**Why STEM?**
- to prepare our students to be global learners and leaders in creating solutions for emerging complexities
- to move public education forward - continue to improve on culturally relevant and responsive practices
- to use problem-based learning that instills creativity and innovation, in order to transform teaching & learning
- to champion equity and inclusive education by intentionally disrupting the achievement gap that exists for marginalized groups in STEM fields (e.g. females, racialized and low-income communities)

**STEM contributes to the development of five key competencies:**
- to master an understanding of civic literacy, financial literacy, global awareness, health literacy and environmental literacy.
- to think critically, problem solve, create, innovate, communicate and collaborate.
- to use information, media and technology literacy.
- to develop self-direction, flexibility, adaptability, cross-cultural awareness, responsibility, productivity and accountability.
- to “learn how to learn” and apply this ability to self-monitor and improve learning across all subjects.


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CurioCity is an interactive, web-based meeting place where teens can connect with post-secondary students and science professionals to explore and discover the science, engineering and technology behind everyday life.
Young learners collaborate in inquiry and experimentation with a wide range of materials and modes of expression to interpret and represent their ideas. Self-regulation develops as they manipulate materials to communicate meaning. They also gain awareness of body science through movement, test solutions to real world problems through pretend play, and co-design solutions to design challenges.

B1.3 plan and shape dramatic play by building on the ideas of others, both in and out of role (r.1)
A1.4 use a variety of locomotor and non-locomotor movements to depict creatures and objects in the world around them (Gr. 2)
D1.3 use elements of design in art works to communicate ideas, messages, and understandings (Gr. 3)

The environment is designed as a third teacher. The physical environment features pedagogical documentation of students’ art and design expressions. Students see themselves reflected in the room. The space is agile, allowing for flexible configurations. The social environment is designed to nurture creative collaboration. The Creative Process and Critical Analysis Process are explicitly taught. Sufficient time is allowed for creative exploration and experimentation.

Students share personal stories, experiences, and ideas. Student interests and curiosity lead to integrated learning across disciplines. Teachers draw upon literature sources to inspire inquiries that connect science, math, literacy, and the arts.

Communication and Collaboration are foundational ideas underpinning the Arts curriculum (p. 8, Arts Curriculum). The Arts are often referred to as multiliteracies, as they expand the modalities of communication. A well-rounded arts education equips students with the capacity to communicate ideas through new media and technologies, visual representations, embodied representations, and through the written and performed word. These creative forms of expression involve collaboration amongst the creators and with the intended audience. Collaborative design of the message, clarity of communication, and originality of expression are key competencies acquired through the arts.

Multidisciplinary Thinking, Learning, and Problem-Solving. The Arts are a pedagogy of connection—connecting people, ideas, cultures, and learning across disciplines. Topics and subject matter in The Arts derive from real-world issues and challenges, and therefore require inquiry, research, design thinking, and problem-solving across disciplines. Science, technology, and mathematical thinking are integral to art-making and design thinking.

"The Arts promote critical thinking, creativity, problem-solving, communication skills, lifelong learning, and adaptability." - Dr. Rena Upitis

The ARTS: Dance, Drama, Media Arts, and Visual Arts support the development of life-long skills and competencies that are critical to success in the complex, global contexts of our times.

Design Thinking and Innovation: when students apply the creative and critical analysis processes that are fundamental to the Arts curriculum, they are learning to use design thinking to problem-solve in creative ways. The conceptualization of new ways of organizing the elements and principles of art and design for particular purposes leads to innovation and originality. Design thinking and creative collaboration are transferable to all learning and a wide range of real-world challenges and opportunities.

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"Art Education for the Whole Child: Dr. Rena Upitis"
Students develop greater independence in the use of art tools, materials, techniques and technologies, and apply those skills to collaborations in art, dance, and drama. Self-regulation is evident in junior students’ capacity to "monitor their own learning and select appropriate strategies to help them make sense of increasingly complex works". (P. 97, Arts Curriculum)

A2.1 describe, with teacher guidance, how forms and styles of dance reflect people’s different social and political roles . . . (Gr. 4)

B1.4 communicate thoughts, feelings, and ideas to a specific audience, using audio, visual and/or technological aids to achieve specific dramatic effects (Gr. 5)

D1.4 use a variety of materials, tools, and techniques to determine solutions to design challenges (Gr. 6)

A blend of independent and collaborative work becomes critical; students apply themselves to design thinking, media production and creation in dance, drama and visual arts, individually and in small groups. Students take more initiative in planning, executing, refining, and sharing their creative projects. Organizing their work for display and performance becomes part of the design process.

D1.4 use a variety of materials, tools, techniques, and technologies to determine solutions to increasingly complex design challenges (Gr. 7)

A1.2 use dance as a language to communicate messages about themes of social justice and/or environmental health (Gr. 8)

B3.3 identify and describe various roles, responsibilities, and competencies of key personnel in theatre work

Building on the STEM and Arts attributes of the K-3 and 4-6 classroom, the Intermediate classroom provides additional arts-based opportunities to:
- view and critically analyse a wider range of dance, drama, media art and visual art works that integrate concepts from multiple disciplines
- study the practices of contemporary multi-disciplinary artists, from diverse cultures
- experience hands-on, collaborative, problem-based learning as an intersection of arts, math, science, technology and engineering, with design-thinking at the centre of the learning process

In addition to the attributes outlined in K-3, the Junior classroom provides opportunities to:
- explore multiple perspectives and develop awareness of global issues
- collaboratively design creative solutions and artistic commentary on issues of social justice and environmental concerns
- integrate technology into arts-based inquiries as a tool for both research and media production
- view and analyse a range of dance, drama, and visual art works that integrate concepts from multiple disciplines
Both independent and collaborative work engage students in self-assessment and peer feedback as they work through the creative and critical analysis processes with greater awareness and understanding. Students refine and organize their work in dance, drama, media and visual arts with intentionality and focus on audience impact. Initiative is demonstrated through creative risk-taking and commitment to originality in their artistic designs and representations.

A1.4 develop solutions to increasingly complex compositional problems, and demonstrate selected solutions through performance (ATC3M)
A3.3 select and use a variety of technological tools, including forms of new media, to highlight the message and enhance the impact of drama works
B3.2 explain how skills associated with the creation and analysis of visual art works, including applied and commercial art works, can be transferred to jobs outside the visual arts

Senior level arts classrooms reflect all of the K-10 attributes. In addition, students are provided with opportunities to:
- exhibit and perform work in public venues, with clearly articulated artist statements that reflect design thinking
- apply their creative skills and design thinking to special projects of personal interest, e.g. gaming, new media, art and science innovations, prototype design, multidisciplinary projects, inventions to address social and global challenges

Visit the Arts Department AW site for arts resources that support the implementation of STEM
http://stemtosteam.org The site includes interesting case studies and current examples of innovative practice from the Rhode Island School of Design.
http://expspace.risd.edu/?page_id=2 EXP Space is a research platform connecting artists, designers, and scientists. Many interesting collaborations are included on this site.
http://www.ocadu.ca/programs/digital_futures_initiative.htm The Digital Futures Initiative at OCAD is a collection of research laboratories with a focus on the role of digital media and technology as catalysts for change. “Disruptive technology and new thinking” are key foci.
https://www.aasa.org/SchoolAdministratorArticle.aspx?id=5958 This article, The Arts in Contemporary Education by John Eger, focuses on “reinventing schools to meet the challenges of the global innovation economy.”
http://online.wsj.com/news/articles/SB10001424052702304747004579224003721262792 This article describes school assignments that blend science, math and the arts.
http://www.djc.com/news/ae/12058836.html This article talks about adding the arts to STEM to promote innovation in fields such as architecture.
http://www.huffingtonpost.com/stephen-beal/turn-stem-to-steam_b_3424356.html This article by Stephen Beal focuses on why the sciences need the arts.
http://www.edutopia.org/stw-arts-integration This site focuses on school transformation through arts integration and interdisciplinary teaching and learning,
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Engaging in the world of business involves studying individuals, communities, and organizations, assessing their needs and problems and generating solutions. Students learning in business studies draw upon facts, concepts and processes from many other fields of study. Knowledge and skills related to information and communication technology which include media literacy, information literacy, financial literacy and Information and Communication Technology (ICT) literacy, are relevant skills required for students to become engaged thinkers and ethical citizens with entrepreneurial spirit. The business studies curriculum supports students developing competencies in five critical areas:

Business Skills - problem-solving, critical and creative thinking, employability skills for the 21st century and beyond, applications software, financial planning, entrepreneurial skills, leadership skills, organizational productivity, team work, strategic planning, research and inquiry;

Communication in a Business Environment - literacy skills, global awareness, conflict resolution, social and cross-cultural skills;

Digital Literacy - developing skills related to: information systems and structures, data management, use of various software applications, integrated technologies, security related to ICT;

Financial Literacy Skills for personal and professional purposes;

Ethical, moral and legal considerations in business - students gain an understanding or the ability to determine social and environmental consequences of business practices on the local, national and global levels.

Students need to be provided opportunities to pursue inquiries of their choosing within the limits of the overall curriculum expectations. Encouraging students’ curiosity assists in igniting innovative thinking as students explore the business of STEM. Students should be provided with a wide range of learning opportunities to discuss issues, solve problems using applications software, participate in business simulations, conduct research, think critically, work cooperatively and make business decisions. Engaging students in active and experiential learning opportunities increases their ability to retain knowledge for longer periods as they find relevance to their learning while developing meaningful skills.
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### Learning Skills

Students will develop the ability to work collaboratively to identify complex problems and review related information to develop solutions to the problems on a local, national and global level.

