THE ONTARIO CURRICULUM

GRADES 1–8

Science and Technology 2022

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- the Program Planning and Assessment and Evaluation sections of the Curriculum and Resources website that apply to all Ontario curriculum, Grades 1–12;
- the Curriculum Context that is specific to a discipline;
- the strands of the curriculum; and
- glossaries and appendices as applicable.

The Ontario Curriculum, Grades 1–8: Science and Technology, 2022

Last issued: March 2022

This curriculum policy replaces *The Ontario Curriculum, Grades 1–8: Science and Technology, 2007*. Beginning in September 2022, all science and technology programs for Grades 1 to 8 will be based on the expectations outlined in this curriculum policy.

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Program Planning and Assessment and Evaluation Content

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This content is part of official issued curriculum providing the most up-to-date information (i.e., front matter). This content is applicable to all curriculum documents, Grades 1 to 12. Educators must consider this information to guide the implementation of curriculum and in creating the environment in which it is taught.

Contents

Considerations for program planning....6
Introduction....6
Student Well-Being and Mental Health....6
Instructional Approaches....8
Planning for Students with Special Education Needs....9
Planning for English Language Learners....13
Healthy Relationships....16
Human Rights, Equity, and Inclusive Education....17
The Role of the School Library....19
The Role of Information and Communications Technology....20
Education and Career/Life Planning....20
Experiential Learning....21
Pathways to a Specialist High Skills Major (SHSM)....22
Health and Safety....23
Ethics....24
Cross-curricular and integrated learning....26
Introduction....26
Integrated Learning....26
Financial Literacy....27
STEM Education....28
Indigenous Education....29
Literacy....30
Critical Thinking and Critical Literacy....31
Mathematical Literacy....32
Environmental Education....33
Social-Emotional Learning Skills....34
Transferable skills....36
Introduction....36
Critical Thinking and Problem Solving....37
Innovation, Creativity, and Entrepreneurship....38
Self-Directed Learning....38

Collaboration 39
Communication 39
Global Citizenship and Sustainability 40
Digital Literacy 41
Assessment and Evaluation 42
Introduction 42
Fundamental Principles 42
Learning Skills and Work Habits 43
Content Standards and Performance Standards 43
Assessment “for Learning” and “as Learning” 44
Evaluation 44
Reporting Student Achievement 45
Categories of Knowledge and Skills 46
Criteria and Descriptors 47
Levels of Achievement 47
Sample Achievement Charts 48
Curriculum context for Science and Technology 57
Preface 57
Vision and Goals 57
The Importance of STEM Education 59
Curiosity and Wonder in Science and Technology 60
The Program in Science and Technology 61
Fundamental Concepts and “Big Ideas” in Science and Technology 63
The Strands and Topics in the Science and Technology Curriculum 66
Scientific and Engineering Design Processes 69
Program Planning and Cross-Curricular and Integrated Learning in Science and Technology 79
Assessment and Evaluation of Student Achievement 86
Science and Technology, Grade 1 91
Science and Technology, Grade 2 102
Science and Technology, Grade 3 113
Science and Technology, Grade 4 124
Science and Technology, Grade 5 135
Science and Technology, Grade 6 146

Science and Technology, Grade 7.....157
Science and Technology, Grade 8.....168

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Considerations for program planning

Introduction

Ontario elementary and secondary schools strive to support high-quality learning and student well-being. Schools give individual students the opportunity to learn in ways that are best suited to their individual strengths and needs. At the secondary level, students' ability to thrive academically and personally is also supported by their ability to choose courses and programs that best suit their skills, interests, and preferred postsecondary destinations.

Educators plan teaching and learning in every subject and discipline so that the various needs of all students are addressed and so that students can see themselves reflected in classroom resources and activities. This section highlights the key strategies and policies that educators and school leaders consider as they plan effective and inclusive programs for all students.

Student Well-Being and Mental Health

Promoting the healthy development of all students, as well as enabling all students to reach their full potential, is a priority for educators across Ontario. Students' health and well-being contribute to their ability to learn in all disciplines, and that learning in turn contributes to their overall well-being. A well-rounded educational experience prioritizes well-being and academic success for all students by promoting physical and mental health, social-emotional learning, and inclusion. Parents, community partners, and educators all play critical roles in creating this educational experience.

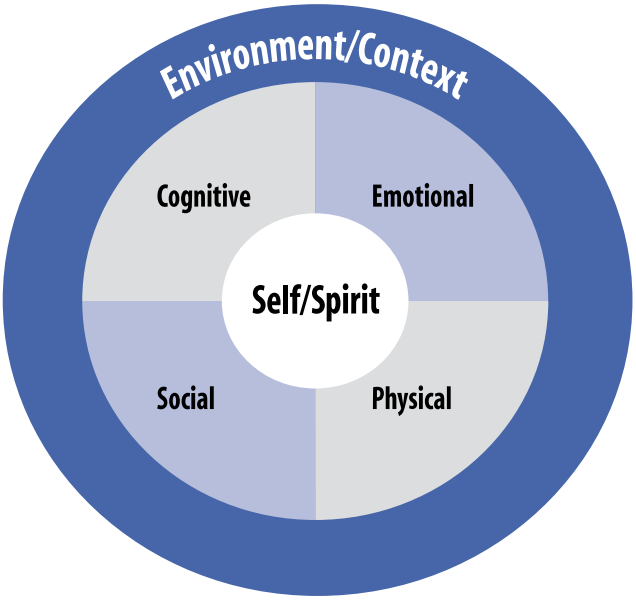
Educators support the well-being of children and youth by creating, fostering, and sustaining a learning environment that is healthy, caring, safe, inclusive, and accepting. A learning environment of this kind supports not only students' cognitive, emotional, social, and physical development but also their sense of self and/or spirit, their mental health, their resilience, and their overall state of well-being. All this will help them achieve their full potential in school and in life.

A variety of factors, known as "determinants of health", have been shown to affect a person's overall state of well-being. Some of these are income, education and literacy, gender and culture, physical and social environment, personal health practices and coping skills, and availability of health services. Together, these factors influence not only whether individuals are physically healthy but also the extent to which they will have the physical, social, and personal resources needed to cope and to identify and achieve personal aspirations. These factors also have an impact on student learning, and it is important to be aware of them as factors contributing to a student's performance and well-being.

An educator's awareness of and responsiveness to students' cognitive, emotional, social, and physical development, and to their sense of self and/or spirit, is critical to their success in school. A number of

research-based frameworks, including those described in *Early Learning for Every Child Today: A Framework for Ontario Early Childhood Settings, 2007*, *On My Way: A Guide to Support Middle Years Childhood Development, 2017*, and *Stepping Stones: A Resource on Youth Development, 2012*, identify developmental stages that are common to the majority of students from Kindergarten to Grade 12. At the same time, these frameworks recognize that individual differences, as well as differences in life experiences and exposure to opportunities, can affect development, and that developmental events are not specifically age dependent.

The framework described in *Stepping Stones* is based on a model that illustrates the complexity of human development. Its components – the cognitive, emotional, physical, and social domains – are interrelated and interdependent, and all are subject to the influence of a person's environment or context. At the centre is an "enduring (yet changing) core" – a sense of self, and/or spirit – that connects the different aspects of development and experience (p. 17).



Source: *Stepping Stones: A Resource on Youth Development*, p. 17

Educators who have an awareness of a student's development are taking all of the components into account. They focus on the following elements of each component:

- ***cognitive development*** – brain development, processing and reasoning skills, use of strategies for learning
- ***emotional development*** – emotional regulation, empathy, motivation
- ***social development*** – self-development (self-concept, self-efficacy, self-esteem); identity formation (gender identity, social group identity, spiritual identity); relationships (peer, family, romantic)
- ***physical development*** – physical activity, sleep patterns, changes that come with puberty, body image, nutritional requirements

The Role of Mental Health and Well-Being

Mental health and well-being touch all components of development. Mental health is much more than the absence of mental illness. Well-being depends not only on the absence of problems and risks but also on the presence of factors that contribute to healthy growth and development. By nurturing and supporting students' strengths and assets, educators help promote positive mental health and well-being in the classroom. At the same time, they can identify students who need additional support and connect them with the appropriate supports and services.

What happens at school can have a significant influence on a student's overall well-being. With a broader awareness of mental health, educators can plan instructional strategies that contribute to a supportive classroom climate for learning in all subject areas, build awareness of mental health, and reduce stigma associated with mental illness. Taking students' well-being, including their mental health, into account when planning instructional approaches helps establish a strong foundation for learning and sets students up for success.

Instructional Approaches

Effective instruction is key to student success. To provide effective instruction, teachers need to consider what they want students to learn, how they will know whether students have learned it, how they will design instruction to promote the learning, and how they will respond to students who are not making progress.

When planning what students will learn, teachers identify the main concepts and skills described in the curriculum expectations, consider the contexts in which students will apply the learning, and determine students' learning goals.

Instructional approaches should be informed by evidence from current research about instructional practices that are effective in the classroom. For example, research has provided compelling evidence about the benefits of explicitly teaching strategies that can help students develop a deeper understanding of concepts. Strategies such as "compare and contrast" (e.g., through Venn diagrams and comparison matrices) and the use of analogy enable students to examine concepts in ways that help them see what the concepts *are* and what they *are not*. Although such strategies are simple to use, teaching them explicitly is important in order to ensure that all students use them effectively.

A well-planned instructional program should always be at the student's level, but it should also push the student towards their optimal level of challenge for learning, while providing support and anticipating and directly teaching skills that are required for success.

A Differentiated Approach to Teaching and Learning

A differentiated approach to teaching and learning is an important part of a framework for effective classroom practice. It involves adapting instruction and assessment to suit individual students' interests, learning preferences, and readiness in order to promote learning.

An understanding of students' strengths and needs, as well as of their backgrounds, life experiences, and possible emotional vulnerabilities, can help teachers identify and address the diverse strengths and needs of their students. Teachers continually build their aware-ness of students' learning strengths and needs by observing and assessing their readiness to learn, their interests, and their learning styles and preferences. As teachers develop and deepen their understanding of individual students, they can respond more effectively to each student's needs by differentiating instructional approaches – for example, by adjusting the method or pace of instruction, using different types of resources, allowing a wider choice of topics, or even adjusting the learning environment, if appropriate, to suit the way the student learns and how the student is best able to demonstrate learning. Differentiation is planned as part of the overall learning design, but it also includes making adaptations during the teaching and learning process based on "assessment for learning". Common classroom strategies that support differentiated instruction include cooperative learning, project-based approaches, problem-based approaches, and explicit instruction. Unless students have an Individual Education Plan with modified expectations, *what* they learn continues to be guided by the curriculum expectations and is the same for all students.

Lesson Design

Effective lesson design involves several important elements. Teachers engage students in a lesson by activating their prior learning and experiences, clarifying the purpose for learning, and making connections to contexts that will help them see the relevance and usefulness of what they are learning. Teachers select instructional strategies to effectively introduce concepts, and consider how they will scaffold instruction in ways that will best meet the needs of their students. At the same time, they consider when and how to check students' understanding and to assess their progress towards achieving their learning goals. Teachers provide multiple opportunities for students to apply their knowledge and skills and to consolidate and reflect on their learning. A three-part lesson design (e.g., "Minds On, Action, and Consolidation") is often used to structure these elements. Effective lesson design also incorporates culturally responsive and relevant pedagogy (CRRP), which recognizes that all students learn in ways that are connected to background, language, family structure, and social or cultural identity. CRRP is discussed more fully in the section Equity and Inclusive Education.

Planning for Students with Special Education Needs

Classroom teachers are the key educators of students with special education needs. They have a responsibility to help *all* students learn, and they work collaboratively with special education teachers

and educational assistants, where appropriate, to achieve this goal. Classroom teachers commit to assisting every student to prepare for living with the highest degree of independence possible.

Learning for All: A Guide to Effective Assessment and Instruction for All Students, Kindergarten to Grade 12, 2013 describes a set of beliefs, based in research, that should guide program planning for students with special education needs. Teachers planning programs or courses in all disciplines need to pay particular attention to these beliefs, which are as follows:

- All students can succeed.
- Each student has their own unique patterns of learning.
- Successful instructional practices are founded on evidence-based research, tempered by experience.
- Universal design[1] and differentiated instruction[2] are effective and interconnected means of meeting the learning or productivity needs of any group of students.
- Classroom teachers are the key educators for a student's literacy and numeracy development.
- Classroom teachers need the support of the larger community to create a learning environment that supports students with special education needs.
- Fairness is not sameness.

In any given classroom, students may demonstrate a wide range of strengths and needs. Teachers plan programs that are attuned to this diversity and use an integrated process of assessment and instruction that responds to the unique strengths and needs of each student. An approach that combines principles of universal design and differentiated instruction enables educators to provide personalized, precise teaching and learning experiences for all students.

In planning programs or courses for students with special education needs, teachers should begin by examining both the curriculum expectations in the grade or course appropriate for the individual student and the student's particular strengths and learning needs to determine which of the following options is appropriate for the student:

- no accommodations[3] or modified expectations; or
- accommodations only; or

[1] The goal of Universal Design for Learning (UDL) is to create a learning environment that is open and accessible to all students, regardless of age, skills, or situation. Instruction based on principles of universal design is flexible and supportive, can be adjusted to meet different student needs, and enables all students to access the curriculum as fully as possible.

[2] Differentiated instruction is effective instruction that shapes each student's learning experience in response to the student's particular learning preferences, interests, and readiness to learn. See the section Instructional Approaches for more information.

[3] "Accommodations" refers to individualized teaching and assessment strategies, human supports, and/or individualized equipment (see *Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools, First Edition, Covering Grades 1 to 12, 2010*, p. 72).

- modified expectations, with the possibility of accommodations; or
- alternative expectations, which are not derived from the curriculum expectations for the grade or course and which constitute alternative programs and/or courses.

If the student requires either accommodations or modified expectations, or both, the relevant information, as described in the following paragraphs, must be recorded in their Individual Education Plan (IEP). More detailed information about planning programs for students with special education needs, including students who require alternative programs[4] and/or courses, can be found in *Special Education in Ontario, Kindergarten to Grade 12: Policy and Resource Guide, 2017 (Draft)* (referred to hereafter as *Special Education in Ontario, 2017*). For a detailed discussion of the ministry's requirements for IEPs, see Part E of *Special Education in Ontario*.

Students Requiring Accommodations Only

Some students with special education needs are able, with certain "accommodations", to participate in the regular grade or course curriculum and to demonstrate learning independently. Accommodations allow the student with special education needs to access the curriculum without changes to the regular expectations. Any accommodations that are required to facili-tate the student's learning must be identified in the student's IEP (*Special Education in Ontario, 2017,* p. E38). A student's IEP is likely to reflect the same required accommodations for many, or all, subjects or courses.

Providing accommodations to students with special education needs should be the first option considered in program planning. Instruction based on principles of universal design and differentiated instruction focuses on providing accommodations to meet the diverse needs of learners.

There are three types of accommodations:

- *Instructional accommodations* are changes in teaching strategies, including styles of presentation, methods of organization, or use of technology and multimedia. Some examples include the use of graphic organizers, photocopied notes, adaptive equipment, or assistive software.
- *Environmental accommodations* are changes that the student may require in the classroom and/or school environment, such as preferential seating or special lighting.
- *Assessment accommodations* are changes in assessment procedures that enable the student to demonstrate their learning, such as allowing additional time to complete tests or assignments or permitting oral responses to test questions.

(For more examples, see page E39 of *Special Education in Ontario, 2017*.)

If a student requires "accommodations only", assessment and evaluation of their achievement will be based on the regular grade or course curriculum expectations and the achievement levels outlined for

[4] Alternative programs are identified on the IEP by the term "alternative (ALT)".

the particular curriculum. The IEP box on the student's Provincial Report Card will not be checked, and no information on the provision of accommodations will be included.

Students Requiring Modified Expectations

Modified expectations for most students with special education needs will be based on the regular grade or course expectations, with changes in the number and/or complexity of the expectations. Modified expectations must represent specific, realistic, observable, and measurable goals, and must describe specific knowledge and/or skills that the student can demonstrate independently, given the appropriate assessment accommodations.

It is important to monitor, and to reflect clearly in the student's IEP, the extent to which expectations have been modified. At the secondary level, the principal will determine whether achievement of the modified expectations constitutes successful completion of the course, and will decide whether the student is eligible to receive a credit for the course. This decision must be communicated to the parents and the student.

Modified expectations must indicate the knowledge and/or skills that the student is expected to demonstrate and that will be assessed in each reporting period (*Special Education in Ontario, 2017,* p. E27). Modified expectations should be expressed in such a way that the student and parents can understand not only exactly what the student is expected to know or be able to demonstrate independently, but also the basis on which the student's performance will be evaluated, resulting in a grade or mark that is recorded on the Provincial Report Card. The student's learning expectations must be reviewed in relation to the student's progress at least once every reporting period, and must be updated as necessary (*Special Education in Ontario, 2017,* p. E28).

If a student requires modified expectations, assessment and evaluation of their achievement will be based on the learning expectations identified in the IEP and on the achievement levels outlined under Levels of Achievement in the "Assessment and Evaluation" section.

Elementary: The IEP box on the Elementary Progress Report Card and the Elementary Provincial Report Card must be checked for any subject in which the student requires modified expectations, and, on the Elementary Provincial Report Card, the appropriate statement from *Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools, First Edition, Covering Grades 1 to 12, 2010,* page 61, must be inserted.

Secondary: If some of the student's learning expectations for a course are modified but the student is working towards a credit for the course, it is sufficient simply to check the IEP box on the Provincial Report Card, Grades 9–12. If, however, the student's learning expectations are modified to such an extent that the principal deems that a credit will not be granted for the course, the IEP box must be checked and the appropriate statement from *Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools, First Edition, Covering Grades 1 to 12, 2010*, pages 62–63, must be inserted.

In both the elementary and secondary panels, the teacher's comments should include relevant information on the student's demonstrated learning of the modified expectations, as well as next steps for the student's learning in the subject or course.

Planning for English Language Learners

English Language Learners in Ontario Schools

Ontario schools have some of the most multilingual student populations in the world. The first language of approximately 28 per cent of the students in Ontario's English-language schools is a language other than English. In addition, some students use varieties of English – sometimes referred to as dialects – that differ significantly from the English required for success in Ontario schools. Many English language learners were born in Canada and have been raised in families and communities in which languages other than English, or varieties of English that differ from the language used in the classroom, are spoken. Other English language learners arrive in Ontario as newcomers from other countries; they may have experience of highly sophisticated educational systems, or they may have come from regions where access to formal schooling was limited.

When they start school in Ontario, many of these students are entering a new linguistic and cultural environment. All teachers share in the responsibility for these students' English-language development.

As students who are learning English as a second or additional language in English-language schools, English language learners bring a rich diversity of background knowledge and experience to the classroom. These students' linguistic and cultural backgrounds not only support their learning in their new environment but also become a cultural asset in the classroom community. Effective teachers find positive ways to incorporate this diversity into their instructional programs and into the classroom environment.

Most English language learners in Ontario schools have age-appropriate proficiency in their first language, as well as age-appropriate literacy skills. Although they need frequent opportunities to use English at school, they also derive important educational and social benefits from continuing to develop their first language while they are learning English. Teachers should encourage parents to continue to use their own language at home, both to preserve the language as part of their children's heritage and identity and to provide a foundation for their language and literacy development in English. It is also important for teachers to find opportunities to bring students' languages into the classroom, using parents and community members as a resource.

English as a Second Language and English Literacy Development Programs

During their first few years in Ontario schools, English language learners may receive support through one of two distinct programs designed to meet their language-learning needs:

English as a Second Language (ESL) programs are for students born in Canada or newcomers whose first language is a language other than English, or is a variety of English significantly different from that used for instruction in Ontario schools. Students in these programs have had educational opportunities to develop age-appropriate first-language literacy skills.

English Literacy Development (ELD) programs are primarily for newcomers whose first language is a language other than English, or is a variety of English significantly different from that used for instruction in Ontario schools, and who arrive with significant gaps in their education. These students generally come from countries where access to education is limited or where there are limited opportunities to develop language and literacy skills in any language. Schooling in their countries of origin may have been inconsistent, disrupted, or even completely unavailable throughout the years that these children would otherwise have been in school.

Supportive Learning Environments

In planning programs for students with linguistic backgrounds other than English, teachers need to recognize the importance of the orientation process, understanding that every learner needs to adjust to the new social environment and language in a unique way and at an individual pace. For example, students who are in an early stage of English-language acquisition may go through a "silent period" during which they closely observe the inter-actions and physical surroundings of their new learning environment. They may use body language rather than speech or they may use their first language until they have gained enough proficiency in English to feel confident of their interpretations and responses. Students thrive in a safe, supportive, and welcoming environment that nurtures their self-confidence while they are receiving focused literacy instruction. When they are ready to participate, in paired, small-group, or whole-class activities, some students will begin by using a single word or phrase to communicate a thought, while others will speak quite fluently.

In a supportive learning environment, most students will develop oral language proficiency quite quickly. Teachers can sometimes be misled by the high degree of oral proficiency demonstrated by many English language learners in their use of everyday English and may mistakenly conclude that these students are equally proficient in their use of academic English. Most English language learners who have developed oral proficiency in everyday English will still require instructional scaffolding to meet curriculum expectations. Research has shown that it takes five to seven years for most English language learners to catch up to their English-speaking peers in their ability to use English for academic purposes.

Program Adaptations

Responsibility for students' English-language development is shared by all teachers, including the ESL/ELD teacher (where available), and other school staff. Volunteers and peers may also be helpful in supporting English language learners in the classroom. By adapting the instructional program, teachers facilitate these students' learning. Appropriate adaptations include modifications and accommodations, as follows:

- modification of some or all of the grade or course expectations so that they are challenging but attainable for the learners at their current level of English proficiency, with the necessary support from the teacher;
- use of a variety of instructional strategies;[5]
- use of a variety of learning resources;[6]
- use of assessment accommodations that support students in demonstrating the full range of their learning.[7]

Teachers need to adapt the program for English language learners as they acquire English proficiency. For English language learners at the early stages of English language acquisition, teachers are required to modify curriculum expectations as needed. Most English language learners require accommodations for an extended period, long after they have achieved proficiency in everyday English.

Assessment and Evaluation

When curriculum expectations are modified in order to meet the language-learning needs of English language learners, assessment and evaluation will be based on the documented modified expectations. Teachers will check the ESL/ELD box on the Provincial Report Card only when modifications have been made to curriculum expectations to address the language needs of English language learners (the box should *not* be checked to indicate simply that they are participating in ESL/ELD programs or if they are only receiving accommodations). There is no requirement for a statement to be added to the "Comments" section of the report cards when the ESL/ELD box is checked.

Although the degree of program adaptation required will decrease over time, students who are no longer receiving ESL or ELD support may still need some program adaptations to be successful.

[5] Examples include: small-group instruction; extensive use of visual cues, images, diagrams; visual representations of key ideas; graphic organizers; scaffolding; previewing of text; modelling; use of music, movement, and gestures; open-ended activities; pre-teaching of key vocabulary; peer tutoring; strategic use of students' first languages.

[6] Examples include: visual material; simplified text; bilingual dictionaries; subject-specific glossaries; resources available in languages that students speak at home; concrete materials; learning materials and activities – displays, music, dances, games, and so on – that reflect cultural diversity.

[7] Examples include: provision of additional time; provision of options for students to choose how they will demonstrate their learning, such as portfolios, oral interviews, presentations, oral or visual representations, demonstrations and models, dramatic activities, and songs and chants; use of tasks requiring completion of graphic organizers or cloze sentences instead of essay questions or other assessment tasks that depend heavily on proficiency in English.

Related Policy and Resource Documents

For further information on supporting English language learners, refer to the following documents:

- *Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools, First Edition, Covering Grades 1 to 12, 2010*
- *The Ontario Curriculum, Grades 9–12: English as a Second Language and English Literacy Development, 2007*
- *English Language Learners – ESL and ELD Programs and Services: Policies and Procedures for Ontario Elementary and Secondary Schools, Kindergarten to Grade 12, 2007*
- *Supporting English Language Learners with Limited Prior Schooling: A Practical Guide for Ontario Educators, Grades 3 to 12, 2008*
- *Supporting English Language Learners: A Practical Guide for Ontario Educators, Grades 1 to 8, 2008*
- *Many Roots, Many Voices: Supporting English Language Learners in Every Classroom, 2005.*

Healthy Relationships

Every student is entitled to learn in a safe, caring environment, free from discrimination, violence, and harassment. Research has shown that students learn and achieve better in such environments. A safe and supportive social environment in a school is founded on healthy relationships – the relationships between students, between students and adults, and between adults. Healthy relationships are based on respect, caring, empathy, trust, and dignity, and thrive in an environment in which diversity is honoured and accepted. Healthy relationships do not tolerate abusive, controlling, violent, bullying/harassing, or other inappropriate behaviours. To experience themselves as valued and connected members of an inclusive social environment, students need to be involved in healthy relationships with their peers, educators, and other members of the school community.

Several provincial policies, programs, and initiatives, including Foundations for a Healthy School, the Equity and Inclusive Education Strategy, and Safe Schools, are designed to foster caring and safe learning environments in the context of healthy and inclusive schools. These policies and initiatives promote positive learning and teaching environments that support the development of healthy relationships, encourage academic achievement, and help all students reach their full potential.

In its 2008 report, *Shaping a Culture of Respect in Our Schools: Promoting Safe and Healthy Relationships*, the Safe Schools Action Team confirmed "that the most effective way to enable all students to learn about healthy and respectful relationships is through the school curriculum" (p. 11). Educators can promote this learning in a variety of ways. For example, by giving students opportunities to apply critical thinking and problem-solving strategies and to address issues through group discussions, role play, case study analysis, and other means, they can help them develop and practise the skills they need for building healthy relationships. Co-curricular activities such as clubs and intramural and interschool sports provide additional opportunities for the kind of interaction that helps students build

healthy relationships. Educators can also have a positive influence on students by modelling the behaviours, values, and skills that are needed to develop and sustain healthy relationships, and by taking advantage of "teachable moments" to address immediate relationship issues that may arise among students.

