so, they make connections [CN] between circle properties and previously learned concepts such as perpendicular lines, congruence, symmetry, and angle relationships.

Throughout these learning experiences, students communicate [C] their solution strategies using labelled diagrams, geometric notation, and precise mathematical language, and justify each step of their reasoning. By relying on fundamental circle properties, students develop a coherent understanding of circle geometry grounded in visual reasoning, logical justification, and interconnected geometric relationships. This understanding provides a foundation for future learning in mathematics and in applied fields such as physics, engineering, architecture, and technology, where geometric reasoning and justification are essential.

STRAND C: **SHAPE AND SPACE**

Three-dimensional objects and two-dimensional shapes: Two-dimensional shapes and three-dimensional objects can be described, classified, and analyzed based on their attributes and the relationships between them.

No learning outcomes for this substrand.

Transformations: Two-dimensional shapes can be moved within a coordinate plane using transformations. Their positions and movements can be described and modeled using coordinates, geometric representations, and transformations.

No learning outcomes for this substrand.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

STRAND D: **STATISTICS AND PROBABILITY**

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Data analysis: Data can be collected, organized, represented, and interpreted to model situations, support decision-making, and solve problems.

MAT.9.1.D.1.

Identify and analyze potential sources of bias in data collection and presentation, including

- the use of language
- ethics
- financial constraints
- time and timing
- confidentiality concerns
- cultural sensitivity
- visual representation

and explain how these factors can affect the reliability and validity of the data.

[C, CN, R, T, V]

MANIFESTATION OF LEARNING

Students develop an understanding of potential sources of bias in data collection and presentation by analyzing data sets, summaries, and representations using clear language, contextual information, and visual or digital formats [C, V, T]. Through learning experiences, students examine how factors such as the use of language, ethical considerations, financial constraints, time and timing, confidentiality concerns, and cultural sensitivity can influence how data are collected, interpreted, and presented [V]. They reason [R] about how these factors may influence results and begin to recognize that data are not always neutral or free from bias.

Students analyze [R] case studies of data collection and presentation to identify potential sources of bias and explain how these may affect the reliability and validity of the data. They examine how wording, question design, sampling choices, access to participants, time constraints, or privacy considerations can influence who is represented in the data and how results are interpreted. In doing so, students make connections [CN] between data, context, and purpose, recognizing that decisions made during data collection and presentation can lead to incomplete, incorrect, or misleading conclusions.

Throughout these learning experiences, students communicate [C] their thinking through written explanations, discussions, and annotated data representations. By making explicit connections [CN] between data, context, and potential bias, and by reasoning critically [R] about the factors that influence data quality, students develop a more informed and reflective approach to working with data. This understanding supports future learning in statistics and data analysis and is essential for interpreting real-world information found in areas such as media reports, surveys, financial data, and social studies, where recognizing bias is critical for making informed and responsible decisions.

STRAND D: STATISTICS AND PROBABILITY

Data analysis: Data can be collected, organized, represented, and interpreted to model situations, support decision-making, and solve problems.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.D.2.

Select and defend the choice of using either a population or a sample of a population to answer a question.

[C, CN, PS, R]

MANIFESTATION OF LEARNING

Students explore situations that require selecting either a population or a sample to answer a given question, and they justify their choice by considering the purpose of the investigation, the nature of the data needed, and the practical constraints. In problem-solving contexts [PS], students examine real-world, hypothetical, or media-based data collection situations, such as school or community surveys, to determine whether it is more appropriate to collect data from an entire population or from a sample.

Students reason [R] about their selection by weighing multiple factors, including potential sources of bias. Rather than treating these factors in isolation, students consider how they interact to influence the quality and usefulness of the data. They explain [C] how biased situations, poorly chosen language, or ethical constraints can affect who is represented, how accurately the question is answered, and level of confidence in the conclusions drawn.

Students compare [R] populations and samples, recognizing that a population can provide more complete information, but that studying an entire population is not always practical. They analyze case studies of data collection and identify potential problems, then use this analysis to support informed judgments about which approach is most appropriate for answering a given question.

Throughout these learning experiences, students make connections [CN] between the context of the question, the method of data collection, and the reliability of the conclusions that can be drawn. They demonstrate an increasing ability to evaluate data collection situations thoughtfully and to defend their choices using reasoned arguments grounded in both context and statistical sense.

STRAND D: STATISTICS AND PROBABILITY

Probability and uncertainty: Probability involves determining the likelihood that an event will occur by drawing on previous experiences or analyzing possible outcomes to solve problems.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.D.3.

Demonstrate an understanding of the role of probability in society.
[C, CN, R, T]

MANIFESTATION OF LEARNING

Students explore the role of probability in society by examining how it is used to describe chance, uncertainty, and risk in a variety of everyday contexts. Through examples drawn from print and electronic media [T], students identify situations where probability is used to inform, explain, or justify decisions and claims. They describe how probability expresses the likelihood that an event will occur and supports decision-making in real-world situations.

Students reason [R] about probability by discussing the assumptions behind a probability statement, such as the data used or how the data was collected. They recognize that probabilities may be based on ideal situations, past results, or estimates, which can influence how they are interpreted. Students explain [C] how the same probability can be used to support different conclusions depending on the context.

Using examples, students explain how decisions based on probability often involve a combination of theoretical probability, experimental probability, and subjective judgment. They describe situations in which precise theoretical calculations are possible, situations where probabilities are estimated from collected data, and situations where personal or societal judgment plays a role in determining the likelihood.

Throughout these learning experiences, students communicate [C] their understanding using mathematical language, written explanations, and discussions. They make connections [CN] between probability, real-world applications, and the ways probabilistic information is presented in society. By examining multiple examples and contexts, students develop an appreciation for how probability is used to describe uncertainty and to support decisions in everyday life.



[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Revenue: Understanding different types of income and how effective money management supports the development of essential skills for making informed financial decisions in everyday life.

MAT.9.1.E.1.

Demonstrate an understanding of the different ways income is earned, how gross and net earnings are determined from wages and salaries, and by examining the societal role of deductions such as taxes, Canadian Pension Plan (CPP), and Employment Insurance (EI).
[C, CN, PS, R, T]

MANIFESTATION OF LEARNING

Students explore real-life scenarios to understand how income is earned through hourly wages, salaries, and commission-based pay. For example, they examine a part-time job paid by the hour, a monthly salary, and a commission on sales. Using technology [T], students model these situations and estimate earnings, verifying the reasonableness of their results through mental math strategies [ME].

Students analyze simplified pay stubs to become familiar with deductions such as income tax, CPP, and EI. They communicate [C] the difference between gross pay and net pay identifying deductions. They make connections [CN] to public services funded by these deductions (e.g., healthcare, education, infrastructure) and reflect on why these contributions are essential for society.

During discussions [C], students engage with the concept of marginal tax rates, enabling them to understand that, as income increases, tax rates increase according to defined tax brackets. This enables students to make connections [CN] and reason [R] about why deductions vary and how they relate to fairness and social responsibility.

