Mathematics, Grade 9, De-Streamed (MTH 1W)
2025-2026 Course Outline
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Credit Value: 1.0

Prerequisite courses: None

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COURSE DESCRIPTION

This course enables students to consolidate, and continue to develop, an understanding of mathematical concepts related to number sense and operations, algebra, measurement, geometry, data, probability, and financial literacy. Students will use mathematical processes, mathematical modelling, and coding to make sense of the mathematics they are learning and to apply their understanding to culturally responsive and relevant real-world situations. Students will continue to enhance their mathematical reasoning skills, including proportional reasoning, spatial reasoning, and algebraic reasoning, as they solve problems and communicate their thinking.

Credit Value: 1.0

Prerequisites: None

This curriculum policy presents the compulsory Grade 9 mathematics course, 2021 (MTH1W). This course supersedes the two Grade 9 courses outlined in *The Ontario Curriculum, Grades 9 and 10: Mathematics, 2005* as well as *The Ontario Curriculum: Mathematics – Mathematics Transfer Course, Grade 9, Applied to Academic, 2006.*

The Grade 9 mathematics curriculum focuses on key mathematics concepts and skills, as well as on making connections between related math concepts, between mathematics and other disciplines, and between mathematics and the lived experiences of students. This curriculum is designed to support all students in developing an understanding of, and the ability to apply, the range of mathematical knowledge and skills appropriate for the grade level. Consequently, this curriculum is intended to support all students in continuing to build confidence in approaching mathematics, develop a positive attitude towards mathematics, think critically, work collaboratively, and feel that they are reflected in mathematics learning.

VISIONS AND GOALS OF THE GRADE 9 MATHEMATICS COURSE

The needs of learners are diverse, and all learners have the capacity to develop the knowledge, concepts, skills, and perspectives they need to become informed, productive, and responsible citizens in their own communities and within the world.

How mathematics is contextualized, positioned, promoted, discussed, taught, learned, evaluated, and applied affects the learning experiences and academic outcomes of all students. Mathematics can be appreciated for its innate beauty, as well as for its role in making sense of the world. Having a solid foundation in, a deep appreciation for, and excitement about mathematics, as well as recognizing their identities, lived experiences, and communities in their mathematics learning, will help ensure that all students grow more confident and capable as they step into the future.

All students bring their mathematical experiences from various contexts to school. Educators can value and build on these lived experiences so that mathematics classrooms become spaces that honour diverse mathematical ideas and thoughts, and incorporate multiple ways of knowing and doing. Such spaces allow all students to become flexible and adaptive learners in an ever-changing world.

The vision of this mathematics course is to support all students as they develop healthy and strong identities as mathematics learners and grow to be mathematically skilled, to enhance their ability to use mathematics to make sense of the world around them, and to enable them to make critical decisions while engaged in mathematical thinking. This vision is attained in a mathematics classroom filled with high academic expectations and deep engagement that generates enthusiasm and curiosity – an inclusive classroom where all students receive the highest-quality mathematics instruction and learning opportunities, are empowered to interact as confident mathematics learners, and are thereby supported in reaching their full potential.

The goal of the Ontario mathematics curriculum is to provide all students with the key skills required to:

- understand the importance of and appreciate the beauty and wonder of mathematics;
- recognize and appreciate multiple mathematical perspectives;
- recognize the ways in which mathematics can be used as a tool to uncover, explore, analyse, and promote actions to address social and environmental issues such as inequity and discrimination;
- make informed decisions and contribute fully to their own lives and to today's interconnected local and global communities;
- adapt to changes and synthesize new ideas;
- work both independently and collaboratively to approach challenges;
- communicate effectively;
- think critically and creatively to connect, apply, and leverage mathematics within other areas of study including science, technology, engineering, the arts, and beyond.

A strong foundation of mathematics is an important contributor to students' future success and an essential part of becoming an informed citizen. In order to develop a strong understanding of mathematics and the ability to apply mathematics in real life, all students must feel that they are connected to the curriculum – to what is taught, why it is taught, and how it is taught.

THE IMPORTANCE AND BEAUTY OF MATHEMATICS

Mathematics is integral to every aspect of daily life – social, economic, cultural, and environmental. It is embedded into the rich and complex story of human history. People around the world have used, and continue to contribute, mathematical knowledge, skills, and attitudes to make sense of the world around them and to develop new mathematical thinking and appreciation for mathematics. Mathematics is conceptualized and practised in many different ways across diverse local and global cultural contexts. It is part of diverse knowledge systems composed of culturally situated thinking and practices. From counting systems, measurement, and calculation to geometry, spatial sense, trigonometry, algebra, functions, calculus, and statistics, mathematics has been evident in the daily lives of people and communities across human histories.

Today, mathematics is found all around us. For example, mathematics can be found in sports performance analysis, navigation systems, electronic music production, computer gaming, graphic art, quantum physics, climate change modelling, and so much more. Mathematics skills are necessary when we buy goods and services online, complete our taxes, do beading, construct buildings, and play sports. Mathematics also exists in nature, storytelling, music, dancing, puzzles, and games. Proficiency with mathematical ideas is needed for many careers, including but not limited to engineering, health care and medicine, psychology, computer science, finance, landscape design, fashion design, architecture, agriculture, ecology, the arts, the culinary arts, and many other skilled trades. In fact, in every field of pursuit, the analytical, problem-solving, critical-thinking, and creative-thinking skills that students develop through the study of mathematics are evident. In the modern age of evolving technologies, artificial intelligence, and access to vast sources of information and big data, knowing how to navigate, interpret, analyse, reason, evaluate, and problem solve is foundational to everyday life.

Mathematics can be understood as a way of studying and understanding structure, order, patterns, and relationships. The power of mathematics is evident in the connections among seemingly abstract mathematical ideas. The applications of mathematics have often yielded fascinating representations and results. As well, the aesthetics of mathematics have also motivated the development of new mathematical thinking. The beauty in mathematics can be found in the process of deriving elegant and succinct approaches to resolving problems.

At times, messy problems and seeming chaos may culminate in beautiful, sometimes surprising, results that are both simple and generalizable. Elegance and chaos are both integral to the beauty of mathematics itself and to the mathematical experience. In other words, the beauty of mathematics is illustrated and enhanced by students' diverse interpretations, strategies, representations, and identities – not diminished by them. Most importantly, students can experience wonder and beauty when they make exciting breakthroughs in problem solving. Therefore, these two aspects of mathematics, aesthetics and application, are deeply interconnected.

The Grade 9 mathematics course strives to equip all students with the knowledge, skills, and habits of mind that are essential to understanding and enjoying the importance and beauty of mathematics. Learning in Grade 9 mathematics begins with a focus on the fundamental concepts and foundational skills. This leads to an understanding of mathematical structures, operations, processes, and language that provides students with the means necessary for reasoning, justifying conclusions, and expressing and communicating mathematical ideas.

When educators put student learning at the centre, provide relevant and meaningful learning opportunities, and use technology strategically to enhance learning experiences, all students are supported as they learn and apply mathematical concepts and skills within and across strands and other subject areas.

The Grade 9 mathematics course emphasizes the importance of establishing an inclusive mathematical learning community where all students are invited to experience the living practice of mathematics, to work through challenges, and to find beauty and success in problem solving. As students engage with the curriculum, they are supported in incorporating their lived experiences and existing mathematical understandings, and then integrating the new ideas they learn into their daily lives. When students recognize themselves in what is taught and how it is taught, they begin to view themselves as competent and confident mathematics learners who belong to the larger mathematics community. As students develop mathematical knowledge and skills, they grow as mathematical thinkers. As students explore histories of mathematics and comprehend the importance and beauty of mathematics, they develop their mathematical agency and identity, at the same time as they make connections to other subjects and the world around them.

HUMAN RIGHTS, EQUITY, AND INCLUSIVE EDUCATION IN MATHEMATICS

Research indicates that there are groups of students (for example, Indigenous students, Black students, students experiencing homelessness, students living in poverty, students with LGBTQ+ identities, and students with special education needs and disabilities) who continue to experience systemic barriers to accessing high-level instruction in and support with learning mathematics. Systemic barriers, such as racism, implicit bias, and other forms of discrimination, can result in inequitable academic and life outcomes, such as low confidence in one's ability to learn mathematics, reduced rates of credit completion, and leaving the secondary school system prior to earning a diploma. Achieving equitable outcomes in mathematics for all students requires educators to be aware of and identify these barriers, as well as the ways in which they can overlap and intersect, which can compound their effect on student well-being, student success, and students' experiences in the classroom and in the school. Educators must not only know about these barriers, they must work actively and with urgency to address and remove them.

Students bring abundant cultural knowledges, experiences, and competencies into mathematical learning. It is essential for educators to develop pedagogical practices that value and centre students' prior learning, experiences, strengths, and interests. Such pedagogical practices are informed by and build on students' identities, lived experiences, and linguistic resources. When educators employ such pedagogy, they hold appropriate and high academic expectations of students, applying the principles of Universal Design for Learning and differentiated instruction to provide multiple entry points and maximize opportunities for all

students to learn. By acknowledging and actively working to eliminate the systemic barriers that some students face, educators create the conditions for authentic experiences that empower student voices and enhance their sense of belonging, so that each student can develop a healthy identity as a mathematics learner and can succeed in mathematics and in all other subjects. Mathematics learning that is student-centred allows students to find relevance and meaning in what they are learning and to make connections between the curriculum and the world outside the classroom.

In mathematics classrooms, teachers also provide opportunities for cross-curricular learning and for teaching about human rights. To create anti-racist, anti-discriminatory learning environments, all educators must be committed to equity and inclusion and to upholding and promoting the human rights of every learner. Students of all identities and social locations have the right to mathematics opportunities that allow them to succeed, personally and academically. In any mathematics classroom, it is crucial to acknowledge students' intersecting social identities and their connected lived realities. Educators have an obligation to develop and nurture learning environments that are reflective of and responsive to students' strengths, needs, cultures, and diverse lived experiences – identity-affirming learning environments free from discrimination. In such learning environments, educators set appropriate and high academic expectations for all.