Students will develop life long learning skills that will assist them adapt to technological advancements, the workplace and the global economy.

### Curriculum Connections

- gain an understanding of business concepts through the study of subjects such as accounting, entrepreneurship, information and communication technology (ICT), international business, marketing, and business leadership;
- achieve business, economic, financial, and digital literacy;
- develop critical thinking skills and strategies required to conduct research and inquiry and communicate findings accurately, ethically and effectively

### Additional Resources

- Ontario Business Educator's Association  www.ohea.ca
- Developing Excellence Celebrating Achievement (DECA)  www.deca.ca
- TDSB Technological Skills Competition  https://aw.tdsb.on.ca/sites/tl/experientiallearning/Home.aspx
- Ontario Technological Skills Competition
- Skills Canadian National Competition www.skillsontario.com
- Specialist High Skills Major Programs, multi sector contextualized learning activity (CLA)  www.edu.gov.on.ca/morestudentsuccess/SHSMBinder.pdf
- Investors Education Fund (IEF)  www.getsmarteraboutmoney.ca
- FIRST robotics competition (FRC)
- The City (interactive online tools)  www.themoneybelt.gc.ca
- Educational Computing Organization of Ontario (ECOO)  ecoo.org

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### What do we need to implement STEM in our learning environments?

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What are emerging STEM competencies that could lead to a sustainable livelihood?

- application of critical thinking skills and effective questioning
- ability to analyze situations to consider possible creative and innovative solutions both independently and collaboratively
- development of mathematical and scientific knowledge and skills
- application of oral, reading and writing competencies to work collaboratively and communicate thinking
- increased confidence and knowledge regarding technological integration
- active learning, problem solving and decision making
- develop persistency of learning and to view learning as an "on-going" process

Learning Skills

- questioning
- predicting
- formulating hypotheses
- designing experiments to test theories
- communicating results
- application of mathematical knowledge and processes
- application of literacy

Curriculum Connections

L 1.6 Use language to talk about their thinking, to reflect and to solve problems
S. 2.1 State problems and pose questions before and during investigations
S all of 2 and 4

What do we need to implement STEM in our learning environments?

- children being intellectually engaged and challenged using open ended materials that support higher order thinking
- rich interactions about ideas and learning in a variety of learning contexts
- involvement in sustained investigations that are authentically relevant
- opportunities to learn, reflect, connect and problem solve in order to overcome obstacles
- taking initiative and developing confidence in their abilities
- children working collaboratively and problem solving through hands on learning experiences

Based on Stem in the Early Years, Lian Katz, Early Childhood Research Papers, Fall 2010
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http://ecrp.uiuc.edu/beyond/seed/katz.html
http://www.academia.edu/3481314/Designing_Classroom_Environments_that_Support_STEM_in_the_Primary_Grades
http://www.claytonearlylearning.org/blog/?p=541
http://www.uni.edu/coe/special-programs/regents-center-early-developmental-education/ceestem/seed-conference-0/ramps-and-pa
Exploring STEM Concepts in the Early Childhood Classroom
https://www.youtube.com/watch?v=HglYz0h2n2E
TDSB Resources: TDSB Science and Technology Kits TDSB ICT Standards Digital Learning For Kindergarten to Grade 12
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The language curriculum focuses on comprehension strategies for listening, viewing, and reading; on the most effective reading and writing processes; on skills and techniques for effective oral and written communication and for the creation of effective media texts; and on the language conventions needed for clear and coherent communication. In addition, it emphasizes the use of higher-level thinking skills, including critical literacy skills, to enable students not only to understand, appreciate, and evaluate what they read and view at a deeper level, but also to help them become reflective, critical, and independent learners and, eventually, responsible citizens. p 5

The language curriculum builds on, reinforces, and enhances certain aspects of the mathematics curriculum. For example, clear, concise communication often involves the use of diagrams, charts, tables, and graphs, and the language curriculum emphasizes students' ability to interpret and use graphic texts. Students apply the knowledge and skills they acquire in their study of graphs and charts in mathematics to the interpretation and communication of precise information in texts supported by graphic forms. p 29

The Ontario Curriculum, Grades 1 - 8, Language Revised emphasizes that students participate in experiences which will provide them with the following skills:
- Communicate effectively and with confidence
- Make meaningful connections between themselves, what they encounter in texts, and the world around them
- Think critically
- Understand that all texts advance a particular point of view that must be recognized, questioned, assessed and evaluated
- Assess the cultural impact and aesthetic power of texts
### Students must be provided with the opportunity to:
- develop appropriate content vocabulary
- assess and evaluate texts for bias
- communicate what they have learned to different audiences in a variety of formats
- identify relevant information, question and validate it
- use ICT as a tool to assist in collecting, organizing and sorting information

### Overall Reading
A1 read and demonstrate an understanding of a variety of literary, graphic, and informational texts, using a range of strategies to construct meaning
A2 recognize a variety of text forms, text features, and stylistic elements and demonstrate how they help communicate meaning

### Overall Writing
A1 generate, gather, and organize ideas and information to write for an intended purpose

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- A2 recognize a variety of text forms, text features, and stylistic elements and demonstrate how they help communicate meaning

**Overall Writing**
- A1 generate, gather, and organize ideas and information to write for an intended purpose

### What do we need to implement STEM in our learning environments?

The Ontario Curriculum, Grades 9 and 10, emphasizes that students participate in experiences which will provide them with the following skills:
- communicate effectively and with confidence
- make meaningful connections between themselves, what they encounter in texts, and the world around them
- think critically
- understand that all texts advance a particular point of view that must be recognized, questioned, assessed and evaluated
Why STEM?
- to prepare our students to be global learners and leaders in creating solutions for emerging complexities
- to move public education forward - continue to improve on culturally relevant and responsive practices
- to use problem-based learning that instills creativity and innovation, in order to transform teaching & learning
- to champion equity and inclusive education by intentionally disrupting the achievement gap that exists for marginalized groups in STEM fields (e.g. females, racialized and low-income communities)

STEM contributes to the development of five key competencies:
- to master an understanding of civic literacy, financial literacy, global awareness, health literacy and environmental literacy.
- to think critically, problem solve, create, innovate, communicate and collaborate.
- to use information, media and technology literacy.
- to develop self-direction, flexibility, adaptability, cross-cultural awareness, responsibility, productivity and accountability.
- to "learn how to learn" and apply this ability to self-monitor and improve learning across all subjects.


The goals of STEM are:
- to promote higher levels of student achievement by supporting all entry points for a STEM-centric pedagogy in all TDSB schools and for a range of career pathways
- to develop students’ creative and innovative thinking in and across the disciplines of mathematics, science and technology
- to increase students’ confidence and engagement in mathematics, science and technology
- to challenge historical and current discrimination, removing barriers that exist to the engagement and achievement of marginalized communities in STEM fields

Professional Learning
TDSB Professional Library
Provides professional learning resources to support STEM
http://aw.tdsb.on.ca/sites/tl/library/tdsbprofe ssionallibrary/SiteHome.aspx

Virtual Researcher On Call (VROC)
Is a set of educational programs that connect knowledge partners - college and university professors and professionals in the fields of Science, Technology, Engineering and Math (STEM) - with Canadian students in elementary and secondary schools for real-time, interactive learning opportunities. www.vroc.ca

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Resources

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English language learners who develop skills that promote growing independence as a learner, inquiry researcher, communicator, and team collaborator are building valuable STEM competencies. While using the home language as a learning resource, as well as a valuable asset in global STEM pursuits, English language learners understand they are on an English language learning continuum while they acquire the necessary STEM area content knowledge.

During their career path exploration, students new to Canada and their parents need to make informed decisions regarding the wide scope of available STEM pathways and careers and require equitable access to career education programs.

In order to be successful in STEM pursuits, ELLs need to possess strong foundational understanding in the content areas, achieved through the support of teachers watchful for possible gaps in students' mathematics and science knowledge due to differences among home countries' curricula or previous educational opportunities. ELLs require the ability to use technology that supports language acquisition needs, deepens understanding of STEM areas, and facilitates communication of their questions and understandings. Developing a sense of word-consciousness, ELLs seek understanding of new academic content vocabulary. They learn to comprehend mathematical and scientific texts and produce procedures and reports. They also comprehend the importance of and act upon safety practices.

Please note: Since recommendations for ELLs are generally aligned to English proficiency levels rather than grade levels, teachers will want to examine the considerations provided in this monograph at various grade levels.

Teachers know their students' current levels of English language proficiency and use that knowledge to plan instruction that addresses the language skills required for students to achieve the content area goals. At the forefront of lesson delivery planning are comprehensible language input considerations such as the use of relevant gestures and visuals; appropriate speed of teacher language; wait time; consistent routines; dramatization; monitoring of student comprehension and repetition or rephrasing; frequent use of realia, manipulatives, and activities that incorporate student talk; and learning opportunities grounded in meaningful, real-life contexts.
Active participation of ELLs in the inquiry process is promoted when students feel relaxed and safe to respond with a variety of approaches and to seek clarification. Front-loading, contextualized, and word roots instructional strategies support vocabulary needs. Inquiries activate prior knowledge, are based on the students' own experiences, and provide frequent opportunities for student talk. Students co-create science and mathematics word walls with dual language and visual supports and learn to access them independently and regularly.