Human Rights, Equity, and Inclusive Education

A positive, inclusive, equitable, and non-discriminatory elementary and secondary school experience is vitally important to a student's personal, social, and academic development, to their future economic security, and to a realization of their full potential. Human rights principles recognize the importance of creating a climate of understanding and mutual respect for the dignity and worth of each person, so that each person can contribute fully to the development and well-being of their community. Indeed, human rights law guarantees a person's right to equal treatment in education. It requires educators and school leaders to prevent and respond appropriately to discrimination and harassment, to create an inclusive environment, to remove barriers that limit the ability of students, and to provide accommodations, where necessary.

Ontario's education system, at all levels, must respect diversity, promote inclusive education, and work towards identifying and eliminating barriers to equal treatment in education that limit the ability of students to learn, grow, and contribute to society. Discriminatory biases, harassment, non-inclusive environments, lack of accommodation, systemic barriers, power dynamics, societal poverty, and racism make it difficult for students to acquire the skills they need to be successful, competitive, and productive members of society. Ontario schools aim to improve the academic outcomes and experiences of students who have traditionally not benefited from the promise of public education.

In an environment based on the principles of inclusive education, all students, parents, caregivers, and other members of the school community – regardless of ancestry, culture, ethnicity, sex, disability, race, colour, religion, age, marital or family status, creed, gender identity/expression, gender, sexual orientation, socio-economic status, or other factors – are welcomed, included, treated fairly, and respected. Diversity is valued when all members of the school community feel safe, welcomed, and accepted. Every student is supported and inspired to succeed in a culture of high expectations for learning.

Research has shown that students who do not see themselves reflected in what they are learning, in their classrooms, and in their schools become disengaged and do not experience as great a sense of well-being or as high a level of academic achievement as those who do.

Culturally Responsive and Relevant Pedagogy (CRRP)

In an inclusive education system, students must see themselves reflected in the curriculum, their physical surroundings, and the broader environment, so that they can feel engaged in and empowered by their learning experiences. Students need to experience teaching and learning that reflect their needs and who they are. To ensure that this happens, educators in Ontario schools embrace *culturally*

responsive and relevant pedagogy (CRRP), which recognizes that all students learn in ways that are connected to background, language, family structure, and social or cultural identity.

CRRP provides a framework for building positive environments, improving student responsibility and success, encouraging parent-school relationships, and building strong community connections. It also emphasizes that it is important for educators and school leaders to examine their own biases and to analyse how their own identities and experiences affect how they view, understand, and interact with all students. This can help to prevent discrimination, harassment, and the creation of poisoned environments. Educators are responsible for meaningful teaching and learning that recognizes and responds to *who is in the classroom and the school*.

By knowing "who our students are", educators and leaders can tailor policies, programs, and practices to better meet the needs of their diverse student populations, to provide accommodation of the needs specified by human rights law, and to ensure that every student has the opportunity to succeed. CRRP involves recognizing that "culture" encompasses various aspects of social and personal identity. It also means acknowledging students' multiple social and personal identities and the social issues that arise where identities intersect. The CRRP approach is designed to spark conversation and support educators and school leaders as they seek to implement effective equity strategies and policies. Educators are encouraged to engage in meaningful inquiry, in collaboration with colleagues, to address equity issues and the particular needs of the students they serve.

Implementing Principles of Inclusive Education

The implementation of inclusive education principles in education influences all aspects of school life. It promotes a school climate that encourages all students to work to high levels of achievement, affirms the worth of all students, and helps students strengthen their sense of identity and develop a positive self-image. It encourages staff and students alike to value and show respect for diversity in the school and the broader society. Inclusive education promotes equity, healthy relationships, and active, responsible citizenship. The absence of inclusive approaches to education can create discriminatory environments, in which certain individuals or groups cannot expect to receive fair treatment or an equitable experience based on aspects of their identity.

Teachers can give students a variety of opportunities to learn about diversity and diverse perspectives. By drawing attention to the contributions and perspectives of historically marginalized groups, and by creating opportunities for their experiences to be affirmed and valued, teachers can enable students from a wide range of backgrounds to see themselves reflected in the curriculum. It is essential that learning activities and materials used to support the curriculum reflect the diversity of Ontario society. In addition, teachers should differentiate instruction and assessment strategies to take into account the background and experiences, as well as the interests, aptitudes, and learning needs, of all students.

Interactions between the school and the community should reflect the diversity of both the local community and the broader society. A variety of strategies can be used to communicate with and engage parents and members of diverse communities, and to encourage their participation in and support for school activities, programs, and events. Family and community members should be invited to take part in teacher interviews, the school council, and the parent involvement committee, and to

attend and support activities such as plays, concerts, co-curricular activities and events, and various special events at the school. Schools need to be prepared and ready to welcome families and community members. Schools may consider offering assistance with child care or making alternative scheduling arrangements in order to help caregivers participate. Special outreach strategies and encouragement may be needed to draw in the parents of English language learners and First Nations, Métis, or Inuit students, and to make them feel more welcomed in their interactions with the school.

The Role of the School Library

The school library program can help build and transform students' knowledge in order to support lifelong learning in our information- and knowledge-based society. The school library program supports student success across the curriculum by encouraging students to read widely, teaching them to examine and read many forms of text for understanding and enjoyment, and helping them improve their research skills and effectively use information gathered through research.

The school library program enables students to:

- develop a love of reading for learning and for pleasure;
- develop literacy skills using fiction and non-fiction materials;
- develop the skills to become independent, thoughtful, and critical researchers;
- obtain access to programs, resources, and integrated technologies that support all curriculum areas;
- understand and value the role of public library systems as a resource for lifelong learning.

The school library program plays a key role in the development of information literacy and research skills. Teacher-librarians, where available, collaborate with classroom or content-area teachers to design, teach, and provide students with authentic information and research tasks that foster learning, including the ability to:

- access, select, gather, process, critically evaluate, create, and communicate information;
- use the information obtained to explore and investigate issues, solve problems, make decisions, build knowledge, create personal meaning, and enrich their lives;
- communicate their findings to different audiences, using a variety of formats and technologies;
- use information and research with understanding, responsibility, and imagination.

In addition, teacher-librarians can work with content-area teachers to help students:

- develop digital literacy in using non-print forms, such as the Internet, social media, and blogs, and knowing the best ways to access relevant and reliable information;
- design inquiry questions for research projects;
- create and produce single-medium or multimedia presentations.

Teachers need to discuss with students the concept of ownership of work and the importance of copyright in all forms of media.

The Role of Information and Communications Technology

The variety and range of information and communications technology (ICT) tools available to educators today enables them to significantly extend and enrich their instructional approaches and to create opportunities for students to learn in ways that best suit their interests and strengths. Technology has also enhanced the ability to connect with communities outside the school, making it possible to engage a diversity of community partners in student learning.

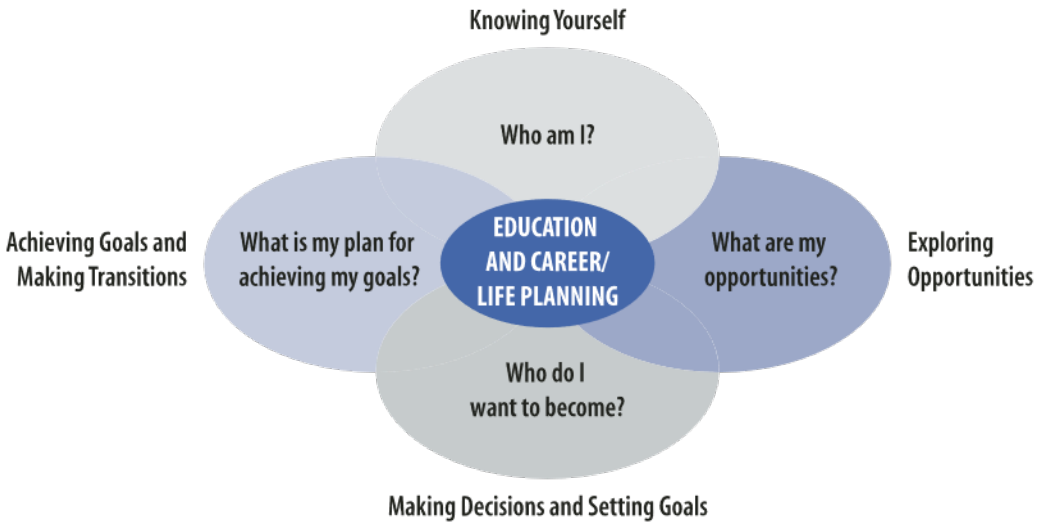
Rich opportunities can be tapped to support students in developing digital literacy, an essential transferable skill.

Education and Career/Life Planning

The goals of the Kindergarten to Grade 12 education and career/life planning program are to:

- ensure that all students develop the knowledge and skills they need to make informed education and career/life choices;
- provide classroom and school-wide opportunities for this learning; and
- engage parents and the broader community in the development, implementation, and evaluation of the program, to support students in their learning.

The framework of the program is a four-step inquiry process based on four questions linked to four areas of learning: (1) Knowing Yourself – Who am I?; (2) Exploring Opportunities – What are my opportunities?; (3) Making Decisions and Setting Goals – Who do I want to become?; and (4) Achieving Goals and Making Transitions – What is my plan for achieving my goals?



The curriculum expectations in most subjects and disciplines of the Ontario curriculum provide opportunities to relate classroom learning to the education and career/life planning program as outlined in *Creating Pathways to Success: An Education and Career/Life Planning Program for Ontario Schools – Policy and Program Requirements, Kindergarten to Grade 12, 2013*. All classroom teachers support students in education and career/life planning by providing them with learning opportunities, filtered through the lens of the four inquiry questions, that allow them to reflect on and apply subject-specific knowledge and skills; explore subject-related education and career/life options; and become competent, self-directed planners who will be prepared for success in school, life, and work. Education and career/life planning will support students in their transition from secondary school to their initial postsecondary destination, whether it be in apprenticeship training, college, community living, university, or the workplace. For more information on postsecondary pathway choices, see the Education and Training and Skilled Trades pages on the Ontario government website.

Experiential Learning

Experiential learning is hands-on learning that occurs in person or virtually and provides developmentally appropriate opportunities for students of all ages to:

- **participate** in rich experiences connected to the world outside the school;
- **reflect** on the experiences to derive meaning; and
- **apply** the learning to their decisions and actions.

Adapted from David A. Kolb, *Experiential Learning: Experience as the Source of Learning and Development, 2nd ed.* (Upper Saddle River, N.J.: Pearson Education, 2015)

Planned learning experiences in the community may include outdoor education, project/program-based learning, job shadowing and job twin-ning, field trips, field studies, work experience, and cooperative education. These experiences provide opportunities for students to see the relevance of their classroom learning and its connection to the broader world. They also help them develop transferable and interpersonal skills and work habits that prepare them for their future, and enable them to explore careers of interest as they plan their pathway through school to their postsecondary destination, whether in apprenticeship training, college, community living, university, or the workplace.

Experiential learning opportunities associated with various aspects of the curriculum help broaden students' knowledge of themselves and of a range of career opportunities – two areas of learning outlined in *Creating Pathways to Success: An Education and Career/Life Planning Program for Ontario Schools – Policy and Program Requirements, Kindergarten to Grade 12, 2013*. The key to providing successful experiential learning opportunities is to ensure that the experiential learning cycle (participate, reflect, apply) is a planned part of the experience.

In secondary school, pathways programs that incorporate experiential learning are available to students. They include the following courses and programs:

- cooperative education courses, outlined in *The Ontario Curriculum, Grades 11–12: Cooperative Education, 2018*
- Ontario Youth Apprenticeship Program (OYAP) (see "Prepare for Apprenticeship" on the Ontario government website)
- Specialist High Skills Major (SHSM) program
- Dual credit programs

Pathways to a Specialist High Skills Major (SHSM)

The Specialist High Skills Major (SHSM) is a specialized, ministry-approved program that allows students in Grades 11 and 12 to focus their learning on a specific economic sector while meeting the requirements of the Ontario Secondary School Diploma (OSSD).

The SHSM program assists students in their transition from secondary school to apprenticeship training, college, university, or the workplace.

This program enables students to gain sector-specific skills and knowledge in engaging, career-related learning environments and to prepare in a focused way for graduation and postsecondary education, training, or employment.

Course offerings and program planning should support students who are pursuing specialized programs, including the SHSM program. Bundles of credits provide students with knowledge and skills that are connected with the specific sector of their SHSM program and that are required for success in their chosen destination.

Health and Safety

In Ontario, various laws, including the Education Act, the Occupational Health and Safety Act (OHSA), Ryan's Law (Ensuring Asthma Friendly Schools), 2015, and Sabrina's Law, 2005, collectively ensure that school boards provide a safe and productive learning and work environment for both students and employees. Under the Education Act, teachers are required to ensure that all reasonable safety procedures are carried out in courses and activities for which they are responsible. Teachers should model safe practices at all times; communicate safety require-ments to students in accordance with school board policies, Ministry of Education policies, and any applicable laws; and encourage students to assume responsibility for their own safety and the safety of others.

Concern for safety should be an integral part of instructional planning and implementa-tion. Teachers are encouraged to review:

- their responsibilities under the Education Act;
- their rights and responsibilities under the Occupational Health and Safety Act;
- their school board's health and safety policy for employees;
- their school board's policies and procedures on student health and safety (e.g., on concussions; on medical conditions such as asthma; with respect to outdoor education excursions);
- relevant provincial subject association guidelines and standards for student health and safety, such as Ophea's Ontario Physical Activity Safety Standards in Education (formerly the Ontario Physical Education Safety Guidelines);
- any additional mandatory requirements, particularly for higher-risk activities (e.g., field trips that involve water-based activities), including requirements for approvals (e.g., from the Supervisory Officer), permissions (e.g., from parents/guardians), and/or qualifications (e.g., proof of students' successful completion of a swim test).

Wherever possible, potential risks should be identified and procedures developed to prevent or minimize, and respond to, incidents and injuries. School boards provide and maintain safe facilities and equipment, as well as qualified instruction. In safe learning environments, teachers will:

- be aware of up-to-date safety information;
- plan activities with safety as a primary consideration;
- inform students and parents of risks involved in activities;
- observe students to ensure that safe practices are being followed;
- have a plan in case of emergency;
- show foresight;
- act quickly.

Students should be made aware that health and safety is everyone's responsibility – at home, at school, and in the community. Teachers should ensure that students have the knowledge and skills needed for safe participation in all learning activities. Students must be able to dem-onstrate knowledge of the equipment being used and the procedures necessary for its safe use. Health and safety resource guides

for Kindergarten to Grade 8 and for Grades 9 to 12 provide the scope and sequence of Ontario curriculum expectations to assist teachers in bringing health and safety education into the classroom in every subject area. The guides identify expectations in the Ontario curriculum that can help students develop knowledge and skills related to health and safety (injury prevention and health protection), safe behaviours, and safe practices.

Learning outside the classroom, such as on field trips or during field studies, can provide a meaningful and authentic dimension to students' learning experiences, but they also take the teacher and students out of the predictable classroom environment and into unfamiliar settings. Teachers must plan these activities carefully in accordance with their school board's relevant policies and procedures and in collaboration with other school board staff (e.g., the principal, outdoor education lead, Supervisory Officer) to ensure students' health and safety.

The information provided in this section is not exhaustive. Teachers are expected to follow school board health and safety policies and procedures.

Ethics

The Ontario curriculum provides varied opportunities for students to learn about ethical issues and to explore the role of ethics in both public and personal decision making. Students may make ethical judgements when evaluating evidence and positions on various issues, and when drawing their own conclusions about issues, developments, and events. Teachers may need to help students determine which factors they should consider when making such judgements. It is crucial that teachers provide support and supervision to students throughout the research and inquiry process, ensuring that students engaged in an inquiry are aware of potential ethical concerns and that they address such concerns in acceptable ways. Teachers may supervise students' use of surveys and/or interviews, for example, to confirm that their planned activities will respect the dignity, privacy, and confidentiality of their partici-pants. When students' activities involve Indigenous communities and/or individuals, teachers need to ensure the appropriate use and protection of Indigenous knowledge. Teachers also supervise the choice of the research topics to protect students from exposure to information and/or perspectives for which they may not be emo-tionally or intellectually prepared (for example, where a student's investigation might involve personal interviews that could lead to the disclosure of abuse or other sensitive topics).

Teachers must thoroughly address the issues of plagiarism and cultural appropriation with students. In a digital world that provides quick access to abundant informa-tion, it is easy to copy the words, music, or images of others and present them as one's own. Even at the secondary level, students need to be reminded of the ethical issues related to plagiarism and appropriation. Before starting an inquiry, students should have an understanding of the range of forms of plagiarism and appropriation, from blatant to nuanced, as well as of their consequences. Students often struggle to find a balance between creating works in their own voice or style and acknowledging the work of others. It is not enough to tell them not to plagiarize or appropriate others' work, and to admonish those who do. Teachers need to

explicitly teach all students how to use their own voice or style while appropriately acknowledging the work of others, using accepted forms of documentation.

Cross-curricular and integrated learning

Introduction

A variety of overarching perspectives, themes, and skills are intentionally incorporated by educators, on an ongoing basis, into teaching and learning across all subjects and disciplines of the curriculum – they are part of "cross-curricular learning". Educators plan programs to include learning in these areas, which are relevant in the context of most curriculum subjects, and are critical to students in navigating their world. They range from environmental education, Indigenous education, and financial literacy to social-emotional learning, critical literacy, mathematical literacy, and STEM education. These various themes, perspectives, and skills are explored in this section.

Another approach to teaching and learning "across subjects" is called "integrated learning". This approach differs from cross-curricular learning because it involves combining curriculum expectations from more than one subject in a single lesson, and evaluating student achievement of the expectations within the respective subjects from which they are drawn.

Scope and Sequence Resource Guides

"Scope and sequence" resource guides are compilations of existing curriculum expectations, from all subjects and disciplines, that relate to specific ministry priorities and initiatives. For example, scope and sequence resource guides have been developed for **environmental education** (elementary and secondary); **financial literacy** (elementary and secondary); **First Nations, Métis, and Inuit connections** (elementary and secondary); and **health and safety** (elementary and secondary).

These documents identify expectations that involve learning about the particular topic, as well as teacher supports that touch on the topic or that describe opportunities for addressing it. The teacher supports include the examples, sample questions, teacher prompts, student responses, and/or instructional tips that accompany the expectations and describe optional ways in which teachers can elicit the learning described in the expectation. Teachers can glean ideas from the teacher supports, based on their professional judgement and taking into account the interests of the students and the local communities represented in their classrooms, for incorporating learning about these topics across subjects. The scope and sequence resource guides can also support divisional/school planning on particular topics or issues across classrooms and grades.

Integrated Learning

Integrated learning engages students in a rich learning experience that helps them make connections across subjects and brings the learning to life. Integrated learning provides students with opportunities

to work towards meeting expectations from two or more subjects within a single unit, lesson, or activity. It can be a solution to the problems of fragmented learning and isolated skill instruction, because it provides opportunities for students to learn and apply skills in meaningful contexts across subject boundaries. In such contexts, students have opportunities to develop their ability to think and reason and to transfer knowledge and skills from one subject area to another. Although the learning is integrated, *the specific knowledge and skills from the curriculum for each subject are taught.*

Elementary Curriculum

By linking expectations from different subjects within a single unit, lesson, or activity, elementary teachers can provide students with multiple opportunities to reinforce and demonstrate their knowledge and skills in a variety of contexts. Teachers then evaluate student achievement in terms of the individual expectations, towards assigning a grade for each of the subjects involved.

One example would be a unit linking expectations from the science and technology curriculum and from the social studies curriculum. Connections can be made between these curricula in a number of areas – for example, the use of natural resources, considered from a scientific and an economic perspective; variations in habitat and ecosystems across the regions of Canada, exploring both the biology and the geography of those regions; historical changes in technology; and the impact of science and technology on various peoples and on the environment. In addition, a unit combining science and technology and social studies expectations could teach inquiry/research skills common to the two subjects, while also introducing approaches unique to each.

Secondary Curriculum

Ontario's secondary curriculum is designed to provide opportunities for educators to integrate student learning across disciplines and subjects. Some secondary expectations are written to implicitly connect with and support content learning and skill development outlined in other curricula. For example, the secondary math and science curricula are aligned so that students can apply what they learn in math to what they are learning in the sciences. For instance, in Grade 11 and 12 math courses, students learn the mathematical concepts needed to support learning in chemistry and physics courses in those grades. As another example, expectations in social sciences and humanities are aligned with some of the expectations in the English curriculum.

Financial Literacy

The education system has a vital role to play in preparing young people to take their place as informed, engaged, and knowledgeable citizens in the global economy. Financial literacy education can provide the preparation Ontario students need to make informed decisions and choices in a complex and fast-changing financial world.

Because making informed decisions about economic and financial matters has become an increasingly complex undertaking in the modern world, students need to build knowledge and skills in a wide variety of areas. In addition to learning about the specifics of saving, spending, borrowing, and investing, students need to develop broader skills in problem solving, research and inquiry, decision making, critical thinking, and critical literacy related to financial issues, so that they can analyse and manage the risks that accompany various financial choices. They also need to develop an understanding of world economic forces and the effects of those forces at the local, national, and global level. In order to make wise choices, they will need to understand how such forces affect their own and their families' economic and financial circumstances. Finally, to become responsible citizens in the global economy, they will need to understand the social, environmental, and ethical implications of their own choices as consumers. For all of these reasons, financial literacy is an essential component of the education of Ontario students in a twenty-first century context – one that can help ensure that Ontarians will continue to prosper in the future.

Resource documents – *The Ontario Curriculum, Grades 4–8: Financial Literacy Scope and Sequence of Expectations, 2016* and *The Ontario Curriculum, Grades 9–12: Financial Literacy Scope and Sequence of Expectations, 2016* – have been prepared to assist teachers in bringing financial literacy into the classroom. These documents identify the curriculum expectations and related examples and prompts, in disciplines across the Ontario curriculum, through which students can acquire skills and knowledge related to financial literacy.

STEM Education

K–12 STEM education is the study of science, technology, engineering, and mathematics, including cross-curricular and/or integrative study, and the application of those subjects in real-world contexts. As students engage in STEM education, they develop transferable skills that they need to meet the demands of today's global economy and society.

STEM education helps students develop an understanding and appreciation of each of the core subjects of mathematics, science, and technological education. At the same time, it supports a more holistic understanding and application of skills and knowledge related to engineering design and innovation. STEM learning integrates and applies concepts, processes, and ways of thinking associated with these subjects to design solutions to real-world problems.

Engineering design and innovation engages students in *applying* the principles of science, technology, and mathematics to develop economical and sustainable solutions to technical and complex societal problems to meet human needs.

Among the transferable skills developed through STEM education are computational thinking, coding, design thinking, innovating, use of the scientific method, scientific inquiry skills, and engineering design skills. These skills are in high demand in today's globally connected world, with its unprecedented advancements in technology.

Approaches to STEM education may vary across Ontario schools. STEM subjects may be taught separately, but with an effort to make cross-curricular connections a part of student learning. Problem-solving application projects may be designed to combine two or more STEM subjects. Alternatively, content from all four STEM subjects might be fully integrated to reinforce students' understanding of each subject, by enhancing their understanding of the interrelationships among them, and by providing the opportunity to apply a spectrum of knowledge and skills in novel ways in real-world contexts. As STEM education is implemented, it is important to engage diverse perspectives and ways of thinking. including those inherent in the arts and humanities. Diverse perspectives engage students in a variety of creative and critical thinking processes that are essential for developing innovative and effective solutions that impact communities or ecosystems.

A robust K–12 STEM education enables Ontario educators and students to become innovators and leaders of change in society and the workforce, and creates opportunities in our diverse communities to foster integrative thinking and problem solving.

Indigenous Education

To move forward on their learning journey, students must have a solid understanding of where we have been as a province and as a country. Consistent with Ontario's vision for Indigenous education, all students will have knowledge of the rich diversity of First Nations, Métis, and Inuit histories, cultures, perspectives, and contributions, as well as an awareness of the importance of Indigenous ways of knowing in a contemporary context. Ontario is committed to ensuring that First Nations, Métis, and Inuit survivors and communities bring their perspectives to students' learning about our shared history.

It is essential that learning activities and resources used to support Indigenous education are authentic and accurate and do not perpetuate culturally and historically inaccurate ideas and understandings. It is important for educators and schools to select resources that represent the uniqueness of First Nations, Métis, and Inuit histories, perspectives, and world views authentically and respectfully. It is also important to select resources that reflect local Indigenous communities as well as First Nations, Métis, and Inuit individuals and communities from across Ontario and Canada. Resources that best support Indigenous education feature Indigenous voices and narratives and are developed by, or in collaboration with, First Nations, Métis, and Inuit communities. Schools can contact their board's Indigenous lead and work with their Indigenous Education Councils for assistance in evaluating and selecting resources.

Cultural Safety

It is important to create a learning environment that is respectful and that makes students feel safe and comfortable not only physically, socially, and emotionally but also in terms of their cultural heritage. A culturally safe learning environment is one in which students feel comfortable about expressing their ideas, opinions, and needs and about responding authentically to topics that may be culturally sensitive. Educators should be aware that some students may experience emotional reactions when learning about issues that have affected their own lives, their family, and/or their community, such as the legacy of the residential school system. Before addressing such topics in the classroom, teachers need to

consider how to prepare and debrief students, and they need to ensure that appropriate resources are available to support students both inside and outside the classroom.

Literacy

Literacy is the ability to use language and images in rich and varied forms to read, write, listen, speak, view, represent, discuss, and think critically about ideas. Literacy enables us to share information and to interact with others. Literacy is an essential tool for personal growth and active participation in a democratic society.