High-quality instruction that emphasizes deep mathematical thinking and cultural and linguistic knowledge and that addresses issues of power and social justice in mathematics education is the foundation of culturally responsive and relevant pedagogy (CRRP) in mathematics. In CRRP classrooms, teachers reflect on their own identities and pay attention to how those identities affect their teaching, their ideas, and their biases. Teachers also learn about students' identities, identifications, and/or affiliations and connected lived experiences. Teachers develop an understanding of how students are thinking about mathematical concepts according to their cultural backgrounds and experiences, and make connections with these cultural ways of knowing in their pedagogy. This approach to pedagogy develops social consciousness and critique while valorizing students' cultural backgrounds, communities, and cultural and linguistic competences. Teachers build on students' experiences, ideas, questions, and interests to support the development of an engaging and inclusive mathematics classroom community.

In mathematics classrooms, educators use CRRP to create anti-racist and anti-oppressive teaching and learning opportunities to engage students in shaping much of the learning and to promote mathematical agency investment in the learning. When students develop agency, they are motivated to take ownership of their learning of, and progress in, mathematics. Teaching about diverse mathematical approaches and figures in history, from different global contexts, can offer opportunities for students to feel that they are reflected in mathematical learning – a key factor in developing students' sense of self – and to learn about others, and about the multiple ways mathematics exists in all aspects of the world around them.

Mathematics is situated and produced within cultures and cultural contexts. Challenging Eurocentric ideas about learning mathematics is key to a CRRP approach. In an anti-racist and anti-discriminatory environment, teachers know that there is more than one way to develop a solution, and students are exposed to multiple ways of knowing and encouraged to explore multiple ways of finding answers.

Indigenous pedagogical approaches emphasize holistic, experiential learning, teacher modelling, and the use of collaborative and engaging activities. Teachers differentiate instruction and assessment opportunities to encourage different ways of learning, to allow students to learn from and with each other, and to promote an awareness of and respect for the diverse and multiple ways of knowing that are relevant to and reflective of students' lived experiences in classrooms, schools, and the world. When making connections between mathematics and real-life applications, teachers are encouraged to work in partnership with First Nations, Inuit, and Métis individuals, communities, and/or nations. Teachers may respectfully incorporate culturally

specific examples that highlight First Nations, Inuit, and Métis cultures, histories, present-day realities, ways of knowing, and contributions, to infuse Indigenous knowledges and perspectives meaningfully and authentically into the mathematics program. In this way, culturally specific examples make visible the colonial contexts of present-day mathematics education, centre Indigenous students as mathematical thinkers, and strengthen learning and course content so that all students continue to learn about diverse cultures and communities in a respectful and informed way. Students' mind, body, and spirit are nourished through connections and creativity.

PRINCIPLES UNDERLYING THE GRADE 9 MATHEMATICS CURRICULUM

- **A mathematics curriculum is most effective when it values and honours the diversity that exists among students and within communities**. The Grade 9 mathematics curriculum is based on the belief that all students can and deserve to be successful in mathematics. In particular, an inclusive curriculum is built on the understanding that not all students necessarily learn mathematics in the same way, use the same resources (e.g., tools and materials), or learn within the same time frames. Setting high academic expectations and building a safe and inclusive community of learners requires the purposeful use of a variety of instructional and assessment strategies and approaches that build on students' prior learning and experiences, and create an optimal and equitable environment for mathematics learning.
- **A robust mathematics curriculum is essential for ensuring that all students reach their full potential.**
  The Grade 9 mathematics curriculum challenges all students by including learning expectations that build on students' prior knowledge and experience; involve higher-order thinking skills; and require students to make connections between their lived experiences, mathematical concepts, other subject areas, and situations outside of school. This learning enables all students to gain a powerful knowledge of the usefulness of the discipline and an appreciation of the histories and importance of mathematics.
- **A mathematics curriculum provides all students with the fundamental mathematics concepts and foundational skills they require to become capable and confident mathematics learners.** The Grade 9 mathematics curriculum provides a balanced approach to the teaching and learning of mathematics. It is based on the belief that all students learn mathematics most effectively when they can build on prior knowledge to develop a solid understanding of the concepts and skills in mathematics, and when they are given opportunities to apply these concepts and skills as they solve increasingly complex tasks and investigate mathematical ideas, applications, and situations in everyday contexts. As students continue to explore the relevance of mathematics, they further develop their identity and agency as capable mathematics learners.
- **A progressive mathematics curriculum includes the strategic integration of technology to support and enhance the learning and doing of mathematics.** The Grade 9 mathematics curriculum strategically integrates the use of appropriate technologies to support all students in developing conceptual understanding and procedural fluency, while recognizing the continuing importance of students' mastering the fundamentals of mathematics. For some students, assistive technology also provides an essential means of accessing the mathematics curriculum and demonstrating their learning. Students develop the ability to select appropriate tools and strategies to perform particular tasks, to investigate ideas, and to solve problems. The curriculum sets out a framework for learning important skills, such as problem solving, coding, and modelling, as well as opportunities to develop critical data literacy, information literacy, and financial literacy skills.
- **A mathematics curriculum acknowledges that the learning of mathematics is a dynamic, gradual, and continuous process, with each stage building on the last.** The Grade 9 mathematics curriculum is dynamic, continuous, and coherent and is designed to support all students in developing an understanding of the interconnected nature of mathematics. Students come to understand how concepts develop and how they build on one another. As students communicate their reasoning and findings, they move towards new understandings. Teachers observe and listen

to all students and then responsively shape instruction in ways that foster and deepen student understanding of important mathematics. The fundamental concepts, skills, and processes introduced in the elementary grades support students in extending their learning in the secondary grades.

- **An equitable mathematics curriculum recognizes that mathematics can be subjective.** Mathematics is often positioned as an objective and pure discipline. However, the content and the context in which it is taught, the mathematicians who are celebrated, and the importance that is placed upon mathematics by society are subjective. Mathematics has been used to normalize racism and marginalization of non-Eurocentric mathematical knowledges, and a decolonial, anti-racist approach to mathematics education makes visible its historical roots and social constructions. The Ontario Grade 9 mathematics curriculum emphasizes the need to recognize and challenge systems of power and privilege, both inside and outside the classroom, in order to eliminate systemic barriers and to serve students belonging to groups that have been historically disadvantaged and underserved in mathematics education.
- **A mathematics curriculum is integrated with the world beyond the classroom.** The Grade 9 mathematics curriculum provides opportunities for all students to investigate and experience mathematical situations they might find outside the classroom and develop an appreciation for the beauty and wide-reaching nature and importance of mathematics. The overall curriculum integrates and balances concept development and skill development, including social-emotional learning skills, as well as the use of mathematical processes and real-life applications.
- **A mathematics curriculum motivates students to learn and to become lifelong learners.** The Grade 9 mathematics curriculum is brought to life in the classroom, where students develop mathematical understanding and are given opportunities to connect their knowledge and skills to wider contexts and other disciplines. Making connections to the world around them stimulates their interest and motivates them to become lifelong learners with healthy attitudes towards mathematics. Teachers bring the mathematics curriculum to life using their knowledge of:
    - the mathematics curriculum;
    - the backgrounds and identities of all students, including their past and ongoing experiences with mathematics and their learning strengths and needs;
    - mathematical concepts and skills, and the ways in which they are connected across the strands, other grades, other disciplines, and the world outside the classroom;
    - instructional approaches and assessment strategies best suited to meet the learning needs of each student;
    - resources designed to support and enhance the achievement of and engagement with the curriculum expectations, while fostering an appreciation for and joy in mathematics learning.

ROLES AND RESPONSIBILITIES

STUDENTS

It is essential that all students continue to develop a sense of responsibility for and ownership of their own learning as they begin their journey through secondary school. Mastering the skills and concepts connected with learning in the mathematics curriculum requires a commitment to:

- continual and consistent personal reflection and goal setting;
- a belief that they are capable of succeeding in mathematics;
- developing the skills to persevere when taking on new challenges;
- connecting prior experiences, knowledge, skills, and habits of mind to new learning;
- a willingness to work both independently and collaboratively in an inclusive environment;
- dedication to ongoing practice;
- a willingness and an ability to receive and respond to meaningful feedback and ask questions to clarify understanding;
- a willingness to explore new learning in mathematics and share insights and experiences.

Through ongoing practice and reflection, all students can develop a strong and healthy mathematical identity whereby they value and appreciate mathematics as a discipline, feel themselves to be confident and competent mathematics learners, and understand what successful mathematics learning and being an effective mathematician look like.

Students' experiences influence their attitudes towards mathematics education and can have a significant impact on their engagement with mathematics learning and their subsequent success in achieving the expectations. Students who are engaged in their learning and who have opportunities to solve interesting, relevant, and meaningful problems within a supportive and inclusive learning environment are more likely to adopt practices and behaviours that support mathematical thinking. More importantly, they are more likely to be successful in their learning, which contributes to their enjoyment of mathematics and increases their desire to pursue further mathematics learning.

With teacher support and encouragement, students learn that they can apply the skills they acquire in mathematics to other contexts and subjects. For example, they can apply the problem-solving skills they develop in mathematics to their study of the science and Canadian and world studies curricula. They can also make connections between their learning and life beyond the classroom. For example, when presented with an issue or a contextually relevant STEM-based (science, technology, engineering, and mathematics–based) problem, they can look for potential applications of mathematical modelling. They can also begin to identify how mathematical modelling can be used to answer important questions related to global health, the environment, and sustainable, innovative development, or to address critical social and environmental issues that are relevant to their lives and communities.

TEACHERS

Teachers have the most important role in the success of students in mathematics. Teachers are responsible for ensuring that all students receive the highest quality of mathematics education. This requires them to have high academic expectations of all students, provide appropriate supports for learning, and believe that all students are capable math learners. Teachers bring expertise and skills to providing varied and equitable instructional and assessment approaches to the classroom. Teachers plan a mathematics program using an asset-based approach that affirms students' identities, reflects their lived experiences, leverages their strengths, and addresses their needs in order to ensure equitable, accessible, and engaging learning opportunities for every student. The attitude with which teachers themselves approach mathematics is critical, as teachers are important role models for students.

Teachers place students' well-being and academic success at the centre of their mathematics planning, teaching, and assessment practices, and understand how the learning experiences they provide will develop an appreciation of mathematics and foster a healthy attitude and engagement in all students.