Teachers value, build on, and encourage students to share and make connections with the variety of mathematical approaches they bring from prior educational experiences in their home countries. They model, explain, and provide opportunities to practise how manipulatives can be used, how cooperative and inquiry groups can explore problems, and how mathematical and scientific thinking can be explained in oral and written form. Co-created academic word walls, anchor charts, student prompts, and organizers support participation in activities requiring an understanding of subject-specific vocabulary and non-fiction text features.
- set own individual goals and monitor progress towards achieving them
- respond positively to the ideas, opinions, values, and traditions of others
- share information, resources, and expertise and promote critical thinking to solve problems and make decisions
- assess and reflect critically on own strengths, needs and interests

- compare, synthesize, and evaluate the information gathered from a variety of sources for an independent research project
- identify and use a wide variety of connecting devices, transition words and phrases, and explain how they express relationships among ideas;
- identify, explain, and use a variety of resources that are available to support lifelong learning

Borgioli, Gina M. Equity for English Language Learners in Mathematics Classrooms. Teaching Children Mathematics, Vol 15, No. 3 (October 2008), pp.185-191.
www.amathsdictionaryforkids.com
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• to move public education forward - continue to improve on culturally relevant and responsive practices
• to use problem-based learning that instills creativity and innovation, in order to transform teaching & learning
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All French as a Second Language programs (Core French, Extended French and French Immersion) emphasize the purpose for learning any language which is communication. Through the French as a Second Language programs students experience multiple opportunities to communicate for authentic purposes in real-life situations. As they explore a problem, collaborate and communicate their ideas with others, students continually build upon and apply their knowledge of French every day in purpose oriented situations, for example conducting an inquiry or proposing ideas to solve a problem. (p.8)

Meaningful and authentic communication is to be at the centre of all learning activities by adopting a communicative and action oriented approach to language learning. In this approach, students see themselves as social actors communicating for meaningful and authentic purposes, for example, to innovate, create and solve problems or to consider information presented in a critical light. (p.9)

Students in French as a Second Language programs develop cognitive, metacognitive and social/affective strategies for learning language. These strategies are used to help students communicate effectively and make meaning in their daily interactions and activities. Students are made aware of these strategies, monitor their effectiveness and set goals for improvement. (p.9)

The Ontario Curriculum French As a Second Language Gr 1-8, 2013

Learners of a second language are engaged in critical and creative thinking on a daily basis. (p. 10)
Problem solving skills are an integral part of learning and interacting in a second language.
Students use the target language to record their observations, to describe their critical analyses and to present their findings in a variety of forms. (p. 44)
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Teachers will provide a language rich environment for students using and encouraging the use of the correct subject-specific vocabulary as they engage in investigations, inquiry or problem-solving. Teachers must create an environment that is safe for risk-taking where students feel valorized using the language they have already acquired while refining and expanding their skills. Teachers in these grades will the use of the target language exclusively to provide a model for effective communication and subject specific vocabulary and students will use the target language exclusively in all their classroom interactions. Teachers will carefully structure learning opportunities and questioning to develop inquiry skills.

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*The Ontario Curriculum French As a Second Language*  
Gr 1-8, 2013

Students will:
- explain ideas and opinions in small-group discussions, impromptu exchanges, large-group presentations and formal debates
- interpret authentic texts written on diverse topics
- write clearly, coherently, and persuasively on diverse topics, choosing a form appropriate to the context

Teachers will provide a language rich environment for students using and encouraging the use of the correct subject-specific vocabulary in the content subject areas as they engage in investigations, inquiry or problem-solving. Teachers must create an environment that is safe for risk-taking where students feel valorized using the language they have already acquired while refining and expanding their skills. Teachers in these grades will model the use of the target language exclusively and provide opportunities for students to interact with each other in French. Teachers will carefully structure learning opportunities and questioning to develop inquiry skills.

**Additional Resources**

Agence spatiale canadienne – zone éducateurs  

Musée des sciences et la technologie du Canada  
http://www.sciencetech.technomuses.ca/francais/schoolzone/index.cfm

Des ailes pour découvrir  
http://www.exploreideapark.org/WingsofDiscovery/DesAilesPourDecouvrir.aspx
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**Source:** Ken Kay and Valerie Greenhill, 2013, *The Leader's Guide to 21st Century Education: 7 Steps for Schools and Districts*

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The development and consolidation of learning skills and work habits enable students to be prepared for postsecondary education and the world of work.

- responsibility
- organization
- independent work
- collaboration
- initiative
- self-regulation

Classroom educators across all subjects provide students with learning opportunities that allow them to apply their knowledge & skills to explore education and career/life options (CPS p 28).

In K-3 children may wonder and ask questions about the STEM work people do in the community. Educators must recognize and promote this growing interest by encouraging questions such as: What does this work involve? Who is doing the work? What skills are required?

Teachers help students connect this knowledge to their learning at school, their strengths & interests and opportunities in the classroom, the school & the community.

We need to create a culture of inquiry-based exploration and learning in which the 4-step inquiry process is at the heart of all reflective conversations. Staff are supported with developing, and effectively using the tools required for helping students process the information about the why, what and how of their own learning experiences. Students must be provided with a model of self-discovery that increasingly emphasizes potential career opportunities connected to their awareness of self, and a goal-setting paradigm that enables them to pursue those goals. Teachers must explicitly introduce the pathways’ possibilities that are accessed through the foundational studies of science, technology, engineering and math.
The development and consolidation of learning skills and work habits enable students to be prepared for postsecondary education and the world of work.
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Classroom educators across all subjects provide students with learning opportunities that allow them to apply their knowledge & skills to explore education and career/life options (CPS p 28).

In Grades 4-6 students become increasingly aware of the people in their community and the work they do. Educators must recognize and promote this growing interest in STEM occupations by encouraging questions such as: What does this work involve? Who is doing the work? What skills are required? Teachers help students connect this knowledge to their learning at school, their strengths & interests and opportunities in the classroom, the school & the community.

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- mastery & application of literacy in civics, finance, global awareness, health, information, media, environment, and technology
- the ability to think critically, solve problems, create, innovate, communicate and collaborate
- ability to ‘learn how to learn’ and application of this ability to self-monitor and improve learning progress across all subjects

- connect and apply math concepts and ideas in a variety of problem-solving situations
- use oral communication skills to support reading, writing and positive interactions with others
- possessing interpersonal and teamwork skills, identifying those needing improvement
- effectively use technology to enhance research, learning and presentation skills
- foster motivation and self-reliance

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### Learning Skills

- the ability to ‘learn how to learn’ and applying this ability to self-monitoring and improving learning progress across all subjects
- the ability to think critically, solve problems, create, innovate, communicate and collaborate
- self-direction, flexibility, adaptability, cross-cultural awareness, responsibility, productivity and accountability
- information, media, and technology literacy

### Curriculum Connections

- knowledge of employment trends, various cultures, and languages is an asset in the global job market
- developing transferable workplace essential skills based on work/community experiences
- understand the inquiry/research process and problem-solving in learning situations
- assess the effects of information technology in workplaces, including its impact on job requirements, learning opportunities, and how work is done

### What do we need to implement STEM in our learning environments?

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### Additional Resources

- Career Moves: Skills for the Journey (DVD & Teacher’s Kit) – Perimeter Institute
- www.vroc.ca - Virtual Researcher On Call (online database of STEM experts that can be brought into classrooms via video conferencing)
- Career Mash - http://careermash.ca/
  http://careermash.ca/educators/resources
  http://www.eir.ca/
  STEM Diagram
  The Learning Partnership
  http://www.explorecuriocity.org/Careers.aspx
  www.myBlueprint.ca/tdsb
  www.careercruising.ca
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7% of 5- to 11-year-olds in Canada, and 4% of 12- to 17-year-olds, meet the Canadian Physical Activity Guidelines for Children and Youth, which recommend at least 60 minutes of daily moderate to vigorous physical activity. (2009-11CHMS) These recent and alarming statistics indicate that our students need to be physically and health literate so that they can reach their academic potential.

There is a natural relationship between Health and Physical Education (HPE), technology, science and math. The chemistry behind proper nutrition to fuel the human body, to the physics behind a slap-shot rotation of the puck and stick, to the engineering rationale of the benefits of the athletic stance in student’s achieving success while participating in physical activities. Through STEM and HPE, students will also demonstrate the ability to use mental and emotional knowledge, skills, and strategies to enhance wellness. They will also demonstrate the ability to use healthy nutritional choices, fitness and movement skill knowledge to promote a healthy lifestyle while promoting personal safety and injury prevention.

The HPE curriculum helps students develop an understanding of what they need in order to make a commitment of lifelong healthy, active living and develop the capacity to live satisfying productive lives. (Ontario Grades 1-8 HPE Interim Edition page 4.)

Integrating the STEM lens in HPE will enable the students to make personal connections to their goals while achieving the expectations of the curriculum and practicing a healthy active lifestyle.