Ontario Ministry of Education, *Paying Attention to Literacy: Six Foundations for Improvement in Literacy, K-12*, 2013

The Importance of Literacy

Literacy[8] continues to evolve as the world changes and its demands shift and become more complex. A focus on literacy goes beyond traditional forms of reading and writing. Today's students live with technological innovations that previous generations never experienced. They are accustomed to receiving information quickly, and often in a non-linear format, and they may engage in social interactions using a variety of technologies.

Literacy skills are embedded in the expectations for all subjects and disciplines of the Ontario curriculum. Each subject provides opportunities for literacy development, often in specialized ways. Literacy needs to be explicitly taught in all subjects. Literacy demands, such as vocabulary acquisition and accessing and managing information, become more complex across subjects and disciplines as students progress through the grades.

The Scope of Literacy

In Ontario schools, all students are equipped with the literacy skills necessary to be critical and creative thinkers, effective meaning-makers and communicators, collaborative co-learners, and innovative problem-solvers. These are the skills that will enable them to achieve personal, career, and societal goals. Students develop literacy skills as they think, express, and reflect.

In every subject, before, during, and after they read, view, listen, speak, or write, students select and use a variety of literacy strategies and subject-specific processes. This helps them comprehend and organize information and ideas, and communicate meaning. Teachers assist students in learning and

[8] This page has been adapted from Adolescent Literacy Learning, *Adolescent Literacy Guide: A Professional Learning Resource for Literacy, Grades 7–12. Revised 2016*, pages 4–19, and the *2016 Student Achievement Literacy Planning Resource: Grades 7–12*, page 7.

selecting appropriate literacy strategies based on assessment of their individual needs and learning preferences.

Students learn to think, express, and reflect in discipline-specific ways. Teachers purposefully teach students about the literacy demands of the particular subject area. Students learn the vocabulary and terminology that are unique to a particular subject area and must be able to interpret symbols, charts and diagrams. Cross-curricular and subject-specific literacy skills are essential to students' success in all subjects of the curriculum, and in all areas of their lives.

Critical Thinking and Critical Literacy

Critical thinking is the process of thinking about ideas or situations in order to understand them fully, identify their implications, make a judgement, and/or guide decision making. It is an essential transferable skill that enables students to become independent, informed, and responsible members of society, and so is a focus of learning across all subjects and disciplines. Critical thinking includes skills such as questioning, predicting, analysing, synthesizing, examining opinions, identifying values and issues, detecting bias, and distinguishing between alternatives. Students who are taught these skills become critical thinkers who can move beyond superficial conclusions to a deeper understanding of the issues they are examining. They are able to engage in an inquiry process in which they explore complex and multifaceted issues, and questions for which there may be no clear-cut answers.

Students use critical-thinking skills when they assess, analyse, and/or evaluate the impact of something and when they form an opinion and support that opinion with a rationale. In order to think critically, students need to ask themselves effective questions in order to interpret information; detect bias in their sources; determine why a source might express a particular bias; examine the opinions, perspec-tives, and values of various groups and individuals; look for implied meaning; and use the information gathered to form a personal opinion or stance, or a personal plan of action with regard to making a difference.

Students approach critical thinking in various ways. Some students find it helpful to discuss their thinking, asking questions and exploring ideas. Other students may take time to observe a situation or consider a text carefully before commenting; they may prefer not to ask questions or express their thoughts orally while they are thinking.

Critical literacy is the term used to refer to a particular aspect of critical thinking. Critical literacy involves looking beyond the literal meaning of a text to determine what is present and what is missing, in order to analyse and evaluate the text's complete meaning and the author's intent. Critical literacy is concerned with issues related to fairness, equity, and social justice. Critically literate students adopt a critical stance, asking what view of the world the text advances and whether they find this view acceptable, who benefits from the text, and how the reader is influenced.

Critically literate students understand that meaning is not found in texts in isolation. People make sense of a text, or determine what a text means, in a variety of ways. Students therefore need to take into account: points of view (e.g., those of people from various cultures); context (e.g., the beliefs and

practices of the time and place in which a text was created and those in which it is being read or viewed); the background of the person who is interacting with the text (e.g., upbringing, friends, communities, education, experiences); intertextuality (e.g., information that a reader or viewer brings to a text from other texts experienced previously); gaps in the text (e.g., information that is left out and that the reader or viewer must fill in); and silences in the text (e.g., the absence of the voices of certain people or groups).

Students who are critically literate are able, for example, to actively analyse media messages and determine possible motives and underlying messages. They are able to determine what biases might be contained in texts, media, and resource material and why that might be, how the content of these materials might be determined and by whom, and whose perspectives might have been left out and why. Only then are students equipped to produce their own interpretation of an issue. Opportunities should be provided for students to engage in a critical discussion of "texts", including books and textbooks, television programs, movies, documentaries, web pages, advertising, music, gestures, oral texts, newspaper and magazine articles, letters, cultural text forms, stories, and other forms of expression. Such discussions empower students to understand the impact on members of society that was intended by the text's creators. Language and communication are never neutral: they are used to inform, entertain, persuade, and manipulate.

The literacy skill of *metacognition* supports students' ability to think critically through reflection on their own thought processes. Acquiring and using metacognitive skills has emerged as a powerful approach for promoting a focus on thinking skills in literacy and across all disciplines, and for empowering students with the skills needed to monitor their own learning. As they reflect on their strengths and needs, students are encouraged to advocate for themselves to get the support they need in order to achieve their goals.

Mathematical Literacy

Mathematical literacy is an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged, and reflective citizens.

Council of Ministers of Education, Canada (CMEC),
Measuring Up: Canadian Results of the OECD PISA Study, 2016, p. 10

The Importance of Mathematical Literacy[9]

Mathematical literacy involves more than executing procedures. It implies a knowledge base and the competence and confidence to apply this knowledge in the practical world. A mathematically literate person can estimate; interpret data; solve day-to-day problems; reason in numerical, graphical, and geometric situations; and communicate using mathematics.

As knowledge expands and the economy evolves, more people are working with technologies or working in settings where mathematics is a cornerstone. Problem solving, the processing of information, and communication are becoming routine job requirements. Outside the workplace, mathematics arises in many everyday situations. Mathematical literacy is necessary both at work and in daily life.

Mathematical literacy is as important as proficiency in reading and writing. Mathematics is so entwined with today's way of life that we cannot fully comprehend the information that surrounds us without a basic understanding of mathematical ideas. Confidence and competence in mathematics lead to productive participation in today's complex information society, and open the door to opportunity.

The Scope of Mathematical Literacy

Mathematical literacy encompasses the ability to:

- estimate in numerical or geometric situations
- know and understand mathematical concepts and procedures
- question, reason, and solve problems
- make connections within mathematics and between mathematics and life
- generate, interpret, and compare data
- communicate mathematical reasoning

Mathematical literacy has several dimensions – for example, numerical literacy, spatial literacy, and data literacy – and extends beyond the mathematics classroom to other fields of study.

Teachers should take advantage of the abundant opportunities that exist for fostering mathematical literacy across the curriculum. All teachers have a responsibility to communicate the view that all students can and should do mathematics.

Environmental Education

Environmental education is both the responsibility of the entire education community and a rich opportunity for cross-curricular learning. It can be taught across subjects and grades, providing context that can enrich and enliven learning in all subject areas. It also provides opportunities for critical

[9] Adapted from *Leading Math Success: Mathematical Literacy, Grades 7–12 – The Report of the Expert Panel on Student Success in Ontario*, 2004, pages 10 and 24.

thinking, learning about citizenship, and developing personal responsibility. It offers students the opportunity to develop a deeper understanding of themselves, their role in society, and their dependence on one another and on the Earth's natural systems.

The curriculum provides opportunities for students to learn about environmental processes, issues, and solutions, and to demonstrate their learning as they practise and promote environmental stewardship at school and in their communities.

Acting Today, Shaping Tomorrow: A Policy Framework for Environmental Education in Ontario Schools outlines an approach to environmental education that recognizes the need for all Ontario students to learn "in, about and/or for" the environment, and promotes environmental responsibility on the part of students, school staff, and leaders at all levels of the education system.

Resource documents – *The Ontario Curriculum, Grades 1–8 and The Kindergarten Program: Environmental Education, Scope and Sequence of Expectations, 2017* and *The Ontario Curriculum, Grades 9–12: Environmental Education, Scope and Sequence of Expectations, 2017* – have been prepared to assist teachers in planning lessons that integrate environmental education with other subject areas. They identify curriculum expectations and related examples and prompts in disciplines across the Ontario curriculum that provide opportunities for student learning "in, about, and/or for" the environment. Teachers can use these documents to plan lessons that relate explicitly to the environment, or they can draw on them for opportunities to use the environment as the *context for learning*. These documents can also be used to make curriculum connections to school-wide environmental initiatives.

Social-Emotional Learning Skills

The development of social-emotional learning (SEL) skills helps students foster overall health and well-being, positive mental health, and the ability to learn, build resilience, and thrive.

Students will learn skills to:	So that they can:
• identify and manage emotions	• express their feelings and understand the feelings of others
• recognize sources of stress and cope with challenges	• develop personal resilience
• maintain positive motivation and perseverance	• foster a sense of optimism and hope
• build relationships and communicate effectively	• support healthy relationships and respect diversity
• develop self-awareness and self-confidence	• develop a sense of identity and belonging
• think critically and creatively	• make informed decisions and solve problems

Social-emotional learning skills are an explicit component of learning in the elementary health and physical education curriculum. However, there are opportunities for students to develop SEL skills in connection with their learning in all subjects and disciplines. Skills to support mental health and well-being can be developed across the curriculum, in the context of school activities, at home, and in the community.

It is beneficial for students to make connections between SEL skills, transferable skills, and learning skills and work habits (see *Growing Success*, 2010, Chapter 2). Taken together, these interrelated skills support students' overall health and well-being, positive mental health, and the ability to learn and to become lifelong learners. They enhance students' experience in school and beyond, preparing them to succeed personally and to become economically productive and actively engaged citizens. School Mental Health Ontario (SMHO) has resources to support the development of social-emotional learning in Ontario schools.

Transferable skills

Introduction

The Importance of Transferable Skills in the Curriculum

Today's graduates will enter a world that is more competitive, more globally connected, and more technologically engaged than it has been in any other period of history. Over the course of the next decade, millions of young Canadians will enter a workforce that is dramatically different from the one we know today. With the growing automation of jobs, extraordinary technological advancements, and the realities of a global economy, students will need to be prepared for job flexibility, frequent career re-orientation, and work and civic life in a globalized, digital age. Equipping students with transferable skills and a desire for lifelong learning will help to prepare them for these new realities, and to navigate and shape their future successfully.

Transferable skills are the skills and attributes that students need in order to thrive in the modern world. Based on international research, information provided by employers, and its work with jurisdictions across Canada, the Ontario Ministry of Education has defined seven important categories of transferable skills – sometimes referred to as "competencies"[10] – that will help students navigate the world of work and meet with success in the future:

- critical thinking and problem solving
- innovation, creativity, and entrepreneurship
- self-directed learning
- collaboration
- communication
- global citizenship and sustainability
- digital literacy

These seven broad categories of skills, necessary in today's rapidly changing world, can be seen as a framework encompassing the wide range of discrete transferable skills that students acquire over time. Developing transferable skills essentially means "learning for transfer" – that is, taking what is learned in one situation and applying it to other, new situations. Students in Ontario schools "learn for transfer" in

[10] These categories of transferable skills are aligned with the six "global competencies" developed collaboratively by ministers of education across Canada on the basis of the competencies outlined in *21st Century Competencies: Foundation Document for Discussion* (Ontario Ministry of Education, 2016). The global competencies were then published by the Council of Ministers of Education, Canada (CMEC) as part of an effort to prepare students across the nation for a complex and unpredictable future with rapidly changing political, social, economic, technological, and environmental landscapes. The new categories of transferable skills outlined here have been updated on the basis of current research, and a seventh category – "digital literacy" – has been added.

all of the subjects and disciplines of the Ontario curriculum, from Kindergarten to Grade 12. In fact, in every grade and subject, their learning is assessed, in part, in terms of their ability to apply or transfer what they have learned to familiar and new contexts (see the category "Application" in the Sample Achievement Charts). The curriculum provides opportunities for students to develop transferable skills in age- and grade-appropriate ways throughout their school years. Students develop transferable skills not in isolation but as part of their learning in all subjects of the curriculum. These skills are developed through students' cognitive, social, emotional, and physical engagement in learning. Educators facilitate students' development of transferable skills explicitly through a variety of teaching and learning methods, models, and approaches, and assessment practices, in a safe, inclusive, and equitable learning environment.

Critical Thinking and Problem Solving

Definition

Critical thinking and problem solving involve locating, processing, analysing, and interpreting relevant and reliable information to address complex issues and problems, make informed judgements and decisions, and take effective action. With critical thinking skills comes an awareness that solving problems can have a positive impact in the world, and this contributes to achieving one's potential as a constructive and reflective citizen. Learning is deepened when it occurs in the context of authentic and meaningful real-world experiences.

Student Descriptors

- Students engage in inquiry processes that include locating, processing, interpreting, synthesizing, and critically analysing information in order to solve problems and make informed decisions. These processes involve critical, digital, and data literacy.
- Students solve meaningful and complex real-life problems by taking concrete steps – identifying and analysing the problem, creating a plan, prioritizing actions to be taken, and acting on the plan – as they address issues and design and manage projects.
- Students detect patterns, make connections, and transfer or apply what they have learned in a given situation to other situations, including real-world situations.
- Students construct knowledge and apply what they learn to all areas of their lives – at school, home, and work; among friends; and in the community – with a focus on making connections and understanding relationships.
- Students analyse social, economic, and ecological systems to understand how they function and how they interrelate.

Innovation, Creativity, and Entrepreneurship

Definition

Innovation, creativity, and entrepreneurship support the ability to turn ideas into action in order to meet the needs of a community. These skills include the capacity to develop concepts, ideas, or products for the purpose of contributing innovative solutions to economic, social, and environmental problems. Developing these skills involves a willingness to assume leadership roles, take risks, and engage in independent, unconventional thinking in the context of experimenting, conducting research, and exploring new strategies, techniques, and perspectives. An entrepreneurial mindset understands the importance of building and scaling ideas for sustainable growth.

Student Descriptors

- Students formulate and express insightful questions and opinions to generate novel ideas.
- Students contribute solutions to economic, social, and environmental problems in order to meet a need in a community by: enhancing concepts, ideas, or products through a creative process; taking risks in their creative thinking as they devise solutions; making discoveries through inquiry research, by testing hypotheses and experimenting with new strategies or techniques.
- Students demonstrate leadership, initiative, imagination, creativity, spontaneity, and ingenuity as they engage in a range of creative processes, motivating others with their ethical entrepreneurial spirit.

Self-Directed Learning

Definition

Self-directed learning involves becoming aware of and managing one's own process of learning. It includes developing dispositions that support motivation, self-regulation, perseverance, adaptability, and resilience. It also calls for a growth mindset – a belief in one's ability to learn – combined with the use of strategies for planning, reflecting on, and monitoring progress towards one's goals, and reviewing potential next steps, strategies, and results. Self-reflection and thinking about thinking (metacognition) support lifelong learning, adaptive capacity, well-being, and the ability to transfer learning in an ever-changing world.

Student Descriptors

- Students learn to think about their own thinking and learning (metacognition) and to believe in their ability to learn and grow (growth mindset). They develop their ability to set goals, stay motivated, and work independently.
- Students who regulate their own learning are better prepared to become lifelong learners. They reflect on their thinking, experiences, and values, and respond to critical feedback, to enhance their learning. They also monitor the progress of their learning.

- Students develop a sense of identity in the context of Canada's various and diverse communities.
- Students cultivate emotional intelligence to better understand themselves and others and build healthy relationships.
- Students learn to take the past into account in order to understand the present and approach the future in a more informed way.
- Students develop personal, educational, and career goals and persevere to overcome challenges in order to reach those goals. They learn to adapt to change and become resilient in the face of adversity.
- Students become managers of the various aspects of their lives – cognitive, emotional, social, physical, and spiritual – to enhance their mental health and overall well-being.

Collaboration

Definition

Collaboration involves the interplay of the cognitive (thinking and reasoning), interpersonal, and intrapersonal competencies needed to work with others effectively and ethically. These skills deepen as they are applied, with increasing versatility, to co-construct knowledge, meaning, and content with others in diverse situations, both physical and virtual, that involve a variety of roles, groups, and perspectives.

Student Descriptors

- Students participate successfully in teams by building positive and respectful relationships, developing trust, and acting cooperatively and with integrity.
- Students learn from others and contribute to their learning as they co-construct knowledge, meaning, and content.
- Students assume various roles on the team, respect a diversity of perspectives, and recognize different sources of knowledge, including Indigenous ways of knowing.
- Students address disagreements and manage conflict in a sensitive and constructive manner.
- Students interact with a variety of communities and/or groups and use various technologies appropriately to facilitate working with others.

Communication

Definition

Communication involves receiving and expressing meaning (e.g., through reading and writing, viewing and creating, listening and speaking) in different contexts and with different audiences and purposes. Effective communication increasingly involves understanding local and global perspectives and societal

and cultural contexts, and using a variety of media appropriately, responsibly, safely, and with a view to creating a positive digital footprint.

Student Descriptors

- Students communicate effectively in different contexts, orally and in writing, using a variety of media.
- Students communicate using the appropriate digital tools, taking care to create a positive digital footprint.
- Students ask effective questions to acquire knowledge; listen to all points of view and ensure that those views are heard; voice their own opinions; and advocate for ideas.
- Students learn about a variety of languages, including Indigenous languages, and understand the cultural importance of language.

Global Citizenship and Sustainability

Definition

Global citizenship and sustainability involves understanding diverse world views and perspectives in order to effectively address the various political, environmental, social, and economic issues that are central to living sustainably in today's interconnected and interdependent world. It also involves acquiring the knowledge, motivation, dispositions, and skills required for engaged citizenship, along with an appreciation of the diversity of people and perspectives in the world. It calls for the ability to envision and work towards a better and more sustainable future for all.

Student Descriptors

- Students understand the political, environmental, economic, and social forces at play in the world today, how they interconnect, and how they affect individuals, communities, and countries.
- Students make responsible decisions and take actions that support quality of life for all, now and in the future.
- Students recognize discrimination and promote principles of equity, human rights, and democratic participation.
- Students recognize the traditions, knowledge, and histories of Indigenous peoples, appreciate their historical and contemporary contributions to Canada, and recognize the legacy of residential schools.
- Students learn from and with people of diverse cultures and backgrounds and develop cross-cultural understanding.
- Students engage in local, national, and global initiatives to make a positive difference in the world.
- Students contribute to society and to the culture of local, national, and global communities, both physical and virtual, in a responsible, inclusive, sustainable, ethical, and accountable manner.

- Students, as citizens, participate in various groups and online networks in a safe and socially responsible manner.

Digital Literacy

Definition

Digital literacy involves the ability to solve problems using technology in a safe, legal, and ethically responsible manner. With the ever-expanding role of digitalization and big data in the modern world, digital literacy also means having strong data literacy skills and the ability to engage with emerging technologies. Digitally literate students recognize the rights and responsibilities, as well as the opportunities, that come with living, learning, and working in an interconnected digital world.

Student Descriptors

- Students select and use appropriate digital tools to collaborate, communicate, create, innovate, and solve problems.
- Students understand how to manage and regulate their use of technology to support their mental health and well-being.
- Students use digital tools to define and plan data searches, collect data, and identify relevant data sets. They analyse, interpret, and graphically represent, or “visualize”, data in various ways to solve problems and inform decisions.
- Students demonstrate a willingness and confidence to explore and use new or unfamiliar digital tools and emerging technologies (e.g., open source software, wikis, robotics, augmented reality). Students understand how different technologies are connected and recognize their benefits and limitations.
- Students manage their digital footprint by engaging in social media and online communities respectfully, inclusively, safely, legally, and ethically. Students understand their rights with respect to personal data and know how to protect their privacy and security and respect the privacy and security of others.
- Students analyse and understand the impact of technological advancements on society, and society’s role in the evolution of technology.

Assessment and Evaluation

Introduction

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 students, parents, and teachers in elementary and secondary schools across the province. Successful implementation of this policy depends on the professional judgement [11] of educators at all levels as well as on their ability to work together and to build trust and confidence among parents and students.

A brief summary of some major aspects of the current assessment, evaluation, and reporting policy is given below. Teachers should refer to *Growing Success* for more detailed information.

Fundamental Principles

The primary purpose of assessment and evaluation is to improve student learning.

The seven fundamental principles given below (excerpted from *Growing Success,* page 6) lay the foundation for rich and challenging practice. When these principles are fully understood and observed by all teachers, they will guide the collection of meaningful information that will help inform instructional decisions, promote student engagement, and improve student learning.

To ensure that assessment, evaluation, and reporting are valid and reliable, and that they lead to the improvement of learning for all students, teachers use practices and procedures that:

- are fair, transparent, and equitable;
- support all students;
- are carefully planned to relate to the curriculum expectations and learning goals and, as much as possible, to the interests, learning styles and preferences, needs, and experiences of all students;
- are communicated clearly to students and parents at the beginning of the school year or course and at other appropriate points throughout the school year or course;
- are ongoing, varied in nature, and administered over a period of time to provide multiple opportunities for students to demonstrate the full range of their learning;

[11] "Professional judgement", as defined in *Growing Success* (p. 152), is "judgement that is informed by professional knowledge of curriculum expectations, context, evidence of learning, methods of instruction and assessment, and the criteria and standards that indicate success in student learning. In professional practice, judgement involves a purposeful and systematic thinking process that evolves in terms of accuracy and insight with ongoing reflection and self-correction".

- provide ongoing descriptive feedback that is clear, specific, meaningful, and timely to support improved learning and achievement;
- develop students' self-assessment skills to enable them to assess their own learning, set specific goals, and plan next steps for their learning.

Learning Skills and Work Habits

The development of learning skills and work habits is an integral part of a student's learning. To the extent possible, however, the evaluation of learning skills and work habits, apart from any that may be included as part of a curriculum expectation in a course, should *not* be considered in the determination of a student's grades. Assessing, evaluating, and reporting on the achievement of curriculum expectations and on the demonstration of learning skills and work habits *separately* allows teachers to provide information to the parents and student that is specific to each of these two areas.

The six learning skills and work habits are responsibility, organization, independent work, collaboration, initiative, and self-regulation.

Content Standards and Performance Standards

The Ontario curriculum for Grades 1 to 12 comprises *content standards* and *performance standards*. Assessment and evaluation will be based on both the content standards and the performance standards.

The content standards are the overall and specific curriculum expectations given in the curriculum for every subject and discipline.

The performance standards are outlined in the achievement chart, also provided in the curriculum for every subject and discipline (each achievement chart is specific to the subject/discipline; see the sample charts provided). The achievement chart is a standard province-wide guide and is to be used by all teachers as a framework for assessing and evaluating student achievement of the expectations in the particular subject or discipline. It enables teachers to make consistent judgements about the quality of student learning, based on clear performance standards and on a body of evidence collected over time. It also provides teachers with a foundation for developing clear and specific feedback for students and parents.

The purposes of the achievement chart are to:

- provide a common framework that encompasses all curriculum expectations for all subjects/courses across the grades;
- guide the development of high-quality assessment tasks and tools (including rubrics);
- help teachers plan instruction for learning;

- provide a basis for consistent and meaningful feedback to students in relation to provincial content and performance standards;
- establish categories and criteria for assessing and evaluating students' learning.

Assessment "for Learning" and "as Learning"

Assessment is the process of gathering information that accurately reflects how well a student is achieving the curriculum expectations in a grade or course. The primary purpose of assessment is to improve student learning. Assessment for the purpose of improving student learning is seen as both "assessment *for* learning" and "assessment *as* learning". As part of assessment *for* learning, teachers provide students with descriptive feedback and coaching for improvement. Teachers engage in assessment *as* learning by helping all students develop their capacity to be independent, autonomous learners who are able to set individual goals, monitor their own progress, determine next steps, and reflect on their thinking and learning.

As essential steps in assessment *for* learning and *as* learning, teachers need to:

- plan assessment concurrently and integrate it seamlessly with instruction;
- share learning goals and success criteria with students at the outset of learning to ensure that students and teachers have a common and shared understanding of these goals and criteria as learning progresses;
- gather information about student learning before, during, and at or near the end of a period of instruction, using a variety of assessment strategies and tools;
- use assessment to inform instruction, guide next steps, and help students monitor their progress towards achieving their learning goals;
- analyse and interpret evidence of learning;
- give and receive specific and timely descriptive feedback about student learning;
- help students to develop skills of peer assessment and self-assessment.

Evaluation

Evaluation refers to the process of judging the quality of student learning on the basis of established performance standards, and assigning a value to represent that quality. Evaluation accurately summarizes and communicates to parents, other teachers, employers, institutions of further education, and students themselves what students know and can do with respect to the overall curriculum expectations. Evaluation is based on assessment *of* learning that provides evidence of student achievement at strategic times throughout the course, often at the end of a period of learning.

All curriculum expectations must be accounted for in instruction and assessment, but *evaluation focuses on students' achievement of the overall expectations*[12]. Each student's achievement of the overall expectations is evaluated on the basis of the student's achievement of related specific expectations. The overall expectations are broad in nature, and the specific expectations define the particular content or scope of the knowledge and skills referred to in the overall expectations. Teachers will use their professional judgement to determine which specific expectations should be used to evaluate achievement of the overall expectations, and which ones will be accounted for in instruction and assessment but not necessarily evaluated.

Determining a report card grade involves the interpretation of evidence collected through observations, conversations, and student products (tests/exams, assignments for evaluation), combined with the teacher's professional judgement and consideration of factors such as the number of tests/exams or assignments for evaluation that were not completed or submitted and the fact that some evidence may carry greater weight than other evidence.

Secondary

Seventy per cent of the final grade (a percentage mark) in a course will be based on evaluation conducted throughout the course. This portion of the grade should reflect the student's most consistent level of achievement, with special consideration given to more recent evidence. Thirty per cent will be based on a final evaluation administered at or towards the end of the course. This evaluation will be based on evidence from one or a combination of the following: an examination, a performance, an essay, and/or another method of evaluation suitable to the course content. The final evaluation allows the student an opportunity to demonstrate comprehensive achievement of the overall expectations for the course.