Through problem-solving tasks [PS], students notice how different earning methods influence income before and after deductions. For instance, “If an employee earns \$18/hour for 15 hours and another earns a \$500 salary plus 5% commission on \$1200 sales, who has the higher gross income?” Students estimate [ME] which scenario results in a higher earned income and use technology [T] to support their calculations.

Throughout this learning, students connect their understanding to broader financial literacy concepts such as budgeting with net income, planning for future expenses, and understanding fairness in taxation. They also make connections [CN] to mathematical concepts, including percentages, proportional reasoning, and algebraic modelling and recognizing how these skills support informed decision-making in real-world contexts.

STRAND E: FINANCIAL LITERACY

Spending and Borrowing: Understanding that spending decisions are based on income, that borrowing involves obligations and risks, and that responsible management enables individuals to make informed financial decisions.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.E.2

Demonstrate an understanding of how personal needs, wants, expectations, and experiences, affect spending decisions, with attention to both individual habits and other factors that tend to impact consumer behaviour and decisions, including

- peer pressure
- social media
- advertising
- cultural influence
- digital and non-digital purchasing models

[C, CN, PS, R, V]

MANIFESTATION OF LEARNING

Students explore how personal needs, wants, expectations, and experiences shape spending decisions by analyzing examples and engaging in reasoning [R] that reveals how internal motivations and external influences interact. Using visual representations [V], such as needs and wants over time and cost comparison charts, students identify how factors like perceived peer pressure, social media trends, advertising bias, cultural norms, and digital purchasing models including subscription services and food delivery apps affect consumer choices.

Through problem-solving tasks [PS], students compare spending situations that highlight how geographical proximity, economic conditions such as inflation, and financial stability or fragility influence decision-making. For example, they might examine how delivery fees or tipping culture change the true cost of a purchase, or how small weekly expenses accumulate over time and could amount to the same overall spending as a substantial planned purchase. Students share [C] their thoughts and justify their reasoning [R] as they evaluate how growing responsibilities affect what they consider essential, and how choosing to spend money on one item can limit what they can afford later.

Students make connections [CN] to broader financial ideas by examining how current decisions influence long-term financial well-being, how cultural or social expectations have shaped consumer behaviour in the past and continue to do so in the present, and how personal experiences such as managing money for the first time can change perceptions of value, quality, and affordability.

Throughout this learning, students integrate their understanding of internal and external influences on spending behaviour with broader ideas in financial literacy, recognizing how informed choices support [CN] responsible decisions in real world contexts.

STRAND E: FINANCIAL LITERACY

Spending and Borrowing: Understanding that spending decisions are based on income, that borrowing involves obligations and risks, and that responsible management enables individuals to make informed financial decisions.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.E.3

Demonstrate an understanding of various payment methods, including cash, debit, and credit, and how ease of access to credit can impact spending habits and financial decision-making.

[C, CN, ME, PS, R]

MANIFESTATION OF LEARNING

Students explore how different payment methods, including cash, gift cards, bank cards (debit and credit), and mobile phones, influence spending habits and financial decision-making by examining how each method shapes perceptions of cost, self-regulation, and consumer behaviour. They reason [R] to distinguish between needs and wants and to analyze how easy access to funds can contribute to impulsive spending. Paying with credit cards, prepaid cards, mobile phones, or “buy now, pay later” options does not have the same effect as the tangible experience of handling cash or immediately seeing an account balance decrease when making a debit purchase. Students identify the advantages and disadvantages of each payment method, including electronic transfers, certified cheques, subscription services, and online purchases. The latter may involve hidden costs such as shipping fees, service charges, or international transaction fees.

Through problem-solving [PS], students examine scenarios showing how ease of access to credit can lead to overspending, how cash transactions can promote more deliberate decision-making, and how debit reinforces the reality of available funds. They communicate [C] their interpretations by explaining how each method affects behaviour, such as how credit can delay the emotional impact of spending, how cash can reduce impulsive purchases, and how debit supports budgeting through immediate account updates.

Students make connections [CN] to broader financial ideas by considering how recurring charges within subscriptions influence long-term budgeting and how features built into digital purchasing systems shape spending patterns. They approximate [ME] the overall cost of purchases and recognize when additional fees may raise the final price.

Throughout this learning, students develop an understanding of how different purchasing methods influence personal spending patterns and connect [CN] these ideas to responsible financial decision-making in everyday situations.

STRAND E: FINANCIAL LITERACY

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Saving and Investing: Personal financial management involves making informed decisions about saving and investing to prepare for the future, manage unexpected events, and achieve personal goals.

MAT.9.1.E.4

Demonstrate an understanding of different financial service providers including

- traditional bank
- online bank
- credit union
- fintech app

to determine the products and services they offer while recognizing their differences and their role in managing personal finances.

[C, CN, R, T, V]

MANIFESTATION OF LEARNING

Students explore the role of different financial service providers, including traditional banks, online banks, credit unions, and fintech apps, by examining the specific products, services, protections, and digital tools each institution offers. Using visual representations [V] such as comparison charts and diagrams showing product features, students organize information about chequing and savings accounts, access to automated teller machines (ATMs), electronic transfer capabilities, investment products, financial management tools, customer service structures, and the features of digital platforms.

Students analyze [R] how different institutions vary in fees, accessibility, and the types of protections they offer to help safeguard personal funds, recognizing that these features support individuals in selecting an institution that aligns with their needs. They also consider general factors such as ATM access and associated fees between institutions, as well as common security measures used to protect account access.

Students communicate [C] their perceptions by explaining how these structural features influence a person's ability to manage money effectively. Using technology [T], students explore digital interfaces provided by different institutions and identify how these tools support informed financial decision-making.

Throughout this learning, students develop an understanding of how financial institutions differ in structure and services and connect [CN] these insights to responsible management of personal finances using secure, reliable, and appropriate financial tools, noting that linking their personal financial needs with the services and protections offered across institutions helps individuals choose financial tools that fit their personal circumstances.

STRAND E: FINANCIAL LITERACY

Saving and Investing: Personal financial management involves making informed decisions about saving and investing to prepare for the future, manage unexpected events, and achieve personal goals.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.1.E.5

Develop a budget that considers personal experiences and cultural influences on saving habits, while supporting short-term and long-term financial goals, including planning for unexpected expenses.

[C, CN, ME, PS, R, T, V]

MANIFESTATION OF LEARNING

Students develop a budget by creating an organized plan that reflects how personal experiences and cultural influences shape saving habits and financial choices, using visual representations [V] such as tables, planning templates, or digital charts to organize income, essential and discretionary expenses, and saving intentions.

Students explore and reflect [R] on how a budget serves as a financial management tool for managing predictable expenses, costs that vary over time, unexpected expenses, and personal decisions such as charitable giving. They use estimation [ME] to determine the amounts needed in each category. They use a variety of budgeting tools to build their budget, drawing on prior mathematical knowledge [CN] of percentages, ratios, and circular graphs to represent how money is allocated across different categories.