### Learning Skills

- **Organization**: uses technology and graphic organizers to share findings
- **Initiative**: hypothesizes different ways for an object to reach the intended target
- **Collaboration**: works with a partner to record distances or number of repetitions
- **Self-Regulation**: gathers and organizes personal fitness data to establish and monitor SMART goals

### Curriculum Connections

- **Kindergarten**:
  1. demonstrate an awareness of health and safety practices for themselves and others and a basic awareness of their own well-being (1.1)
- **Grades 1-3**:
  A2. Active Living (A2.3)

### What do we need to implement STEM in our learning environments?

- conduct experiments related to exertion: Why do we sweat? What should we do if we are sweating?
- engage in different fitness activities and monitoring one’s ability to complete the task (e.g., counting how many repetitions or timing how long you can perform at task such as a wall squat before before becoming too tired)
- explore the concept of balance individually with different body parts or with beanbags
- estimate how far or how high you can jump and measure the actual distance
- describe relative locations and paths of motion by travelling using different locomotor patterns at different levels and in different direction
- determine the amount of force needed to propel an object a desired distance
### Grades 4 - 6

#### Learning Skills
- Organization: uses technology (such as heart rate monitors) to predict and monitor exertion over time
- Initiative: hypothesizes different ways to transition between balances
- Collaboration: works with others to design an experiment related to the principles of movement
- Self-Regulation: gathers and organizes personal fitness data to establish and monitor SMART goals

#### Curriculum Connections
- A2 - demonstrate an understanding of the importance of being physically active, and apply physical fitness concepts and practices that contribute to healthy active living (A2.2, A2.3, A2.4)
- B1 - perform movement skills, demonstrating an understanding of the basic requirements of the skills and applying movement concepts as appropriate, as they engage in a variety of activities (B1.1, B1.2, B1.3, B1.4)

### Grades 7 - 9

#### Learning Skills
- Organization: uses technology (such as video analysis) to predict and monitor movement skill execution
- Initiative: hypothesizes different ways to transition between locomotor movements
- Collaboration: works with others to deconstruct the principles of movement for a given skill
- Self-Regulation: gathers and organizes personal fitness data to establish and monitor SMART goals

#### Curriculum Connections
- Grades 7&8:
  - A2. Active Living (A 2.2, A2.3, A2.4)
- PPL 10
  - PA. 1. demonstrate personal competence in applying movement skills and principles

### What do we need to implement STEM in our learning environments?
- work collaboratively to design an ideal work-out space for students
- use technology and analysis to engineer the perfect jump for distance and height (force, velocity, speed, levers)
- hypothesize and conduct experiments related to the principles of movement (balance -- static / dynamic, locomotion, throwing, catching)
- research, monitor and assess change in the components of fitness over time and then design program plans for the various stages of life (adolescence, adulthood)
- evaluate energy balance, how food and fuels affect the body (Pre / post) exercise

### What do we need to implement STEM in our learning environments?
- use technology (pedometers, smart-phone app) to calibrate stride length with distance in order to determine steps per km.
- monitor and assess personal fitness and level of exertion using formulas for maximum HR, target HR, target HR chart and the FITT principle
- design personal training plans to meet personal fitness goals or the goals of an athlete participating in a certain activity (e.g.: long-distance running, hockey, etc.)
- determine the optimal angle of approach/contact to achieve desired execution of a movement skill (smash in badminton versus clear in badminton)
- analyse the phases of movement to determine the optimal joint angle (i.e: knee flex) to generate the desired force to complete the movement (e.g.: jumping during a dance routine)
**Learning Skills**

| Organization: uses technology to complete tasks (heart rate monitors, pedometers, etc.,) |
| Independent Work: independently monitors, assesses, and revises plans to complete tasks and achieve goals (SMART, IDEAL) |
| Collaboration: builds healthy peer-to-peer relationships (ability to function effectively in a group) |
| Self-Regulation: identifies strategies to meet personal needs and achieve goals (interpret fitness data and create a personal fitness plan) |

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<tr>
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<tbody>
<tr>
<td>PPL2/3/4</td>
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<td>PA1. Demonstrate personal competence in applying movement skills and principles</td>
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<tr>
<td>AL2. Demonstrate improved personal fitness</td>
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<td>PSE4U</td>
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<tr>
<td>Biological Basis of Movement</td>
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<tr>
<td>Motor Development</td>
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<td>Physical Activity and Sports in Society</td>
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**What do we need to implement STEM in our learning environments?**

- create a culture of inquiry-based exploration and learning in which the 4-step inquiry process is at the core of all teaching and learning
- analyze biomechanical principles using technology (joint mechanics, relationship between force and movement)
- analyze and interpret fitness data using mathematical skills and design a fitness program
- select and safely use appropriate devices, tools, and equipment to observe, measure and record data (heart rate monitors, pedometers, VO2 Max testing, calipers, bio impedance analysis, etc.,)
- work collaboratively in groups with different individuals using appropriate strategies

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**Additional Resources**

- **PHE Canada** (for a national perspective on physical literacy and LTAD model of program delivery): [http://www.phecanada.ca/](http://www.phecanada.ca/)
- **Active Healthy Kids Canada** (for statistics, environmental impact and data relating (Report card) to physical activity in Canada)
- **Canadian Sport for Life** (for the national perspective on the LTAD model and assessment tools for physical literacy for children based on age): [http://canadiansportforlife.ca/](http://canadiansportforlife.ca/)
- **Motion Analysis Apps** (for video analysis with deconstructing capabilities): [http://www.ubersense.com/](http://www.ubersense.com/)
- **ParticipACTION** and **SPARK** (for access to Health and Physical Education APPs)
- **Thompson HUDDLE** (for collaborating with HPE leaders from across Canada on topics such as technology and cross-curricular connections)
- **Montana State University-Bozeman** (shows how science illuminates human activity): [http://btc.montana.edu/olympics/default.htm](http://btc.montana.edu/olympics/default.htm)
- **NBC Sports** (science behind sport in partnership with the National Science Foundation): [https://www.nbclearn.com/portal/site/learn/resources](https://www.nbclearn.com/portal/site/learn/resources)
- **Fundamental Movement Skills Video Collection** (PHE Canada - instruction in, and demonstration of, fundamental movement skills and competencies): [http://www.phecanada.ca/resources/fms-videos](http://www.phecanada.ca/resources/fms-videos)
- **Active Healthy Kids Canada** (for statistics, environmental impact and data relating (Report card) to physical activity in Canada): [http://www.60minkidsclub.org/](http://www.60minkidsclub.org/)
Aboriginal Education

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**CurioCity**
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The People for Education report on First Nations, Métis and Inuit Education defines Aboriginal as “the term used in the Canadian Constitution to recognize and affirm the existing rights and treaties of First Nations, Métis and Inuit peoples” (2). We are all Treaty people, as the Treaties were established by our ancestors and by the government on behalf of all people who would share this land. Aboriginal Education is not just for Aboriginal students. The report asserts that “all of Ontario’s students should know about the long and complex history of the relationship between Aboriginal and non-Aboriginal peoples in Canada, and all students should have a deep understanding of historical and contemporary First Nations, Métis and Inuit culture, perspectives, and experiences” (3). From an Indigenous perspective, Culturally Relevant and Responsive Pedagogy is composed of 4 R’s: Respect of First Nations, Métis and Inuit cultural integrity, Relevance to First Nations, Métis and Inuit perspectives and experiences, Reciprocity in the form of reciprocal relationships, and Responsibility through participation (Kirkness and Barnhardt). Learning is a lifelong process that affects individual and collective well-being whereby a person learns from and through the natural world, language, traditions and ceremonies, and other social relations. Individual well-being supports the collective well-being.
What do we need to implement STEM in our learning environments?

Ensure STEM is locally and culturally relevant. Wholistic learning experience that engages four dimensions - physical, mental, emotional, and spiritual. Draw on students' diverse cultural and personal experiences and prior knowledge. Engage in an active, hands-on, inquiry-based learning where students use all of their senses. Teach with the big ideas in an integrated approach to help students see the interconnectedness and interrelatedness.

Ensure STEM draws on local and culturally relevant resources to provide a holistic learning experience that engages four dimensions - physical, mental, emotional, and spiritual. Introduce and engage Aboriginal role models and mentors, particularly from the local community. Transdisciplinary and experiential approach to teaching and learning in an environment that students understand and have a connection to, and with things that are already available. Share Indigenous knowledge and demonstrate how it plays a significant role in the study of science.
Learning Skills

- Divergent thinking
- Design thinking
- Ecological literacy and sustainable development
- Inquiry learning

Curriculum Connections

SNC2D-Bio Big Idea 2; Earth & Space Science B.I. 1, 2, 3, 4; SBI3U-Bio B.I. 2; Plants B.I. 2; SBI3C-Anatomy of Mammals B.I. 3; Plants B.I. 2, 3; SBI4U-Population Dynamics B.I. 2; SCH3U-Solutions B.I. 3; Gases B.I. 3; SCH4U-Organic Chem B.I. 1; Electrochem B.I. 2; SCH4U-Chem in the Enviro B.I. 2

Additional Resources


Dion, Susan D.; Johnston, Krista; Rice, Carla, M (2010) Decolonizing Our Schools Aboriginal Education in the Toronto District School Board. (Toronto)

Good Minds. Aboriginal Environment, Science, and Traditional Knowledge List for TDSB
- Teacher Resources http://bit.ly/1fl2dFX
- K to Grade 3 http://bit.ly/1h5n6l
- Grades 4 to 6 http://bit.ly/1pFpAK2
- Grades 7 and 8 http://bit.ly/1ny8yLR
- Grades 9 to 12 http://bit.ly/1ny8ETR

Resources for Rethinking http://resources4rethinking.ca/


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Our world is increasingly interconnected and interdependent. Communications networks exchange information around the globe, creating new forms of collaboration and transforming the nature of work and learning. New areas of study develop to advance human knowledge and respond to the challenges of our changing world… These include areas that often combine or cross subjects or disciplines, such as space science, information management systems, alternative energy technologies, and computer art and animation.

In interdisciplinary studies courses, students consciously apply the concepts, methods, and language of more than one discipline to explore topics, develop skills, and solve problems. These courses are intended to reflect the linkages and interdependencies among subjects, disciplines, and courses and their attendant concepts, skills, and applications, and are more than the sum of the disciplines included. In an unpredictable and changing world, interdisciplinary study encourages students to choose new areas for personal study and to become independent, life-long learners who have learned not only how to learn but also how to assess and value their own thinking, imagination, and ingenuity in decision-making situations. Interdisciplinary Studies Curriculum, pg 5.