Teachers have a thorough understanding of the mathematics content they teach, which enables them to provide relevant and responsive, high-quality mathematical opportunities through which all students can develop their understanding of mathematical knowledge, concepts, and skills. Teachers understand the learning continua along which students develop their mathematical thinking and, with effective use of direct instruction and high-quality mathematical tasks, can thus support all students' movement along these continua. Teachers provide ongoing meaningful feedback to all students about their mathematics learning and achievement, which helps to build confidence and provide focused next steps. Teachers support students in developing their ability to solve problems, reason mathematically, and connect the mathematics they are learning to the real world around them. They recognize the importance of emphasizing and illustrating the usefulness of mathematics in students' lives, and of integrating mathematics with other areas of the curriculum – such as making connections with science, engineering, art, and technology to answer scientific questions or solve problems, or engaging in political debate and community development. They recognize the importance of supporting students in learning about careers involving mathematics, and of supporting the development of students' mathematical agency to grow their identity as capable mathematical thinkers.

As part of effective teaching practice, teachers use multiple ways and both formal and informal means to communicate with parents and develop partnerships between home or caring adults and school that meet the varied needs of families. Through various types of communication, teachers discuss with parents or caring adults what their children are learning in mathematics at school. These communications also help teachers better understand students' mathematical experiences beyond the classroom, and learn more about students' interests, skills, and aspirations. Ongoing communication leads to stronger connections between the home, community, and school to support student learning and achievement in mathematics.

PRINCIPALS

Principals model the importance of lifelong learning and understand that mathematics plays a vital role in the future success of students. Principals provide instructional leadership for the successful implementation of the mathematics curriculum – in the school and in communications with parents – by emphasizing the importance of a well-planned mathematics program and high-quality mathematical instruction, by promoting the idea that all students are capable of becoming confident mathematics learners, and by encouraging a positive and proactive attitude towards mathematics and student agency in mathematics.

Principals work in partnership with teachers and parents to ensure that all students have access to the best possible educational experience. To support student learning, principals monitor the implementation of the Ontario mathematics curriculum. Principals ensure that English language learners are being provided the accommodations and/or modifications they require for success in the mathematics program. Principals are also responsible for ensuring that every student who has an Individual Education Plan (IEP) is receiving the modifications and/or accommodations described in their plan – in other words, for ensuring that the IEP is properly developed, implemented, and monitored.

Ensuring that teachers have the competence, agency, support, confidence, resources, and tools they need to deliver a high-quality program is essential. Principals collaborate with teachers and school and system leaders to develop professional learning opportunities that deepen teachers' curriculum knowledge, mathematical content knowledge for teaching, and pedagogy, and enhance their self-efficacy in teaching mathematics.

CURRICULUM EXPECTATIONS

The expectations identified for this course describe the knowledge, concepts, and skills that students are expected to acquire, demonstrate, and apply in their class work and tasks, on tests, in demonstrations, and in various other activities on which their achievement is assessed and evaluated.

Mandatory learning is described in the overall and specific expectations of the curriculum.

Two sets of expectations – overall expectations and specific expectations – are listed for each *strand*, or broad area of the curriculum. The strands in this course are lettered AA and A through F.

The *overall expectations* describe in general terms the knowledge and skills that students are expected to demonstrate by the end of the course. The *specific expectations* describe the expected knowledge, concepts, and skills in greater detail. The specific expectations are grouped under numbered subheadings, each of which indicates the strand and the overall expectation to which the group of specific expectations corresponds (e.g., "B2" indicates that the group relates to overall expectation 2 in strand B). This organization is not meant to imply that the expectations in any one group are achieved independently of the expectations in the other groups, nor is it intended to imply that learning the expectations happens in a linear, sequential way. The numbered headings are used merely as an organizational structure to help teachers focus on particular aspects of knowledge, concepts, and skills as they develop various lessons and learning activities for students. In the mathematics curriculum, additional subheadings are used within each group of expectations to identify the topics addressed in the strand.

The knowledge and skills described in the expectations in Strand A: Mathematical Thinking and Making Connections apply to all areas of course content and must be developed in conjunction with learning in strands B through F. Teachers should ensure that students develop the mathematics knowledge and skills in appropriate ways as they work to achieve the curriculum expectations in strands B through F. Students' application of the knowledge and skills described in Strand A must be assessed and evaluated as part of their achievement of the overall expectations in strands B through F.

Note: Strand AA: Social-Emotional Learning (SEL) Skills in Mathematics is an exception. It has a single overall expectation that is to be included in classroom instruction throughout the course, *but not in assessment, evaluation, or reporting*.

TEACHER SUPPORTS

The expectations are accompanied by "teacher supports", which may include examples, key concepts, teacher prompts, instructional tips, and/or sample tasks. These elements are intended to promote understanding of the intent of the specific expectations and are offered as illustrations for teachers. *The teacher supports do not set out requirements for student learning; they are optional, not mandatory*.

"Examples" are meant to illustrate the intent of the expectation, the kind of knowledge, concepts, or skills, the specific area of learning, the depth of learning, and/or the level of complexity that the expectation entails.

"Key concepts" identify the central principles and mathematical ideas that underpin the learning in that specific expectation.

"Teacher prompts" are sample guiding questions and considerations that can lead to discussions and promote deeper understanding.

"Instructional tips" are intended to support educators in delivering instruction that facilitates student learning related to the knowledge, concepts, and skills set out in the expectations.

"Sample tasks" are developed to model appropriate practice for the course. They provide possible learning activities for teachers to use with students and illustrate connections between the mathematical knowledge, concepts, and skills. Teachers can choose to draw on the sample tasks that are appropriate for their classrooms, or they may develop their own approaches that reflect a similar level of complexity and high-quality mathematical instruction. Whatever the specific ways in which the requirements outlined in the expectations are implemented in the classroom, they must, wherever possible, be inclusive and reflect the diversity of the student population and the population of the province. When designing inclusive learning tasks, teachers reflect on their own biases and incorporate their deep knowledge of the curriculum, as well as their understanding of the diverse backgrounds, lived experiences, and identities of students. Teachers will notice that some of the sample tasks address the requirements of the expectation they are associated with and incorporate mathematical knowledge, concepts, or skills described in expectations in other strands of the course. Some tasks are cross-curricular in nature and will cover expectations in other disciplines in conjunction with the mathematics expectations.

THE MATHEMATICAL PROCESSES

Students learn and apply the mathematical processes as they work to achieve the expectations outlined in the curriculum. All students are actively engaged in applying these processes throughout the course.

The mathematical processes that support effective learning in mathematics are as follows:

- problem solving
- reasoning and proving
- reflecting
- connecting
- communicating
- representing
- selecting tools and strategies

The mathematical processes can be understood as the processes through which all students acquire and apply mathematical knowledge, concepts, and skills. These processes are interconnected. Problem solving and communicating have strong links to all of the other processes. A problem-solving approach encourages students to reason their way to a solution or a new understanding. As students engage in reasoning, teachers further encourage them to pose questions, make conjectures, and justify solutions, orally and in writing. The communication and reflection that occur before, during, and after the process of problem solving support students as they work to articulate and refine their thinking and to examine the problem they are solving from different perspectives. This opens the door to recognizing the range of strategies that can be used to arrive at a solution. By understanding how others solve a problem, students can begin to reflect on their own thinking (a process known as "metacognition") and the thinking of others, as well as their own language use (a process known as "metalinguistic awareness"), and to consciously adjust their own strategies in order to make their solutions as efficient and accurate as possible.

The mathematical processes cannot be separated from the knowledge, concepts, and skills that students acquire throughout the course. All students problem solve, communicate, reason, reflect, and so on, as they develop the knowledge, the understanding of mathematical concepts, and the skills required in all strands.

PROBLEM SOLVING

Problem solving is central to doing mathematics. By learning to solve problems and by learning *through* problem solving, students are given, and create, numerous opportunities to connect mathematical ideas and to develop conceptual understanding. Problem solving forms the basis of effective mathematics programs that place all students' experiences and queries at the centre of mathematical learning. Therefore, problem solving should be the foundation of mathematical instruction. It is considered an essential process through which all students are able to achieve the expectations in mathematics and is an integral part of the Ontario mathematics curriculum.

Problem solving:

- increases opportunities for the use of critical thinking skills (e.g., selecting appropriate tools and strategies, estimating, evaluating, classifying, assuming, recognizing relationships, conjecturing, posing questions, offering opinions with reasons, making judgements) to develop mathematical reasoning;
- supports all students in developing their own mathematical identity;
- allows all students to use the varied mathematical knowledge and experiences they bring to school;
- supports all students in making connections among mathematical knowledge, concepts, and skills, and between situations inside and outside the classroom;
- has the potential to promote the collaborative sharing of ideas and strategies, and promotes talking about and interacting with mathematics;
- empowers students to use mathematics to address issues relevant to their lived realities;
- facilitates the use of creative-thinking skills when developing solutions and approaches;
- supports students in finding enjoyment in mathematics and becoming more confident in their ability to do mathematics.

Most importantly, when problem solving is done in a mathematical context relevant to students' experiences and/or derived from their own problem posing, it furthers their understanding of mathematics and develops their mathematical agency.

PROBLEM-SOLVING STRATEGIES

Problem-solving strategies are methods that can be used to solve problems of various types. Common problem-solving strategies include the following: simulating; making a model, picture, or diagram; using concrete materials; looking for a pattern; guessing and checking; making an organized list; making a table or chart; solving a simpler version of the problem; working backwards; and using logical reasoning. Teachers can support all students as they develop their use of these strategies by engaging with solving various kinds of problems – instructional problems, routine problems, and non-routine problems. As students develop their repertoire over time, they become more confident in posing their own questions, more mature in their problem-solving skills, and more flexible in using appropriate strategies when faced with new problem-solving situations.

REASONING AND PROVING

Reasoning and proving are integral to mathematics and involve students using their understanding of mathematical knowledge, concepts, and skills to justify their thinking. Proportional reasoning, algebraic reasoning, spatial reasoning, statistical reasoning, and probabilistic reasoning are all forms of mathematical reasoning. Students also use their understanding of numbers and operations, geometric properties, and measurement relationships to reason through solutions to problems. Students develop algebraic reasoning by generalizing understanding of numbers and operations, properties, and relationships between quantities. They develop functional thinking by generalizing patterns and non-numeric sequences and using inverse operations. Students may need to identify assumptions in order to begin working on a solution. Teachers can provide all students with learning opportunities where they must form mathematical conjectures and

then test or prove them to verify whether they hold true. Initially, students may rely on the viewpoints of others to justify a choice or an approach to a solution. As they develop their own reasoning skills, they will begin to justify or prove their solutions by providing evidence.