Through problem-solving [PS], students revise their budget as circumstances change, adjusting amounts to ensure their plan still supports both short-term and long-term financial goals, such as preparing for an upcoming activity while also setting aside funds for future needs. They communicate [C] their thinking by explaining how the structure of their budget aligns with their needs, values, and responsibilities, and how subtle cultural influences or personal experiences shape their saving and spending patterns. Students explore digital budgeting features [T] that help track expenses, visualize spending, and plan for future adjustments.

As students progress through this learning, they make connections [C] between their understanding of budgeting and responsible money management by linking their financial goals to organizational habits that account for both anticipated and unexpected expenses, while developing confidence in managing their personal finances.

Throughout this learning, students develop an understanding of how the value of investments changes over time, the effects of simple and compound interest on growth, and how the use of tables, graphs, and technological tools supports informed financial decision-making.

COURSE II (3014)

LEARNING OUTCOMES AND MANIFESTATIONS



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5 6 7 8 9
+ - x ÷ =



STRAND A: **NUMBER**

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

MAT.9.2.A.1.

Determine the square root of positive rational numbers that are perfect squares.

[C, CN, ME, PS, R, V]

MANIFESTATION OF LEARNING

Students develop an understanding of square roots by identifying positive rational numbers that are perfect squares and determining their exact square roots. They reason [R] about what it means for a number to be a square number by considering whether it can represent the area of a square with a rational side length. Through explanation and discussion, students recognize that only rational numbers that are perfect squares have exact rational square.

Students determine square roots by reasoning [R] about the inverse relationship between squaring and taking the square root. Building on prior learning, they realize that finding a square root involves identifying a value that, when squared, produces the given number. This inverse relationship is used to justify results and to verify calculations [ME].

Students use representations [V], such as area models, number lines, and expressions, to justify and explain their reasoning about square roots. These representations support students in making sense of results, including cases where values are less than 1, and in identifying and explaining errors in square root calculations. Students communicate [C] how the structure of each representation supports their conclusions.

Throughout this learning, students use problem solving [PS] to make connections [CN] between square roots, square numbers, and number structure. They develop an understanding that, while a positive rational number can have both a positive and a negative solution when solving an equation of the form $x^2 = a$, the square root symbol represents the principal (positive) square root. These experiences support students in viewing square roots as exact values grounded in reasoning and structure.

STRAND A: **NUMBER**

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.A.2.

Determine an approximate square root of positive rational numbers that are non-perfect squares.

[C, CN, ME, PS, R, T, V]

MANIFESTATION OF LEARNING

Students deepen their understanding of square roots by reasoning about positive rational numbers that are not perfect squares. They recognize that, unlike perfect squares, these values do not have square roots that can be expressed exactly, which necessitates approximation. Students reason [R] about why approximation is required and build on their understanding of square roots as inverse operations of squaring to make sense of non perfect square values.

Students estimate square roots by identifying the two nearest known perfect squares as benchmarks to establish a range for the value. They then determine an approximate value based on its location between those benchmarks. Using mental math and estimation strategies [ME], students explain how a number's proximity to each benchmark influences the location of its square root, thereby strengthening their reasoning [R] about numerical magnitude.

Students use visual representations [V], such as number lines and area models, to represent and communicate their reasoning. They use these representations to illustrate the approximate location of a square root and to make connections between the area of a square and the length of its side. By communicating [C] their thinking, students compare different estimation strategies and apply them in problem-solving [PS] contexts.

Throughout this learning, students use technology [T] as a tool to refine and confirm estimates that were first developed through reasoning and representation. They compare outputs with their prior estimates and evaluate their precision on why results are approximations rather than exact values. Through these learning experiences, students make connections [CN] between square roots, powers, estimation, and number structure, thus reinforcing their understanding of these relations.

STRAND A: NUMBER

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

MAT.9.2.A.3.

Demonstrate an understanding of powers with bases that are natural numbers and exponents that are integers, by:

- using patterns to show why $a^{-n} = \frac{1}{a^n}$
- evaluating expressions of the form
 - $a^{-n} = \frac{1}{a^n}$
 - $\frac{1}{a^{-n}} = a^n$
- applying the laws of exponents
 - $a^m \cdot a^n = a^{m+n}$
 - $\frac{a^m}{a^n} = a^{m-n}$
 - $(a^m)^n = a^{mn}$
 - $(ab)^m = a^m \cdot b^m$
 - $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$
 - $a^0 = 1$
 - $a^{-n} = \frac{1}{a^n}$
 - $\frac{1}{a^{-n}} = a^n$

where a and b are natural numbers and m and n are integers.

[C, CN, ME, PS, R]

MANIFESTATION OF LEARNING

Students deepen their understanding of exponent laws by extending their work from whole-number exponents to include integer exponents, with a particular focus on negative exponents. They reason [R] and use pattern-based exploration to investigate why the general rule, $a^{-n} = \frac{1}{a^n}$ holds true. Using mental math strategies [ME], students estimate and evaluate expressions such as 3^3 , 3^2 , 3^1 , 3^0 and continue the pattern to reason why the next term is 3^{-1} , and what that implies about its value.

Students evaluate expressions involving negative exponents and apply the full set of exponent laws to simplify and compare expressions. For instance, students may simplify expressions like $3, 3 + (5 \cdot 2)^4$ or $6 - \left(-\frac{2}{3}\right)^2$, and explain the structure and reasoning behind each step. Through problem-solving [PS], students engage with tasks that require them to apply various exponent laws to analyze, simplify and compare expressions.

Students make connections [CN] between exponent laws and the structure of algebraic expressions. They communicate [C] their thinking using symbolic notation, explanations, and pattern-based justifications to show why the laws of exponents remain consistent when extended to negative exponents.

Throughout these learning experiences, students move beyond procedural fluency, developing a conceptual understanding of powers as a flexible and powerful mathematical tool for mathematical reasoning.

STRAND A: NUMBER

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

MAT.9.2.A.4.

Demonstrate an understanding of exponential notation by expressing and interpreting decimal numbers ranging from 0.001 to 1 000 000 using powers of ten, including expanded exponential forms that reflect place value.

[C, CN, R]

MANIFESTATION OF LEARNING

Students develop an understanding of exponential notation by connecting it to the structure of the base ten place value system. They express and interpret decimal numbers between 0.001 and 1 000 000 using powers of ten, reasoning [R] about how each place value corresponds to a power of ten. For example, students may explain why 1 000 000 is represented as 10^6 , and why 0.001 is represented as 10^{-3} , making connections [CN] between place value and exponential form.

Students relate standard numerical representations to powers of ten to further their understanding of magnitude and place value of numbers. For example, students explore expanded exponential forms to represent numbers such as 345 000 as $3 \times 10^5 + 4 \times 10^4 + 5 \times 10^3$ and 6.072 as $6 \times 10^0 + 7 \times 10^{-2} + 2 \times 10^{-3}$. Through these learning experiences, students observe how powers of ten capture both large and small numbers, strengthening their ability to reason about number size using structure rather than computation alone.