Reporting Student Achievement

Elementary

Three formal report cards are issued in Ontario's publicly funded elementary schools, as described below.

The Elementary Progress Report Card shows a student's development of learning skills and work habits during the fall of the school year, as well as the student's general progress in working towards

[12] Beginning in the 2021–22 school year, schools are asked not to assess, evaluate or report on the overall expectations related to social-emotional learning skills in *The Ontario Curriculum, Grades 1–8, Mathematics (2020)* and *The Ontario Curriculum, Grades 1–8, Health and Physical Education (2019)*. It is the ministry's expectation that instruction of the social-emotional learning skills will continue while educators engage in ongoing professional learning.

achievement of the curriculum expectations in each subject (reported as “progressing very well”, “progressing well”, or “progressing with difficulty”).

The Elementary Provincial Report Card shows a student’s achievement at specific points in the school year. The first Provincial Report Card reflects student achievement of the overall curriculum expectations introduced and developed from September to January/February of the school year, as well as the student’s development of learning skills and work habits during that period. The second reflects achievement of curriculum expectations introduced or further developed from January/February to June, as well as further development of learning skills and work habits during that period. The Provincial Report Card for Grades 1–6 uses letter grades; the report card for Grades 7 and 8 uses percentage grades.

Secondary

The Provincial Report Card, Grades 9–12, shows a student’s achievement at specific points in the school year or semester. There are two formal reporting periods for a semestered course and three formal reporting periods for a non-semestered course. The reports reflect student achievement of the overall curriculum expectations, as well as development of learning skills and work habits.

Communication with parents and students

Although there are formal reporting periods, communication with parents and students about student achievement should be continuous throughout the year or course, by a variety of means, such as parent-teacher or parent-student-teacher conferences, portfolios of student work, student-led conferences, interviews, phone calls, checklists, and informal reports. Communication about student achievement should be designed to provide detailed information that will encourage students to set goals for learning, help teachers to establish plans for teaching, and assist parents in supporting learning at home.

Categories of Knowledge and Skills

The categories represent four broad areas of knowledge and skills within which the expectations for any given subject or course can be organized. The four categories should be considered as interrelated, reflecting the wholeness and interconnectedness of learning.

The categories help teachers focus not only on students’ acquisition of knowledge but also on their development of the skills of thinking, communication, and application.

The categories of knowledge and skills are as follows:

Knowledge and Understanding. Subject-specific content acquired in each grade or course (knowledge), and the comprehension of its meaning and significance (understanding).

Thinking. The use of critical and creative thinking skills and/or processes.

Communication. The conveying of meaning and expression through various forms.

Application. The use of knowledge and skills to make connections within and between various contexts.

In all subjects and courses, students should be given numerous and varied opportunities to demonstrate the full extent of their achievement of the curriculum expectations across all four categories of knowledge and skills.

Teachers will ensure that student learning is assessed and evaluated in a balanced manner with respect to the four categories, and that achievement of particular expectations is considered within the appropriate categories. The emphasis on "balance" reflects the fact that all categories of the achievement chart are important and need to be a part of the process of instruction, learning, assessment, and evaluation. However, it also indicates that for different courses, the *relative* importance of each of the categories may vary. The importance accorded to each of the four categories in assessment and evaluation should reflect the emphasis accorded to them in the curriculum expectations for the subject or course and in instructional practice.

Criteria and Descriptors

To further guide teachers in their assessment and evaluation of student learning, the achievement chart provides "criteria" and "descriptors".

A set of criteria is identified for each category in the achievement chart. The criteria are subsets of the knowledge and skills that define the category. The criteria identify the aspects of student performance that are assessed and/or evaluated, and they serve as a guide to what teachers look for. Each curriculum has subject- or discipline-specific criteria and descriptors. For example, in the English curriculum, in the Knowledge and Understanding category, the criteria are "knowledge of content" and "understanding of content". The former includes examples such as forms of text and elements of style, and the latter includes examples such as relationships among facts. "Descriptors" indicate the characteristics of the student's performance, with respect to a particular criterion, on which assessment or evaluation is focused. *Effectiveness* is the descriptor used for each of the criteria in the Thinking, Communication, and Application categories. What constitutes effectiveness in any given performance task will vary with the particular criterion being considered. Assessment of effectiveness may therefore focus on a quality such as appropriateness, clarity, accuracy, precision, logic, relevance, significance, fluency, flexibility, depth, or breadth, as appropriate for the particular criterion.

Levels of Achievement

The achievement chart also identifies four levels of achievement, defined as follows:

Level 1 represents achievement that falls much below the provincial standard. The student demonstrates the specified knowledge and skills with limited effectiveness. Students must work at significantly improving in specific areas, as necessary, if they are to be successful in a subject or course in the next grade.

Level 2 represents achievement that approaches the standard. The student demonstrates the specified knowledge and skills with some effectiveness. Students performing at this level need to work on identified learning gaps to ensure future success.

Level 3 represents the provincial standard for achievement. The student demonstrates the specified knowledge and skills with considerable effectiveness. Parents of students achieving at level 3 can be confident that their children will be prepared for work in subsequent grades or courses.

Level 4 identifies achievement that surpasses the provincial standard. The student demonstrates the specified knowledge and skills with a high degree of effectiveness. *However, achievement at level 4 does not mean that the student has achieved expectations beyond those specified for the grade or course.*

Specific "qualifiers" are used with the descriptors in the achievement chart to describe student performance at each of the four levels of achievement – the qualifier *limited* is used for level 1; *some* for level 2; *considerable* for level 3; and *a high degree of* or *thorough* for level 4. Hence, achievement at level 3 in the Thinking category for the criterion "use of planning skills" would be described in the achievement chart as "[The student] uses planning skills with *considerable* effectiveness".

Sample Achievement Charts

Three samples of the achievement chart are provided, from the following subjects/disciplines:

- The Arts, Grades 1–8
- Science and Technology, Grades 1–8
- English, Grades 9–12

These three samples illustrate the consistent characteristics of the performance standards across all subjects and disciplines and across all grades. The samples also illustrate how the achievement chart varies – particularly with respect to the examples provided for the criteria in each category – to reflect the nature of the particular subject or discipline. For instance, the examples for the criterion "Application of knowledge and skills" in the Application category of the achievement chart for the arts include performance skills, composition, and choreography, whereas those for science and technology include investigation skills and safe use of equipment and technology.

As discussed in the preceding sections, the achievement chart identifies four categories of knowledge and skills and four levels of achievement in the particular subject/discipline.

The Achievement Chart for The Arts, Grades 1–8

Knowledge and Understanding – Subject-specific content acquired in each grade (knowledge), and the comprehension of its meaning and significance (understanding)				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Knowledge of content *(e.g., facts, genres, terms, definitions, techniques, elements, principles, forms, structures, conventions)*	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, ideas, procedures, processes, themes, relationships among elements, informed opinions)*	demonstrates limited understanding of content	demonstrates some understanding of content	demonstrates considerable understanding of content	demonstrates thorough understanding of content
Thinking – The use of critical and creative thinking skills and/or processes				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Use of planning skills *(e.g., formulating questions, generating ideas, gathering information, focusing research, outlining, organizing an arts presentation or project, brainstorming/ bodystorming, blocking, sketching, using visual organizers, listing goals in a rehearsal log, inventing notation)*	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., analysing, evaluating, inferring, interpreting, editing, revising, refining, forming conclusions, detecting bias, synthesizing)*	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., creative and analytical processes, design process, exploration of the elements, problem solving, reflection, elaboration, oral discourse, evaluation, critical literacy, metacognition, invention, critiquing, reviewing)*	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	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Expression and organization of ideas and understandings in art forms (dance, drama, music, and the visual arts), including media/ multimedia forms *(e.g., expression of ideas and feelings using visuals, movements, the voice, gestures, phrasing, techniques)*, **and in oral and written forms** (*e.g., clear expression and logical organization in critical responses to art works and informed opinion pieces)*	expresses and organizes ideas and understandings with limited effectiveness	expresses and organizes ideas and understandings with some effectiveness	expresses and organizes ideas and understandings with considerable effectiveness	expresses and organizes ideas and understandings with a high degree of effectiveness
Communication for different audiences *(e.g., peers, adults, younger children)* **and purposes through the arts** *(e.g., drama presentations, visual arts exhibitions, dance and music performances)* **and in oral and written forms** *(e.g., debates, analyses)*	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 in dance, drama, music, and the visual arts *(e.g., allegory, narrative or symbolic representation, style, articulation, drama conventions, choreographic forms, movement vocabulary)* **and arts vocabulary and terminology in oral and written forms**	uses conventions, vocabulary, and terminology of the arts with limited effectiveness	uses conventions, vocabulary, and terminology of the arts with some effectiveness	uses conventions, vocabulary, and terminology of the arts with considerable effectiveness	uses conventions, vocabulary, and terminology of the arts with a high degree of effectiveness

Application – The use of knowledge and skills to make connections within and between various contexts				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Application of knowledge and skills *(e.g., performance skills, composition, choreography, elements, principles, processes, technologies, techniques, strategies, conventions)* **in familiar contexts** *(e.g., guided improvisation, performance of a familiar work, use of familiar forms)*	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., concepts, strategies, processes, techniques)* **to new contexts** *(e.g., a work requiring stylistic variation, an original composition, student-led choreography, an interdisciplinary or multidisciplinary project)*	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., between the arts; between the arts and personal experiences and the world outside the school; between cultural and historical, global, social, and/or environmental contexts; between the arts and other 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

The Achievement Chart for Science and Technology, Grades 1–8

Knowledge and Understanding – Subject-specific content acquired in each grade (knowledge), and the comprehension of its meaning and significance (understanding)				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Knowledge of content (*e.g., facts, terminology, definitions)*	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, ideas, theories, principles, procedures, 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 inquiry and problem-solving skills and/or processes				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Use of initiating and planning skills and strategies (*e.g., formulating questions, identifying the problem, developing hypotheses, scheduling, selecting strategies and resources, developing plans*)	uses initiating and planning skills and strategies with limited effectiveness	uses initiating and planning skills and strategies with some effectiveness	uses initiating and planning skills and strategies with considerable effectiveness	uses initiating and planning skills and strategies with a high degree of effectiveness
Use of processing skills and strategies *(e.g., performing and recording; gathering evidence and data; examining different points of view; selecting tools, equipment, materials, and technology; observing; manipulating materials; proving)*	uses processing skills and strategies with limited effectiveness	uses processing skills and strategies with some effectiveness	uses processing skills and strategies with considerable effectiveness	uses processing skills and strategies with a high degree of effectiveness
Use of critical/creative thinking processes, skills, and strategies *(e.g., analysing, interpreting, problem solving, evaluating, forming and justifying conclusions on the basis of evidence, developing solutions, considering diverse perspectives)*	uses critical/ creative thinking processes, skills, and strategies with limited effectiveness	uses critical/ creative thinking processes, skills, and strategies with some effectiveness	uses critical/ creative thinking processes, skills, and strategies with considerable effectiveness	uses critical/ creative thinking processes, skills, and strategies with a high degree of effectiveness

Communication – The conveying of meaning through various forms				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Expression and organization of ideas and information in oral, visual, and/or written forms *(e.g., diagrams, models, articles, project journals, reports)*	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 *(e.g., peers, adults, community members)* **and purposes** *(e.g., to inform, to persuade)* **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., symbols, formulae, International System of Units)*	uses conventions, vocabulary, and terminology of the discipline with limited effectiveness	uses conventions, vocabulary, and terminology of the discipline with some effectiveness	uses conventions, vocabulary, and terminology of the discipline with considerable effectiveness	uses conventions, vocabulary, and terminology of the discipline with a high degree of effectiveness
Application – The use of knowledge and skills to make connections within and between various contexts				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Application of knowledge and skills *(e.g., concepts and processes; procedures related to the safe use of tools, equipment, materials, and technology; investigation skills)* **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., concepts and processes, safe use of equipment and technology, investigation skills)* **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 between sciences; connections to everyday and real-life situations; connections among concepts within science and technology; connections involving use of prior knowledge and experience; connections among science and technology and other disciplines, including other STEM [science, technology, engineering, and mathematics] 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
Proposing courses of practical action to deal with problems relating to our changing world	proposes courses of practical action of limited effectiveness	proposes courses of practical action of some effectiveness	proposes courses of practical action of considerable effectiveness	proposes highly effective courses of practical action

The Achievement Chart for English, Grades 9–12

Knowledge and Understanding – Subject-specific content acquired in each 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)**
	The student:			
Knowledge of content *(e.g., forms of text; strategies used when listening and speaking, reading, writing, and viewing and representing; elements of style; literary terminology, concepts, and theories; language conventions)*	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; ideas; opinions; relationships among facts, ideas, concepts, themes)*	demonstrates limited understanding of content	demonstrates some understanding of content	demonstrates considerable understanding of content	demonstrates thorough understanding of content

Thinking – 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)**
	The student:			
Use of planning skills *(e.g., generating ideas, gathering information, focusing research, organizing information)*	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., drawing inferences, interpreting, analysing, synthesizing, evaluating)*	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., oral discourse, research, critical analysis, critical literacy, metacognition, creative process)*	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)**
	The student:			
Expression and organization of ideas and information *(e.g., clear expression, logical organization)* **in oral, graphic, and written forms, including media forms**	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., use of appropriate style, voice, point of view)* **in oral, graphic, and written forms, including media 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 *(e.g., grammar, spelling, punctuation, usage)***, vocabulary, and terminology of the discipline in oral, graphic, and written forms, including media forms**	uses conventions, vocabulary, and terminology of the discipline with limited effectiveness	uses conventions, vocabulary, and terminology of the discipline with some effectiveness	uses conventions, vocabulary, and terminology of the discipline with considerable effectiveness	uses conventions, vocabulary, and terminology of the discipline 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)**
	The student:			
Application of knowledge and skills *(e.g., literacy strategies and processes; literary terminology, concepts, and theories)* **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., literacy strategies and processes; literary terminology, concepts, and theories)* **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., between the text and personal knowledge and experience, other texts, and the world outside school)*	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

Curriculum context for Science and Technology

Preface

The Ontario Curriculum, Grades 1–8: Science and Technology, 2022 focuses on fundamental science and technology concepts and on science, technology, engineering, and mathematics (STEM) skills. It supports students in making connections between skills and concepts, and the practical applications of science and technology in their lives, and in learning about life systems, matter and energy, structures and mechanisms, and Earth and space systems. This curriculum is designed to help students prepare for deeper levels of science and technology learning in secondary school and beyond.

In addition to the considerations outlined in this curriculum context, all of the general "Program Planning" sections on this site apply to this curriculum. Educators should review and implement these general sections, as well as the components that appear below.

Vision and Goals

The vision of the elementary science and technology curriculum is for students to acquire and develop the skills and knowledge they need to thrive in today's rapidly changing world. As discoveries and innovations in STEM increasingly impact our lives, science and technology continues to adapt and evolve. A central component of this curriculum is safe, practical, hands-on, experiential learning that will support students in becoming successful and discerning individuals who are scientifically and technologically literate.

Throughout the elementary science and technology program, students apply scientific and engineering design processes to develop their sense of wonder about the world, to explore their curiosity about what they observe, and to investigate problems relating to science, technology, society, and the environment. From Grades 1 to 8, students are encouraged to consider what practical steps they themselves can take to help solve some of these problems.

This curriculum provides numerous opportunities for students to develop essential STEM skills and to extend and deepen their understanding of the fundamental concepts of science and technology. Throughout the grades and strands, they learn to apply their understanding with increasing sophistication. In addition, students will develop the ability to make connections that honour the complex, cross-curricular, and sometimes ambiguous nature of modern scientific and technological problems. Students are encouraged to see the connections between these areas, and the connections to other subject areas, as they bring to the classroom experiences from their own lives.

Environmental education[13] concepts and skills appear throughout the curriculum, providing students with opportunities to investigate the world around them and to build the skills and knowledge that serve as the foundation for deep understanding about complex and interconnected issues such as ecosystem balance, biodiversity, sustainability, and climate change. Learning in all strands is enriched when students think critically about environmental issues when relating science and technology to society, or when developing innovative solutions through a scientific or engineering design process.

As students progress through the grades, they gain an appreciation for the broad range of STEM fields and skilled trades sectors. They also come to realize that, while they are all impacted in various ways by discoveries and innovations in these areas, they can one day become contributing members of these fields and sectors and shape the direction of future scientific and technological innovation, to help support a better future for all.

While embodying optimism and hope for the future, this curriculum provides opportunities to investigate exciting innovations, discoveries, and concepts in science and technology. The curriculum also provides opportunities for students to consider the intended and unintended consequences of scientific and technological progress as they relate science and technology to our changing world, and as they investigate important issues such as climate change and issues related to the impacts of coding and emerging technologies, which can include bias, accessibility, and ethical concerns.

Ensuring that all students see themselves as confident, effective science and technology learners and practitioners is at the forefront of the program. Students analyse scientific and technological discoveries and innovations made by people with diverse experiences, and integrate their own scientific and technological skills and knowledge to enhance their learning in the classroom. Students explore Indigenous knowledges, which can broaden their understanding of and appreciation for Indigenous cultures and practices, and also provide them with valuable ways in which to investigate how diverse perspectives enrich science and technology practices.

Finally, and most importantly, the science and technology curriculum helps students develop important scientific literacy and technological skills that will enable them to thrive in their future professional and personal lives, and to become discerning, knowledgeable, and active problem solvers in their communities.

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[13] "Environmental education is education about the environment, for the environment, and in the environment that promotes an understanding of, rich and active experience in, and an appreciation for the dynamic interactions of:

- the Earth's physical and biological systems;
- the dependency of our social and economic systems on these natural systems;
- the scientific and human dimensions of environmental issues;
- the positive and negative consequences, both intended and unintended, of the interactions between human-created and natural systems."

– Ontario Ministry of Education, *Shaping Our Schools, Shaping Our Future: Report of the Working Group on Environmental Education* (June 2007), p. 6

In summary, the Ontario science and technology curriculum aims to provide all students with the skills and knowledge required to:

- apply research, experimentation, and engineering design skills to help find solutions to complex problems in their own lives and in the lives of those in their communities;
- understand the cross-curricular and cross-disciplinary nature of problem solving within the STEM fields;
- appreciate the wonder and awe of the world and be optimistic and realistic about the power and limitations of science and technology to solve environmental and social problems;
- consider carefully the intended and unintended consequences of scientific and technological progress;
- develop scientific literacy and technological skills that will allow them to be discerning citizens and find answers to scientific and technological questions;
- see themselves as future contributing members of STEM fields or skilled trades sectors;
- see themselves as confident, effective science and technology learners, with rich social and cultural backgrounds that can help them to contribute to scientific discovery and technological innovation;
- discover effective, equitable, inclusive, and sustainable solutions to scientific and technological problems that impact their lives and the lives of those in their communities;
- recognize the importance of Indigenous knowledges and ways of knowing, and how diverse perspectives benefit current challenges within STEM fields.

The three main goals of the curriculum are for students:

1. to develop the skills and make the connections needed for scientific and technological investigation

2. to relate science and technology to our changing world, including society, the economy, and the environment

3. to explore and understand science and technology concepts.

The Importance of STEM Education

STEM education is the cross-curricular study of science, technology, engineering, and mathematics, and the application of those subjects in real-world contexts. As students engage in STEM education, they develop the transferable skills that they need to meet the demands of today's global economy and society, and to become scientifically and technologically literate citizens.

STEM education helps students develop an understanding and appreciation of each of the core subjects of science, technology, and mathematics. At the same time, it supports a more holistic understanding and application of skills and knowledge related to engineering design and innovation. STEM learning integrates and applies concepts, processes, and ways of thinking associated with these subjects to

enable students to design economical, ethical, innovative, and sustainable solutions to technical and complex real-world problems.

Skills developed through STEM education include computational thinking, coding, innovation, and scientific and engineering design. These skills are in high demand in today's globally connected world, as advancements in science and technology continue to impact all areas of our lives, and they form a critical component of the science and technology curriculum. Students use an engineering design process and associated skills to design, build, and test devices, models, structures, and systems, and they write and execute code in investigations and when modelling concepts.

Approaches to STEM education may vary across Ontario schools. STEM-related subjects may be taught separately, but cross-curricular connections should form a part of student learning. Strand A of the science and technology curriculum focuses on the STEM skills and connections that frame learning in the other four strands: Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems. Strand A also provides opportunities for critical cross-curricular learning as students consider the connections between science and technology and other subject areas.

Classroom activities focused on solving real-world problems and on understanding practical applications of concepts can combine components from two or more STEM-related subjects and can include contexts related to the student's home and community or to various occupations, including the skilled trades. The integration of a number of STEM-related subjects can reinforce students' understanding of each subject and of the interrelationships among them.

Curriculum expectations related to exploring Indigenous knowledges and ways of knowing can create opportunities for inclusive and impactful integrative studies. Diverse perspectives engage students in a variety of creative and critical thinking processes that are essential for developing innovative, ethical, and effective solutions to societal and environmental problems.

The themes and components of STEM education are woven throughout the science and technology curriculum to ensure that Ontario educators and students become innovators and leaders for ethical and sustainable change in society and the workforce, and to create opportunities in our diverse communities to foster integrative thinking and problem solving. The curriculum also supports the development of scientific and technological literacy in students, enabling them to better appreciate, understand, and navigate the world in which they live.

Curiosity and Wonder in Science and Technology

Curiosity and wonder are at the core of science and technology disciplines and should be at the core of a student-centred science and technology education. Students come to school with a natural curiosity about the way in which the world works, and as they learn about natural phenomena, science and technology concepts and theories, and scientific and technological discoveries and innovations made by diverse individuals, they can be amazed and inspired. The Ontario science and technology curriculum strives to nurture and support curiosity and wonder in order for all students to enjoy science and technology, to be engaged and achieve success within the program, and to see themselves as confident

learners and as scientifically and technologically literate individuals. The curriculum also strives to inspire students with a spirit of inventing, designing, making, and entrepreneurship as they use their knowledge from the classroom to develop innovative, made-in-Canada solutions to global issues.

Within the science and technology classroom, students' curiosity may be expressed explicitly, with direct questions, such as "How does that work?", or expressed subtly as they consider the results of an experiment or the results of testing an engineered design. They may bring questions into the classroom about scientific and technological phenomena they have observed in their own lives, or initial classroom investigations may lead them to extend their thinking and further compare and analyse concepts. Processes such as scientific research, scientific experimentation, and engineering design provide a framework within which to situate and nurture this curiosity. Students can revise and refine their initial questions, and then proceed through a formal process to seek answers or develop solutions.

Wonder is exhibited as students are surprised at the results of their research, experimentation, or engineered design, or as they admire the natural processes that make up our world. Through opportunities to engage in a wide variety of investigations related to the small (chloroplasts, vacuoles, mitochondria, and cytoplasm) and the large (the Sun, Earth and other planets, and the solar system), the stable (struts, ties, and structures) and the dynamic (pulleys, wheels, axles, and flying machines), the Ontario curriculum provides opportunities for students to appreciate and wonder about scientific concepts and processes, as well as current and emerging technologies and innovations.

The excitement and promise of discoveries and innovations is balanced with an awareness of the limitations, and potentially harmful impacts, of science and technology. Students should develop an understanding of the types of problems that can be solved by science and technology, as well as of the critical role that human creativity, empathy, and ethics have in innovations and solutions that support accessibility, inclusivity, and equity for all.

In addition to being at the core of science and technology disciplines, curiosity and wonder should be integral components of helping students develop the skills and make the connections needed for scientific and technological investigation, develop the ability to relate science and technology to our changing world, explore and understand concepts, and develop as scientifically and technologically literate individuals.

The Program in Science and Technology

Curriculum Expectations

The Ontario Curriculum, Grades 1–8: Science and Technology, 2022 identifies the expectations for each grade and describes the skills and knowledge that students are expected to acquire, demonstrate, and apply in their class work and investigations, 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, in science and technology for Grades 1 to 8. The strands include Strand A: STEM Skills and Connections and four other strands, lettered B, C, D, and E. *Taken together, the overall and specific expectations represent the mandated curriculum*.

The *overall expectations* describe in general terms the skills and knowledge that students are expected to demonstrate by the end of each grade. The *specific expectations* describe the expected skills and knowledge in greater detail. The specific expectations are organized 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 science and technology curriculum, the overall expectations outline the fundamental knowledge, concepts, and skills that are required for engaging in appropriate scientific and technological situations in and out of the classroom at any grade or stage of development. The curriculum focuses on connecting, developing, reinforcing, and refining the knowledge, concepts, and skills that students acquire as they work towards meeting the overall expectations in the elementary school program. This approach reflects and accommodates the progressive nature of development of knowledge, concepts, and skills in science and technology learning.

The specific expectations reflect this progression in skill and knowledge development through changes in the wordings of the expectations and through the introduction of new expectations, where appropriate. The progression is captured by the increasing complexity of the teacher supports (see below) associated with most expectations and by the diversity of contexts in which the learning is applied, along with the variety of opportunities presented for applying it. Note that *all* the skills specified in the early grades continue to be developed and refined as students move through the grades, whether or not each of those skills continues to be explicitly required in an expectation.

Teacher Supports

Specific expectations are accompanied by examples and/or instructional tips.[14] The examples are meant to clarify the requirement specified in the expectation, illustrating the kind of skill or knowledge, the specific area of learning, the depth of learning, and/or the level of complexity that the expectation entails. The instructional tips suggest instructional strategies and authentic contexts for the effective modelling, practice, and application of science and technology concepts. The examples and instructional

[14] The teacher supports will be made available at a later date, after the issuing of the curriculum expectations and the curriculum context.

tips are optional supports that teachers can draw on to support teaching and learning, in addition to developing their own supports that reflect a similar level of complexity. Whatever the specific ways in which the requirements outlined in the expectations are implemented in the classroom, they must be inclusive and, wherever possible, reflect the diversity of the student population and the population of the province.