Interdisciplinary work is all about making connections that go beyond where you started. While “interdisciplinarians” carefully investigate the foundations of discrete subjects, they build on them to meet the challenges that arise from recurrent issues and “big picture” problems. Interdisciplinary students and teachers approach learning directly, naming strategies, collecting perspectives, researching methodologies, and reflecting on paradoxes. Then they apply the naming, collecting researching, and reflecting to both familiar and unfamiliar contexts, often in community-based activities. Interdisciplinary tasks are challenging, but the transfer of learning is uniquely rewarding. TDSB. Making Connections: a guide to interdisciplinary studies for Ontario schools, pg 2.
### Grades 4 - 6

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**What do we need to implement STEM in our learning environments?**

### Grades 7 - 9

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**What do we need to implement STEM in our learning environments?**
### Learning Skills

IDS encourages students to: learn to plan and work independently and collaboratively; apply established and new technologies appropriately and effectively; use higher-level critical- and creative-thinking skills; implement innovative solutions; use interdisciplinary activities to stimulate, monitor, regulate, and evaluate their thinking processes and thus learn how to learn. pg 5

### Curriculum Connections

As their ability to analyse issues and synthesize diverse kinds of information develops, students [learn] to evaluate their research findings... to work collaboratively and independently on real-life tasks [in order] to produce innovative interdisciplinary products. Students investigate the impact of interdisciplinary studies on their personal development and career opportunities... to solve problems and discover new relationships and possibilities. pg 16

### What do we need to implement STEM in our learning environments?

Innovative approaches to teaching and learning will encourage students to create and communicate new ideas, extend personal meaning, and develop innovative solutions. These approaches may involve collaborative planning and implementation by teachers and teacher-librarians; innovative leadership by administrators; cooperative models that link subjects in a structured way; team teaching, flexible scheduling, and creative timetabling; and planning, implementation, and assessment in a variety of settings. Strong linkages to the communities inside and outside the school are also essential to an effective interdisciplinary curriculum. pg 9

### Additional Resources

- TDSB. Building Connections: new course models and online resources for Interdisciplinary studies, 2009.
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The Learning Commons forms "the framework for teaching and learning in the school library, linking curriculum expectations to research and inquiry skill development, and providing a vision for school library practice within both a physical and virtual environment. By explicitly addressing and delivering a continuum of information literacy skill development and by connecting students to the local and global community and its resources, teacher-librarians prepare students as literate, contributing, global citizens."

"Research and Inquiry are integral to Ontario curriculum in all subject areas. " (TDSB Expected Practice). Application of the inquiry models and disciplinary thinking encourages cross-curricular connections, critical thinking and the use of multiple literacies. There is a synergy of connection between curricular disciplines, throughout the K-12 learning experience and via collaborative practice in the library learning commons.

Language/English, 1-12 (pg 30, 34-35); Social Studies, 1-6; History/Geography, 7-8 (pg 5); and Science and Technology 1-8 (pg 41) state: "The school library program plays a key role in the development of information literacy and research skills. In collaboration with classroom or content-area teachers, teacher librarians develop, teach, and provide students with authentic information and research tasks that foster learning, including the ability to: access, select, gather, critically evaluate, create, and communicate information; use the information obtained to solve problems, make decisions, build knowledge, create personal meaning, and enrich their lives; communicate their findings for different audiences, using a variety of formats and technologies; use information and research with understanding, responsibility, and imagination." Science (pg 40) and Social Science and Humanities, 9 -12 (pg 46) state that students "will practise using a variety of inquiry and research skills, . . . will learn how to determine the most appropriate methods to use in a particular inquiry or research activity . . . [and] learn how to locate relevant information in a variety of print and electronic resources."

Libraries need: flexible physical and virtual spaces/learning environments; accessible differentiated learning resources (print/digital collections/TDSB Virtual Library); digital tools (data projector/mobile devices); equitable & universal access; maker spaces for creating/tinkering in activity/tool centres; and open library timetabling to support partnering, collaborative teaching & learning. "Effective strategies for teaching and learning recognize that students today have immediate access to global information, wider possibilities for collaboration, and a need to see relevance in their studies. The focus in inquiry has moved from information seeking and reporting to individual and collective knowledge creation." (Expected Practice)
### Inquiry and Learning Skills

**Mathematics, 1-8**

Inquiry allows students to develop, practise, and demonstrate learning skills required for personal and academic success. Using a variety of strategies including descriptive feedback, teacher-librarians engage students in assessment as learning within the context of research/inquiry, making reading selections, and learning collaboratively. TDSB Research/Inquiry guides provide tools for students.

**Literacy and Inquiry/Research Skills (pg 29)** states:

As they solve problems, students develop their ability to ask questions and to plan investigations to answer those questions and to solve related problems;

Language, 4-8, Writing, Research 1.3 gather information to support ideas for writing, using a variety of strategies and a range of print and electronic resources.

**Science & Technology, 1-8**

The goal is to develop the skills, strategies, and habits of mind required for scientific inquiry and technological problem solving; similar to Social Studies, 1-6 & History/Geography, 7-8 inquiry concepts: formulating questions; gathering and organizing information, evidence; interpreting, analysing, evaluating information, drawing conclusions and communicating findings.

### Libraries Need

- **Flexible physical and virtual spaces/learning environments**
- **Accessible differentiated learning resources** (print/digital/TDSB Virtual Library)
- **Digital tools** (data projector/mobile devices)
- **Equitable & universal access**
- **Maker spaces** for creating/tinkering in activity/tool centres
- **Open library timetabling** to support partnering, collaborative teaching & learning

Students develop critical literacy skills when they: work with print/visual/spoken texts, make connections to themselves/the world, and know that all text has a point of view, needing critical questioning and evaluation.

**Teacher-librarians** plan collaboratively with teachers to:

- Support student inquiry and problem-based learning
- Integrate authentic experiences that extend beyond classroom walls
- Provide students with opportunities to investigate, form opinions, take action, and reflect, to develop students’ awareness of and skill in using multiple types of literacies e.g. critical, digital, visual, cultural.
Inquiry allows students to develop, practise, and demonstrate learning skills required for personal and academic success. Using a variety of strategies including descriptive feedback, teacher-librarians engage students in assessment as learning within the context of research/inquiry, making reading selections, and learning collaboratively. TDSB Research/Inquiry guides provide tools for students.

Sci 9-12 "Students learn to apply scientific investigation skills in four broad areas: initiating & planning; performing & recording; analyzing & interpreting; & communicating"; Tech Studies 9-12 The ability to locate, question, evaluate information allows students to become independent lifelong learners (42); Eng 9-12 "Use search strategies and source evaluation criteria to locate appropriate... sources; engage in note making, and create a reference list."

Libraries need flexible physical and virtual spaces/learning environments; accessible differentiated learning resources (print/physical collections/TDSB Virtual Library); digital tools (data projector/mobile devices); equitable/universal access; maker/creation spaces. Teacher-librarians plan collaboratively with classroom teachers to support student inquiry... integrate authentic experiences that go beyond the classroom walls, provide opportunities for students to: develop multiple literacies, investigate, evaluate, form opinions, express voice, take action, and reflect. "The focus in inquiry has moved from information seeking and reporting to individual and collective knowledge creation."

Additional Resources

TDSB. ICT Standards: digital learning for kindergarten to grade 12.
TDSB. Imagine the Learning!: A Guide for Elementary Teacher-Librarians and Teachers to Use with Students.
TDSB. "Inquiry Process Achievement Chart" in Library and Learning K to 12 Expected Practice.
TDSB. Library and Learning Commons K to 12 Expected Practice Series, 2012.
TDSB. Research Success @ Your Library: A Guide for Secondary Students.
TDSB. Réussir dans vos recherches à la bibliothèque : Un guide pour les élèves du secondaire.
Wilhelm, J., et. al., Inquiring Minds Learn to Read and Write, Scholastic, 2009.
Why STEM?

• to prepare our students to be global learners and leaders in creating solutions for emerging complexities
• to move public education forward - continue to improve on culturally relevant and responsive practices
• to use problem based learning that instills creativity and innovation, in order to transform teaching & learning

STEM contributes to the development of five key competencies:

• to master an understanding of civic literacy, financial literacy, global awareness, health literacy and environmental literacy.
• to think critically, problem solve, create, innovate, communicate and collaborate.
• to use information, media and technology literacy.
• to develop self-direction, flexibility, adaptability, cross-cultural awareness, responsibility, productivity and accountability.
• to “learn how to learn” and application of this ability to self-monitor and improve learning progress across all subjects.


The goals of STEM are:

• to promote higher levels of student achievement by supporting all entry points for a STEM-centric pedagogy in all TDSB schools and for a range of career pathways;
• to develop students’ creative and innovative thinking in and across the disciplines of mathematics, science and technology;
• to increase students’ confidence and engagement in mathematics, science and technology.