Students communicate [C] their reasoning by expressing numbers in equivalent forms that reflect place value relationships. They establish connections [CN] between standard decimal notation and representations involving powers of ten, explaining how each form conveys the same value. This understanding naturally builds on their recent learning about negative exponents, allowing students to represent numbers less than 1 using powers of ten rather than viewing such values as exceptions within the place value system. These connections help students see exponential notation as an extension of familiar place value concepts, rather than as a separate or abstract notation.

Throughout this learning, students make connections [CN] between exponential notation, place value structure, and mathematical concepts related to number representation. They develop an understanding of powers of ten as tools for representing and interpreting numbers across a defined range, laying the groundwork for later work with scientific notation and proportional reasoning.

STRAND A: NUMBER

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Number sense and operations: Different representations of numbers help reveal certain properties and make calculations easier. Regardless of the type of numbers or symbols used, each operation retains the same meaning, operations are interconnected, and there are multiple ways to reach a result, including estimation, some of which may be more useful depending on the situation or the problem to be solved.

MAT.9.2.A.5.

Explain and apply the order of operations on rational numbers, including exponents (limited to whole numbers) with and without technology. [ME, PS, R, T]

MANIFESTATION OF LEARNING

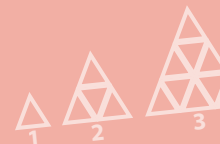
Students deepen their understanding of the order of operations by applying it to expressions involving rational numbers and whole number exponents, extending their prior learning with integers to include rational numbers. They use mental math skills [ME] to evaluate expressions such as $3.3 + (5 \cdot 2)^4$ or $6 - \left(-\frac{2}{3}\right)^2$, by correctly applying the order of operations used and recognizing how exponents and brackets influence the outcome. Students reason [R] through the structure of expressions and reflect on how the placement of parentheses affects the result.

Through problem-solving [PS], students engage with tasks that require them to apply the order of operations in varied formats. For example, students may solve a situation in which they must compare different phone or subscription plans that include fixed fees and variable costs. They represent the situation using numerical expressions and apply the order of operations to determine the most advantageous option. These tasks help students build fluency and confidence in applying the correct order of operations.

Students use technology [T] to explore how order of operations is handled in digital tools, and to understand how and when to use technology appropriately. They reflect on the role of technology in supporting their conceptual understanding of complex expressions, recognizing that while tools can assist with computation, they must enter expressions into a calculator or digital tool in a way that accurately reflects the intended mathematical conventions.

Throughout these learning experiences, students develop an understanding of the importance of structure, precision, and reasoning [R] when evaluating expressions involving rational numbers and exponents. They deepen their understanding of the order of operations as a mathematical convention that allows for correct interpretation of the value of expressions.

STRAND B: PATTERNS AND RELATIONS



[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Patterns: Recognizing and representing patterns helps us understand the world, formulate generalizations, and solve problems.

MAT.9.2.B.1.

Represent and describe exponential patterns and relations using a table of values, graphs, and analyze these relationships to draw conclusions.

[C, CN, R, T, V]

MANIFESTATION OF LEARNING

Students use visual models and concrete situations [V] to explore patterns (geometric progressions) in which each term is obtained by multiplying the previous term by a constant factor. When they represent these patterns using tables of values and simple graphs, they notice [R] that the change is not constant as in a linear relation but instead involves a constant multiplicative factor. They connect [CN] this observation to the general form of an exponential relation $y = a \cdot b^x$, where a represents the initial value and b describes the base of the power, which determines the multiplicative factor between successive terms. Students observe that as x increases, the relationship is increasing when $b > 1$ and decreasing when $0 < b < 1$.

Students represent these exponential patterns in tables of values and with technological tools [T], then describe [C] how the values change as the variable increases, observing that the effect of the constant multiplicative factor becomes more noticeable over time. By comparing [CN] these representations with those of linear relations, they explain that linear relations involve a constant difference, while exponential relations involve a constant factor.

Students use calculations to predict how situations will evolve, such as doubling, tripling, or dividing by two. They reason [R] about questions such as: “At what point does the value of the exponential relation surpass the linear one?” or “How do the differences between the values change over time?”

Throughout this learning experiences, students model situations in which quantities change by a constant multiplicative factor, using tables of values, graphs, and descriptions [C] to represent and explain exponential patterns. Contexts may include population change, repeated sharing, or financial situations such as simple interest (linear) and compound interest (exponential, modeled by $A = P(1 + r)^n$).

STRAND B: PATTERNS AND RELATIONS

Variables and equations: Symbols, expressions, and equations are used to represent patterns and describe relationships between quantities.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.B.2.

Model and solve problems using linear equations of the form

- $ax = b + cx$
- $ax + b = cx + d$
- $a(x + b) = cx + d$
- $a(bx + c) = d(ex + f)$
- $\frac{a}{x} = b, x \neq 0$

where a, b, c, d, e and f are rational numbers.

[C, CN, ME, PS, V]

MANIFESTATION OF LEARNING

Students use concrete and pictorial representations [V], such as equality models or algebra tiles, to model linear equations that are structurally familiar. They then apply their reasoning to equations involving rational coefficients as they work to isolate the variable. Students demonstrate that operations performed on one side of an equation must also be performed on the other side. They use models to illustrate how equality is preserved throughout the equation-solving process.

In problem-solving contexts [PS], students model and solve situations using linear equations with rational coefficients. They compare different strategies, such as using inverse operations, applying the distributive property, or combining like terms, and explain [C] their choice of strategy. Students estimate the result, including the sign of the solution [ME], by drawing on their number sense to judge the reasonableness of the result. They verify their solution by substituting their answer into the original equation. When the solution does not satisfy the original equation, students identify the error, determine where the process failed to preserve equality, and make the necessary corrections to obtain a valid solution.

Students represent situations [PS] using linear equations by creating or interpreting contexts which can be represented by equations involving rational coefficients. Throughout these learning experiences, students communicate [C] their understanding using explanations, visual models, and symbolic notation. They make connections [CN] among concrete, visual, and symbolic representations, as well as to contextualized situations, thereby developing increased flexibility, precision, and confidence in modelling and solving linear equations involving rational coefficients.

STRAND B: PATTERNS AND RELATIONS

Variables and equations: Symbols, expressions, and equations are used to represent patterns and describe relationships between quantities.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.B.3.

Explain, illustrate and apply strategies to solve single variable linear inequalities with rational coefficients within a problem-solving context.
[C, CN, ME, PS, R, V]

MANIFESTATION OF LEARNING

Students develop their understanding of linear inequalities involving rational coefficients by explaining, illustrating, and applying strategies to determine solution sets within problem-solving contexts [PS]. Using graphical and symbolic representations [V], students represent inequalities, including on vertical and horizontal number lines, to interpret solutions as ranges of values rather than single values. They translate contextual problems into linear inequalities using the symbols ($\leq, \geq, <, >$). They create contexts for situations that can be modeled by an inequality represented symbolically or graphically.