REFLECTING

Students reflect when they are working through a problem to monitor their thought process, to identify what is working and what is not working, and to consider whether their approach is appropriate or whether there may be a more effective approach. Students also reflect after they have solved a problem by considering the reasonableness of their answer and whether adjustments need to be made. Teachers can support all students as they develop their reflecting and metacognitive skills by asking questions that have them examine their thought processes. In an inclusive learning environment, students also reflect on their peers' thinking processes to further develop deep understanding. Students can also reflect on how their new knowledge can be applied to past and future problems in mathematics.

CONNECTING

Experiences that allow all students to make connections – to understand, for example, how knowledge, concepts, and skills from one strand of mathematics are related to those from another – will support students in grasping general mathematical principles. Through making connections, students learn that mathematics is more than a series of isolated skills and concepts and that they can use their learning in one area of mathematics to understand another, and to understand other disciplines. Recognizing the relationships between representations, concepts, and procedures also supports the development of deeper mathematical understanding. In addition, making connections between the mathematics they learn at school and its significance in their everyday lives supports students in deepening their understanding of mathematics and allows them to understand how useful and relevant it is in the world beyond the classroom.

COMMUNICATING

Communication is an essential process in learning mathematics. Students communicate for various purposes and for different audiences, such as the teacher, a peer, a group of students, the whole class, a community member or group, or their family. They may use oral, visual, written, or gestural communication. Students also acquire the language of mathematics and develop their communication skills, which includes expressing, understanding, and using appropriate mathematical terminology, symbols, conventions, and models, through meaningful interactions with each other.

For example, teachers can ask students to:

- illustrate their mathematical understanding in various ways, such as with diagrams and representations;
- share and clarify their ideas, understandings, and solutions;
- create and defend mathematical arguments;
- provide meaningful descriptive feedback to peers;
- pose and ask relevant questions.

Communication also involves active listening and responding mindfully with an awareness of socio-cultural contexts. Using Culturally Responsive and Relevant Pedagogy, teachers provide opportunities for all students to contribute to discussions about mathematics in the classroom. Effective classroom communication requires a supportive and inclusive environment in which all members of the class are invited to participate and are valued when they speak and when they question, react to, and elaborate on the statements of their peers and the teacher.

REPRESENTING

Students represent mathematical ideas and relationships and model situations using tools, pictures, diagrams, graphs, tables, numbers, words, and symbols. Some students may also be able to use other languages and/or digital and multimodal resources. Teachers recognize and value the variety of representations that students use, as each student may have different prior access to and experiences with mathematics. While encouraging student engagement and affirming the validity of their representations, teachers support students in reflecting on the appropriateness of their representations and refining them. Teachers support students as they make connections among various representations that are relevant to both the student and the audience they are communicating with, so that all students can develop a deeper understanding of mathematical concepts and relationships. All students are supported in using the different representations appropriately and as needed to model situations, solve problems, and communicate their thinking.

SELECTING TOOLS AND STRATEGIES

Students develop the ability to select appropriate tools, technology, and strategies to perform particular mathematical tasks, to investigate mathematical ideas, and to solve problems.

TOOLS

All students should be encouraged to select and use tools to illustrate mathematical ideas. Students come to understand that making their own representations is a powerful means of building understanding and of explaining their thinking to others. Using tools supports students as they:

- identify patterns and relationships;
- make connections between mathematical concepts and between concrete and abstract representations;
- test, revise, and confirm their reasoning;
- remember how they solved a problem;
- communicate their reasoning to others, including by gesturing.

TECHNOLOGY

A wide range of technological and digital tools can be used in many contexts for students to interact with as they learn and extend concepts, and do mathematics.

Students can use:

- computers, calculators, probes, and computer algebra systems to perform complex operations; create graphs; and collect, organize, and display data;
- digital tools, apps, and social media to investigate mathematical concepts and develop an understanding of mathematical relationships;
- statistical software to manipulate, analyse, represent, sort, and communicate real-life data sets of all sizes;
- coding software to better understand the structures and relationships of mathematics;
- dynamic geometry software and online geometry tools to develop spatial sense;
- computer programs to represent and simulate mathematical situations (i.e., mathematical modelling);
- communications technologies to support and communicate their thinking and learning;
- computers, tablets, and mobile devices to access mathematical information available on the websites of organizations around the world in the language of instruction and/or other languages and to develop information literacy.

Developing the ability to perform mental computations is an important aspect of student learning in mathematics. Students must, therefore, use technology with discretion, when it makes sense to do so. When students use technology in their mathematics learning, they should apply mental computation, reasoning, and estimation skills to predict and check the reasonableness of answers.

STRATEGIES

Problem solving often requires students to select an appropriate strategy. Students learn to use more efficient ways to reach a conclusion. For example, students can solve problems involving a linear relationship by extending a pattern using pictures, creating a table of values, or developing a general case and solving an equation. The selection of an appropriate strategy may also be based on feasibility. For example, students may choose to collect their own samples of data or access data collected in large amounts via computer programs.

THE STRANDS IN THE GRADE 9 MATHEMATICS COURSE

The Grade 9 mathematics course is designed to be inclusive of all students in order to facilitate their transition to learning at the secondary level by offering opportunities to broaden their knowledge and skills in mathematics. This approach allows students to make informed decisions in choosing future mathematics courses based on their interests and on requirements for future jobs, trades, and professions.

The Grade 9 mathematics course is organized into seven strands. Strand AA: Social-Emotional Learning (SEL) Skills in Mathematics focuses on a set of skills to be developed in the context of learning across all other strands. Strand A focuses on developing mathematical thinking and making connections to students' lived experiences as well as connecting curriculum to real-life applications as students acquire the mathematical concepts and skills set out in strands B through F. The remaining strands cover the interrelated content areas of number, algebra, data, geometry and measurement, and financial literacy. The Grade 9 mathematics course consolidates learning from the elementary grades and sets a foundation for learning in future secondary mathematics courses.

Strand AA: Social-Emotional Learning (SEL) Skills in Mathematics

This strand comprises a single overall expectation that is to be included in classroom instruction throughout the course, but not in assessment, evaluation, or reporting. Students are supported in exploring social-emotional learning skills in mathematics.

Strand A: Mathematical Thinking and Making Connections

Throughout the course, students apply the mathematical processes to develop conceptual understanding and procedural fluency while they engage in learning related to strands B through F. They also make connections between the mathematics they are learning and their lived experiences, various knowledge systems, and real-life applications, including employment and careers.

Strand B: Number

In this strand, students continue to make connections among various number systems, the cultural development of number concepts, and real-life applications. They will extend their learning about positive

fractions, positive decimal numbers, and integers to work with negative fractions and negative decimal numbers. Students also extend their knowledge and skills related to percentages, ratios, rates, and proportions to make further connections to real life.

Strand C: Algebra

In this strand, students continue to develop an understanding of algebra by making connections between algebra and numbers as they generalize relationships with algebraic expressions and equations. Students will extend and apply coding skills to dynamically represent situations, analyse mathematics concepts, and solve problems in various contexts. Students will be introduced to various representations of linear and non-linear relations that they will study in more depth in future secondary mathematics courses. Students develop an understanding of constant rate of change and initial values of linear relations, and solve related real-life problems.

Strand D: Data

In this strand, students extend their data literacy skills to examine the collection, representation, and use of data, as well as their implications in various contexts. Students consolidate and extend their understanding of data involving one and two variables and its connections to real life. Using data, students continue to apply the process of mathematical modelling to analyse real-life situations.

Strand E: Geometry and Measurement

In this strand, students make connections among various geometric properties and their real-life applications. Students analyse and create designs to extend their understanding of geometric relationships to include circle and triangle properties. Students solve problems using different units within and between various measurement systems, examine the relationships between the volume of cones and cylinders and of pyramids and prisms, and solve problems that involve the application of perimeter, area, surface area, and volume.

Strand F: Financial Literacy

In this strand, students analyse financial situations to explain how mathematics can be used to understand such situations and inform financial decisions. They extend their financial literacy knowledge to answer questions related to appreciation and depreciation, and explain how budgets can be modified based on changes in circumstances. Students compare the effects of different interest rates, down payments, and other factors associated with purchasing goods and services. Students use their learning from other strands to solve financial problems of interest.

SOME CONSIDERATIONS FOR PROGRAM PLANNING

Teachers consider many factors when planning a mathematics program that cultivates an inclusive environment in which all students can maximize their mathematical learning. This section highlights the

key strategies and approaches that teachers and school leaders should consider as they plan effective and inclusive mathematics programs. Additional information can be found in the "Considerations for Program Planning" section, which provides information applicable to all curricula.

INSTRUCTIONAL APPROACHES IN MATHEMATICS

Instruction in mathematics should support all students in acquiring the knowledge, skills, and habits of mind that they need in order to achieve the curriculum expectations and be able to enjoy and participate in mathematics learning for years to come.

Effective mathematics instruction begins with knowing the complex identities and profiles of the students, having high academic expectations for and of all students, providing supports when needed, and believing that all students can learn and do mathematics. Teachers incorporate Culturally Responsive and Relevant Pedagogy (CRRP) and provide authentic learning experiences to meet individual students' learning strengths and needs. Effective mathematics instruction focuses on the development of conceptual understanding and procedural fluency, skill development, and communication, as well as problem-solving skills. It takes place in a safe and inclusive learning environment, where all students are valued, empowered, engaged, and able to take risks, learn from mistakes, and approach the learning of mathematics in a confident manner. Instruction that is student centred and asset-based builds effectively on students' strengths to develop mathematical habits of mind, such as curiosity and open-mindedness; a willingness to question, to challenge and be challenged; and an awareness of the value of listening intently, reading thoughtfully, and communicating with clarity.