Professional Learning

TDSB Professional Library
Provides professional learning resources to support STEM

http://aw.tdsb.on.ca/sites/tl/library/tdsbprofessionallibrary/SiteHome.aspx
Virtual Researcher On Call (VROC)
Is a set of educational programs that connect knowledge partners - college and university professors and professionals in the fields of Science, Technology, Engineering and Math (STEM) - with Canadian students in elementary and secondary schools for real-time, interactive learning opportunities. www.vroc.ca

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The Learning Destinations For All Students in Mathematics

- understand, remember, and apply mathematical concepts
- articulate clear understanding of mathematical concepts and ideas and give clear examples of use
- apply concepts, skills, and strategies to propose solutions to problems
- analyze problems, use a variety of strategies & processes to find solutions, and be able to check and evaluate effectiveness of processes used
- work effectively alone and with others
- communicate effectively using words, symbols, and representations
- connect ideas to staff, others and other ideas/tasks
- use "mathematical habits of mind", for example persistence, questioning, prior knowledge/experience, precision of language and thinking
- demonstrate learning and thinking in a range of ways including observations, conversations, written reflections, teacher-student conferences, performance tasks, work samples/products e.g. work samples, tests, quizzes;
- observations e.g. class work, demonstrations, performance tasks, teacher observations;
and conversations e.g. discussions, written discussions, written reflections, journal entries, Conference, interview.

(Adapted from Reporting in Mathematics 2010, Ann Davies)
The Effective Mathematics Classroom Environment
- both teachers and students demonstrate a positive attitude towards mathematics
- is a safe, supportive and respectful classroom
- includes engaging, challenging and authentic mathematics
- high expectations are held by teachers and students
- provides collaborative learning opportunities
- student mathematical thinking and learning is evident and posted
- student generated work and/or co-constructed with the teacher are posted and clearly defined
- students have easy access to and choice of learning tools, mathematics resources and technologies
- includes activities and resources that are inclusive and reflect the needs of students with varying backgrounds, abilities, interests and learning styles

Life-long learners of mathematics build new knowledge and skills on prior knowledge using mathematical processes.
- Problem solving
- reasoning and proving
- reflecting
- selecting tools and computational strategies
- connecting
- representing
- communicating

Processes are interconnected and interrelated,
- students’ construction of their knowledge and skills related to mathematics are fundamental
- students monitor and reflect on their learning (metacognitive)
- Learning Skills are:
  - central to the actions of doing mathematics;
  - ways of acquiring and using the content, knowledge and skills of mathematics;
  - linked to three of the categories of the Achievement Chart- Thinking, Communication, and Application, Knowledge and Understanding

What do we need to implement STEM in our learning environments?

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- to use problem-based learning that instills creativity and innovation, in order to transform teaching & learning
- to champion equity and inclusive education by intentionally disrupting the achievement gap that exists for marginalized groups in STEM fields (e.g. females, racialized and low-income communities)

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- to challenge historical and current discrimination, removing barriers that exist to the engagement and achievement of marginalized communities in STEM fields

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Big Idea: Musical learning involves understanding the science of sound.

Suggestions for specific inquiries related to the Big Idea:
1. Examining sound environments (e.g., in the classroom, neighbourhood, a nature walk) to develop an understanding of the principles of sound musically (timbre, duration, resonance, harmonics, pitch) and relating the musical principles to the scientific principles (sound waves).
2. Study of acoustics and a variety of accoustical environments (e.g. through experimenting with performing music in different spaces, researching the accoustical design of various concert halls).
3. Experimenting with musical instruments and examining how they produce sound.
4. Researching how technological inventions (e.g. electricity) have impacted the sound of music (e.g. volume/dynamics) and musical creation.
5. Examination of how sounds and sound environments impact health and wellness (e.g., sounds used for music therapy, noise pollution, amplified sound and its effects on hearing).
6. Exploring the science of sound to create desired effects in musical compositions.
7. Studying and experimenting with vocal techniques for creating resonant sound when using the voice in musical performances.

“When we are involved in [creativity], we feel that we are living more fully than during the rest of life. The excitement of the artist at the easel or the scientists in the lab comes close to the ideal fulfillment we all hope to get from life, and so rarely do.”

Mihaly Csikzentimehaly (1997, p.2)
<table>
<thead>
<tr>
<th>Learning Skills</th>
<th>Curriculum Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong>-gathering and ordering sounds to examine sound environments and complete musical compositions.</td>
<td><strong>C1.2</strong> apply the elements of music when singing and/or playing, composing, and arranging music to create a specific effect</td>
</tr>
<tr>
<td><strong>Initiative</strong>-curiosity about sound production with the voice and with instruments and inquiry questions about sound.</td>
<td><strong>C1.3</strong> create musical compositions for specific purposes and audiences</td>
</tr>
<tr>
<td><strong>Self-regulation</strong>-assesses and reflects critically on use of sound in compositions and performances.</td>
<td><strong>C2. Reflecting, Responding, and Analysing</strong>- apply the critical analysis process to communicate their feelings, ideas, and understandings in response to a variety of music and musical experience</td>
</tr>
</tbody>
</table>

**What do we need to implement STEM in our learning environments?**

- experimenting the widening range of the voice (head voice to chest voice) and vocal styles (e.g. vocal beat boxing) to understand voice mechanics and resonance
- learning to play instruments (e.g. recorder, ukulele, xylophones, drums) to explore how sound is made and to use sounds for musical compositions
- space for students to work in small groups to create musical compositions
- use of digital equipment to record and create
- use of a variety of art materials to graph sounds and student created compositions (e.g. creation of graphic scores)

**What do we need to implement STEM in our learning environments?**

- singing and playing instruments individually and in ensembles exploring the science behind the technique
- analysing musical sounds (attack, decay, harmonics) while performing/creating music.
- inquiry into the relationship of sound environment to musical culture through listening and performing a wide variety of music
- visits and performances in a variety of performance spaces to hear how sound/music changes in different environments
- researching careers in music/sound (acoustical engineers, sound architecture, music therapist)
- use of digital equipment to record and create

**Grade 8**

- **C2.1** express analytical, personal responses to musical performances in a variety of ways (e.g., record detailed analyses of music they have listened to in a log or reflection journal to explain why they enjoy it and how the elements of music are
- **C3.1** analyse the influences of music and the media on the development of personal and cultural identity
### Learning Skills

- Organization-planning and completing musical compositions and performances.
- Initiative-curiosity about sound production and inquiry questions that further the understanding about use of sound as a composer/performer.
- Self-regulation-assesses and reflects critically on use of sound in compositions and performances.
- Independent Work-revises musical compositions to create a desired effect.

### Curriculum Connections

- A1.2 apply the creative process when composing and/or arranging music
- A2.2 manipulate the elements of music and related concepts appropriately when improvising melodies and rhythms
- A3.3 use current technology when practising, performing, composing, and/or arranging music
- B1.3 describe the difference between technical aspects and expressive aspects of music

### What do we need to implement STEM in our learning environments?

- singing and playing instruments individually and in ensembles developing a sophisticated understanding of the science behind the technique
- regularly analysing musical sounds (attack, decay, harmonics) while performing/creating music to invent and push boundaries
- inquiry into the relationship of sound environment to musical culture through listening and performing a wide variety of music
- choosing performance spaces based on accoustical properties to suit the music
- researching careers in music (acoustical engineers, sound architecture, music therapist)
- use of digital equipment to record and create

### Additional Resources

- **TDSB Music Department Instruments:**
  - Orff instruments, Indonesian Gamelan, Cuban Brazilian percussion and Ghanaian percussion instrument kits. Visit [http://aw.tdsb.on.ca/sites/tl/music](http://aw.tdsb.on.ca/sites/tl/music)

- **TDSB Music Library:**
  - A repertoire for choirs, string orchestras, and bands as well as teacher resources. Visit [http://tdsbhip.tdsb.on.ca/ipac20/ipac.jsp?profile=music](http://tdsbhip.tdsb.on.ca/ipac20/ipac.jsp?profile=music)

- **TDSB Music Department Modules and Discussion Forums Including:**
  - Student voice
  - [https://drive.google.com/a/tdsb.on.ca/#folders/0B_X-ckX8hvKURGJUYzBXNTJCdzug](https://drive.google.com/a/tdsb.on.ca/#folders/0B_X-ckX8hvKURGJUYzBXNTJCdzug)
  - Technology in the Music Classroom
  - [http://aw.tdsb.on.ca/sites/tl/music/techintheclassroom/SiteHome.aspx](http://aw.tdsb.on.ca/sites/tl/music/techintheclassroom/SiteHome.aspx)

- **Internet and Music Software:**
  - Finale-Ministry licenced music notation program
  - Audacity-records and can be used for creating music
  - Garage Band-for Mac users-records and can be used for creating music
  - Youtube-for listening to and examining musical performance

- **Books:**
  - Meyers, Victoria: The Shape of Sound (Artifice Books on Architecture, 2014)
  - "Meyers analyses the shape of sound; architecture and sound; form; materiality; windows; the urban soundscape, its politics, aesthetics and social character; reflection; virtuality; sound art; and silence."
  - "The book is a pioneering exploration of our acoustic environment, past and present, and an attempt to imagine what it might become in the future."
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Responsibility:
- Fulfils responsibilities and commitments within the learning environment
- Takes responsibility for and manages own behaviour

Self-Regulation:
- Sets own individual goals and monitors progress towards achieving them
- Seeks clarification or assistance when needed

Kindergarten:
- demonstrate an understanding of the natural world and the need to care for and respect the environment
application of all Mathematics and Science & Technology Strands

Social Studies
- People and the Environment (Gr. 2: B1)
- Heritage and Identity (Gr. 1 & 3: A1)

By engaging students in the natural environment we are promoting:
- Advocating
- Building on principals of natural design (biomimicry)
- Collaboration with peers, teachers
- Communication
- Comparing
- Critical Thinking
- Deductive Reasoning
- Experiential Experiences
- Experimenting
- Innovative Thinking
- Inter-disciplinary Studies
- Investigating
- Negotiating