Students verify the solution set by substituting multiple values into the inequality and explaining why some values belong to the solution set while others do not [ME]. They develop an understanding of the boundaries of a solution set, recognizing that the inequality symbol indicates whether a boundary value is included or excluded, while the direction of the symbol determines on which side of the boundary the values that satisfy the inequality lie. Students represent the solution set graphically on a number line using open or closed circles and directional arrows to communicate the meaning of the inequality.

Students generalize and apply rules for performing operations on linear inequalities. They reason [R] about why the direction of the inequality symbol changes when both sides are multiplied or divided by a negative rational number. Students anticipate the direction and approximate location of a solution set [ME] before graphing or solving the inequality algebraically. They verify their solution set by first substituting the boundary value to confirm equality, and then substituting a value from their solution set to confirm that the inequality is satisfied. Students compare and explain the processes used to solve linear inequalities and linear equations [CN], identifying the similarities related to maintaining equality as well as the key differences related to inequality symbols and solution sets. They distinguish between a single solution for an equation and the range of solutions associated with an inequality, thereby strengthening their conceptual understanding.

Throughout these learning experiences, students communicate [C] their reasoning and make connections [CN] among symbolic, graphical, and visual representations of linear inequalities and real world situations by solving inequalities to obtain solution sets that can be interpreted as constraints and ranges of possible values.

STRAND B: PATTERNS AND RELATIONS

Variables and equations: Symbols, expressions, and equations are used to represent patterns and describe relationships between quantities.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.B.4.

Model, record, and explain the operations of multiplication and division of polynomial expressions (limited to polynomials of degree less than or equal to 2) by monomials and binomials, concretely, pictorially, and symbolically.
[C, CN, R, V]

Note: The intent is not to factor polynomials, but to relate multiplication of binomials to the division of a polynomial by a binomial through concrete, pictorial, and symbolic representation.

MANIFESTATION OF LEARNING

Students model, record, and explain [C] the multiplication and division of polynomial expressions of degree less than or equal to 2 using concrete representations (algebra tiles), pictorial representations (rectangular array models), and symbolic representations [V]. They develop and apply strategies for multiplying and dividing polynomial expressions by monomials, with particular attention to how these operations change the form of an expression while producing equivalent expressions of the same degree. Students apply these strategies in situations involving binomials in order to deepen their understanding of structure, the distributive property, and the relationship between multiplication and division. **(The intent is not to factor polynomials into products of binomials, but rather to understand how multiplication creates new polynomial expressions and how division can be used to reverse this process when the structure is already known.)**

Students represent the multiplication of polynomial expressions by monomials through the use of rectangular array models [V]. They reason [R] about how each term in the product is represented within the rectangular arrangement and make connections between these visual representations and symbolic expansion. They identify and analyze errors made during simplification [R] and use models or mathematical reasoning to correct them.

Students make connections [CN] between the multiplication and division of polynomial expressions by exploring division as the inverse operation of a previously modelled multiplication. Building on the rectangular array model used to multiply two digit numbers, students make a visual connection to the multiplication of two binomials. They observe similarities in structure between the two models and to develop a deep understanding of the binomial $\times$ binomial operation. Students also rely on the relationship between multiplication and division when they are multiplying polynomial expressions to obtain a new expression. Students observe, for example, that $(x + 3)(x + 4) = x^2 + 7x + 12$ and understand that the expressions $x + 3$, $x + 4$ and $x^2 + 7x + 12$ are connected through multiplication and division operations, therefore, $\frac{x^2 + 7x + 12}{x + 3} = x + 4$ or $\frac{x^2 + 7x + 12}{x + 4} = x + 3$. They understand that the product of two binomials is a polynomial, and that dividing this polynomial by one of the factors produces the other. Students understand this relationship without having to rely on formal factoring methods.

Throughout these learning experiences, students rewrite and analyze polynomial expressions by drawing on concrete, pictorial, and symbolic representations. By connecting these representations [V] and applying to binomials strategies initially used with monomials, in targeted contexts [CN], students develop a coherent and lasting understanding of operations on polynomials, grounded in structure, meaning, and mathematical reasoning.



[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Measurement: Measurement is a useful process for comparing the dimensions of certain attributes of two-dimensional shapes and three-dimensional objects, whether through direct or indirect methods, in order to solve problems in real-world contexts.

No learning outcomes for this substrand.

DOMAINE C: SHAPE AND SPACE

Measurement: Measurement is a useful process for comparing the dimensions of certain attributes of two-dimensional shapes and three-dimensional objects, whether through direct or indirect methods, in order to solve problems in real-world contexts.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.C.1.

Determine the surface area of composite 3-D objects to solve problems.
[C, CN, ME, PS, R, T, V]

Note: It is intended that the composite 3-D objects be made up of objects limited to right cylinders, right rectangular prisms, and right triangular prisms.

MANIFESTATION OF LEARNING

Students develop an understanding of the surface area of composite 3-D objects by representing and analyzing objects composed of right rectangular prisms, right triangular prisms, and right cylinders using concrete models, nets and diagrams [V]. They explore how 3-D objects are formed by combining simpler solids and identify the individual faces that constitute to the overall surface area.

Students analyze [R] composite objects by deconstructing them and identifying which faces are exposed and which are shared or hidden within the object. They pay particular attention to areas of overlap, recognizing that faces where solids touch are internal and therefore must be excluded when determining the total surface area. Students reason about how overlap affects calculations and explain [C] why these areas should not be counted, making connections [CN] between surface area, spatial structure, and prior understanding of area and nets. Students use mental math to approximate surface areas and estimation [ME] to assess the reasonableness of their calculations before carrying out exact calculations, using technology [T] as needed.

Students apply these understandings in problem solving contexts [PS], such as determining the surface area of a composite object or solving contextual problems involving packaging, storage, or construction. Students justify [R] their solution strategies by clearly explaining how the object was deconstructing, how overlap was handled, and why their approach leads to a valid solution.

Throughout these learning experiences, students communicate [C] their thinking using labelled diagrams, nets, formulas, and precise mathematical language. By making explicit connections [CN] between a three dimensional structure and its two dimensional representations, and by reasoning about exposed and hidden surfaces, students develop a coherent understanding of the surface area for composite 3-D objects. This understanding supports future learning in geometry, measurement, and applied contexts, such as design, manufacturing, and construction, where accurate calculations and attention to structure are essential.

DOMAINE C: SHAPE AND SPACE

Three-dimensional objects and two-dimensional figures: Two-dimensional figures and three-dimensional objects can be described, classified, and analyzed based on their attributes and the relationships between them.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.C.2.