Learning should be relevant: embedded in the lived realities of all students and inspired by authentic, real-life contexts as much as possible. This approach allows students to develop key mathematical concepts and skills, to appreciate the beauty and wide-ranging nature of mathematics, and to realize the potential of mathematics to raise awareness and effect social change that is innovative and sustainable. A focus on making learning relevant supports students in their use of mathematical reasoning to make connections throughout their lives.

UNIVERSAL DESIGN FOR LEARNING (UDL) AND DIFFERENTIATED INSTRUCTION (DI)

Students in every mathematics classroom vary in their identities, lived experiences, personal interests, learning profiles, and readiness to learn new concepts and skills. Universal Design for Learning (UDL) and differentiated instruction (DI) are robust and powerful approaches to designing assessment and instruction to engage all students in mathematical tasks that develop conceptual understanding and procedural fluency. Providing each student with opportunities to be challenged and to succeed requires teachers to attend to student differences and provide flexible and responsive approaches to instruction. UDL and DI can be used in combination to help teachers respond effectively to the strengths and needs of all students.

The aim of the UDL framework is to assist teachers in designing mathematics programs and environments that provide all students with equitable access to the mathematics curriculum. Within this framework, teachers engage students in multiple ways in order to support them in becoming purposeful and motivated in their mathematics learning. Teachers take into account students' diverse learner profiles by designing tasks that offer individual choice, ensuring relevance and authenticity, providing graduated levels of challenge, and fostering collaboration in the mathematics classroom. Teachers also represent concepts and information in multiple ways to help students become resourceful and knowledgeable learners. For example, teachers use a variety of media to ensure that students are provided with alternatives for auditory and visual information; they clarify mathematics vocabulary and symbols; and they highlight patterns and big ideas to guide information processing. To support learners as they focus strategically on their learning goals, teachers create an environment in which learners can express themselves using a range of kinesthetic,

visual, and auditory strengths. For example, teachers can improve access to tools or assistive devices; vary ways in which students can respond and demonstrate their understanding of concepts; and support students in goal-setting, planning, and time-management skills related to their mathematics learning.

Designing mathematics tasks through UDL allows the learning to be "low floor, high ceiling" – that is, all students are provided with the opportunity to find their own entry point to the learning. Teachers can then support students in working at their own pace and provide further support as needed, while continuing to move student learning forward. Tasks that are intentionally designed to be low floor, high ceiling provide opportunities for students to use varied approaches and to continue to be engaged in learning with varied levels of complexity and challenge. This is an inclusive approach that is grounded in a growth mindset: the belief that everyone can do well in mathematics.

While UDL provides teachers with broad principles for planning mathematics instruction and learning experiences for a diverse group of students, DI allows them to address specific skills and learning needs. DI is rooted in assessment and involves purposefully planning varied approaches to teaching the content of the curriculum; to the processes (e.g., tasks and activities) that support students as they make sense of what they are learning; to the ways in which students demonstrate their learning and the outcomes they are expected to produce; and to the learning environment. DI is student centred and involves a strategic blend of whole-class, small-group, and individual learning activities to suit students' differing strengths, interests, and levels of readiness to learn. Attending to students' varied readiness for learning mathematics is an important aspect of differentiated teaching. Learners who are ready for greater challenges need support in aiming higher, developing belief in excellence, and co-creating problem-based tasks to increase the complexity while still maintaining joy in learning. Students who are struggling to learn a concept need to be provided with the scaffolding and encouragement to reach high standards. Through an asset-based approach, teachers focus on these learners' strengths, imbuing instructional approaches with a strong conviction that all students can learn. To make certain concepts more accessible, teachers can employ strategies such as offering students choice, and providing open-ended problems that are based on relevant real-life situations and supported with visual and hands-on learning. Research indicates that using differentiated instruction in mathematics classrooms can diminish inequities.

Universal Design for Learning and differentiated instruction are integral aspects of an inclusive mathematics program and the achievement of equity in mathematics education. More information on these approaches can be found in the ministry publication *Learning for All: A Guide to Effective Assessment and Instruction for All Students, Kindergarten to Grade 12* (2013).

HIGH-IMPACT PRACTICES

Teachers understand the importance of knowing the identities and profiles of all students and of choosing the instructional approaches that will best support student learning. The approaches that teachers employ vary according to both the learning outcomes and the needs of the students, and teachers choose from and use a variety of accessible, equitable high-impact instructional practices.

The thoughtful use of these high-impact instructional practices – including knowing when to use them and how they might be combined to best support the achievement of specific math goals – is an essential component of effective math instruction. Researchers have found that the following practices consistently have a high impact on teaching and learning mathematics:

- **Learning Goals, Success Criteria, and Descriptive Feedback.** Learning goals and success criteria outline the intention for the lesson and how this intention will be achieved to ensure teachers and students have a clear and common understanding of what is being learned and what success

looks like. The use of descriptive feedback involves providing students with the precise information they need in order to reach the intended learning goal.

- **Direct Instruction.** This is a concise, intentional form of instruction that begins with a clear learning goal. It is not a lecture or a show-and-tell. Instead, direct instruction is a carefully planned and focused approach that uses questioning, activities, or brief demonstrations to guide learning, check for understanding, and make concepts clear. Direct instruction prioritizes feedback and formative assessment throughout the learning process and concludes with a clear summary of the learning that can be provided in written form, orally, and/or visually.
- **Problem-Solving Tasks and Experiences.** It is an effective practice to use a problem, intentionally selected or created by the teacher or students, to introduce, clarify, or apply a concept or skill. This practice provides opportunities for students to demonstrate their agency by representing, connecting, and justifying their thinking. Students communicate and reason with one another and generate ideas that the teacher connects in order to highlight important concepts, refine existing understanding, eliminate unsuitable strategies, and advance learning.
- **Teaching about Problem Solving.** Teaching students about the process of problem solving makes explicit the critical thinking that problem solving requires. It involves teaching students to identify what is known and unknown, to draw on similarities and differences between various types of problems, and to use representations to model the problem-solving situation.
- **Tools and Representations.** The use of a variety of appropriate tools and representations supports a conceptual understanding of mathematics. Carefully chosen and used effectively, representations and tools such as manipulatives make math concepts accessible to a wide range of learners. At the same time, student interactions with representations and tools also give teachers insight into students' thinking and learning.
- **Math Conversations.** Effective mathematical conversations create opportunities for all students to express their mathematical thoughts and to engage meaningfully in mathematical talk by listening to and responding to the ideas of others. These conversations involve reasoning, proving, building on the thinking of others, defending and justifying their own thinking, and adjusting their perspectives as they build their mathematical understanding, confidence, and awareness of the mathematical thoughts of others.
- **Small-Group Instruction.** A powerful strategy for moving student learning forward, small-group instruction involves targeted, timely, and scaffolded mathematics instruction that meets the learning needs of specific students at appropriate times. By working with small and flexible groups, whether they are homogenous or heterogenous, teachers can personalize learning in order to close gaps that exist or extend thinking. Small-group instruction also provides opportunities for teachers to connect with and learn more about student identities, experiences, and communities, which the teachers can build on as a basis for their mathematics instruction.
- **Deliberate Practice.** Practice is best when it is purposeful and spaced over time. It must always follow understanding and should be continual and consistent. Teachers provide students with timely descriptive feedback to ensure that students know they are practising correctly and sufficiently. Students also need to practise metacognition, or reflecting on their learning, in order to become self-directed learners.
- **Flexible Groupings.** The intentional combination of large-group, small-group, partnered, and independent working arrangements, in response to student and class learning needs, can foster a rich mathematical learning environment. Creating flexible groupings in a mathematics class enables students to work independently of the teacher but with the support of their peers, and it strengthens collaboration and communication skills. Regardless of the size of the group, it is of utmost importance that individual students have ownership of their learning.

While a lesson may prominently feature one of these high-impact practices, other practices will inevitably also be involved. The practices are rarely used in isolation, nor is there any single "best" instructional practice. Teachers strategically choose the right practice, for the right time, in order to create an optimal

learning experience for all students. They use their socio-cultural awareness of themselves and their students, a deep understanding of the curriculum and of the mathematics that underpins the expectations, and a variety of assessment strategies to determine which high-impact instructional practice, or combination of practices, best supports the students. These decisions are made continually throughout a lesson. The appropriate use of high-impact practices plays an important role in supporting student learning.

More information can be found in the resource section on high-impact practices in mathematics.

When teachers effectively implement Universal Design for Learning, differentiated instruction, and high-impact practices in mathematics programs, they create opportunities for students to develop mathematics knowledge and skills, to apply mathematical processes, and to develop transferable skills that can be applied in other curricular areas.

THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN MATHEMATICS

The mathematics curriculum was developed with the understanding that the strategic use of technology is part of a balanced mathematics program. Technology can extend and enrich teachers' instructional strategies to support all students' learning in mathematics. Technology, when used in a thoughtful manner, can support and foster the development of mathematical reasoning, problem solving, and communication. For some students, technology is essential and required to access curriculum.

When using technology to support the teaching and learning of mathematics, teachers consider the issues of student safety, privacy, ethical responsibility, equity and inclusion, and well-being.

The strategic use of technology to support the achievement of the curriculum expectations requires a strong understanding of:

- the mathematical concepts being addressed;
- high-impact teaching practices that can be used, as appropriate, to achieve the learning goals;
- the capacity of the chosen technology to augment the learning, and how to use this technology effectively.

Technology (e.g., digital tools, computation devices, calculators, data-collection programs and coding environments) can be used specifically to support students' thinking in mathematics, to develop conceptual understanding (e.g., visualization using virtual graphing or geometry tools), and to facilitate access to information and allow better communication and collaboration (e.g., collaborative documents and web-based content that enable students to connect with experts and other students; language translation applications).

Coding has been introduced into the Grade 9 mathematics course as a continuum from the elementary mathematics curriculum. The elementary mathematics curriculum outlines a developmental progression for students to develop foundational coding skills. In Grade 9, students transition to using coding as a tool to interact with the mathematics they are learning. They use the skills developed in elementary to create and alter code in a multitude of coding environments including text-based programming languages, spreadsheets, computer algebra systems (CAS), and virtual graphing and geometry tools.

Technology can support English language learners in accessing mathematics terminology and ways of solving problems in their first language. Assistive technologies are critical in enabling some students with special education needs to have equitable access to the curriculum and in supporting their learning, and must be provided in accordance with a student's Individual Education Plan (IEP).