Applications in the real world:
- Arborist
- Art and design (architecture, landscaper, etc.)
- Conservationist - resource management, Park Ranger, advocate
- Ecologist
- Engineer (Civil, Geo/ECC, etc.)
- Environmental Lawyer
- Farmer
- Geologist
- Meteorologist
- Sustainable construction

What do we need to implement STEM in our learning environments?
- create a culture for risk taking
- encourage questioning and exploring
- intentional opportunities provided for exploration, discovery and problem solving
- opportunity for teacher collaboration
- safe environment (physically and emotionally)

Equipment and Materials
- a variety of tools to support investigations (e.g., magnifiers, collections jars, measuring tools, trowels, digital camera, iPad, etc.)
- safe outdoor space for exploration (e.g., ravine, meadow, schoolyard, etc.)
### Initiative:
- Looks for and acts on new ideas and opportunities for learning
- Demonstrates the capacity for innovation and a willingness to take risks
- Demonstrates curiosity and interest in learning

### Organization:
- Establishes, prioritizes, and manages time to complete tasks

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### Social Studies:
- People and Environments (Gr. 4 - B1)
- Heritage and Identity (Gr. 5 - A2)

### Geography:
- Patterns in a Changing World (Gr. 7: A1, A2, A3)
- Natural Resources Around the World & Sustainability (Gr. 7: B1, B2, B3)
- Global Settlement Patterns and Sustainability (Gr. 8 A1, A2, A3)

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### Independent Work:
- Independently monitors, assesses, and revises plans to complete tasks and meet goals
- Follows instructions with minimal supervision

### Collaboration:
- Accepts various roles and an equitable share of work in a group

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### What do we need to implement STEM in our learning environments?
- CRRP related lesson plans to adapt to an ever changing demographic (providing understanding in an international context)
- Partnerships with community members and other educational institutions
- Professional development in math and engineering
- Professional training and funding related to technology which can be utilized in the outdoors
- Analyze programs from a STEM perspective to see which ones would be improved with an infusion of STEM perspective and/or activities
- Consider STEM ideas to revitalize programs or create new program possibilities
- Consider prior learning opportunities at school or follow up activities to enhance hands on STEM learning at Outdoor Education centres
- Draw attention to learning opportunities in Outdoor Education programs that already contain STEM aspects
- responsibility
- independent work
- initiative
- organization
- collaboration
- self-regulation

Issues in Canadian Geography (CGC1D/P)
Green Industries (THJ2O, THJ3M/E, THJ4M/E)
Physical Geography (CGF3M)
Travel and Tourism (CGG2O)
Aboriginal Beliefs, Values and Aspirations (NBV3C)
Environmental Science (SVN3M/E)
Environment and Resource Management (CGR4M/E)
Geomatics (CGO4M)
Earth and Space Science (SES4U)

- CRRP related resources
- experiential, integrated programs (2- or 4-credit)
- partnerships with community members and other educational institutions
- professional development in math and engineering
- professional development in current/leading edge technological tools for field studies
- using technology outdoors

What do we need to implement STEM in our learning environments?

Academic Workspace - Outdoor Education
Toronto Outdoor Education Schools, http://toes.tdsb.on.ca/

Professional Development:
Discovering Nature with Young Children
Ingrid Chalufour and Karen Worth

Ministry Documents (available on-line):
- Environmental Education: Scope and Sequence of Expectations, 2011 (elementary and secondary curriculum versions available)
- Growing Success
- Ready, Set, Green! Tips, Techniques and Resources from Ontario Educators
- Shaping Our Schools, Shaping Our Future: Environmental Education in Ontario Schools
- Specialist High Skills Major – The Environment, Sector-Specific Guide
- Standards for Environmental Education in the Curriculum

Lesson Plans:

Organizations and Partnerships:
David Suzuki Foundation
Natural Curiosity: A Resource for Teachers http://www.naturalcuriosity.ca/
Publisher: University of Toronto (2011)
Green Teacher (http://greenteacher.com/)
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Inquiry skills: Design of an investigation/inquiry
Technology skills: Exploration of a problem that requires designing, building, and testing a possible solution
Research skills: Answering questions through primary and secondary research

STEM contexts to engage students in their learning can be drawn from expectations from four strands:

1. **Life Systems** (plants and animals)
2. **Structures and Mechanisms** (materials, objects, movement and stability)
3. **Matter and Energy** (liquids, solids, force and energy)
4. **Earth and Space Systems** (daily and seasonal changes, air, water, soil)

Material-rich classrooms that support multi-sensory exploration of phenomena
- growth mindsets that encourage curiosity, creativity, problem solving, and risk taking with multiple entry points
- various tools and equipment to support inquiry and technological problem solving
- student and teacher generated tasks that are contextually rich and engage students with authentic problems and inquiry questions
- digital devices for research, sharing, and documentation
- facilities and space that support safe learning both indoors and outdoors
Learning Skills: Observing, Questioning, Inferring, Measuring, Recording, Constructing, Comparing, Contrasting, Analyzing, Explaining, Defending

Inquiry skills: Design of an inquiry or investigation

Technology skills: Exploration of a problem that requires designing, building, and testing a possible solution

Research skills: Answering questions through primary and secondary research

STEM contexts to engage students in their learning can be drawn from expectations from four strands:

**Life Systems** (habitats, organ systems, biodiversity)

**Structures and Mechanisms** (pulleys, gears, forces, flight)

**Matter and Energy** (light, sound, electricity, changes in matter)

**Earth and Space Systems** (rocks and minerals, energy conservation, space)

**What do we need to implement STEM in our learning environments?**

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Grade 7-8:
Life Systems, Structures and Mechanisms, Matter and Energy
Earth and Space Systems

Grade 9:
Biology, Physics, Chemistry, Earth and Space Science

Material-rich classrooms that support multi-sensory exploration of phenomena
- growth mindsets that encourage curiosity, creativity, problem solving, and risk taking
- various tools and equipment to support inquiry and technological problem solving
- student and teacher generated tasks that are contextually rich and engage students with authentic problems and inquiry questions
- digital devices for research, sharing, and documentation
- facilities and space that support safe learning both indoors and outdoors.
- opportunity to develop skills and interests related to various career paths through the use of equipment, hand and machine tools to solve rich practical problems
### Learning Skills

- Observing, Questioning, Inferring, Measuring, Recording,
- Comparing, Contrasting, Analyzing,
- Explaining, Interpreting, Modeling, Reflecting, Defending, Evaluating

### Inquiry skills:
Design of an inquiry or investigation

### Research skills:
Developing and answering questions through primary and secondary research

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#### What do we need to implement STEM in our learning environments?

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- growth mindsets that encourage curiosity, creativity, problem solving, and risk taking
- various tools and equipment to support inquiry and technological problem solving
- student and teacher generated tasks that are contextually rich and engage students with authentic problems and inquiry questions
- digital devices for research, sharing, and documentation
- facilities that support safe learning and space for differentiated learning opportunities

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#### Curriculum Connections

The fundamental concepts provide a framework for the deeper understanding of all scientific knowledge — a structure that facilitates integrated thinking as students draw from the knowledge base of science and see patterns and connections within the sub-disciplines of science, and between science and other disciplines:
- Matter · Energy · Systems and Interactions
- Structure and Function · Sustainability and Stewardship · Change and Continuity

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#### Additional Resources

### Local Resources
- AW Science (Secondary)
- AW Science and Technology (Elementary)
- TDSBweb Science and Technology
- Science and Technology YouTube Channel
- EcoSchools
- Ontario Science Centre
- Royal Ontario Museum
- MetroTorontoZoo

### Federal and Provincial Resources
- Government of Canada
- The Ontario Curriculum
- Science Teachers Association of Ontario
- Ontario Council of Technology Educators
- Environmental Careers Organization
- Career Mash: Inspiring Tech Careers

### Global Resources
- The National Science Foundation
- Learning with STEM Central
- The Exploratorium
Why STEM?

- to prepare our students to be global learners and leaders in creating solutions for emerging complexities
- to move public education forward - continue to improve on culturally relevant and responsive practices
- to use problem-based learning that instills creativity and innovation, in order to transform teaching & learning
- to champion equity and inclusive education by intentionally disrupting the achievement gap that exists for marginalized groups in STEM fields (e.g. females, racialized and low-income communities)

STEM contributes to the development of five key competencies:

- to master an understanding of civic literacy, financial literacy, global awareness, health literacy and environmental literacy.
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- to use information, media and technology literacy.
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- to "learn how to learn" and apply this ability to self-monitor and improve learning across all subjects.


The goals of STEM are:

- to promote higher levels of student achievement by supporting all entry points for a STEM-centric pedagogy in all TDSB schools and for a range of career pathways
- to develop students’ creative and innovative thinking in and across the disciplines of mathematics, science and technology
- to increase students’ confidence and engagement in mathematics, science and technology
- to challenge historical and current discrimination, removing barriers that exist to the engagement and achievement of marginalized communities in STEM fields

Professional Learning

TDSB Professional Library
Provides professional learning resources to support STEM

http://aw.tdsb.on.ca/sites/tl/library/tdsbprofessionallibrary/SiteHome.aspx

Virtual Researcher On Call (VROC)
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Critically literate students in Social Studies:

Students need to be aware of points of view (perspectives) (e.g., those of people from various cultures), the 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 interacting with the text (e.g., upbringing, friends, school and other communities, education, experiences), intertextuality (e.g., information that a reader or viewer brings to a text from other texts read 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., voices of a person or group not heard). Pg. 51

Grade 2 Overall B

use the social studies inquiry process to investigate aspects of the interrelationship between the natural environment, including the climate, of selected communities and the ways in which people in those communities live.