Demonstrate an understanding of similarity of polygons.
[C, CN, PS, R, T, V]

MANIFESTATION OF LEARNING

Students develop an understanding of the similarity of polygons by representing, analyzing, and comparing shapes using annotated diagrams and visual models [V]. Through learning experiences, they examine pre sorted sets of polygons and analyze corresponding sides and angles to determine whether polygons are similar. Students explicitly apply the criteria for similarity, recognizing that corresponding angles must be congruent and corresponding side lengths must be proportional, and communicate their reasoning clearly using mathematical language and visual references [C].

Students reason [R] about relationships between polygons by comparing ratios of corresponding side lengths and verifying corresponding angle measures. They make connections [CN] between similarity, proportional reasoning, and concepts involving scales, ratios and congruence. When drawing a polygon similar to a given polygon, students maintain consistent proportions and relationships between corresponding angles, explaining why the resulting shape is similar rather than congruent. When appropriate, students use technology [T], such as dynamic geometry tools or digital drawing tools, to support the construction, comparison, or verification of similar polygons.

Students apply their understanding of similarity in problem solving contexts [PS], such as solving geometric problems that require determining missing side lengths, comparing shapes of different sizes, or interpreting scaled diagrams. They select appropriate strategies, justify their solutions using similarity properties, and explain how proportional relationships and equivalent angles support their conclusions. Through these experiences, students strengthen their ability to justify mathematical claims and evaluate whether their solutions are reasonable.

Throughout these learning experiences, students communicate [C] their thinking using annotated diagrams, symbolic representations, and mathematical justifications. By making explicit connections [CN] between visual representations and proportional relationships, and by reasoning systematically about the properties of similar polygons, students develop a coherent understanding of similarity that supports future learning in geometry, measurement, and real world contexts involving scale and proportional reasoning.

DOMAINE C: SHAPE AND SPACE

Transformations: Two-dimensional shapes can be moved within a coordinate plane using transformations. Their positions and movements can be described and modeled using coordinates, geometric representations, and transformations.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.C.3.

Draw and interpret scale diagrams of 2-D shapes.
[CN, R, T, V]

MANIFESTATION OF LEARNING

Students develop an understanding of scale diagrams of 2-D shapes by representing, interpreting, and analyzing scaled shapes using drawings and visual representations [V]. Through learning experiences, they examine examples of scaling found in print and electronic media, such as maps, plans, or diagrams with stated scales, and interpret the meaning of the scale factor. Students analyze how a scale factor represents an enlargement or a reduction of an original shape and make connections [CN] between scale, proportional reasoning, and prior understanding of ratios and similarity.

Students analyze scale representations by comparing the lengths of corresponding sides and determining whether the relationships between the dimensions remain proportional. Based on these observations, they justify their conclusions using mathematical reasoning [R]. When drawing diagrams to scale, students attend carefully to maintaining consistent proportions, explaining how the scale factor applies uniformly to all corresponding side lengths. When appropriate, students use technology [T], such as digital drawing tools, to support accurate construction and interpretation of scale diagrams.

Students apply their understanding of scale diagrams in problem solving contexts, such as determining actual dimensions from a scaled representation, interpreting diagrams drawn to different scales, or solving problems that require using a scale diagram to make informed decisions. In these contexts, students draw on properties of similar polygons to justify their strategies, explaining how proportional relationships between corresponding sides ensure that scaled figures preserve the shape of the original. They reason [R] about the suitability of a scale and select appropriate strategies to determine the scale factor used.

Throughout these learning experiences, students communicate their reasoning using drawings, annotated diagrams, symbolic notation, and precise mathematical language. By making explicit connections [CN] between scale diagrams and the properties of similar polygons, and by reasoning systematically about proportional relationships, students develop an understanding of scale that supports future learning in geometry, measurement, and real world contexts such as mapping, design, and technical drawing, where interpreting and creating scale representations is essential.

DOMAINE C: SHAPE AND SPACE

Transformations: Two-dimensional shapes can be moved within a coordinate plane using transformations. Their positions and movements can be described and modeled using coordinates, geometric representations, and transformations.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.C.4.

Demonstrate an understanding of line and rotation symmetry.
[C, CN, PS, V]

MANIFESTATION OF LEARNING

Students develop an understanding of symmetry of 2-D shapes and designs by representing and analyzing, shapes, drawings and visual representations [V]. Through learning experiences, students examine a variety of shapes, patterns, and designs and classify them according to the number of lines of symmetry or the presence of rotational symmetry. They explore the relationship between symmetry and the structure of shapes [CN] and communicate [C] their observations using precise mathematical language and annotated visual representations.

Students make connections [CN] between the visual properties of shapes and their symmetrical features by identifying lines of symmetry, completing diagrams given one half and a line of symmetry, and determining whether a shape or a diagram has rotational symmetry about its centre. They analyze how rotating an image through equivalent angles can result in congruent images and determine the order and angle of rotation when rotational symmetry is present. Students also rotate two dimensional images about a given vertex and draw the resulting image, reasoning visually about how the position and orientation of the image changes.

Students apply their understanding of symmetry in problem-solving contexts [PS], such as when determining the transformations needed to complete a pattern, creating a tessellation that meets specific constraints, or identifying the symmetry properties required to reproduce a design or logo. In these contexts, they identify lines of symmetry or describe the order and angle of rotation present and explain how symmetry contributes to the overall structure and repetition of the design. Students justify their conclusions by referring to visual evidence and by explaining how these transformations preserve the shape and size of the original figure.

Throughout these learning experiences, students communicate [C] their reasoning using drawings, annotated diagrams, and mathematical explanations. By making connections [CN] between geometric transformations, visual patterns, and real-world designs, students develop a coherent understanding of line and rotation symmetry. This understanding supports future learning in geometry and spatial reasoning, as well as applications in areas such as art, design, and pattern creation, where recognizing and applying symmetry plays an essential role.

STRAND D: **STATISTICS AND PROBABILITY**

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Data analysis: Data can be collected, organized, represented, and interpreted to model situations, support decision-making, and solve problems.

MAT.9.2.D.1.

Develop and implement a project plan for the collection, display, and analysis of data by

- formulating a question for investigation
- choosing a data collection method that includes social considerations
- selecting a population or a sample
- collecting the data
- displaying the collected data in an appropriate manner
- drawing conclusions to answer the question.

[C, CN, PS, R, T, V]

MANIFESTATION OF LEARNING

Students develop and implement a project plan to investigate a question using data by engaging in the full process of planning, inquiry, analysis, and communication [C] of results. They begin by formulating a clear and purposeful question for investigation [PS], considering what information is needed and how data might help answer the question meaningfully. Students plan an appropriate method of data collection that is designed to minimize bias and support the reliability of the data. They select either a population or a sample and justify this choice through reasoning [R], considering the context of the question and the practical constraints of data collection. Students then collect data according to their plan, using appropriate tools and digital technologies [T] when applicable.

Students organize and display their collected data in ways that support its analysis and interpretation, such as charts, graphs, tables, or digital displays [V]. They select representations that highlight patterns, trends, or relationships relevant to their question, and present their data clearly and effectively.