Technologies are important problem-solving tools. Computers and calculators are tools of mathematicians, and students should be given opportunities to select and use the learning tools that may be helpful or necessary for them as they search for their own solutions to problems.

Teachers understand the importance of technology and how it can be used to access and support learning for all students. Additional information can be found in the "The Role of Information and Communications Technology" subsection of "Considerations for Program Planning".

EDUCATION AND CAREER/LIFE PLANNING

Education and career/life planning supports students in their transition from secondary school to their initial postsecondary destinations, whether in apprenticeships, college, community living, university, or the workplace.

Mathematics teachers can support students in education and career/life planning by making authentic connections between the mathematics concepts students are learning in school and the knowledge and skills needed in different careers. These connections engage students' interest and allow them to develop an understanding of the usefulness of mathematics in the daily lives of workers.

Teachers can promote students' awareness of careers involving mathematics by exploring real-life applications of mathematics concepts and providing opportunities for career-related project work. Such activities allow students to investigate mathematics-related careers compatible with their interests, aspirations, and abilities.

Community members can also act as a valuable resource by sharing their career expertise and supporting students in understanding the relevance of mathematics to various fields of study and careers. Career fairs, guest speakers, and job-shadowing days can provide opportunities for students to identify and explore mathematics-related careers.

Students may need support to comprehend the wide variety of professions and careers where mathematical concepts and processes are used. For example:

- fractions and imperial measures are used in various trades and daily activities;
- rates and percentages are used in banking, investing, and currency exchange;
- ratios and proportions are used in architecture, engineering, construction, nursing, pharmacy practice, hair colouring techniques, and fields related to culinary arts;
- algebraic reasoning is used in the sciences and computer programming;
- geometry and measurement concepts are used in construction, civil engineering, and art; statistics are used in real estate, the retail sector, tourism and recreation, conservation, finance, insurance, sports management, and research.

Students should be made aware that mathematical literacy, problem solving, and the other skills and knowledge they learn in the mathematics classroom are valuable assets in an ever-widening range of jobs and careers in today's society. More information can be found in the "Education and Career/Life Planning" subsection of "Considerations for Program Planning".

PLANNING MATHEMATICS PROGRAMS FOR STUDENTS WITH SPECIAL EDUCATION NEEDS

Classroom teachers hold high expectations of all students and are the key educators in designing and supporting mathematics assessment and instruction for students with special education needs. They have a

responsibility to support all students in their learning and to work collaboratively with special education teachers, where appropriate, to plan, design and implement appropriate instructional and assessment accommodations and modifications in the mathematics program to achieve this goal. More information on planning for and assessing students with special education needs can be found in the "Planning for Students with Special Education Needs" subsection of "Considerations for Program Planning".

PRINCIPLES FOR SUPPORTING STUDENTS WITH SPECIAL EDUCATION NEEDS

The following principles guide teachers in effectively planning and teaching mathematics programs to students with special education needs, and also benefit all students:

- The teacher plays a critical role in student success in mathematics.
- It is important for teachers to develop an understanding of the general principles of how students learn mathematics.
- The learning expectations outline interconnected, developmentally appropriate key concepts and skills of mathematics across all of the strands.
- It is important to support students in making connections between procedural knowledge and conceptual understanding of mathematics.
- The use of concrete, visual, and virtual representations and tools is fundamental to learning mathematics and provides a way of representing both concepts and student understanding.
- The teaching and learning process involves ongoing assessment. Students with special education needs should be provided with various opportunities to demonstrate their learning and thinking in multiple ways.

An effective mathematics learning environment and program that addresses the mathematical learning needs of students with special education needs is purposefully planned with the principles of Universal Design for Learning in mind and integrates the following elements:

- knowing the student's cultural and linguistic background, strengths, interests, motivations, and needs in mathematics learning in order to differentiate learning and make accommodations and modifications as outlined in the student's Individual Education Plan;
- building the student's confidence and positive identity as a mathematics learner;
- valuing the student's prior knowledge and connecting what the student knows with what the student needs to learn;
- identifying and focusing on the connections between broad concepts in mathematics;
- connecting mathematics with familiar, relevant, everyday situations and providing rich and meaningful learning contexts;
- fostering a positive attitude towards mathematics and an appreciation of mathematics through multimodal means, including through the use of assistive technology and the performance of authentic tasks;
- implementing research-informed instructional approaches (e.g., Concrete – Semi-Concrete – Representational – Abstract) when introducing new concepts to promote conceptual understanding, procedural accuracy, and fluency;
- creating a balance of explicit instruction, problem solving within a student's zone of proximal development, learning in flexible groupings, and independent learning. Each instructional strategy should take place in a safe, supportive, and stimulating environment while taking into consideration that some students may require more systematic and intensive support, and more explicit and direct instruction, before engaging in independent learning;
- assessing student learning through observations, conversations with the students, and frequent use of low-stakes assessment check-ins and tools;
- providing immediate feedback in order to facilitate purposeful, correct practice that supports understanding of concepts and procedures, as well as efficient strategies;

- providing environmental, assessment, and instructional accommodations in order to maximize the student's learning (e.g., making available learning tools such as virtual manipulatives, computer algebra systems, and calculators; ensuring access to assistive technology), as well as modifications that are specified in the student's Individual Education Plan;
- building an inclusive community of learners and encouraging students with special education needs to participate in various mathematics-oriented class projects and activities;
- building partnerships with administrators and other teachers, particularly special education teachers, where available, to share expertise and knowledge of the curriculum expectations; co-develop content in the Individual Education Plan that is specific to mathematics; and systematically implement intervention strategies, as required, while making meaningful connections between school and home to ensure that what the student is learning in the school is relevant and can be practised and reinforced beyond the classroom.

PLANNING MATHEMATICS PROGRAMS FOR ENGLISH LANGUAGE LEARNERS

English language learners are working to achieve the curriculum expectations in mathematics while they are developing English-language proficiency. An effective mathematics program that supports the success of English language learners is purposefully planned with the following considerations in mind.

- Students' various linguistic identities are viewed as a critical resource in mathematics instruction and learning. Recognizing students' language resources and expanding linguistic competence enables students to use their linguistic repertoire in a fluid and dynamic way, mixing and meshing languages to communicate. This translingual practice is creative and strategic, and allows students to communicate, interact, and connect with peers and teachers using the full range of their linguistic repertoire, selecting features and modes that are most appropriate to communicate across a variety of purposes, such as when developing conceptual knowledge and when seeking clarity and understanding.
- Students may be negotiating between school-based mathematics and ways of mathematical reasoning from diverse cultural and linguistic backgrounds. They may have deep mathematical knowledge and skills developed in another educational cultural and/or linguistic context, and may already have learned the same mathematical terms and concepts that they are studying now, but in another language.
- Knowledge of the diversity among English language learners and of their mathematical strengths, interests, and identities, including their social and cultural backgrounds, is important. These "funds of knowledge" are historically and culturally developed skills and assets that can be incorporated into mathematics learning to create a richer and more highly scaffolded learning experience for all students, promoting a positive, inclusive teaching and learning environment. Understanding how mathematical concepts are described in students' home languages and cultures can provide insight into how students are thinking about mathematical ideas.
- In addition to assessing their level of English-language proficiency, an initial assessment of the mathematics knowledge and skills of newcomer English language learners is required in Ontario schools.
- Differentiated instruction is essential in supporting English language learners, who face the dual challenge of learning new conceptual knowledge while acquiring English-language proficiency. Designing mathematics learning to have the right balance for English language learners is achieved through program adaptations (e.g., accommodations that utilize their background knowledge in their first language) that ensure the tasks are mathematically challenging, reflective of learning demands within the mathematics curriculum, and comprehensible and accessible to English language learners. Using the full range of a student's language assets, including additional languages that a student speaks, reads, and writes, as a resource in the mathematics classroom

supports access to their prior learning, reduces the language demands of the mathematics curriculum, and increases engagement.
- Working with students and their families and with available community supports allows for the multilingual representation of mathematics concepts to create relevant and real-life learning contexts and tasks.

In a supportive learning environment, scaffolding the learning of mathematics assessment and instruction offers English language learners the opportunity to:

- integrate their linguistic repertoire rather than engage in language separation, and select and use the linguistic features and modes that are most appropriate for their communication purposes;
- discuss how mathematical concepts are described in their language(s) and cultures;
- draw on their additional language(s) (e.g., some newcomer students may use technology to access mathematical terminology and ways of solving problems in their first language), prior learning experiences, and background knowledge in mathematics;
- learn new mathematical concepts in authentic, meaningful, and familiar contexts;
- engage in open and parallel tasks to allow for multiple entry points for learning;
- work in a variety of settings that support co-learning and multiple opportunities for practice (e.g., with partners or in small groups with same-language peers, as part of cooperative or collaborative learning, in group conferences);
- access the language of instruction during oral, written, and multimodal instruction and assessment, during questioning, and when encountering texts, learning tasks, and other activities in mathematics;
- use oral language in different strategically planned activities, such as "think-pair-share", "turn-and-talk", and "adding on", to express their ideas and engage in mathematical discourse;
- develop both everyday and academic vocabulary, including specialized mathematics vocabulary in context, through rephrasing and recasting by the teacher and through using student-developed bilingual word banks or glossaries;
- practise using sentence frames adapted to their English-language proficiency levels to describe concepts, provide reasoning, hypothesize, make judgements, and explain their thinking;
- use a variety of concrete and/or digital learning tools to demonstrate their learning in mathematics in multiple ways (e.g., orally, visually, kinesthetically), through a range of representations (e.g., portfolios, displays, discussions, models), and in multiple languages (e.g., multilingual word walls and anchor charts);
- have their learning assessed in terms of the processes they use in multiple languages, both during the learning and through teachers' observations and conversations.

Strategies used to differentiate instruction and assessment for English language learners in the mathematics classroom also benefit many other learners in the classroom, since programming is focused on leveraging all students' strengths, meeting learners where they are in their learning, being aware of language demands in mathematics, and making learning visible. For example, different cultural approaches to solve mathematical problems can help students make connections to the Ontario curriculum and provide classmates with alternative ways of solving problems.