Fundamental Concepts and "Big Ideas" in Science and Technology

This curriculum provides numerous opportunities for students to develop essential STEM skills and make important connections that will allow them to deepen their understanding of the fundamental concepts and big ideas of science and technology. The fundamental concepts in science and technology provide a framework for the acquisition of all scientific and technological knowledge. They also help students to integrate scientific and technological knowledge with knowledge in other subject areas, such as mathematics and social studies. The fundamental concepts that are addressed in the curriculum for science and technology in Grades 1 to 8 are matter, energy, systems and interactions, automation, structure and function, sustainability and stewardship, and change and continuity. These fundamental concepts are described in the following chart.

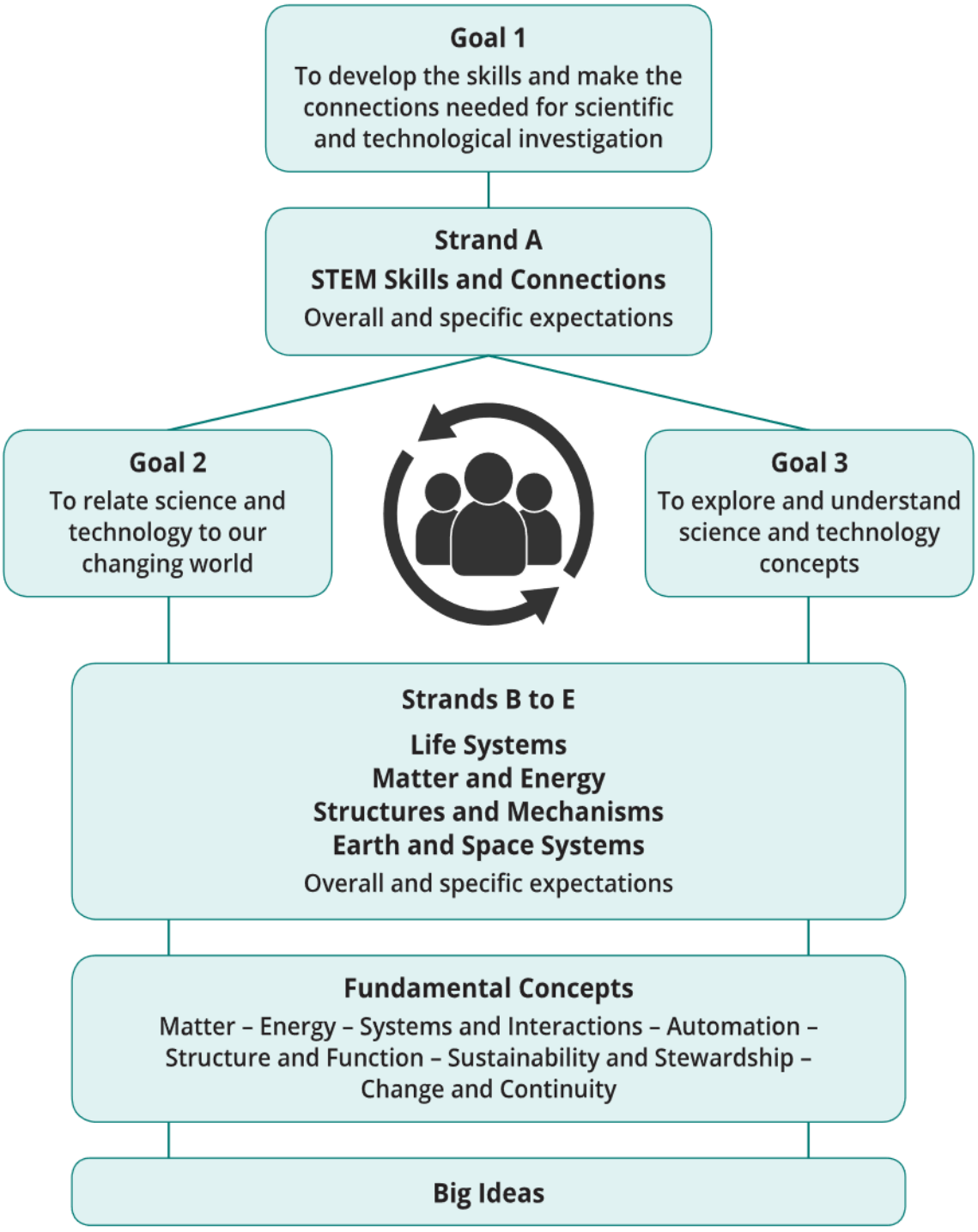
Fundamental Concepts	
Matter	Matter is anything that has mass and occupies space. Matter has particular structural and behavioural characteristics.
Energy	Energy comes in many forms, and can change forms. Energy is required to make things happen (to do work). Work is done when a force causes movement.
Systems and Interactions	A system is a collection of living and/or non-living things and processes that interact to perform some function. A system includes inputs, outputs, and relationships among system components. Natural and human systems develop in response to, and are limited by, a variety of environmental factors.
Automation	Automation involves implementing technologies to make systems run on their own, without further human intervention. Automation can facilitate and accelerate functions that are otherwise difficult, repetitive, or dangerous for human beings to perform. Coding and emerging technologies play an increasingly important role in controlling automated systems.
Structure and Function	This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Sustainability and Stewardship	Sustainability is the concept of meeting the needs of the present without compromising the ability of future generations to meet their needs. Stewardship involves understanding that we need to use and care for the natural environment in a responsible way and making the effort to pass on to future generations no less than what we have access to ourselves. Values that are central to responsible stewardship are as follows: using non-renewable resources with care; reusing and recycling what we can; and switching to renewable resources where possible.
Change and Continuity	Change is the process of becoming different over time, and can be quantified. Continuity represents consistency and connectedness within and among systems over time. Interactions within and among systems result in change and variations in consistency.

In this curriculum, "big ideas"[15] describe the aspects of the fundamental concepts that are addressed at each grade level. Developing an understanding of the big ideas requires students to consider and apply STEM skills as they engage in investigative processes and make connections between related science and technology concepts, between science and technology and other disciplines, and between science and technology and everyday life.

The relationships between the fundamental concepts, STEM skills and connections, big ideas, goals of the science and technology program, and overall and specific expectations of this curriculum are indicated in the chart that follows.

[15] The big ideas will be included in the grade-by-grade overviews, to be made available at a later date, after the issuing of the curriculum expectations and the curriculum context.


Goal 1
To develop the skills and make the connections needed for scientific and technological investigation
Strand A
STEM Skills and Connections
Overall and specific expectations
Goal 2
To relate science and technology to our changing world
Goal 3
To explore and understand science and technology concepts
Strands B to E
Life Systems
Matter and Energy
Structures and Mechanisms
Earth and Space Systems
Overall and specific expectations
Fundamental Concepts
Matter – Energy – Systems and Interactions – Automation – Structure and Function – Sustainability and Stewardship – Change and Continuity
Big Ideas

The Strands and Topics in the Science and Technology Curriculum

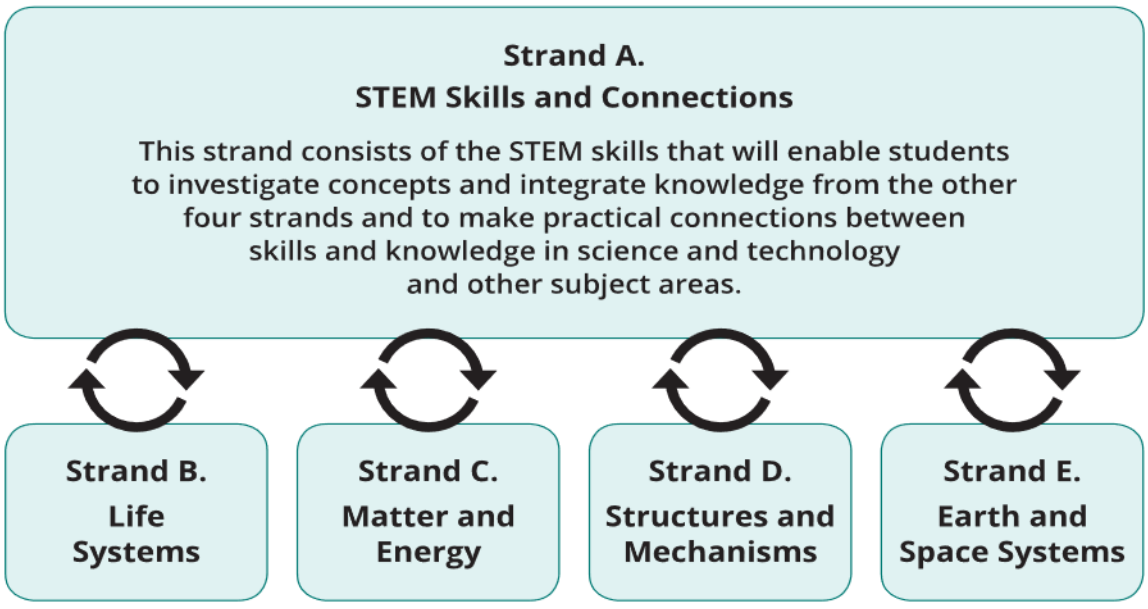
The expectations in the science and technology curriculum are organized into five distinct but related strands. Strand A is an overarching strand that focuses on the foundational STEM skills and connections that will enable students to investigate concepts and integrate knowledge from each of the other strands and to make practical connections between science and technology and other subject areas. In Strands B through E, students integrate Strand A expectations as they develop their understanding of strand-specific concepts, investigate phenomena, and make meaningful connections to the real world.

In all grades, learning related to the expectations in Strand A occurs in the context of learning related to the other four strands.

The five strands are as follows:

- A. STEM Skills and Connections
- B. Life Systems
- C. Matter and Energy
- D. Structures and Mechanisms
- E. Earth and Space Systems

The chart below illustrates the relationship between Strand A and the other four strands.



Strand A – STEM Skills and Connections

Strand A focuses on the STEM skills that will enable students to explore and investigate concepts. Students apply these skills as they integrate knowledge from the other four strands and as they make connections between these skills and knowledge and real-world issues in science and technology as well as other subject areas.

In this strand, students use scientific research, scientific experimentation, and engineering design processes to carry out formal investigations, design solutions to problems, and communicate their findings. Students also learn how to follow established health and safety procedures.

Students gain an understanding of the technology they use every day and use coding in investigations and to model science and technology concepts. In addition to using coding, students assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields.

Students can learn about Indigenous sciences and technologies, and make connections to First Nations, Métis, and Inuit knowledge systems and perspectives, helping them assess the impacts of discoveries and innovations on First Nations, Métis, and Inuit communities. They can also investigate the scientific and technological knowledge systems and perspectives of various cultures, analyse the contributions of people with diverse experiences, and describe practical applications of science and technology.

Strand B – Life Systems

In this strand, students investigate the needs, characteristics, and interconnectedness of living things in the natural environment. Students examine various animals and plants and their importance to society and the environment. Students make connections to food literacy as they investigate different plants and animals used for food and the importance of food literacy in supporting decisions related to physical and mental health. They explore how living things adapt to the dynamic nature of the environment and to human activity, and they expand their understanding of the concept of structure and function as they study human organ systems and the cell as the basic unit of life. Students' understanding of the concept of systems and interactions is broadened during their investigation of habitats and communities, biodiversity, and interactions within local ecosystems. Throughout, students deepen their understanding of the fundamental concept of sustainability and stewardship. In all grades, students assess the impact of human activity and technology on society and the environment.

Strand C – Matter and Energy

In this strand, students develop their understanding of matter as they explore the properties and physical and chemical changes of matter. Students are introduced to the particulate nature of matter as they investigate pure substances and mixtures. They deepen their understanding of fluids and learn about fluid mechanics by investigating hydraulic and pneumatic devices and systems. Additionally, students develop an understanding of energy as they study its various forms – including electrical energy, light, and sound – and their uses in everyday life. In this strand, students make connections to food literacy as they learn about the importance of the Sun as the principal source of energy on Earth and develop an understanding of food as a source of energy for living things. Students also investigate

the relationship between forces and energy by designing and building devices for specific purposes. Throughout the grades, students examine the environmental and social impacts associated with the use of various materials and electrical energy.

Strand D – Structures and Mechanisms

In this strand, students develop their understanding of structures as they investigate the factors that contribute to a structure's stability and strength. Through designing structures for specific purposes, they learn about the relationship between the design and function of structures and the forces that act on them. Students also develop their understanding of machines, building from the concept of simple machines to more complex machines and their mechanisms. They apply their understanding of forces and properties of air by designing and testing devices such as flying machines. Students also learn about systems and their components and investigate how to improve the efficiency of systems and automated processes. In this strand, students make connections to food literacy as they investigate systems related to food processing. Throughout the grades, students assess the impacts on society and the environment of machines and their mechanisms, and of structures and the materials used to make them.

Strand E – Earth and Space Systems

In this strand, students investigate the cyclical nature of days and seasons and the importance of the Sun, air, and water to life on Earth. Students also explore the importance of soils, and develop an understanding of rocks, minerals, geological processes, and natural resources. In this strand, students make connections to food literacy as they investigate how different soils are suited to growing different types of food, including crops. Students are introduced to space exploration, the law of conservation of energy, and concepts associated with heat transfer in the environment. Students explore various aspects of water systems and their importance both locally and globally. Throughout, students deepen their understanding of change and continuity through the lens of stewardship and sustainability of Earth's resources. In all grades, students assess the impact of human activity and technology on society and the environment.

Topics in Science and Technology

The chart below provides an outline of the topics in Grade 1 to 8 science and technology.

Elementary Science and Technology Curriculum Overview

	STEM Skills and Connections STEM Investigation and Communication Skills Coding and Emerging Technologies Applications, Connections, and Contributions			
Grade	Life Systems	Matter and Energy	Structures and Mechanisms	Earth and Space Systems
1	Needs and Characteristics of Living Things	Energy in Our Lives	Everyday Materials, Objects, and Structures	Daily and Seasonal Changes
2	Growth and Changes in Animals	Properties of Liquids and Solids	Simple Machines and Movement	Air and Water in the Environment
3	Growth and Changes in Plants	Forces and Motion	Strong and Stable Structures	Soils in the Environment
4	Habitats and Communities	Light and Sound	Machines and Their Mechanisms	Rocks, Minerals, and Geological Processes
5	Human Health and Body Systems	Properties of and Changes in Matter	Forces Acting on Structures	Conservation of Energy and Resources
6	Biodiversity	Electrical Phenomena, Energy, and Devices	Flight	Space
7	Interactions in the Environment	Pure Substances and Mixtures	Form, Function, and Design of Structures	Heat in the Environment
8	Cells	Fluids	Systems in Action	Water Systems

Scientific and Engineering Design Processes

In addition to developing knowledge related to specific concepts, the study of science and technology offers students varied opportunities to learn skills that are relevant to their everyday world. Strand A is focused on such skills, and refers to the following three processes:

- scientific research process
- scientific experimentation process
- engineering design process

The skills associated with these processes include:

- initiating and planning (e.g., asking questions, clarifying problems, planning procedures)

- performing and recording (e.g., following procedures, accessing information, recording observations and findings)
- analysing and interpreting (e.g., organizing data, reflecting on the effectiveness of actions performed, drawing conclusions)
- communicating (e.g., using appropriate vocabulary, communicating findings in a variety of ways)

Scientific Processes

There are a variety of processes that are followed when investigating questions in a scientific manner. In scientific investigations, students engage in activities that allow them to develop knowledge and understanding of scientific ideas in much the same way that scientists do. Like scientists, students must develop skills in the two major processes of scientific investigations: research and experimentation. These two processes play an important role in the Grade 1 to 8 science and technology curriculum. Teachers should ensure that students engage often in these processes and consider ethical protocols when doing so, as they develop skills and knowledge in the other four strands of the curriculum.

When planning scientific investigations, teachers should also consider the impact that emerging technologies are having on scientific processes, and how scientific processes have led to innovations and new technologies. For example, ongoing advances in technology are changing how data is obtained, processed, stored, and visualized, as well as how scientific knowledge is shared; while scientific discoveries related to materials and their use are being applied to the development of new technologies. In this context, teachers can make important connections between technology and science, showing how they are interrelated. They can encourage students to use technologies to support their scientific investigations, and students can consider how their research and experimentation findings relate to potential new technologies.

Scientific Research Process

Scientific research includes both primary research, which is done through first-hand, direct observation of objects, living things, phenomena, and systems; and secondary research, which is done by reviewing the work and the findings of others. Research is a starting point for investigations, and it can also play a role during or after an experiment to support or build upon findings and observations.

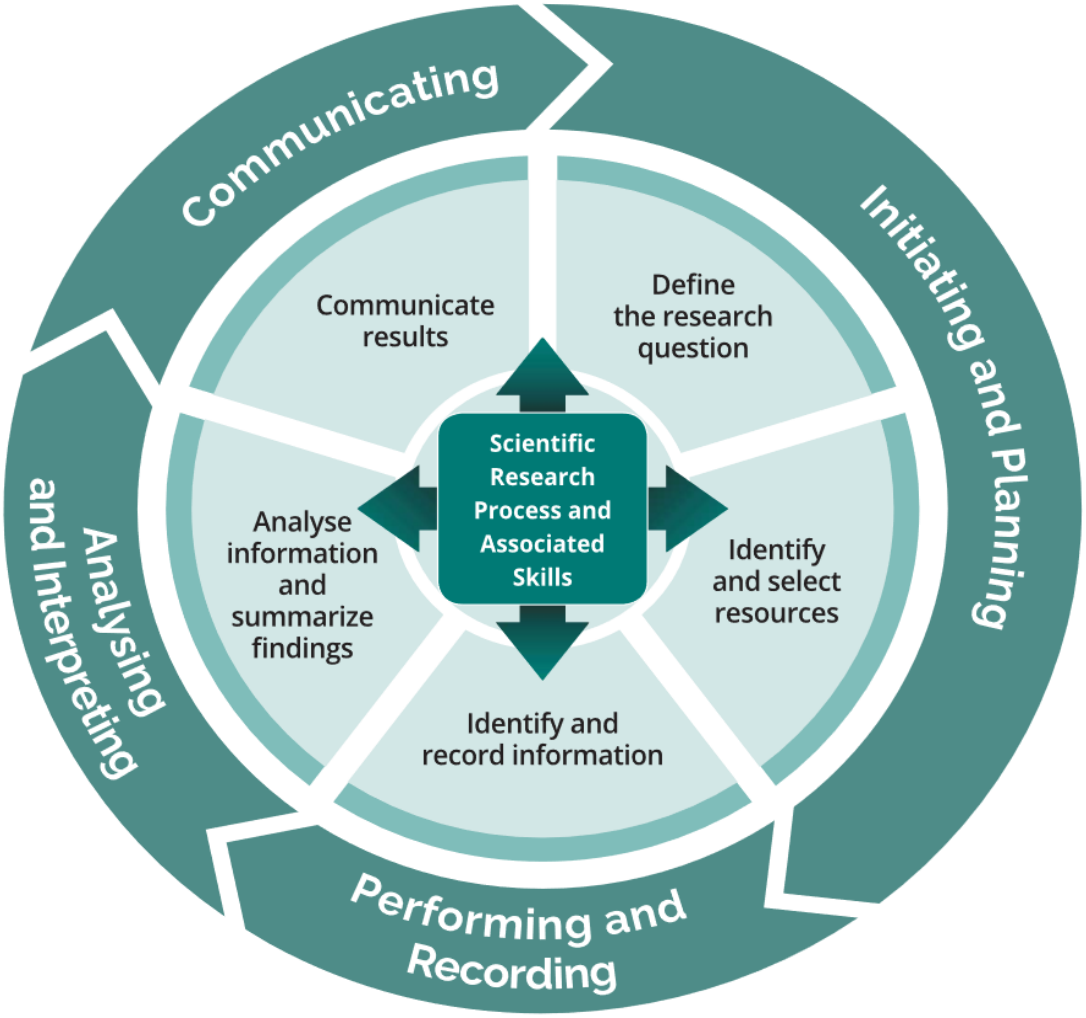
Research does not always follow a linear path. New information or findings may lead students to refine their research question(s) or change the course of the intended research. This should not be a source of concern, as there are times when research proceeds in this manner, with new findings impacting the researcher and the research process itself.

The most appropriate entry points into a scientific research process, and the most appropriate components of the process to be focused on, may depend on student readiness. Prior experience and knowledge, as well as access to resources, the context of the learning, and the amount of time available,

may also be factors. For these reasons, educators may need to provide multiple entry points to engage all students in the learning.

Considering the vast and ever-increasing number of sources of information available today, students need to be aware of how to find and identify appropriate information during research. Critical-thinking skills are essential to assess the information gathered, in part by considering the biases, interests, and motivation of the authors, as well as the trustworthiness of the source or publisher. Students should also carefully consider how scientific knowledge is shared, whether in formal, peer-reviewed contexts or through less formal channels such as social media.

The following diagram summarizes the scientific research process and shows how its components relate to the skills of *initiating and planning; performing and recording; analysing and interpreting*; and *communicating.*



The components of a research process are described in more detail below. Students may not engage in all of these components in all grades, and the process will not always be linear. These components are meant as a general guide to the process.

Initiating and Planning

Define the research question

- develop several specific and concise research questions
- select an appropriate research question for investigation
- identify prior knowledge and experiences related to the research question
- identify key words
- develop a work plan
- consider resources available

Identify and select resources

- identify various resources to consult
- consult the selected resources, using various research tools and/or by visiting a library, museum, or other facility
- consider bias in the resources
- select relevant and appropriate resources

Performing and Recording

Identify and record information

- classify resources by subtopics
- identify important data from the selected resources
- identify important information, and record it in the form of notes, graphics, or illustrations or using audio and video formats
- keep track of references for all resources

Analysing and Interpreting

Analyse information and summarize findings

- look for missing or conflicting ideas
- rank the information according to its relevance
- eliminate unnecessary data

- consider bias in the data or on the part of the researcher
- check whether the data answers the research question
- answer the research question and write a summary

Communicating

Communicate results

- choose a form or medium for communication that is appropriate for the intended audience
- choose the information to share, and develop a draft presentation or publication, using appropriate vocabulary
- consider cultural, ethical, and other implications related to the communication of the work
- review the draft, considering the audience's perspective, and edit as required
- present or publish the work

Scientific Experimentation Process

Experimentation involves performing various steps to test and validate or reject a hypothesis, as well as manipulating different variables in order to observe the results. It involves experiential, hands-on learning that engages and empowers students as they develop their investigation skills.

A process of experimentation is often iterative and may involve conducting *fair tests* to determine the effects of changing one factor in an experimental set-up. In a fair test, the student identifies variables that may affect the results of the experiment; selects one variable to be altered (tested) while keeping other variables constant; measures all trials in the same way; and repeats tests to determine the validity of the results. As part of their experimentation, students are encouraged to consider the concept of *fair tests*, and whether or not complete objectivity and the absence of bias is possible in science investigations.

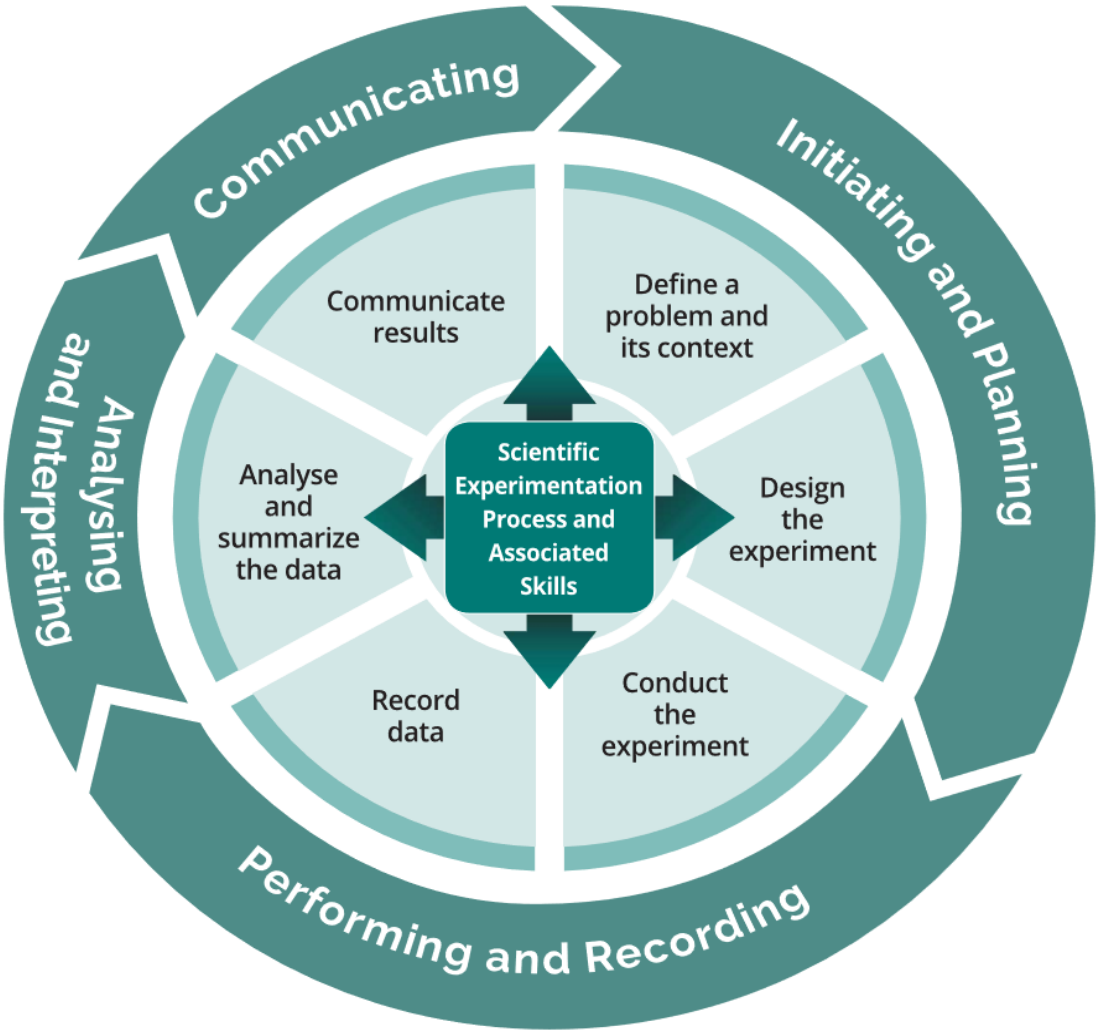
As with the scientific research process described above, the most appropriate entry points into a scientific experimentation process, and the most appropriate components of the process to be focused on, may depend on student readiness. Prior experience and knowledge, as well as access to tools and equipment, the context of the learning, and the amount of time available, may also be factors. Educators may therefore need to provide multiple entry points to engage all students in the learning. In any given classroom, students may demonstrate a wide range of strengths and needs. It is important that experiments are attuned to this diversity and include an integrated process that responds to the unique strengths and needs of each student.