Students analyze the data and draw conclusions that address the original question, explaining how the evidence supports their findings. They evaluate the strength and limitations of their conclusions by reflecting on factors such as the quality of the data, the method of collection, and the representativeness of the population or sample. Where appropriate, they consider how different choices in data collection or display might lead to different interpretations [R].

Throughout the project, students communicate [C] their reasoning, processes, and conclusions using mathematical language, visual representations, and justifications. They share results with an audience and respond to feedback by clarifying their justifications, modifying their representations, or adjusting their conclusions. By making connections [CN] between the question, the data, the methods used, and the conclusions drawn, students develop an integrated understanding of how data investigations are planned, carried out, and evaluated.

STRAND D: STATISTICS AND PROBABILITY

Probability and uncertainty: Probability involves determining the likelihood that an event will occur by drawing on previous experiences or analyzing possible outcomes to solve problems.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.D.2.

Identify the sample space and calculate the theoretical probability for a random experiment involving two dependent events.

[C, CN, ME, PS, R, T]

MANIFESTATION OF LEARNING

Students develop an understanding of probability involving two dependent events by identifying and organizing the sample space for a probability experiment and using it to determine theoretical probability [R]. Through learning experiences, students examine probability situations, such as repeated selections without replacement, and recognize that the outcome of the first event affects the possible outcomes of the second. That is, the probability of two dependent events is calculated by multiplying the probability of the first event by the probability of the second event, given that the first event has already occurred. They communicate [C] their understanding by describing the sample space and explaining how dependence changes the structure of the experiment.

Students represent sample spaces using tools such as lists, tables, or simple tree diagrams, recognizing these representations as tools to both develop and demonstrate understanding [R]. They analyze how the sample space changes after the first event and make explicit connections [CN] between the sample space and the calculation of theoretical probability, reasoning that probabilities arise directly from the number of favourable outcomes compared to all possible outcomes. Students use mental math and estimation [ME] to anticipate whether probabilities should increase or decrease after the first event and to assess the reasonableness of calculated results.

Students apply their understanding in problem solving contexts [PS] by calculating theoretical probabilities for experiments involving dependent events and explaining their reasoning step by step. They justify their solutions by referring to the sample space and by explaining how dependence affects outcomes, rather than relying solely on formulas. When appropriate, students use technology [T] to perform calculations or to organize outcomes efficiently.

Throughout these learning experiences, students communicate [C] their reasoning using organized representations and by expressing probabilities as ratios, fractions, and percents. By making explicit connections [CN] between dependent events, sample space, and theoretical probability, and by reasoning about how outcomes are affected by prior events, students develop a coherent understanding of probability that supports future learning in statistics and data analysis, as well as informed decision-making in real-world contexts involving uncertainty.

STRAND D: STATISTICS AND PROBABILITY

Probability and uncertainty: Probability involves determining the likelihood that an event will occur by drawing on previous experiences or analyzing possible outcomes to solve problems.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.D.3.

Explore dependent events through experimentation, calculate and compare their experimental and theoretical probabilities.
[C, CN, PS, R, T, V]

MANIFESTATION OF LEARNING

Students deepen their understanding of probability involving dependent events by exploring probability situations through a variety of experimental methods, including hands-on experiments, simulations, and visual models [T, V]. Through learning experiences, students carry out probability experiments, such as repeated selections without replacement, and collect data to observe how outcomes are affected when events are dependent. They communicate [C] their observations by describing the experimental process and recording results in an organized and meaningful way.

Students reason [R] about experimental results by analyzing how outcomes vary over repeated trials and by comparing experimental probabilities to corresponding theoretical probabilities. They make connections [CN] between the experimental data collected and the theoretical probability determined from the sample space, recognizing that experimental results may vary but are informed by the structure of the probability experiment. Through comparison, students recognize patterns in results and develop an understanding of how experimental probability approaches theoretical probability as the number of trials increases.

Students apply their understanding in problem-solving contexts [PS] by analyzing situations involving dependent events in order to answer questions, compare different possibilities, or determine which outcome is most likely. They explain how their experimental data support or differ from theoretical expectations and justify their reasoning by referring to the nature of dependent events and the conditions of the experiment. When appropriate, students use technology [T] to collect data, organize results, or increase the number of trials.

Throughout these learning experiences, students communicate [C] their reasoning using explanations, numerical values, and contextual references to the experiment. By making connections [CN] between experiments, probability models, and theoretical reasoning, students develop a clear understanding of how experimental and theoretical probabilities are related. This understanding supports future learning in probability and statistics and strengthens students' ability to interpret results and make informed decisions in situations involving uncertainty.



[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Revenue: Understanding different types of income and how effective money management supports the development of essential skills for making informed financial decisions in everyday life.

MAT.9.2.E.1.

Develop an understanding of how education, career choices, and personal goals can impact future earning potential and lifestyle, recognizing the connection between individual expectations and long-term financial planning.

[C, CN, R, T]

MANIFESTATION OF LEARNING

Students investigate a variety of future possibilities by exploring multiple career pathways, including trades, skilled work, entrepreneurship, apprenticeships, college programs, and university studies. Using career exploration tools [T], they examine the job market demand, necessary education or training, necessary levels of secondary mathematics, and other prerequisites. They also consider whether relocation or added living costs may be required and how these factors influence long-term planning.

Through reasoning tasks [R], students analyze realistic scenarios representing a wide range of careers and compare lifestyle expectations like housing, transportation, recreation, and well-being with projected income. They discuss and explain why certain high visibility paths (e.g., professional athletics or social media influencer) have statistically low stability, considering factors such as limited opportunities, short career spans, inconsistent income, and high competition.

Students explore diversified sources of income, including typical teen income streams such as part-time work, lawn care, babysitting, tutoring, or small business ventures. They distinguish between gross and net income by considering overhead costs to compare the financial implications of different income structures. Students' approximate tuition expenses, relocation and furnishing costs, student loan repayment timelines, and long-term savings potential.

Students construct sample budgets for different career paths, incorporating realistic living expenses, multiple income streams, and personal well-being considerations. They examine how ongoing technological change, including AI driven transformations in the labour market, may affect future job availability, the skills demanded of workers, and trends in earnings.

Students communicate [C] their understanding by describing how personal goals, values, lifestyle expectations, and wellness priorities intersect with financial realities. They make explicit connections [CN] between their chosen career paths, required education, income patterns, and the long-term planning needed to support a sustainable, healthy future.

Throughout this learning, students develop a realistic and informed understanding of how their educational choices, mathematical preparation, personal interests, and financial decision-making collectively shape the lifestyles they may wish to pursue.

STRAND E: FINANCIAL LITERACY

Spending and Borrowing: Understanding that spending decisions are based on income, that borrowing involves obligations and risks, and that responsible management enables individuals to make informed financial decisions.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.E.2

Develop an understanding of available borrowing options, including a short-term loan, student loan, car loan, line of credit, and mortgage, and recognize their impact on personal finances.
[C, PS, R, T]

MANIFESTATION OF LEARNING

Students investigate a variety of borrowing options such as short term loans, student loans, car loans, lines of credit, and mortgages, comparing their purposes, conditions, and long term financial impacts. Using technology tools [T] like online payment calculators, they examine how interest rates, loan terms, and repayment schedules influence the total cost of borrowing. Students also explore additional borrowing mechanisms including buy-now-pay-later services, payday loans, and cellphone leasing or renting agreements to understand how each option functions and the inherent risks.