English language learners in English Literacy Development (ELD) programs require accelerated support to develop both their literacy skills and their numeracy skills. These students have significant gaps in their education because of limited or interrupted opportunities for or access to schooling. In order to build a solid foundation of mathematics, they are learning key mathematical concepts missed in prior years. At the same time, they are learning the academic language of mathematics in English while not having acquired developmentally appropriate literacy skills in their first language. Programming for these students is therefore highly differentiated and intensive. These students often require focused support over a longer period than students in English as a Second Language (ESL) programs. The use of students' oral

competence in languages other than English is a non-negotiable scaffold. The strategies described above, such as the use of visuals, the development of everyday and academic vocabulary, the use of technology, and the use of oral competence, are essential in supporting student success in ELD programs and in mathematics.

Supporting English language learners is a shared responsibility. Collaboration with administrators and other teachers, particularly ESL/ELD teachers, and Indigenous representatives, where possible, contributes to creating equitable outcomes for English language learners. Additional information on planning for and assessing English language learners can be found in the "Planning for English Language Learners" subsection of "Considerations for Program Planning".

CROSS-CURRICULAR AND INTEGRATED LEARNING IN MATHEMATICS

When planning an integrated mathematics program, educators should consider that, although the mathematical content in the curriculum is outlined in discrete strands, students develop mathematical thinking, such as proportional reasoning, algebraic reasoning, and spatial reasoning, that transcends the expectations in the strands and even connects to learning in other subject areas. By purposefully drawing connections across all areas of mathematics and other subject areas, and by applying learning to relevant real-life contexts, teachers extend and enhance student learning experiences and deepen their knowledge and skills across disciplines and beyond the classroom.

For example, proportional reasoning, which is developed through the study of ratios and rates in the Number strand, is also used when students are working towards meeting learning expectations in other strands of the math curriculum, such as in Geometry and Measurement and in Algebra, and in other disciplines, such as science, geography, and the arts. Students then apply this learning in their everyday lives – for example, when adjusting a recipe, preparing a mixture or solutions, or making unit conversions.

Similarly, algebraic reasoning is applied beyond the Number and Algebra strands. For example, it is applied in measurement when learning about formulas, such as . It is applied in other disciplines, such as science, when students study simple machines and learn about the formula $work = force \times distance$. Algebraic reasoning is also used when making decisions in everyday life – for example, when determining which service provider offers a better consumer contract or when calculating how much time it will take for a frozen package to thaw.

Spatial thinking has a fundamental role throughout the Ontario curriculum, from Kindergarten to Grade 12, including in mathematics, the arts, health and physical education, and science. For example, a student demonstrates spatial reasoning when mentally rotating and matching shapes in mathematics, navigating movement through space and time, and using diagonal converging lines to create perspective drawings in visual art and to design and construct objects. In everyday life, there are many applications of spatial reasoning, such as when creating a garden layout or when using a map to navigate the most efficient way of getting from point A to point B.

Algebraic and proportional reasoning and spatial thinking are integral to all STEM disciplines. For example, students may apply problem-solving skills and mathematical modelling through engineering design as they build and test a prototype and design solutions intended to solve complex real-life problems. Consider how skills and understanding that students gain across the strands of the Grade 9 Mathematics course, such as Financial Literacy, Number, and Data, can be integrated into real-life activities. For example, as students collect financial data relating to compound interest, and examine patterns in the data involving compound interest, they apply their understanding of exponents and non-linear growth to generalize rules that can be coded in technology programming environments. This process allows students to create a variety of mathematical models and analyse them quantitatively. These models can then be used to support

discussions about what factors can enable or constrain financial decision making, while taking ethical, societal, environmental, and personal considerations into account.

Teaching mathematics as a narrowly defined subject area places limits on the depth of learning that can occur. When teachers work together to develop integrated learning opportunities and highlight cross-curricular connections, students are better able to:

- make connections among the strands of the mathematics curriculum, and between mathematics and other subject areas;
- improve their ability to consider different strategies to solve a problem;
- debate, test, and evaluate whether strategies are effective and efficient;
- apply a range of knowledge and skills to solve problems in mathematics and in their daily experiences and lives.

When students are provided with opportunities to learn mathematics through real-life applications, integrating learning expectations from across the curriculum, they use their lived experiences and knowledge of other subject matter to enhance their learning of and engagement in mathematics. More information can be found in "Cross-Curricular and Integrated Learning".

LITERACY IN MATHEMATICS

Literacy skills needed for reading and writing in general are essential for the learning of mathematics. To engage in mathematical activities and develop computational fluency, students require the ability to read and write mathematical expressions, to use a variety of literacy strategies to comprehend mathematical text, to use language to analyse, summarize, and record their observations, and to explain their reasoning when solving problems. Mathematical expressions and other mathematical texts are complex and contain a higher density of information than any other text. Reading mathematical text requires literacy strategies that are unique to mathematics.

The learning of mathematics requires students to navigate discipline-specific reading and writing skills; therefore, it is important that mathematics instruction link literacy practices to specific mathematical processes and tasks. To make their thinking visible, students should be encouraged to clearly communicate their mathematical thinking, using the discipline-specific language of mathematics, which provides educators with the opportunity to correct student thinking when necessary. The language of mathematics includes special terminology. To support all students in developing an understanding of mathematical texts, teachers need to explicitly teach mathematical vocabulary, focusing on the many meanings and applications of the terms students may encounter. In mathematics, students are required to use appropriate and correct terminology and are encouraged to use language with care and precision in order to communicate effectively.

More information about the importance of literacy across the curriculum can be found in the "Literacy" and "Mathematical Literacy" subsections of "Cross-curricular and Integrated Learning".

TRANSFERABLE SKILLS IN MATHEMATICS

The Ontario curriculum emphasizes a set of skills that are critical to all students' ability to thrive in school, in the world beyond school, and in the future. These are known as transferable skills. Educators facilitate students' development of transferable skills across the curriculum, from Kindergarten to Grade 12. They are as follows:

- Critical Thinking and Problem Solving. In mathematics, students and educators learn and apply strategies to understand and solve problems flexibly, accurately, and efficiently. They learn to understand and visualize a situation and to use the tools and language of mathematics to reason, make connections to real-life situations, communicate, and justify solutions.

- Innovation, Creativity, and Entrepreneurship. In mathematics, students and educators solve problems with curiosity, creativity, and a willingness to take risks. They pose questions, make and test conjectures, and consider problems from different perspectives to generate new learning and apply it to novel situations.
- Self-Directed Learning. By reflecting on their own thinking and emotions, students, with the support of educators, can develop perseverance, resourcefulness, resilience, and a sense of self. In mathematics, they initiate new learning, monitor their thinking and their emotions when solving problems, and apply strategies to overcome challenges. They perceive mathematics as useful, interesting, and doable, and confidently look for ways to apply their learning.
- Collaboration. In mathematics, students and educators engage with others productively, respectfully, and critically in order to better understand ideas and problems, generate solutions, and refine their thinking.
- Communication. In mathematics, students and educators use the tools and language of mathematics to describe their thinking and to understand the world. They use mathematical vocabulary, symbols, conventions, and representations to make meaning, express a point of view, and make convincing and compelling arguments in a variety of ways, including multimodally; for example, using combinations of oral, visual, textual, and gestural communication.
- Global Citizenship and Sustainability. In mathematics, students and educators recognize and appreciate multiple ways of knowing, doing, and learning, and value different perspectives. They recognize how mathematics is used in all walks of life and how engaged citizens can use it as a tool to raise awareness and generate solutions for environmental and social justice issues.
- Digital Literacy. In mathematics, students and educators learn to be discerning users of technology. They select when and how to use tools to understand and model real-life situations, predict outcomes, and solve problems, and they assess and evaluate the reasonableness of their results.

Transferable skills can be developed through the effective implementation of high-impact instructional strategies. More information can be found in "Transferable Skills".

ASSESSMENT AND EVALUATION OF STUDENT ACHIEVEMENT

Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools, First Edition, Covering Grades 1 to 12, 2010 sets out the Ministry of Education's assessment, evaluation, and reporting policy. The policy aims to maintain high standards, improve student learning, and benefit all students, parents, and teachers in elementary and secondary schools across the province. Successful implementation of this policy depends on the professional judgement of teachers at all levels as well as their high expectations of all students, and on their ability to work together and to build trust and confidence among parents and students.

CULTURALLY RESPONSIVE AND RELEVANT ASSESSMENT AND EVALUATION IN MATHEMATICS

Culturally Responsive and Relevant Pedagogy (CRRP) reflects and affirms students' racial and social identities, languages, and family structures. It involves careful acknowledgement, respect, and understanding of the similarities and differences among students, and between students and teachers, in order to respond effectively to student thinking and promote student learning.

Engaging in assessment from a CRRP stance requires that teachers gain awareness of and interrogate their own beliefs about who a mathematical learner is and what they can achieve (see the questions for consideration provided below). In this process, teachers engage in continual self-reflection – and the critical analysis of various data – to understand and address the ways in which power and privilege affect the assessment and evaluation of student learning. Assessment from a CRRP stance starts with having a deep knowledge of every student and understanding of how they learn best. Teachers seek to build authentic,

trusting relationships with students, and with their families and community, as they seek opportunities to build new understanding and support equitable outcomes for all students.

Assessment from a CRRP stance, by its nature, encompasses a wide variety of assessment approaches. It is designed to reflect, affirm, and enhance the multiple ways of knowing and being that students bring to the classroom while maintaining appropriate and high academic expectations for all students. The primary purpose of assessment is to improve student learning. Assessment *for* learning creates opportunities for teachers to intentionally learn about each student and their sociocultural and linguistic background in order to gather a variety of evidence about their learning in an anti-racist, anti-discriminatory environment, in a way that is reflective of and responsive to each student's strengths, experiences, interests, and cultural ways of knowing. Ongoing descriptive feedback and responsive coaching for improvement is essential for improving student learning.

Teachers engage in assessment *as* learning by creating ongoing opportunities for all students to develop their capacity to be confident, independent, autonomous learners who set individual goals, monitor their own progress, determine next steps, and reflect on their thinking and learning in relation to learning goals and curriculum expectations. Teachers engage in culturally responsive and relevant practices by supporting students in the development of these skills by holding positive and affirming views of their students and of their ability to learn and achieve academic success. One way in which teachers differentiate assessment is by providing tasks that allow multiple entry points for all students to engage and that enable all students to access complex mathematics.