It is important to have students conduct experiments in all strands, so that students can gain experience doing different types of experiments in different contexts. This also ensures that students are provided with hands-on, experiential, and exciting ways to uncover a broad range of science concepts. The

experiments can be small or large, guided by the teacher or student-led. They can be designed to consolidate existing skills and knowledge or to introduce new skills and develop new knowledge.

Students should be encouraged to follow established experimental and health and safety procedures. They should also be guided to eventually develop their own experimental procedures, keeping health and safety in mind.

The following diagram summarizes the scientific experimentation process and shows how its components relate to the skills of *initiating and planning; performing and recording; analysing and interpreting*; and *communicating.*



Components of this experimentation process are described in more detail below. Students may not engage in all of these components in all grades, and the process will not always be linear. These components are meant as a general guide to the process.

Initiating and Planning

Define a problem and its context

- identify and review resources related to an area of investigation
- consider questions related to the area of investigation
- define a specific problem, and identify what is to be investigated
- formulate a hypothesis or consider expected results

Design the experiment

- clearly define the steps of the experiment
- identify the materials, equipment, and health and safety precautions needed
- consider the variables that will remain constant and those that will be changed
- identify the data to be collected

Performing and Recording

Conduct the experiment

- carry out the experiment, paying close attention to the designed steps
- follow all procedures and processes related to health and safety and environmental sustainability

Record data

- consider the potential type of data to be obtained
- consider how to best record, organize, and represent the data
- record clear and precise data

Analysing and Interpreting

Analyse and summarize the data

- perform any required calculations
- represent the data, using appropriate forms
- explain the result obtained based on the data
- review the identified resources, considering the results from the experiment
- develop a clear and concise conclusion based on a summary of the data
- consider sources of error and how to minimize these sources of error in future experiments

Communicating

Communicate results

- choose a form or medium for communication that is appropriate for the intended audience
- choose the information to share, and develop a draft presentation or publication, using appropriate vocabulary
- review the draft, considering the audience's perspective, and edit as required
- present or publish the work

Engineering Design Process

An engineering design process (EDP) provides a framework for students and teachers as they plan and build solutions to problems or develop ways to address needs that connect to the curriculum and the world around them. An EDP recognizes that twenty-first-century science and technology problems can be complex and sometimes ambiguous, and provides appropriate, purposeful stages to navigate these challenges.

Like the two scientific processes described above, an EDP is an iterative process that may involve students revisiting a prior stage as they acquire new information about the problem being investigated, or as they acquire a better understanding of the person or people for whom they are designing a solution. Students may even restart, or repeat, the entire process when one approach proves unsuccessful. This should be seen as an important and necessary part of learning and design in science and technology.

Since students will be seeking solutions to problems that will impact others, ethical considerations as well as the perspectives and needs of a variety of individuals and communities should be considered throughout the process. Students can conduct interviews with end-users, or they can research individuals or communities that may be affected by potential solutions. Their approach should be empathetic, and students should consider various perspectives, as well as factors such as usability and environmental sustainability, throughout the process.

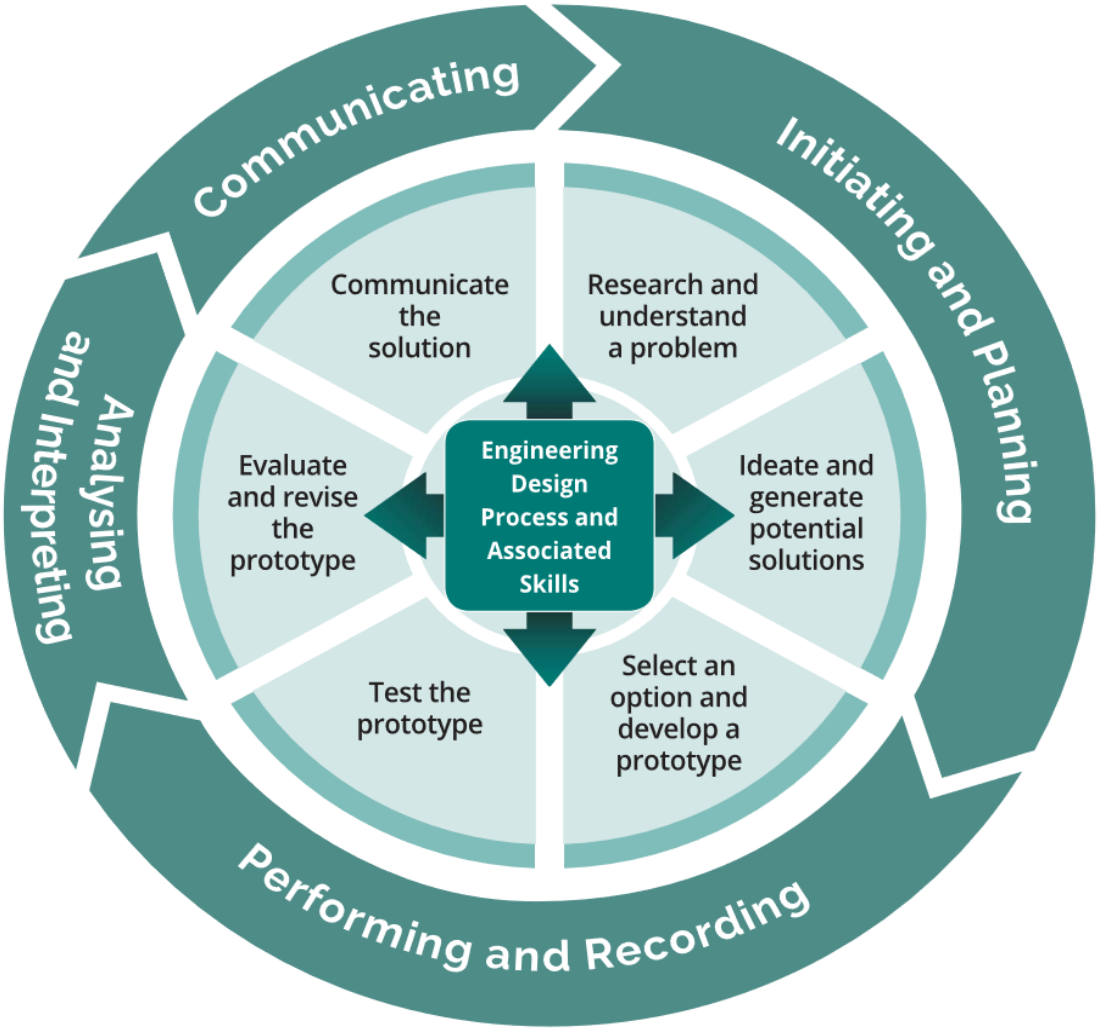
The EDP described below involves students initiating and planning solutions, performing tests and recording data, analysing and interpreting results, and communicating those results using appropriate vocabulary and forms for a variety of purposes. The end product of the EDP might not be a tangible object; it might instead be a computer simulation or a model, or even a new scientific or technological process or system.

As with scientific processes, there is no single EDP, but rather a range of engineering practices that are followed when designing solutions or developing projects. Students and teachers may find the need to emphasize specific aspects of the EDP provided, or to make substitutions with components of processes that they may find elsewhere. Students and teachers may even find other EDPs that they may want to work with, and a comparison of various processes may prove beneficial for students and teachers.

Appropriate entry points into the EDP and the specific components of the process that are focused on may depend on student readiness. Prior experience and knowledge, as well as access to resources, the context of the learning, and the amount of time available, may also be factors; therefore, educators may need to provide multiple entry points to engage all students in the learning.

The EDP provided here allows students to engage with important scientific and technological concepts and skills within curriculum expectations as they develop the transferable skills and cross-curricular concepts that embody STEM education.

The following diagram summarizes the EDP and shows how its components relate to the skills of *initiating and planning; performing and recording; analysing and interpreting*; and *communicating.*



Components of this EDP are described in more detail below. Students may not engage in all of these components in all grades, and the process will not always be linear. These components are meant as a general guide to the process.

Initiating and Planning

Research and understand a problem

- identify and review resources related to a problem
- identify the users affected by the problem
- conduct interviews with those affected by the problem
- listen closely to those affected by the problem and use empathy to understand their experiences, perspectives, and concerns
- review related problems and solutions to these problems
- identify issues related to sustainability and to health and safety

Ideate and generate potential solutions

- brainstorm several ideas and potential solutions
- review potential solutions, considering related research, problems, and solutions
- develop specific success criteria and constraints, and evaluate potential solutions based on these criteria and constraints
- consider the end-users and those impacted by potential solutions, taking into consideration their experiences, perspectives, and concerns
- consider applying related and existing solutions (or some aspects of them) to the identified problem
- consider developing new solutions that are different from existing solutions
- refine or combine potential solutions

Performing and Recording

Select an option and develop a prototype

- select the most appropriate solution, based on established criteria
- plan the design of the solution, considering the required stages as well as available materials, equipment, and time
- consider the economic, environmental, ethical, and health and safety concerns related to the potential design
- consider the key components of the design, and ensure that they can be effectively produced
- construct a prototype of the design

Test the prototype

- develop tests to evaluate the solution
- conduct tests in a variety of contexts, including in controlled and in real-world environments and with various potential users
- record observations and data
- obtain feedback on the prototype from others, including teachers, classmates, friends, family members, and/or community members

Analysing and Interpreting

Evaluate and revise the prototype

- analyse results from testing to determine what changes should be made to the prototype to enhance the end-user experience
- considering the results of testing, review initial resources, existing knowledge, and other brainstormed ideas to improve upon the design
- consider additional components, materials, equipment, or time needed
- refine the prototype to develop a finished product

Communicating

Communicate the solution

- choose a form or medium for communication that is appropriate for the intended audience
- identify the important information and components of the solution or project to share, and develop a draft or plan for the presentation or demonstration, using appropriate vocabulary
- consider issues that might arise during the presentation or demonstration, and minimize their risk
- review drafts and plans, considering the audience's perspective, and make changes as required
- present or finalize the design or solution

Program Planning and Cross-Curricular and Integrated Learning in Science and Technology

Educators consider many factors when planning a science and technology program that cultivates the best possible environment in which all students can maximize their learning. This section highlights important areas of focus that educators should consider, including areas of cross-curricular and integrated learning, as they plan effective and inclusive science and technology programs.

In addition, all of the general "Program Planning" sections on this site apply to this curriculum.

Health and Safety in Science and Technology Education

In Ontario, various laws, including the Education Act, the Occupational Health and Safety Act (OHSA), Ryan's Law, and Sabrina's Law, collectively ensure that school boards provide a safe and productive learning and work environment for both students and employees. Under the Education Act, teachers are required to ensure that all reasonable safety procedures are carried out in the programs and activities for which they are responsible. Teachers should always model safe practices; communicate safety requirements to students in accordance with school board policies, Ministry of Education policies, and any applicable laws; and encourage students to assume responsibility for their own safety and the safety of others.

Concern for safety must be an integral part of instructional planning and implementation. Teachers are encouraged to review:

- their responsibilities under the Education Act;
- their rights and responsibilities under the Occupational Health and Safety Act;
- their school board's health and safety policy for employees;
- their school board's policies and procedures relating to student health and safety (e.g., those related to concussions, medical conditions such as asthma, outdoor education excursions);
- relevant provincial subject association guidelines and standards for student health and safety;
- any additional mandatory requirements, particularly for higher-risk activities (e.g., field trips, workplaces), including requirements for approvals (e.g., from the supervisory officer), permissions (e.g., from parents),[16] and/or qualifications.

Wherever possible, potential risks should be identified and procedures developed to prevent or minimize, and respond to, incidents and injuries. School boards provide and maintain safe equipment, facilities, materials, and tools as well as qualified instruction. In safe learning environments, teachers will:

- be aware of up-to-date safety information;
- plan activities with safety as a primary consideration;
- inform students and parents of risks involved in activities;
- observe students to ensure that they are following safe practices, including the wearing of personal protective equipment;
- have a plan in case of emergency;
- show foresight;

[16] The word *parent(s)* is used on this website to refer to parent(s) and guardian(s). It may also be taken to include caregivers or close family members who are responsible for raising the child.

- act quickly.

To carry out their responsibilities with regard to safety, it is important not only that teachers have concern for their own safety and that of students, but also that they have:

- the knowledge necessary to safely use the materials, tools, and procedures involved in science and technology;
- knowledge concerning the care of living things – plants and animals – that are brought into the classroom;
- the skills needed to perform tasks efficiently and safely.

Note: Teachers supervising students using power equipment such as drills, sanders, and saws need to have specialized training in handling such tools.

Students should be made aware that health and safety is everyone's responsibility – at home; at school; in the community, including in the natural environment; and while visiting, and participating in experiential learning in, workplace settings. Teachers should ensure that students have the knowledge and skills needed for safe participation in all learning activities. Students must be able to demonstrate knowledge of the equipment, facilities, materials, and tools being used and the procedures necessary for their safe use.

Students demonstrate that they have the knowledge, skills, and habits of mind required for safe participation in science and technology activities when they:

- maintain a well-organized and uncluttered work space;
- follow established safety procedures;
- identify possible safety concerns;
- suggest and implement appropriate safety procedures;
- carefully follow the instructions and example of the teacher;
- consistently show care and concern for their safety and that of others.

An important part of scientific research, scientific experimentation, and engineering design processes is that students select appropriate equipment, materials, and tools for their investigations and designs. Schools and boards should collaborate to ensure that students have access to the necessary facilities, equipment, materials, and tools to support their learning and maintain a safe learning environment.

Learning outside the classroom, such as on field trips or during field studies, can provide a meaningful and authentic dimension to students' learning experiences. Teachers must plan these activities carefully in accordance with their school board's relevant policies and procedures and in collaboration with other school board staff (e.g., the principal, outdoor education lead, supervisory officer) to ensure students' health and safety.

The information provided in this section is not exhaustive. Teachers are expected to follow all school board health and safety policies and procedures.

Coding and the Impact of Coding and Emerging Technologies

Coding Concepts and Skills

Strand A, STEM Skills and Connections, includes expectations related to the application of coding concepts and skills that are to be integrated across the other four strands. This allows students to explore a wide variety of science and technology concepts and contexts through coding, while also learning valuable skills related to the automation and control of systems.

In Grades 1 to 3, students learn foundational concepts and practices that will allow them to successfully approach coding activities in science and technology, as well as in mathematics and other subjects. These concepts and practices include the creation of clear and precise algorithms; decomposing problems into smaller steps; and testing, debugging, and refining programs.

In Grades 4 to 6, students explore different ways of generating output, storing and processing data, and obtaining input. The physical computing context, which can include components such as motors, sensors, and microcontrollers, can provide a valuable context for this learning, or students can explore these concepts and associated skills by developing programs without external, physical components.

In Grade 7, students learn about effective ways to use coding to plan, design, and implement projects. Such learning ensures that students are equipped with skills to effectively complete more complex programs. In Grade 8, students combine the skills developed in the previous grades, as they design and implement a larger, automated system in action.

In Grade 1 to 8 science and technology, coding is to be integrated across the strands as a means of providing the following:

- a hands-on, experiential way to learn about science and technology concepts. For example, students can create models or simulations and then alter their components to see how the changes affect the system. This approach gives students a better understanding of both the system itself and the scientific and technological concepts involved;
- a hands-on, experiential way to do science. For example, students can obtain data from sensors and use coding concepts and skills to analyse experimental data, draw conclusions, and solve scientific problems;
- a hands-on, experiential way to develop solutions to technological problems. For example, students can design, build, and program robots, conveyor belts, or interactive art projects with music, motors, and LEDs to help them visualize elements of a possible solution and gain an appreciation of the power of automation. Students have opportunities to feel empowered as they build physical, working solutions;
- a hands-on, experiential way to demonstrate their learning. For example, students can program automated digital stories, dioramas, presentation components, or interactive museum displays to showcase their skills and knowledge and to teach others about science and technology concepts in an engaging and interactive way;

- a hands-on, experiential way to learn about the digital world around them. For example, students can learn about algorithms and automation and can develop an introductory understanding of how social media, autonomous cars, artificial intelligence, and other digital technologies are programmed. Digital technologies are demystified as students develop an understanding of the foundational instructions that program our digital world;
- an opportunity to share and take pride in their work. For example, after students have programmed a computer, they can share their project with their classmates, peers, family, and/or community members. This gives them an opportunity to connect with others in a science and technology context;
- an opportunity for agency in their science and technology learning. For example, the coding context provides students with multiple entry points and multiple directions to take, allowing them to be creative and innovative as they design and build scientific and technological solutions, and as they imagine what might be possible in the future;
- an opportunity for students to realize that they can shape the future in a positive way. For example, while students are accustomed to using digital technologies, they learn through coding that they also have the opportunity to develop these technologies and create change.

Teachers may find it valuable to connect coding expectations with an engineering design process (EDP), as the development of a coding project often requires a guiding design framework for which an EDP is very well suited. Students can define and research the specific science and/or technology problem that they want to solve through coding and then generate ideas and select the best plan or program design. Coding environments allow for rapid ideating, prototyping, testing, and evaluating as students refine and debug their projects, and as they connect these projects to entrepreneurial ventures or to solving problems in their communities. The finalizing and sharing stage of an EDP provides an exciting and enriching classroom and school experience where students can showcase their coding projects to classmates, peers, and/or the school community. Finally, students or teachers should find creative ways of archiving projects, through digital storage of code, photographs, or videos. Many students may want to keep these archived projects in a science and technology portfolio.

It is important to note that the coding expectations in Grade 1 to 8 science and technology complement the coding expectations in Grade 1 to 8 mathematics, without repeating the same learning. Students and teachers will find that the skills and knowledge developed in one curriculum area will be supported in the other. By complementing each other, these two sets of expectations provide students with an in-depth exploration of coding concepts and skills within science and technology as well as mathematics, which speaks to coding's cross-curricular nature and its application in a wide variety of STEM fields.

The Impact of Coding and of Emerging Technologies

Strand A includes learning related to the impact of coding and of emerging technologies on everyday life and in STEM-related fields, including skilled trades. This is an engaging topic that can capture the imagination of students as they consider exciting innovations in science and technology across all strands of the curriculum, and as they imagine a hopeful future. This topic also provides students with an opportunity to critically assess technologies and to consider issues surrounding accessibility, appropriate use, bias, ethical design, and environmental sustainability.

Teachers and students may want to investigate emerging technologies, such as artificial intelligence and automation, that impact a wide range of areas and disciplines. They may also want to explore emerging technologies in specific areas, such as agriculture, horticulture, health care, or biology, in the Life Systems strand, or in electrical and communication systems, transportation, and chemistry, in the Matter and Energy strand. The Structures and Mechanisms strand provides opportunities to investigate emerging technologies in construction, manufacturing, design, or physics, while the Earth and Space Systems strand provides exciting opportunities for investigations into sustainable energy use, green industries, and Earth and space science.

Students will assess the impact of coding and of emerging technologies on their own lives and the lives of others, in fields of study within science and technology, and on related careers. In doing so, students can establish a critical lens when investigating important environmental and societal issues related to science and technology, and can be optimistic and excited about the future. This learning also provides an opportunity for students to see themselves working with and further developing these emerging technologies in the future.

Skilled Trades

A number of concepts and skills in the science and technology curriculum relate directly to the skilled trades. A skilled trade is a career path that requires hands-on work and specialty knowledge. Skilled trades workers apply science and technology concepts as they build and maintain infrastructure like our homes, schools, hospitals, roads, water treatment plants, power stations, farms, and parks. They keep industries running and perform many services that we rely on every day, such as hairstyling, food preparation, and social services. There is a wide variety of skilled trades in Ontario, falling under the sectors of construction, industrial, motive power, and service.

Throughout the science and technology curriculum, students will identify and describe the impact of coding and of emerging technologies and will describe practical applications of science and technology concepts in their home and community. These expectations provide opportunities for students to learn about technology and innovation related to the skilled trades. In addition, a number of science and technology concepts within Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems relate directly to the creative and critical-thinking, problem-solving, and hands-on work essential to the skilled trades. Educators are encouraged to help students make these important connections, as they provide students with authentic, meaningful, and hands-on experiences and activities that connect directly to their lives and communities. Educators are also encouraged to provide students with valuable experiential learning opportunities that connect students with role models with diverse lived experiences. Classroom presentations given by guest speakers from under-represented populations, such as women engaged in the skilled trades, may provide an excellent opportunity to do so.

The secondary technological education curriculum includes broad-based areas of learning that relate to many skilled trades, and it is important that students become aware of and exposed to the skilled trades and apprenticeship as a potential pathway. Elementary science and technology sets the groundwork for this secondary curriculum.

Climate Change

Climate change is an important topic addressed in age-appropriate learning throughout the strands of the science and technology curriculum. While climate change concepts and discussions address important environmental concerns, it is important to also foster hope and optimism in teaching and learning about climate change and other environmental issues. Students will develop the skills and knowledge needed to understand the causes and potential innovative solutions and mitigation strategies related to climate change and other environmental issues, and how they can make the most environmentally responsible decisions possible, given the choices they have.

Food Literacy

In the science and technology curriculum, skills and knowledge related to food literacy are wide-ranging, from students developing an understanding of where food comes from, including the importance of locally sourced food and how it is grown and prepared, to students investigating the importance of biodiversity in agriculture.

Specific expectations related to food literacy are found in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands. In these strands, students describe various plants used for food; explain how food literacy can support decisions related to physical and mental health; describe the purpose, inputs, and outputs of systems related to food processing; identify food as a source of energy for living things; and describe how different soils are suited to growing different types of food, including crops.

Food literacy involves considering not only where food comes from, but also the interrelationships between food and the environment, the economy, our society, and diverse cultures. Food literacy has connections to climate change, biodiversity, and relationships with the land and ecosystems, including varying perspectives on foods and plants within First Nations, Métis, and Inuit contexts, and provides educators and students with valuable opportunities in which to situate and connect their learning. Experiential, hands-on approaches to food literacy skills and knowledge can help students to connect their learning to Ontario's diverse agricultural sector, as well as their own lives and communities.

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,[17] and teachers in elementary and secondary schools across the province. Successful implementation of this policy depends on the professional judgement[18] 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.

Major aspects of assessment, evaluation, and reporting policy are summarized in the main "Assessment and Evaluation" section. The key tool for assessment and evaluation in science and technology – the achievement chart – is provided below.

The Achievement Chart for Science and Technology

The achievement chart identifies four categories of knowledge and skills and four levels of achievement in science and technology. (For important background, see "Content Standards and Performance Standards" in the main Assessment and Evaluation section.)

Knowledge and Understanding – Subject-specific content acquired in each grade (knowledge), and the comprehension of its meaning and significance (understanding)				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Knowledge of content (*e.g., facts, terminology, definitions)*	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, ideas, theories, principles, procedures, processes*)	demonstrates limited understanding of content	demonstrates some understanding of content	demonstrates considerable understanding of content	demonstrates thorough understanding of content

[17] The word *parent(s)* is used on this website to refer to parent(s) and guardian(s). It may also be taken to include caregivers or close family members who are responsible for raising the child.

[18] "Professional judgement", as defined in *Growing Success* (p. 152), is "judgement that is informed by professional knowledge of curriculum expectations, context, evidence of learning, methods of instruction and assessment, and the criteria and standards that indicate success in student learning. In professional practice, judgement involves a purposeful and systematic thinking process that evolves in terms of accuracy and insight with ongoing reflection and self-correction".

Thinking and Investigation – The use of critical and creative thinking skills and inquiry and problem-solving skills and/or processes				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Use of initiating and planning skills and strategies (*e.g., formulating questions, identifying the problem, developing hypotheses, scheduling, selecting strategies and resources, developing plans*)	uses initiating and planning skills and strategies with limited effectiveness	uses initiating and planning skills and strategies with some effectiveness	uses initiating and planning skills and strategies with considerable effectiveness	uses initiating and planning skills and strategies with a high degree of effectiveness
Use of processing skills and strategies *(e.g., performing and recording; gathering evidence and data; examining different points of view; selecting tools, equipment, materials, and technology; observing; manipulating materials; proving)*	uses processing skills and strategies with limited effectiveness	uses processing skills and strategies with some effectiveness	uses processing skills and strategies with considerable effectiveness	uses processing skills and strategies with a high degree of effectiveness
Use of critical/creative thinking processes, skills, and strategies *(e.g., analysing, interpreting, problem solving, evaluating, forming and justifying conclusions on the basis of evidence, developing solutions, considering diverse perspectives)*	uses critical/ creative thinking processes, skills, and strategies with limited effectiveness	uses critical/ creative thinking processes, skills, and strategies with some effectiveness	uses critical/ creative thinking processes, skills, and strategies with considerable effectiveness	uses critical/ creative thinking processes, skills, and strategies with a high degree of effectiveness

Communication – The conveying of meaning through various forms				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Expression and organization of ideas and information in oral, visual, and/or written forms *(e.g., diagrams, models, articles, project journals, reports)*	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 *(e.g., peers, adults, community members)* **and purposes** *(e.g., to inform, to persuade)* **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., symbols, formulae, International System of Units)*	uses conventions, vocabulary, and terminology of the discipline with limited effectiveness	uses conventions, vocabulary, and terminology of the discipline with some effectiveness	uses conventions, vocabulary, and terminology of the discipline with considerable effectiveness	uses conventions, vocabulary, and terminology of the discipline with a high degree of effectiveness
Application – The use of knowledge and skills to make connections within and between various contexts				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Application of knowledge and skills *(e.g., concepts and processes; procedures related to the safe use of tools, equipment, materials, and technology; investigation skills)* **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., concepts and processes, safe use of equipment and technology, investigation skills)* **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 between sciences; connections to everyday and real-life situations; connections among concepts within science and technology; connections involving use of prior knowledge and experience; connections among science and technology and other disciplines, including other STEM [science, technology, engineering, and mathematics] 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
Proposing courses of practical action to deal with problems relating to our changing world	proposes courses of practical action of limited effectiveness	proposes courses of practical action of some effectiveness	proposes courses of practical action of considerable effectiveness	proposes highly effective courses of practical action

Criteria and Descriptors for Science and Technology

To guide teachers in their assessment and evaluation of student learning, the achievement chart provides "criteria" and "descriptors" within each of the four categories of knowledge and skills.