Students compare borrowing choices for larger purchases that a teenager might realistically make, such as buying a used bicycle, a gaming console, a computer, or a phone. Through problem solving tasks [PS], they consider how the value of the item relates to the length of the repayment period and examine the additional costs that can come with borrowing, such as interest, warranties, repairs, or fees. Using digital tools [T], they calculate estimated monthly payments, total interest charges, and the long term financial commitments associated with different borrowing options. Students apply reasoning skills [R] to reflect on how these repayment obligations may affect their day to day finances, savings goals, or future spending opportunities.

Students communicate [C] their understanding by explaining how borrowing decisions influence personal finances and long term financial well being. They describe how responsible borrowing, awareness of hidden costs, and a good understanding of loan structures support financial stability and informed decision making.

Throughout this learning, students develop a clear and informed understanding of how various borrowing options, credit behaviours, interest costs, and repayment responsibilities shape their financial well being and future opportunities.

STRAND E: FINANCIAL LITERACY

Spending and Borrowing: Understanding that spending decisions are based on income, that borrowing involves obligations and risks, and that responsible management enables individuals to make informed financial decisions.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.E.3

Demonstrate an understanding of borrowing decisions, the advantages and disadvantages of using credit, including credit cards, and how paying back debt can affect personal finances and influence credit scores over time.

[C, CN, ME, PS, R, T, V]

MANIFESTATION OF LEARNING

Students explore how credit works as a financial agreement in which a lender provides access to money or goods with the expectation of repayment over time. Through reasoning tasks [R], they examine how interest, repayment terms, and borrowing conditions shape the real cost of purchasing with credit. Students consider why individuals might choose to borrow, such as managing the timing between expenses and their income, while recognizing that every borrowing decision carries responsibilities that influence long term financial outcomes. This foundational understanding sets the stage for perceiving credit cards as a common form of credit and as one of the primary ways individuals begin establishing a credit score.

Students learn about the specific features of credit cards, including credit limits, interest rates, minimum payments, fees, and reward structures. They also examine the advantages of responsible use, such as convenience, purchase protection, fraud safeguards, and the opportunity to establish a good credit history. Through problem-solving tasks [PS], students examine sample credit card statements to compare the impacts of payment behaviours. Using technology tools [T], such as credit card and payment calculators, they model how different repayment choices affect the cost of borrowing. With visual models [V], students represent and approximate [ME] how payment patterns, such as paying in full, paying a fixed amount, or paying only the minimum payment, will impact the repayment timeline and overall amount paid.

Through communication [C], they describe the interconnected benefits and responsibilities of using credit cards, explaining how repayment behaviours influence these advantages. Students make connections [CN] to broader financial habits by examining how everyday spending behaviours, including small and frequent charges such as micropayments, microtransactions, and subscription services, can accumulate and influence credit utilization.

Throughout this learning, students develop a clear understanding of how repayment patterns, credit utilization, and spending behaviours influence personal finances and credit scores, and how informed borrowing decisions contribute to long term financial stability.

STRAND E: FINANCIAL LITERACY

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

Saving and Investing: Personal financial management involves making informed decisions about saving and investing to prepare for the future, manage unexpected events, and achieve personal goals.

MAT.9.2.E.4

Demonstrate an understanding of different types of investments and recognize how returns, tax implications, risk factors including frauds, scams, and misleading schemes, as well as volatility, differ among investment options.

[C, CN, R, T]

MANIFESTATION OF LEARNING

Students examine a range of investment options, such as savings accounts, Guaranteed Investment Certificates (GICs), mutual funds, exchange traded funds (ETFs), stocks, and alternative assets such as gold or collectible items. They explore how accessibility to money, duration, volatility, and potential returns vary among investment choices. Using technology tools [T], such as comparison platforms or investment information websites, students access documents and resources that describe investment products, explain when they might be used, and outline how different investments align with personal financial goals.

Students analyze [R] how taxes apply differently to income from investments, including interest, dividends, and capital gains, and consider the role of tax protected accounts. They investigate how investment fees influence overall returns and examine how factors such as risk, volatility, and potential loss differ across investment types. Students also learn to identify warning signs of frauds, scams, and misleading schemes, including risks related to identity theft, and discuss how these threats can impact financial security. Students make connections [CN] between investment choices, personal needs, and financial planning.

Students communicate [C] their understanding by explaining how investment characteristics, risks, costs, and tax implications influence long-term financial well-being. They describe strategies for approaching investments with caution, recognizing sources of reliable information, and identifying situations that may compromise financial safety.

Throughout this learning, students develop an understanding of how varied investment options function, how risk and return differ among them, and how careful decision-making supports long-term financial stability.

STRAND E: FINANCIAL LITERACY

Saving and Investing: Personal financial management involves making informed decisions about saving and investing to prepare for the future, manage unexpected events, and achieve personal goals.

[C]	Communication
[ME]	Mental Math and Estimation
[CN]	Connections
[R]	Reasoning
[PS]	Problem Solving
[T]	Technology
[V]	Visualization

MAT.9.2.E.5

Demonstrate an understanding of how different types of investments can grow or lose value over time by using technology, tables, and graphs to explore simple and compound interest and compare changes across various options.

[C, CN, PS, R, T, V]

MANIFESTATION OF LEARNING

Students explore how investments can increase or decrease in value over time by examining simple and compound interest using tables, graphs, and digital tools. Using technology [T] such as interest calculators or graphing tools, they create visual models [V] that show how different interest rates and investment duration affect growth. They compare tables and graphs to visualize numerical patterns and identify key differences between simple and compound interest.

Students examine and reason [R] to understand why different investments can grow or fluctuate in value. They consider how the type of investment, the length of time money is invested, and the degree of price volatility can influence both growth and the potential for loss. Students examine examples of common financial investments as well as personal asset based items, such as gold, cards, or collectibles, to understand how easily or difficultly money can be accessed and to reflect on what level of risk they feel comfortable with.

Through problem-solving tasks [PS], students compare investment scenarios to analyze how interest and time shape outcomes. They interpret tables and graphs [V] to see how values change over time and use technology tools to test how adjusting interest rates or duration affect results. Students make connections [CN] by linking patterns of growth in simple and compound interest to real-life investment choices, such as recognizing how faster exponential growth can influence long term financial decisions.

Students communicate [C] their understanding by explaining interest models, describing the effect of investment duration and interest rate on growth, and justifying how their personal risk preferences influence their investment choices.

Throughout this learning, students develop a clear understanding of how investments change over time, how simple and compound interest influence growth, and how using tables, graphs, and technology helps support informed financial decisions.