Assessment *of* learning is used by the teacher to summarize learning at a given point in time. This summary is used to make judgements about the quality of student learning on the basis of established criteria, to assign a value to represent that quality, and to support the communication of information about achievement to each student, parents, teachers, and others. Teachers engage in culturally responsive and relevant practices that honour and value the importance of student agency and voice in determining the variety of ways in which students can demonstrate their learning.

The evidence that is collected about student learning, including observations and conversations as well as student products, should reflect and affirm the student's lived experiences within their school, home, and community, learning strengths, and mathematical knowledge. This process of triangulating evidence of student learning allows teachers to improve the accuracy of their understanding with respect to how each student is progressing in their learning. Assessment that is rooted in CRRP is an equitable, inclusive, and transparent process that values students as active participants in their learning.

When teachers engage in the process of examining their own biases regarding classroom assessment and evaluation practices, they might consider some of the following questions:

- Are the tasks accessible to, and inclusive of, all learners? Do the tasks include appropriate and varied entry points for all students?
- Do the tasks connect to students' prior learning and give them opportunities to be sense makers and to integrate their new learning? Do the selected tasks reflect students' identities and lived experiences?
- Do all students have equitable access to the tools they need to complete the tasks being set?
- What opportunities can teachers build into their practice to offer students descriptive feedback to enhance learning? Are graded assessment tasks used in a way that complements the use of descriptive feedback for growth?
- How can information be conveyed about students' learning progress to students and parents in an ongoing and meaningful way?
- What is the purpose of assigning and grading a specific task or activity? Are student choice and agency considered?

- How do teacher biases influence decisions about what tasks or activities are chosen for assessment?

COURSE OUTLINE

Unit	Topics	Expectations Covered	Time
Cycle 1	Introduction Number Systems; Order of Operations; Integers Fractions Coding Algebraic Expressions: Translating, Evaluating, Adding/Subtracting The Cartesian Plane Talking About Scatter Plots Working with Powers Measurement of Composite Shapes	AA, A1, A2, B1.2, B2.1, B3.1, B3.2, B3.3, B3.4, C1.2, C1.3, C1.4, C1.5, D1.3, E1.3	22 hrs
Cycle 2	1-Step and 2-Step Equations Rates, Percentages & Proportions Slope Rate of Change Coding Multiplying and Dividing Powers Powers of Powers Measurement Conversions Right Triangles Angle and Triangle Properties Budgets	B2.2, B3.3, B3.4, B3.5, C1.2, C1.4, C1.5, C3.1, C3.2, E1.1, E1.2, E1.3, E1.5, F1.4	22 hrs
Cycle 3	Measurement and Percentages in the Real World Equations with Variables on Both Sides Negative Exponents Growing Patterns Coding Slope Formula Equation of the Line Intersecting Lines & Special Lines	B2.1, B3.3, B3.4, B3.5, C1.2, C1.3, C1.4, C1.5, C3.1, C3.2, C3.3, C4.4, D2.2, D2.3, D2.4, D2.5, E1.3, E1.4, F1.2, F1.3	22 hrs
Cycle 4	Multiplying and Dividing Monomials Changing Dimensions Solving Equations with Fractions and Distribution Linear vs. Nonlinear Graphs Coding Special Lines Equation of Lines with Slope and a Point Equation of Lines with 2 Points	B2.2, B3.3, B3.4, B3.5, C1.4, C1.5, C2, C3.1, C4.2, C4.4, D1.3, E1.3, E1.4	22 hrs
Cycle 5	Linear vs. Nonlinear Relations Determining the Point of Intersection with an Equation Coding Application of Exponent Laws Factoring and Algebra Tangents and Chords	B2.1, B2.2, C1.4, C3.1, C3.3, D2.4, E1.2, E1.5	22 hrs

APPENDIX 1 – ACHIEVEMENT CHART

Knowledge & Understanding – Subject-specific content acquired in the course (knowledge), and the comprehension of its meaning and significance (understanding)				
Categories	**50–59% (Level 1)**	**60–69% (Level 2)**	**70–79% (Level 3)**	**80–100% (Level 4)**
Knowledge of content (e.g., terminology, procedural skills, mathematical models)	Demonstrates limited knowledge of content	Demonstrates some knowledge of content	Demonstrates considerable knowledge of content	Demonstrates thorough knowledge of content
Understanding of content (e.g., concepts, principles, mathematical structures and processes)	Demonstrates limited understanding of content	Demonstrates some understanding of content	Demonstrates considerable understanding of content	Demonstrates thorough understanding of content
Thinking and Investigation – The use of critical and creative thinking skills and/or processes				
Categories	**50–59% (Level 1)**	**60–69% (Level 2)**	**70–79% (Level 3)**	**80–100% (Level 4)**
Use of planning skills (e.g., understanding the problem; generating ideas; formulating a plan of action; selecting strategies, models, and tools; making conjectures and hypotheses)	Uses planning skills with limited effectiveness	Uses planning skills with some effectiveness	Uses planning skills with considerable effectiveness	Uses planning skills with a high degree of effectiveness
Use of processing skills (e.g., carrying out a plan: collecting data, questioning, testing, revising, modelling, solving, inferring, forming conclusions; looking back at a solution: evaluating reasonableness, making arguments in support of a solution, reasoning, justifying, proving, reflecting)	Uses processing skills with limited effectiveness	Uses processing skills with some effectiveness	Uses processing skills with considerable effectiveness	Uses processing skills with a high degree of effectiveness
Use of critical/creative thinking processes (e.g., posing and solving problems, critiquing solutions, using mathematical reasoning, evaluating mathematical models, making inferences and testing conjectures and hypotheses)	Uses critical/creative thinking processes with limited effectiveness	Uses critical/creative thinking processes with some effectiveness	Uses critical/creative thinking processes with considerable effectiveness	Uses critical/creative thinking processes with a high degree of effectiveness

Communication – The conveying of meaning through various forms				
Categories	**50–59% (Level 1)**	**60–69% (Level 2)**	**70–79% (Level 3)**	**80–100% (Level 4)**
Expression and organization of ideas and information in oral, visual, and/or written forms (e.g., pictorial, graphic, dynamic, numeric, algebraic forms; gestures and other nonverbal forms; models)	Expresses and organizes ideas and information with limited effectiveness	Expresses and organizes ideas and information with some effectiveness	Expresses and organizes ideas and information with considerable effectiveness	Expresses and organizes ideas and information with a high degree of effectiveness
Communication for different audiences and purposes (e.g., to share mathematical thinking, to inform, to persuade, to share findings) **in oral, visual, and/or written forms**	Communicates for different audiences and purposes with limited effectiveness	Communicates for different audiences and purposes with some effectiveness	Communicates for different audiences and purposes with considerable effectiveness	Communicates for different audiences and purposes with a high degree of effectiveness
Use of conventions, vocabulary, and terminology of the discipline in oral, visual, and/or written forms (e.g., terms, symbols, units, labels, structures)	Uses conventions, vocabulary, and terminology with limited effectiveness	Uses conventions, vocabulary, and terminology with some effectiveness	Uses conventions, vocabulary, and terminology with considerable effectiveness	Uses conventions, vocabulary, and terminology with a high degree of effectiveness
Application – The use of knowledge and skills to make connections within and between various contexts				
Categories	**50–59% (Level 1)**	**60–69% (Level 2)**	**70–79% (Level 3)**	**80–100% (Level 4)**
Application of knowledge and skills (e.g., selecting and using representations, mathematical tools, and strategies) **in familiar contexts**	Applies knowledge and skills in familiar contexts with limited effectiveness	Applies knowledge and skills in familiar contexts with some effectiveness	Applies knowledge and skills in familiar contexts with considerable effectiveness	Applies knowledge and skills in familiar contexts with a high degree of effectiveness
Transfer of knowledge and skills (e.g., selecting and using representations, mathematical tools, and strategies) **to new contexts**	Transfers knowledge and skills to new contexts with limited effectiveness	Transfers knowledge and skills to new contexts with some effectiveness	Transfers knowledge and skills to new contexts with considerable effectiveness	Transfers knowledge and skills to new contexts with a high degree of effectiveness
Making connections within and between various contexts (e.g., connections to real-life situations; connections among concepts and representations;connections between mathematics and other disciplines, including other STEM subjects)	Makes connections within and between various contexts with limited effectiveness	Makes connections within and between various contexts with some effectiveness	Makes connections within and between various contexts with considerable effectiveness	Makes connections within and between various contexts with a high degree of effectiveness

APPENDIX 2 - LEARNING SKILLS & WORK HABITS

LEARNING SKILLS AND WORK HABITS IN GRADES 1 TO 12

Learning Skills and Work Habits	Sample Behaviours
Responsibility	The student: • fulfils responsibilities and commitments within the learning environment; • completes and submits class work, homework, and assignments according to agreed-upon timelines; • takes responsibility for and manages own behaviour.
Organization	The student: • devises and follows a plan and process for completing work and tasks; • establishes priorities and manages time to complete tasks and achieve goals; • identifies, gathers, evaluates, and uses information, technology, and resources to complete tasks.
Independent Work	The student: • independently monitors, assesses, and revises plans to complete tasks and meet goals; • uses class time appropriately to complete tasks; • follows instructions with minimal supervision.
Collaboration	The student: • accepts various roles and an equitable share of work in a group; • responds positively to the ideas, opinions, values, and traditions of others; • builds healthy peer-to-peer relationships through personal and media-assisted interactions; • works with others to resolve conflicts and build consensus to achieve group goals; • shares information, resources, and expertise and promotes critical thinking to solve problems and make decisions.
Initiative	The student: • looks for and acts on new ideas and opportunities for learning; • demonstrates the capacity for innovation and a willingness to take risks; • demonstrates curiosity and interest in learning; • approaches new tasks with a positive attitude; • recognizes and advocates appropriately for the rights of self and others.
Self-regulation	The student: • sets own individual goals and monitors progress towards achieving them; • seeks clarification or assistance when needed; • assesses and reflects critically on own strengths, needs, and interests; • identifies learning opportunities, choices, and strategies to meet personal needs and achieve goals; • perseveres and makes an effort when responding to challenges.