A set of criteria is identified for each category in the achievement chart. The criteria are subsets of the knowledge and skills that define the category. The criteria identify the aspects of student performance that are assessed and/or evaluated, and they serve as a guide to what teachers look for. In the science and technology curriculum, the criteria for each category are as follows:

Knowledge and Understanding

- knowledge of content (e.g., facts, terminology, definitions)
- understanding of content (e.g., concepts, ideas, theories, principles, procedures, processes)

Thinking and Investigation

- use of initiating and planning skills and strategies (e.g., formulating questions, identifying problems, developing hypotheses, scheduling, selecting strategies and resources, developing plans)

- use of processing skills and strategies (e.g., performing and recording; gathering evidence and data; examining different points of view; selecting tools, equipment, materials, and technology; observing; manipulating materials; proving)
- use of critical/creative thinking processes, skills, and strategies (e.g., analysing, interpreting, problem solving, evaluating, forming and justifying conclusions on the basis of evidence, developing solutions, considering diverse perspectives)

Communication

- expression and organization of ideas and information in oral, visual, and/or written forms (e.g., diagrams, models, articles, project journals, reports)
- communication for different audiences (e.g., peers, adults, community members) and purposes (e.g., to inform, to persuade) in oral, visual, and/or written forms
- use of conventions, vocabulary, and terminology of the discipline in oral, visual, and written forms (e.g., symbols, formulae, International System of Units)

Application

- application of knowledge and skills (e.g., concepts and processes; procedures related to the safe use of tools, equipment, materials, and technology; investigation skills) in familiar contexts
- transfer of knowledge and skills (e.g., concepts and processes, safe use of equipment and technology, investigation skills) to new contexts
- making connections within and between various contexts (e.g., connections between sciences; connections to everyday and real-life situations; connections among concepts within science and technology; connections involving use of prior knowledge and experience; connections among science and technology and other disciplines, including other STEM [science, technology, engineering, and mathematics] subjects)
- proposing courses of practical action to deal with problems relating to our changing world

"Descriptors" indicate the characteristics of the student's performance, with respect to a particular criterion, on which assessment or evaluation is focused. *Effectiveness* is the descriptor used for each criterion in the Thinking and Investigation, Communication, and Application categories. What constitutes effectiveness in any given performance task will vary with the particular criterion being considered. Assessment of effectiveness may therefore focus on a quality such as appropriateness, clarity, accuracy, precision, logic, relevance, significance, fluency, flexibility, depth, or breadth, as appropriate for the particular criterion.

Science and Technology, Grade 1

Expectations by strand

A. STEM Skills and Connections

This strand focuses on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. In all grades of the science and technology program, the learning related to this strand takes place in the context of learning related to the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, and it should be assessed and evaluated within these contexts.

Overall expectations

Throughout Grade 1, in connection with the learning in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, students will:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific expectations

Throughout Grade 1, in connection with the learning in the other strands, students will:

A1.1

use a scientific research process and associated skills to conduct investigations

A1.2

use a scientific experimentation process and associated skills to conduct investigations

A1.3

use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A1.4

follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials

A1.5

communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life

Specific expectations

Throughout Grade 1, in connection with the learning in the other strands, students will:

A2.1

write and execute code in investigations and when modelling concepts, with a focus on creating clear and precise instructions for simple algorithms

A2.2

identify and describe impacts of coding and of emerging technologies on everyday life

A3. Applications, Connections, and Contributions

demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

Specific expectations

Throughout Grade 1, in connection with the learning in the other strands, students will:

A3.1

describe practical applications of science and technology concepts in their home and community, and how these applications address real-world problems

A3.2

investigate how science and technology can be used with other subject areas to address real-world problems

A3.3

analyse contributions to science and technology from various communities

B. Life Systems

Needs and Characteristics of Living Things

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 1, students will:

B1. Relating Science and Technology to Our Changing World

assess the importance of a healthy environment for living and non-living things, and the responsibilities of humans in contributing to a healthy environment

Specific expectations

By the end of Grade 1, students will:

B1.1

describe changes or problems that could result from the loss of living and non-living things that are part of everyday life, while taking different perspectives into consideration

B1.2

identify actions that can be taken to contribute to a healthy environment

B2. Exploring and Understanding Concepts

demonstrate an understanding of the basic needs and characteristics of living things, including humans

Specific expectations

By the end of Grade 1, students will:

B2.1

demonstrate an understanding of the natural environment as a place where living and non-living things are interconnected

B2.2

identify the basic needs of living things, including the need for air, water, food, heat, shelter, and space

B2.3

identify the physical characteristics of various plants and animals, including humans, and explain how these characteristics help the plants and animals meet their basic needs

B2.4

identify the location and the function of various parts of the human body, including sensory organs

B2.5

describe the characteristics of a healthy environment, including clean air and water and nutritious food, and how a healthy environment enables living things to meet their needs

B2.6

describe ways in which living things provide for the needs of other living things

C. Matter and Energy

Energy in Our Lives

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 1, students will:

C1. Relating Science and Technology to Our Changing World

assess uses of energy at home, at school, and in the community, and suggest ways to use energy responsibly

Specific expectations

By the end of Grade 1, students will:

C1.1

describe everyday uses of energy at school and at home, and suggest ways to use energy responsibly

C1.2

describe how the lives of people and other living things would be affected if electrical energy were no longer available

C2. Exploring and Understanding Concepts

demonstrate an understanding of how energy affects their lives, and that the Sun is the principal source of energy for Earth

Specific expectations

By the end of Grade 1, students will:

C2.1

demonstrate an understanding that energy is the ability to move or change something

C2.2

demonstrate an understanding that the Sun is Earth's principal source of energy, including how it warms the air, land, and water; is a source of light for Earth; and makes it possible for plants to grow

C2.3

identify food as a source of energy for living things

C2.4

identify everyday uses of various sources of energy

C2.5

demonstrate an understanding that humans get the energy resources they need from the world around them, and that the supply of many of these resources is limited

C2.6

describe seasonal differences in how we use energy and in the forms of energy we use

D. Structures and Mechanisms

Everyday Materials, Objects, and Structures

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 1, students will:

D1. Relating Science and Technology to Our Changing World

assess the impact on people and the environment of everyday objects, including structures, and the materials they are made of

Specific expectations

By the end of Grade 1, students will:

D1.1

identify the kinds of waste materials produced by humans, and plan and carry out a course of action for minimizing waste in the classroom or at home, explaining why each action is important

D1.2

assess everyday objects, including structures, that have similar purposes, in terms of the materials they are made from, the source of these materials, and what happens to these objects when they are worn out or no longer needed

D2. Exploring and Understanding Concepts

demonstrate an understanding that objects, including structures, have observable characteristics and are made from materials with specific properties that determine how they are used

Specific expectations

By the end of Grade 1, students will:

D2.1

describe objects as things that are made of one or more materials

D2.2

identify structures that are objects designed to support a load, including those acting as supporting frameworks for objects

D2.3

identify materials that are used to make various everyday objects, including structures

D2.4

describe observable characteristics of various everyday objects, including structures, using qualitative information gathered through their senses

D2.5

describe purposes of everyday objects, including structures

D2.6

identify properties of materials that enable the objects made from them to perform their intended function

D2.7

identify different kinds of fasteners and describe uses for each

D2.8

identify sources in nature of some common materials that are used to make various objects, including structures

E. Earth and Space Systems

Daily and Seasonal Changes

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 1, students will:

E1. Relating Science and Technology to Our Changing World

assess the impact of daily and seasonal changes on living things, including humans

Specific expectations

By the end of Grade 1, students will:

E1.1

assess the impact of daily and seasonal changes on human outdoor activities, and identify innovations that enable people to engage in various activities year-round

E1.2

assess ways in which daily and seasonal changes have an impact on society, the environment, and living things in the natural environment

E2. Exploring and Understanding Concepts

demonstrate an understanding of daily and seasonal changes and of how living things respond to those changes

Specific expectations

By the end of Grade 1, students will:

E2.1

demonstrate an understanding of Earth's relationship to the Sun and that this relationship results in daily and seasonal changes on Earth

E2.2

demonstrate an understanding that a cycle is a series of repeating events, and that cycles can be observed in daily and seasonal changes

E2.3

describe the changes in the amount of light and heat from the Sun that occur throughout the day and in the four seasons

E2.4

describe and compare the four seasons in terms of the weather, including precipitation and temperature, in their local area

E2.5

describe changes in the appearance or behaviour of living things that are adaptations to seasonal changes

E2.6

describe how humans prepare for, and respond to, daily and seasonal changes

Science and Technology, Grade 2

Expectations by strand

A. STEM Skills and Connections

This strand focuses on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. In all grades of the science and technology program, the learning related to this strand takes place in the context of learning related to the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, and it should be assessed and evaluated within these contexts.

Overall expectations

Throughout Grade 2, in connection with the learning in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, students will:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific expectations

Throughout Grade 2, in connection with the learning in the other strands, students will:

A1.1

use a scientific research process and associated skills to conduct investigations

A1.2

use a scientific experimentation process and associated skills to conduct investigations

A1.3

use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A1.4

follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials

A1.5

communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life

Specific expectations

Throughout Grade 2, in connection with the learning in the other strands, students will:

A2.1

write and execute code in investigations and when modelling concepts, with a focus on decomposing problems into smaller steps

A2.2

identify and describe impacts of coding and of emerging technologies on everyday life

A3. Applications, Connections, and Contributions

demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

Specific expectations

Throughout Grade 2, in connection with the learning in the other strands, students will:

A3.1

describe practical applications of science and technology concepts in their home and community, and how these applications address real-world problems

A3.2

investigate how science and technology can be used with other subject areas to address real-world problems

A3.3

analyse contributions to science and technology from various communities

B. Life Systems

Growth and Changes in Animals

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 2, students will:

B1. Relating Science and Technology to Our Changing World

assess ways in which animals have an impact on society and the environment, and ways in which human activities have an impact on animals and the places where they live

Specific expectations

By the end of Grade 2, students will:

B1.1

examine impacts that animals can have on society and the environment, and describe some ways in which any negative impacts can be minimized

B1.2

assess impacts of various human activities on animals and the places where they live, and describe practices that can minimize negative impacts

B2. Exploring and Understanding Concepts

demonstrate an understanding that animals grow and change and have distinct characteristics

Specific expectations

By the end of Grade 2, students will:

B2.1

compare physical characteristics of various animals, including characteristics that are constant and those that change

B2.2

describe the locomotion of various animals

B2.3

describe the life cycle of a variety of animals, including insects, amphibians, birds, and mammals

B2.4

compare changes in the appearance and behaviour of various animals as they go through a complete life cycle

B2.5

describe adaptations, including physical and/or behavioural characteristics, that allow various animals to survive in their natural environment

C. Matter and Energy

Properties of Liquids and Solids

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 2, students will:

C1. Relating Science and Technology to Our Changing World

assess ways in which liquids and solids and their uses can have an impact on society and the environment

Specific expectations

By the end of Grade 2, students will:

C1.1

assess practices related to the use, storage, and disposal of liquids and solids in the home in terms of the effects on personal health and safety and on the environment, and suggest ways to improve these practices

C1.2

assess the impacts of changes of state of liquids and solids on humans and on environments

C2. Exploring and Understanding Concepts

demonstrate an understanding of the properties and physical changes of liquids and solids

Specific expectations

By the end of Grade 2, students will:

C2.1

identify various types of matter in natural and built environments as liquids or solids

C2.2

describe the properties of liquids and solids

C2.3

describe properties of liquid water and solid water, and identify the conditions that cause changes from one state to the other

C2.4

identify conditions in which the states of liquids and solids remain constant and conditions that can cause their states to change

C2.5

describe some ways in which liquids and solids can be combined to make useful mixtures

C2.6

classify solid objects and materials in terms of their buoyancy and in terms of their ability to absorb or repel water

C2.7

explain the meaning of international symbols that give us information on the safety of substances

D. Structures and Mechanisms

Simple Machines and Movement

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 2, students will:

D1. Relating Science and Technology to Our Changing World

assess the impact of simple machines on society and on the environment

Specific expectations

By the end of Grade 2, students will:

D1.1

assess the impact of simple machines on the daily lives of people in various communities

D1.2

assess the impact on the environment of technologies that use simple machines to facilitate movement

D2. Exploring and Understanding Concepts

demonstrate an understanding of movement and ways in which simple machines help to move objects

Specific expectations

By the end of Grade 2, students will:

D2.1

describe different ways an object can move

D2.2

identify ways in which the position of an object can be changed

D2.3

identify the six basic types of simple machines: lever, inclined plane, wedge, pulley, wheel and axle, and screw

D2.4

describe ways in which each type of simple machine is used in daily life to make tasks easier

D2.5

compare, qualitatively or quantitatively, the force required to move an object using various simple machines to the force required to move the object without using a simple machine

E. Earth and Space Systems

Air and Water in the Environment

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 2, students will:

E1. Relating Science and Technology to Our Changing World

assess ways in which the actions of humans have an impact on the quality of air and water, and create plans to protect these resources

Specific expectations

By the end of Grade 2, students will:

E1.1

assess the impact of human activities on air and water, taking various perspectives into consideration, including those of First Nations, Métis, and Inuit, and plan a course of action to protect the quality of the air and/or water in the local community

E1.2

assess their personal and household uses of water, and create a plan to use water responsibly

E1.3

examine the availability of fresh water and drinking water around the world, and describe the impact on communities

E2. Exploring and Understanding Concepts

demonstrate an understanding of the properties of air and water, including water in various states, and of ways in which living things depend on air and water for their survival

Specific expectations

By the end of Grade 2, students will:

E2.1

demonstrate an understanding of the key properties of air and water

E2.2

identify sources of water in the natural and built environments

E2.3

describe the stages of the water cycle, including evaporation, condensation, precipitation, and collection

E2.4

identify the three states of water in the environment, and describe how temperature changes affect the state of water within the water cycle

E2.5

describe ways in which living things, including humans, depend on air and water

Science and Technology, Grade 3

Expectations by strand

A. STEM Skills and Connections

This strand focuses on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. In all grades of the science and technology program, the learning related to this strand takes place in the context of learning related to the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, and it should be assessed and evaluated within these contexts.

Overall expectations

Throughout Grade 3, in connection with the learning in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, students will:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific expectations

Throughout Grade 3, in connection with the learning in the other strands, students will:

A1.1

use a scientific research process and associated skills to conduct investigations

A1.2

use a scientific experimentation process and associated skills to conduct investigations

A1.3

use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A1.4

follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials

A1.5

communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life

Specific expectations

Throughout Grade 3, in connection with the learning in the other strands, students will:

A2.1

write and execute code in investigations and when modelling concepts, with a focus on testing, debugging, and refining programs

A2.2

identify and describe impacts of coding and of emerging technologies on everyday life

A3. Applications, Connections, and Contributions

demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

Specific expectations

Throughout Grade 3, in connection with the learning in the other strands, students will:

A3.1

describe practical applications of science and technology concepts in their home and community, and how these applications address real-world problems

A3.2

investigate how science and technology can be used with other subject areas to address real-world problems

A3.3

analyse contributions to science and technology from various communities

B. Life Systems

Growth and Changes in Plants

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 3, students will:

B1. Relating Science and Technology to Our Changing World

assess ways in which plants are beneficial to society and the environment, and ways in which human activity has an impact on plants and plant habitats

Specific expectations

By the end of Grade 3, students will:

B1.1

assess ways in which plants are important to humans and other living things, taking different perspectives into consideration, and identify ways in which humans can protect native plant species and their habitats

B1.2

assess ways in which human activities have an impact on plants and plant habitats, and identify personal actions that they could take to minimize harmful effects and enhance positive ones

B1.3

assess the benefits and limitations of locally grown food

B2. Exploring and Understanding Concepts

demonstrate an understanding of characteristics and uses of plants and of plants' responses to the natural environment

Specific expectations

By the end of Grade 3, students will:

B2.1

describe the basic needs of plants, including the need for air, water, light, heat, nutrients, and space, and identify environmental conditions that may threaten plant survival

B2.2

identify different parts of plants, including the root, stem, flower, stamen, pistil, leaf, seed, cone, and fruit, and describe how each part contributes to plants' survival within their environment

B2.3

describe changes that different plants undergo in their life cycles

B2.4

describe ways in which a variety of plants adapt and/or react to their environment and to changes in their environment

B2.5

demonstrate an understanding that most plants get energy directly from the Sun through the process of photosynthesis, which involves the absorption of carbon dioxide and the release of oxygen

B2.6

describe ways in which people, including Indigenous peoples, from various cultures around the world use plants for food, shelter, medicine, and clothing

B2.7

describe various plants used for food, including those grown by First Nations, Métis, and Inuit, and identify local settings where these plants are grown or found

B2.8

describe ways in which plants and animals, including humans, depend on each other

C. Matter and Energy

Forces and Motion

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 3, students will:

C1. Relating Science and Technology to Our Changing World

assess the impacts of various forces on society and the environment

Specific expectations

By the end of Grade 3, students will:

C1.1

assess the effects of the action of forces from natural phenomena on natural and built environments, and identify ways in which human activities can reduce or enhance these effects

C1.2

assess harmful effects of forces that may result from various human activities, and describe how health and safety devices can minimize these effects

C2. Exploring and Understanding Concepts

demonstrate an understanding of how forces cause motion and changes in motion

Specific expectations

By the end of Grade 3, students will:

C2.1

describe different types of contact forces and non-contact forces

C2.2

describe different ways a force can be exerted on an object

C2.3

describe how different forces applied to an object, including forces of varying magnitude, can cause the object to start, stop, or change its direction, speed, or shape

C2.4

identify ways in which forces are used in their daily lives

D. Structures and Mechanisms

Strong and Stable Structures

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 3, students will:

D1. Relating Science and Technology to Our Changing World

assess the importance of form, function, strength, and stability in structures to society and the environment

Specific expectations

By the end of Grade 3, students will:

D1.1

assess effects on society and the environment of strong and stable structures

D1.2

assess the environmental impact of structures built by various animals, including structures built by humans

D2. Exploring and Understanding Concepts

demonstrate an understanding of the concepts of *strength* and *stability* as they relate to structures with various forms and functions, and of the factors that affect structures' strength and stability

Specific expectations

By the end of Grade 3, students will:

D2.1

describe a structure as a supporting framework that holds a load and has a definite size, shape, and function, and identify structures in the natural environment and in the built environment

D2.2

demonstrate an understanding of the relationship between form and function for various structures

D2.3

identify the strength of a structure as its ability to support a load and describe ways to increase the strength of structures, including ways to increase the strength of different materials used to build them

D2.4

describe the stability of a structure as its ability to keep its shape, maintain balance, float, and/or stay fixed in one spot when a force is applied to the structure, and describe ways to improve a structure's stability

D2.5

identify properties of materials that need to be considered when building structures

D2.6

describe ways in which different forces can affect the shape, balance, or position of structures

D2.7

explain the role of struts and ties in structures under load

E. Earth and Space Systems

Soils in the Environment

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 3, students will:

E1. Relating Science and Technology to Our Changing World

assess the importance of soils for society and the environment, and the impact of human activity on soils

Specific expectations

By the end of Grade 3, students will:

E1.1

assess the importance of soils for society and the environment

E1.2

assess the impact of human activity on soils, and describe ways in which humans can improve the quality of soils and/or lessen or prevent harmful effects on soils

E2. Exploring and Understanding Concepts

demonstrate an understanding of the composition of soils, of different types of soils, and of processes and practices that can affect the health of soil

Specific expectations

By the end of Grade 3, students will:

E2.1

identify the living and non-living components of soil, and describe the characteristics of healthy soil

E2.2

identify different substances that are commonly added to, or absorbed by, the soil, and describe their effects on soil health

E2.3

examine different types of soils found in Ontario, and describe how different soils are suited to growing different types of food, including crops

E2.4

explain the process of erosion, including its causes and its impact on soils

E2.5

identify various strategies used to maintain and improve soil health in Ontario

E2.6

describe the process of composting, and explain some benefits of composting

Science and Technology, Grade 4

Expectations by strand

A. STEM Skills and Connections

This strand focuses on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. In all grades of the science and technology program, the learning related to this strand takes place in the context of learning related to the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, and it should be assessed and evaluated within these contexts.

Overall expectations

Throughout Grade 4, in connection with the learning in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, students will:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific expectations

Throughout Grade 4, in connection with the learning in the other strands, students will:

A1.1

use a scientific research process and associated skills to conduct investigations

A1.2

use a scientific experimentation process and associated skills to conduct investigations

A1.3

use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A1.4

follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials

A1.5

communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields

Specific expectations

Throughout Grade 4, in connection with the learning in the other strands, students will:

A2.1

write and execute code in investigations and when modelling concepts, with a focus on producing different types of output for a variety of purposes

A2.2

identify and describe impacts of coding and of emerging technologies on everyday life, including skilled trades

A3. Applications, Connections, and Contributions

demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

Specific expectations

Throughout Grade 4, in connection with the learning in the other strands, students will:

A3.1

describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems

A3.2

investigate how science and technology can be used with other subject areas to address real-world problems

A3.3

analyse contributions to science and technology from various communities

B. Life Systems

Habitats and Communities

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 4, students will:

B1. Relating Science and Technology to Our Changing World

assess impacts of human activities on habitats and communities, and analyse actions for minimizing negative impacts and enhancing positive ones

Specific expectations

By the end of Grade 4, students will:

B1.1

assess positive and negative impacts of human activities on habitats and communities, while taking different perspectives into account

B1.2

analyse the impact of the depletion or extinction of a species on its habitat and community, and describe possible actions to prevent such depletions or extinctions

B2. Exploring and Understanding Concepts

demonstrate an understanding of habitats and communities and of interrelationships among the organisms that live in them

Specific expectations

By the end of Grade 4, students will:

B2.1

describe habitats as areas that provide organisms, including plants and animals, with the necessities of life, and identify ways in which a local habitat provides these necessities

B2.2

describe a community as a group of interacting species sharing a common habitat, and identify factors that affect the ability of a community of plants and animals to survive in a local habitat

B2.3

describe the relationship of organisms in a food chain, and classify organisms as producers, consumers, or decomposers

B2.4

demonstrate an understanding of a food web as the interconnection of multiple food chains in a natural community

B2.5

describe how animals are categorized according to their diet, and categorize various animals as carnivores, herbivores, or omnivores

B2.6

describe structural adaptations of a variety of plants and animals and how these adaptations allow the organisms to survive in specific habitats

B2.7

explain why all habitats have limits to the number of plants and animals they can support

C. Matter and Energy

Light and Sound

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 4, students will:

C1. Relating Science and Technology to Our Changing World

assess the impacts on society and the environment of technological innovations related to light and sound

Specific expectations

By the end of Grade 4, students will:

C1.1

assess the impacts on society of devices that use the properties of light or sound, or both

C1.2

assess the impacts on the environment of light energy and sound energy produced by various technologies, while taking different perspectives into account

C2. Exploring and Understanding Concepts

demonstrate an understanding of light and sound as forms of energy that have specific characteristics and properties

Specific expectations

By the end of Grade 4, students will:

C2.1

identify a variety of natural and artificial light sources

C2.2

distinguish between objects and living things that emit their own light and those that reflect light from other sources

C2.3

describe properties of light, including that light travels in a straight path and that light can be absorbed, reflected, and refracted

C2.4

describe properties of sound, including that sound travels through a medium as a wave and that sound can be absorbed or reflected and modified

C2.5

explain how vibrations cause sound waves

C2.6

describe how different objects and materials interact with light and sound energy

C2.7

distinguish between sources of light that emit both light and heat and those that emit light but little heat

C2.8

identify sensory organs and devices that make use of the properties of light and sound

D. Structures and Mechanisms

Machines and Their Mechanisms

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 4, students will:

D1. Relating Science and Technology to Our Changing World

evaluate the impacts of various machines and their mechanisms on society and the environment

Specific expectations

By the end of Grade 4, students will:

D1.1

assess the impacts of machines and their mechanisms on the daily lives of people in various communities

D1.2

assess and compare the environmental impacts of using different machines designed for similar purposes

D2. Exploring and Understanding Concepts

demonstrate an understanding of the basic principles and functions of machines and their mechanisms

Specific expectations

By the end of Grade 4, students will:

D2.1

identify machines that are used in daily life, and describe their purposes

D2.2

identify the parts of various mechanisms and describe the purpose of each part

D2.3

describe how different mechanisms transmit various types of motion, including rotary motion, from one system to another

D2.4

describe how mechanisms transform motion, including how they can change the geometric plane in which the motion occurs and the speed and/or direction of motion

D2.5

explain how forces are changed in a variety of machines

E. Earth and Space Systems

Rocks, Minerals, and Geological Processes

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 4, students will:

E1. Relating Science and Technology to Our Changing World

assess the social and environmental impacts of geological processes and of human uses of rocks and minerals

Specific expectations

By the end of Grade 4, students will:

E1.1

analyse ways in which geological processes impact society and the environment

E1.2

assess social and environmental impacts of extracting and refining rocks and minerals and of manufacturing, recycling, and disposing of products derived from rocks and minerals, while taking various perspectives into account

E2. Exploring and Understanding Concepts

demonstrate an understanding of rocks, minerals, and Earth's geological processes

Specific expectations

By the end of Grade 4, students will:

E2.1

explain geological processes that result in the formation of igneous, sedimentary, and metamorphic rocks, using the rock cycle

E2.2

describe the physical properties of igneous, sedimentary, and metamorphic rocks

E2.3

classify different rocks and minerals according to their composition and physical properties, using various tests and criteria

E2.4

describe everyday uses of rocks and minerals

E2.5

describe how fossils are formed and what information they can provide about Earth's history

E2.6

demonstrate an understanding of First Nations, Métis, and Inuit geological knowledges that are used in the selection of different rocks and minerals for specific purposes

Science and Technology, Grade 5

Expectations by strand

A. STEM Skills and Connections

This strand focuses on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. In all grades of the science and technology program, the learning related to this strand takes place in the context of learning related to the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, and it should be assessed and evaluated within these contexts.

Overall expectations

Throughout Grade 5, in connection with the learning in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, students will:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific expectations

Throughout Grade 5, in connection with the learning in the other strands, students will:

A1.1

use a scientific research process and associated skills to conduct investigations

A1.2

use a scientific experimentation process and associated skills to conduct investigations

A1.3

use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A1.4

follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials

A1.5

communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields

Specific expectations

Throughout Grade 5, in connection with the learning in the other strands, students will:

A2.1

write and execute code in investigations and when modelling concepts, with a focus on using different methods to store and process data for a variety of purposes

A2.2

identify and describe impacts of coding and of emerging technologies on everyday life, including skilled trades

A3. Applications, Connections, and Contributions

demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

Specific expectations

Throughout Grade 5, in connection with the learning in the other strands, students will:

A3.1

describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems

A3.2

investigate how science and technology can be used with other subject areas to address real-world problems

A3.3

analyse contributions to science and technology from various communities

B. Life Systems

Human Health and Body Systems

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 5, students will:

B1. Relating Science and Technology to Our Changing World

analyse impacts of various social and environmental factors, human activities, and technologies on human health

Specific expectations

By the end of Grade 5, students will:

B1.1

assess effects of a variety of social and environmental factors on human health, and describe ways in which individuals can reduce the harmful effects of these factors and take advantage of those that are beneficial

B1.2

evaluate beneficial and harmful effects of various technologies on human health and body systems, while taking different perspectives into consideration

B1.3

explain how food literacy can support decisions that affect physical and mental health

B2. Exploring and Understanding Concepts

demonstrate an understanding of the structure and function of human body systems and interactions within and between systems

Specific expectations

By the end of Grade 5, students will:

B2.1

identify systems of the human body, and describe their basic function

B2.2

describe the basic structure and function of vital organs in various systems in the human body

B2.3

describe interrelationships between human body systems

B2.4

identify various diseases and medical disorders in humans and the organs and/or body system or systems that they affect

C. Matter and Energy

Properties of and Changes in Matter

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 5, students will:

C1. Relating Science and Technology to Our Changing World

assess the impacts on society and the environment of various processes and materials used in the manufacture of common products, and ways to mitigate negative impacts

Specific expectations

By the end of Grade 5, students will:

C1.1

assess the impacts on society and the environment of various processes used in the manufacture of common products

C1.2

assess how the use of specific materials in the manufacture of common products affects the environment, and identify actions that society and individuals can take to mitigate negative impacts

C2. Exploring and Understanding Concepts

demonstrate an understanding of the properties of matter, changes of state, and physical and chemical change

Specific expectations

By the end of Grade 5, students will:

C2.1

describe matter as everything that has mass and occupies volume

C2.2

identify the states of matter, and describe characteristics and properties of solids, liquids, and gases

C2.3

describe changes of state of matter observed at home, in the community, or in the natural environment

C2.4

describe physical changes in matter as changes of the state, volume, or form of the matter that do not result in the formation of a different substance

C2.5

describe chemical changes in matter as changes that result in the formation of different substances, and identify signs that a chemical change has occurred

C2.6

explain how changes of state can occur when matter absorbs or releases thermal energy

C2.7

explain why specific physical properties of various solids, liquids, and gases make them useful for particular applications

D. Structures and Mechanisms

Forces Acting on Structures

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 5, students will:

D1. Relating Science and Technology to Our Changing World

analyse social and environmental impacts of forces acting on structures, and assess ways to mitigate these impacts

Specific expectations

By the end of Grade 5, students will:

D1.1

analyse the effects of forces from natural phenomena on structures in natural and built environments

D1.2

assess various ways in which humans mitigate impacts of forces from natural phenomena on structures in urban, rural, and remote communities

D2. Exploring and Understanding Concepts

demonstrate an understanding of forces that act on structures, and how various structures withstand them

Specific expectations

By the end of Grade 5, students will:

D2.1

identify internal forces acting on a structure, and describe their effects on the structure

D2.2

identify external forces acting on a structure, and describe their effects on the structure

D2.3

describe forces resulting from natural phenomena that can have severe consequences for human-built structures, and identify structural features and materials that can allow such structures to withstand these forces

D2.4

describe ways in which physical characteristics of various animal and plant species help to protect them from potentially harmful effects of forces

D2.5

describe ways in which protective equipment helps to protect humans from potentially harmful effects of forces

E. Earth and Space Systems

Conservation of Energy and Resources

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 5, students will:

E1. Relating Science and Technology to Our Changing World

assess effects of energy and resource use on society and the environment, and suggest options for conserving energy and resources

Specific expectations

By the end of Grade 5, students will:

E1.1

analyse long-term impacts of human uses of energy and natural resources, on society and the environment, including climate change, and suggest ways to mitigate these impacts

E1.2

evaluate effects of various technologies on energy consumption, and describe ways in which individuals can use technology to reduce energy consumption

E1.3

analyse how First Nations, Métis, and Inuit communities use their knowledges and ways of knowing to conserve energy and resources

E2. Exploring and Understanding Concepts

demonstrate an understanding of the conservation of energy, and the forms, sources, and uses of energy and resources

Specific expectations

By the end of Grade 5, students will:

E2.1

identify a variety of forms of energy, and describe how each form is used in everyday life

E2.2

demonstrate an understanding of the law of conservation of energy, including how energy cannot be created or destroyed but can only be transformed from one form to another

E2.3

describe how energy is stored as potential energy and transformed in a given device or system

E2.4

demonstrate an understanding that when energy is transformed from one form to another, some energy may dissipate into the environment in the form of heat, light, and/or sound energy

E2.5

identify renewable and non-renewable sources of energy

E2.6

explain how the use of energy derived from fossil fuels changes the composition of the atmosphere and how these changes contribute to climate change

Science and Technology, Grade 6

Expectations by strand

A. STEM Skills and Connections

This strand focuses on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. In all grades of the science and technology program, the learning related to this strand takes place in the context of learning related to the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, and it should be assessed and evaluated within these contexts.

Overall expectations

Throughout Grade 6, in connection with the learning in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, students will:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific expectations

Throughout Grade 6, in connection with the learning in the other strands, students will:

A1.1

use a scientific research process and associated skills to conduct investigations

A1.2

use a scientific experimentation process and associated skills to conduct investigations

A1.3

use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A1.4

follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials

A1.5

communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields

Specific expectations

Throughout Grade 6, in connection with the learning in the other strands, students will:

A2.1

write and execute code in investigations and when modelling concepts, with a focus on obtaining input in different ways for a variety of purposes

A2.2

identify and describe impacts of coding and of emerging technologies on everyday life, including skilled trades

A3. Applications, Connections, and Contributions

demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

Specific expectations

Throughout Grade 6, in connection with the learning in the other strands, students will:

A3.1

describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems

A3.2

investigate how science and technology can be used with other subject areas to address real-world problems

A3.3

analyse contributions to science and technology from various communities

B. Life Systems

Biodiversity

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 6, students will:

B1. Relating Science and Technology to Our Changing World

assess the importance of biodiversity, and describe ways of protecting biodiversity

Specific expectations

By the end of Grade 6, students will:

B1.1

assess the benefits of biodiversity and the consequences of the diminishing of biodiversity

B1.2

analyse a local issue related to biodiversity while considering different perspectives; plan a course of action in response to the issue; and act on their plan

B2. Exploring and Understanding Concepts

demonstrate an understanding of biodiversity, its contributions to the stability of natural systems, and its benefits to humans

Specific expectations

By the end of Grade 6, students will:

B2.1

describe the distinguishing characteristics of different groups of organisms, and use these characteristics to further classify these organisms using a classification system

B2.2

demonstrate an understanding of biodiversity as the diversity of life on Earth, including the diversity of organisms within species, among species in a community, and among communities and the habitats that support them

B2.3

describe ways in which biodiversity within species is essential for their survival

B2.4

describe ways in which biodiversity within and among communities is essential for maintaining the resilience of these communities

B2.5

describe interrelationships within species, between species, and between species and their natural environment, and explain how these interrelationships sustain biodiversity

B2.6

explain how invasive species reduce biodiversity in local environments

B2.7

explain how climate change contributes to a loss of biodiversity, and describe the impact of this loss

B2.8

describe the importance of biodiversity in supporting agriculture, including Indigenous agriculture around the world

C. Matter and Energy

Electrical Phenomena, Energy, and Devices

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 6, students will:

C1. Relating Science and Technology to Our Changing World

evaluate the impact of the use and generation of electrical energy on society and the environment, and suggest ways to use electrical energy responsibly

Specific expectations

By the end of Grade 6, students will:

C1.1

assess the short- and long-term impacts of electrical energy generation technologies in Canada on society and the environment, including impacts on First Nations, Métis, and Inuit communities, and on climate change

C1.2

assess choices that reduce personal use of electrical energy from both renewable and non-renewable sources, and advocate for the responsible use of electrical energy by the school community

C2. Exploring and Understanding Concepts

demonstrate an understanding of the principles of electrical energy and its transformation into and from other forms of energy

Specific expectations

By the end of Grade 6, students will:

C2.1

explain commonly observed electrostatic phenomena, using the principles of static electricity

C2.2

describe current electricity, and compare and contrast current electricity with static electricity

C2.3

identify materials that are good conductors of electric current and materials that are good insulators

C2.4

describe how technologies transform various forms of energy into electrical energy

C2.5

describe ways in which electrical energy is transformed into other forms of energy

C2.6

explain the functions of the components of a simple electrical circuit

C2.7

distinguish between series and parallel circuits, and identify common uses of each type of circuit

D. Structures and Mechanisms

Flight

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 6, students will:

D1. Relating Science and Technology to Our Changing World

assess the environmental impacts of flying machines

Specific expectations

By the end of Grade 6, students will:

D1.1

assess the impacts on society of aviation technologies, while considering both local and global perspectives

D2. Exploring and Understanding Concepts

demonstrate an understanding of the ways in which properties of air can be applied to the principles of flight and flying machines

Specific expectations

By the end of Grade 6, students will:

D2.1

identify flight-related applications of the properties of air

D2.2

describe the relationships between the four forces of flight – lift, weight, thrust, and drag – that make flight possible

D2.3

describe ways in which flying machines and various organisms use balanced and unbalanced forces to control their flight

D2.4

describe ways in which the four forces of flight can be altered

D2.5

describe characteristics and adaptations that enable organisms to fly

E. Earth and Space Systems

Space

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 6, students will:

E1. Relating Science and Technology to Our Changing World

assess the impact of space exploration on humans, society, and the environment

Specific expectations

By the end of Grade 6, students will:

E1.1

analyse the impact that conditions in space have on humans engaged in space exploration, and explain how humans meet their social, emotional, and physiological needs in space

E1.2

assess the role of space exploration technology in observing and understanding environmental changes on Earth, including climate change

E1.3

evaluate the social and environmental impacts of space exploration, while taking various perspectives into consideration

E2. Exploring and Understanding Concepts

demonstrate an understanding of the solar system, the phenomena that result from the movement of different bodies within it, and the technologies used in space exploration

Specific expectations

By the end of Grade 6, students will:

E2.1

identify components of the solar system, including the Sun, Earth and other planets, natural satellites, comets, asteroids, and meteoroids, and describe their main physical characteristics

E2.2

distinguish between the concepts of *mass* and *weight*

E2.3

describe the relationship between the force of gravity and the weight of a body

E2.4

identify the types of bodies in space that emit light and those that reflect light

E2.5

describe various effects of the relative positions and motions of Earth, the Moon, and the Sun

E2.6

identify various technologies used in space exploration, and describe how technological innovations have contributed to our understanding of space

Science and Technology, Grade 7

Expectations by strand

A. STEM Skills and Connections

This strand focuses on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. In all grades of the science and technology program, the learning related to this strand takes place in the context of learning related to the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, and it should be assessed and evaluated within these contexts.

Overall expectations

Throughout Grade 7, in connection with the learning in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, students will:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific expectations

Throughout Grade 7, in connection with the learning in the other strands, students will:

A1.1

use a scientific research process and associated skills to conduct investigations

A1.2

use a scientific experimentation process and associated skills to conduct investigations

A1.3

use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A1.4

follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials

A1.5

communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields

Specific expectations

Throughout Grade 7, in connection with the learning in the other strands, students will:

A2.1

write and execute code in investigations and when modelling concepts, with a focus on planning and designing programs

A2.2

identify and describe impacts of coding and of emerging technologies, such as artificial intelligence systems, on everyday life, including skilled trades

A3. Applications, Connections, and Contributions

demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

Specific expectations

Throughout Grade 7, in connection with the learning in the other strands, students will:

A3.1

describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems

A3.2

investigate how science and technology can be used with other subject areas to address real-world problems

A3.3

analyse contributions to science and technology from various communities

B. Life Systems

Interactions in the Environment

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 7, students will:

B1. Relating Science and Technology to Our Changing World

assess the impact of human activities and technologies on the environment, and analyse ways to mitigate negative impacts and contribute to environmental sustainability

Specific expectations

By the end of Grade 7, students will:

B1.1

assess the impact of various technologies on the environment

B1.2

assess the effectiveness of various ways of mitigating the negative and enhancing the positive impact of human activities on the environment

B1.3

analyse how diverse First Nations, Métis, and Inuit practices and perspectives contribute to environmental sustainability

B2. Exploring and Understanding Concepts

demonstrate an understanding of interactions between and among biotic and abiotic components in the environment

Specific expectations

By the end of Grade 7, students will:

B2.1

explain that an ecosystem is a network of interactions among living organisms and their environment

B2.2

identify biotic and abiotic components in an ecosystem, and describe the interactions between them

B2.3

describe roles and relationships between producers, consumers, and decomposers within an ecosystem

B2.4

describe the transfer of energy in a food chain, and explain the effects of altering any part of the chain

B2.5

describe how matter is cycled within the environment, and explain how the cycling of matter promotes sustainability

B2.6

explain the differences between primary succession and secondary succession in ecosystems

B2.7

explain how biotic and abiotic factors limit the number of organisms an ecosystem can sustain

B2.8

describe how different approaches to agriculture and to harvesting food from the natural environment can impact an ecosystem, and identify strategies that can be used to maintain and/or restore balance to ecosystems

C. Matter and Energy

Pure Substances and Mixtures

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 7, students will:

C1. Relating Science and Technology to Our Changing World

evaluate the environmental and social impacts of the use and disposal of various pure substances and mixtures

Specific expectations

By the end of Grade 7, students will:

C1.1

analyse the social and environment impacts of the use and disposal of pure substances found in technological devices, considering local and global perspectives

C1.2

assess environmental and social impacts of different industrial methods used to separate mixtures

C2. Exploring and Understanding Concepts

demonstrate an understanding of the nature of matter, including the properties of pure substances and mixtures, and describe these properties using particle theory

Specific expectations

By the end of Grade 7, students will:

C2.1

demonstrate an understanding of the particle theory of matter

C2.2

use particle theory to distinguish between pure substances and mixtures

C2.3

distinguish between homogenous and heterogenous mixtures

C2.4

use the particle theory to describe how different factors affect the solubility of a substance and the rate at which it dissolves

C2.5

describe the concentration of a saturated solution in both qualitative and quantitative terms, and differentiate between saturated and unsaturated solutions

C2.6

explain why water is referred to as the universal solvent

C2.7

explain various processes used to separate mixtures, including solutions, into their components, and identify some applications of these processes

C2.8

describe pure substances as elements and compounds consisting of atoms and combinations of atoms

D. Structures and Mechanisms

Form, Function, and Design of Structures

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 7, students will:

D1. Relating Science and Technology to Our Changing World

analyse personal, social, economic, and environmental factors that should be considered when designing and building structures

Specific expectations

By the end of Grade 7, students will:

D1.1

evaluate environmental, social, and economic factors that should be considered when designing and building structures to meet specific needs for individuals and communities

D1.2

evaluate the impact of the ergonomic design of various tools, objects, and work spaces on a user's health, safety, and ability to work efficiently, and use this information to describe changes that could be made in their own spaces and activities

D2. Exploring and Understanding Concepts

demonstrate an understanding of the relationship between structural forms and the forces acting on them

Specific expectations

By the end of Grade 7, students will:

D2.1

classify structures as solid structures, frame structures, or shell structures

D2.2

describe ways in which the centre of gravity of a structure affects the structure's stability

D2.3

identify the magnitude, direction, point of application, and plane of application of the forces applied to a structure

D2.4

describe the role of symmetry in structures, and identify instances of symmetry in various structures

D2.5

describe factors that can cause a structure to fail

D2.6

identify the factors that determine the suitability of materials for use in manufacturing a product or constructing a structure

D2.7

describe methods engineers and other professionals use to assess, improve, and maintain the safety of structures

E. Earth and Space Systems

Heat in the Environment

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 7, students will:

E1. Relating Science and Technology to Our Changing World

assess the benefits of technologies that reduce heat loss, and analyse various social and environmental impacts of the use of energy from renewable and non-renewable sources

Specific expectations

By the end of Grade 7, students will:

E1.1

assess the social and environmental benefits of technologies that reduce heat loss in enclosed spaces or heat transfer to surrounding spaces

E1.2

analyse various social, economic, and environmental impacts, including impacts related to climate change, of using non-renewable and renewable sources of energy

E2. Exploring and Understanding Concepts

demonstrate an understanding of heat as a form of energy that is associated with the movement of particles and is essential for many natural processes within Earth's systems

Specific expectations

By the end of Grade 7, students will:

E2.1

use particle theory to explain how heat affects the motion of particles in a solid, a liquid, and a gas

E2.2

demonstrate an understanding of various ways in which heat is generated

E2.3

use particle theory to explain the effects of heat on volume in solids, liquids, and gases, including during changes of states of matter

E2.4

explain how heat is transmitted through conduction, and describe natural processes that are affected by conduction

E2.5

explain how heat is transmitted in liquids and gases through convection, and describe natural processes that depend on convection

E2.6

explain how heat is transmitted through radiation, and describe the effects of radiation from the Sun on different kinds of surfaces

E2.7

describe the role of radiation in heating and cooling Earth, and explain how greenhouse gases affect the transmission of radiated heat through the atmosphere

E2.8

identify common sources of greenhouse gases, including sources resulting from human activity, and describe how humans can reduce emissions of these gases

Science and Technology, Grade 8

Expectations by strand

A. STEM Skills and Connections

This strand focuses on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. In all grades of the science and technology program, the learning related to this strand takes place in the context of learning related to the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, and it should be assessed and evaluated within these contexts.

Overall expectations

Throughout Grade 8, in connection with the learning in the Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems strands, students will:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific expectations

Throughout Grade 8, in connection with the learning in the other strands, students will:

A1.1

use a scientific research process and associated skills to conduct investigations

A1.2

use a scientific experimentation process and associated skills to conduct investigations

A1.3

use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A1.4

follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials

A1.5

communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields

Specific expectations

Throughout Grade 8, in connection with the learning in the other strands, students will:

A2.1

write and execute code in investigations and when modelling concepts, with a focus on automating large systems in action

A2.2

identify and describe impacts of coding and of emerging technologies, such as artificial intelligence systems, on everyday life, including skilled trades

A3. Applications, Connections, and Contributions

demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

Specific expectations

Throughout Grade 8, in connection with the learning in the other strands, students will:

A3.1

describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems

A3.2

investigate how science and technology can be used with other subject areas to address real-world problems

A3.3

analyse contributions to science and technology from various communities

B. Life Systems

Cells

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 8, students will:

B1. Relating Science and Technology to Our Changing World

assess developments in cell biology and their impact on individuals, society, and the environment

Specific expectations

By the end of Grade 8, students will:

B1.1

assess how various technologies have enhanced our understanding of cells and cellular processes

B1.2

analyse beneficial and harmful effects of developments in cell biology and associated emerging technologies on human health and the environment, while taking different perspectives into consideration

B2. Exploring and Understanding Concepts

demonstrate an understanding of the basic structure and function of plant and animal cells and cell processes

Specific expectations

By the end of Grade 8, students will:

B2.1

demonstrate an understanding of cells, using cell theory

B2.2

identify organelles and other cell components, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain their basic functions

B2.3

compare the structure and function of plant and animal cells

B2.4

explain the processes of diffusion and osmosis within a cell

B2.5

describe various unicellular and multicellular organisms, and compare ways in which these two types of organisms meet their basic needs

B2.6

describe the organization of cells into tissues, organs, and systems

C. Matter and Energy

Fluids

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 8, students will:

C1. Relating Science and Technology to Our Changing World

analyse uses of various technologies that rely on the properties of fluids, and assess the impact of these technologies on society and the environment

Specific expectations

By the end of Grade 8, students will:

C1.1

assess the environmental, social, and economic impacts of various innovations and technologies that are based on the properties of fluids

C1.2

assess the environmental and social impacts of fluid spills, including impacts on First Nations, Métis, and Inuit communities, and including the cost and technical challenges related to cleanup and remediation efforts

C2. Exploring and Understanding Concepts

demonstrate an understanding of basic fluid mechanics, including the properties and uses of fluids

Specific expectations

By the end of Grade 8, students will:

C2.1

demonstrate an understanding of the factors that affect viscosity, and compare the viscosity of various fluids, including volumetric flow rate

C2.2

demonstrate an understanding of the relationship between mass, volume, and density

C2.3

explain the difference between solids, liquids, and gases in terms of their density, using the particle theory of matter

C2.4

explain the difference between liquids and gases in terms of their compressibility and how their compressibility affects their technological applications

C2.5

determine the buoyancy of an object, given its density, in a variety of fluids

C2.6

explain in qualitative terms the relationship between pressure, volume, and temperature when a liquid or a gas is compressed or heated

C2.7

describe how forces are transferred in all directions in fluids, including using Pascal's law to quantify the transfer of forces in fluids

C2.8

describe factors that affect the flow of fluids

C2.9

describe the differences between pneumatic and hydraulic systems

C2.10

compare how fluids are used and how their flow is regulated in living organisms and in mechanical devices or systems

D. Structures and Mechanisms

Systems in Action

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 8, students will:

D1. Relating Science and Technology to Our Changing World

assess the social and environmental impacts of various systems, and evaluate improvements to the systems or alternative ways of meeting the same needs

Specific expectations

By the end of Grade 8, students will:

D1.1

assess the social, economic, and environmental impacts of automating systems

D1.2

assess the impact on individuals, society, and the environment of alternative ways of meeting needs that are currently met by existing systems, taking different points of view into consideration

D2. Exploring and Understanding Concepts

demonstrate an understanding of different types of systems and the factors that contribute to their safe and efficient operation

Specific expectations

By the end of Grade 8, students will:

D2.1

identify various types of systems

D2.2

describe the purpose, inputs, and outputs of various systems, including systems related to food processing

D2.3

identify the various processes and components of a system that allow it to perform its function efficiently and safely

C2.4

use the scientific terms *displacement*, *force*, *work*, *energy*, and *efficiency* to describe everyday experiences

D2.5

demonstrate an understanding of the relationships between work, force, and displacement in simple systems

D2.6

explain the relationship between input and output forces and determine the mechanical advantage of various mechanical systems, including simple machines

D2.7

identify ways in which energy can dissipate from mechanical systems, and describe technological innovations that make these systems more efficient

D2.8

explain how providing information and support to consumers helps to ensure that the systems they use run safely and efficiently

D2.9

describe technological innovations involving mechanical systems that have increased productivity in various industries

D2.10

identify social factors that influence the evolution of a system

E. Earth and Space Systems

Water Systems

In this strand, students integrate learning from Strand A as they investigate concepts, develop and apply skills, and make meaningful connections to their lives and communities.

Overall expectations

By the end of Grade 8, students will:

E1. Relating Science and Technology to Our Changing World

assess the impact of human activities and technologies on the sustainability of water resources

Specific expectations

By the end of Grade 8, students will:

E1.1

assess the social and environmental impact of the scarcity of fresh water, and propose a plan of action to help address fresh water sustainability issues

E1.2

demonstrate an understanding of First Nations, Métis, and Inuit knowledges and values about water, connections to water, and ways of managing water resources sustainably

E1.3

assess the impact of scientific discoveries and technological innovations on local and global water systems

E2. Exploring and Understanding Concepts

demonstrate an understanding of the characteristics of Earth's water systems and of factors that affect these systems

Specific expectations

By the end of Grade 8, students will:

E2.1

identify the states of water on Earth's surface, their distribution, relative amounts, and circulation, and the conditions under which they exist

E2.2

demonstrate an understanding of a watershed, and explain its importance to water management and planning

E2.3

explain how human activity and natural phenomena cause changes in the water table

E2.4

identify factors, including climate change, that have contributed to the melting of glaciers and polar ice-caps, and describe the effects of this phenomenon on local and global water systems

E2.5

explain changes in atmospheric conditions caused by the presence of bodies of water

E2.6

describe various indicators of water quality, and explain the impact of human activity on those indicators

E2.7

explain how municipalities process water and manage water usage