Grade 3

B2.1 formulate questions to guide investigations into some of the short- and/or long-term effects on the environment of different types of land and/or resource use in two or more municipal regions of Ontario.
Computer programs can help students to collect, organize, and sort the data they gather, and to write, edit, and present reports on their findings. ICT can also be used to connect students to other schools, at home and abroad, and to bring the global community into the local classroom.

The integration of information and communications technologies into the social studies, history, and geography program represents a natural extension of the learning expectations. ICT tools can be used in a number of ways: in the inquiry process, to help develop spatial skills, and as part of field studies.

What do we need to implement STEM in our learning environments?

Students need to be given opportunities to pursue inquiries of their choosing within the limits of the overall curriculum expectations. They must be given opportunities to learn and practice the components of inquiry and the appropriate concepts of disciplinary thinking. Students must be challenged to pursue a problem of their determination and gather reliable sources of information that help them arrive at a potential answer to the selected problem. Students must have access to on-line search engines and with the guidance of their teachers learn what qualifies as a reliable site and how information from one source can be corroborated or disproved through further searches.
Research and Inquiry skills are forefront in all Social Science and Humanities courses. Students learn to explore; investigate; process information; and communicate and reflect what they have learned.

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| Research and Inquiry skills are forefront in all Social Science and Humanities courses. Students learn to explore; investigate; process information; and communicate and reflect what they have learned. | In all courses:  
A1. Exploring; explore topics and formulate questions  
A2. Investigating; create research plans, locate and select relevant information  
A3. Processing Information; assess, record, analyse and synthesize  
A4. Communicating and Reflecting; communicate, reflect and evaluate research, inquiry and communication skills |

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<tr>
<th>Spatial Technologies to support Social, World Studies and Humanities</th>
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</table>
| **Google Earth**  
Web Based Free intuitive Program that Than be used on both on a variety of platforms including computers and tablets  
Great place to have students of a grades ages and abilities to make initial spatial connections  
Great to start the location conversation as part of Stem inquiries (all inquiries have a where?)  
Use of Aerial photography with Mapping conventions  
easy to grasp some concepts such as Great circle route and scale (zoom) |
| **ArcGIS online**  
Web based Free -- able to obtain subscription series  
Students can create collaborative maps and they can be saved for assessment. Also supports a range of Inquiry at all grade levels.  
A very good platform for students to move from geo –visual to being able to include a range of analysis. They can create very professional maps  
Subscription series allows for saving, collaboration and work from many sites. There is an iPad and android app to work from tables. With subscription use can create story maps using a range of templates |
| **ESRI Story Maps**  
Story maps combine intelligent Web maps with Web applications and templates that incorporate text, multimedia, and interactive functions. Story maps inform, educate, entertain, and inspire people about a wide variety of topics.  
| **ArcGIS- Desktop 10.1**  
Ministry licensed to all schools in Ontario. Comes with a range of data that can be used to create an types of Maps. Full industrial strength program that is used by most GIS professional worldwide. Very good for any type of spatial and locational analysis |
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Technological education focuses on developing students' ability to work creatively and competently with technologies that are central to their lives. The learning outcomes for all students in technological education are:

- to ignite students desire to explore, investigate, and understand technological concepts
- to develop confidence and self direction when working independently or in collaboration with a team
- to develop creative and adaptive behaviour that fosters new thinking skills around innovative and holistic technological practice
- to demonstrate an understanding of environmentally responsible design practices, and apply them in the technological design process
- to use appropriate tools, techniques and strategies to research, design, build, and assess prototypes for products and/or processes that respond to society's changing needs
- to demonstrate competence in technological literacy

- work collaboratively to explore, inquire and solve problems
- develop technological literacy and numeracy skills as they explore, assess, analyse, and/or evaluate
- relate technology to society and the environment through inquiry
- develop skills, strategies and habits of mind required for technological problem solving

- Experiential learning is essential in assisting students with understanding basic concepts, developing inquiry and problem-solving skills and connecting these concepts and skills to the world beyond the classroom

- What are emerging STEM competencies that could lead to a sustainable livelihood?

What do we need to implement STEM in our learning environments?
### Grades 4 - 6

<table>
<thead>
<tr>
<th>Learning Skills</th>
<th>Curriculum Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>As students progress through the various courses integrating concepts from technological studies they develop:</td>
<td>- students will learn, apply and integrate technology skills by integrating with other subject areas—experiential learning opportunities will assist in engaging students in learning and provide relevance and meaning to STEM concepts</td>
</tr>
<tr>
<td>- the use of critical and creative thinking skills and/or processes</td>
<td>- application of knowledge and skills to demonstrate understanding of scientific inquiry, technological problem solving and communication</td>
</tr>
<tr>
<td>- communication skills</td>
<td></td>
</tr>
<tr>
<td>- inquiry/research skills</td>
<td></td>
</tr>
<tr>
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<tr>
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<td></td>
</tr>
</tbody>
</table>

### What do we need to implement STEM in our learning environments?

- to be given opportunities to integrate their cognitive, psychomotor and affective capacities to encourage them to make holistic judgements that lead to making sense of the world
- an approach to learning that emphasizes open-ended learning that encourages creativity
- to be given opportunities to develop life-long learning habits that will help them adapt to technological advances in the changing workplace and world
- to be provided with tools, equipment and materials to promote inquiry and technological problem-solving
- a safe learning environment that allows them to practice the design and engineering

### Grades 7 - 9

<table>
<thead>
<tr>
<th>Learning Skills</th>
<th>Curriculum Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>As students progress through technological education courses they develop:</td>
<td>- gain an understanding of the fundamental concepts underlying technological education;</td>
</tr>
<tr>
<td>- the use of critical and creative thinking skills and/or processes</td>
<td>- develop a creative and flexible approach to problem solving</td>
</tr>
<tr>
<td>- communication skills</td>
<td>- develop critical thinking skills, and the knowledge of strategies required to do research, conduct inquiries, and communicate findings accurately, ethically and effectively</td>
</tr>
<tr>
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<td></td>
</tr>
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- to be provided with tools, equipment and materials to promote inquiry and technological problem-solving
- a safe learning environment that allows them to practice the design and engineering process that enable them to create and construct

Additional Resources
- Ontario Council for Technological Education (OCTE) www.octe.on.ca
- OCTE LAB/Safety Net www.octelab.com
- TDSB Technological Skills Competition https://aw.tdsb.on.ca/sites/tli/experientiallearning/Home.aspx
- Ontario Technological Skills Competition www.skillsontario.com
- Skills Canada National Competition
- Toronto Automobile Dealers Association Competition (TADA) /www.tada.ca
- Robotics: FIRST Robotics Competition (FRC) www.firstroboticscanada.org, FIRST Lego League (FLL), Skills Robotics
- F1 Challenge Competition www.f1inschools.com
- Specialist High Skills Major Programs, multi sector contextualized learning activity (CLA) /www.edu.gov.on.ca/morestudentsuccess/SHSMBinder.pdf
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Students to take an active role in understanding how they can use the competencies of STEM to impact their lives and the lives of others through research, career pathways, advocacy and activism.

Students to embrace opportunities through inquiry and problem based learning to wonder, experiment and innovate in collaborative teams.

Students are critical thinkers where they can access challenge and solve problems through the concepts, tools and skills derived from their learning in STEM.

Students are motivated to gain ownership of their learning and to connect their learning to complex real world problems which allow them to take risks and develop confidence in their ability to enter into learning through multiple perspectives.

Students to question, critique and explore how STEM connects to their identity, their communities and the world around them so that they can see the pathways of STEM as viable options for their lives.

Students to understand the cross-curricular connections of STEM so that they can acquire a deeper understanding of the concepts and skills required in real world situations.

Students see value of asking why instead of what.

Initiative: Inquire through curiosity and play relevant topics of interest in STEM.
Critical Consciousness: Ask questions related to exploration of real life contexts of STEM.
Collaboration: Connect prior knowledge to build new collective understandings.
Application: To access information and technology to communicate new learning.

FDK: Meaningful, integration which generates new connections and expands existing understanding.
Gr. 1 - 3 Science: Assess, investigate, and demonstrate their understanding.
Gr. 1-3 Math Process Exp.: Apply and develop problem solving strategies as they pose, solve and conduct real world investigations.

Provide developmentally appropriate lessons and spaces which incorporate active, multi-sensory learning reflective of student interest and experience.
Create opportunities for student voice, experience, interests and engagement through student directed inquiry and collaboration.
Opportunity for student thinking to be visible through documentation of student work and the knowledge building process.
Encourage multiple perspectives and diverse representations of STEM through community connections, parental engagement and global learning.
Initiative: Work with real life problems that are connected through STEM.
Critical Consciousness: Take risks to question and pose problems that allow for multiple entry points to tasks and learning.
Collaboration: Use varied mediums/partnerships to access information and learning.
Application: Make links to literacies and global awareness.

Gr. 4 - 6 Science/Technology: Assess, investigate, and demonstrate their understanding.
Gr. 4-6 Math Process Exp.: Apply and develop problem solving strategies as they pose, solve and conduct real world investigations.
Gr. 4 - 6 Media Literacy: Reflect on and identify their strengths as media interpreters and creators.

Initiative: Demonstrate capacity for innovation and willingness to take risks.
Critical Consciousness: Pursue multiple perspectives and critical thinking on issues related to STEM.
Collaboration: Collectively resolve conflicts and build consensus for learning goals.
Application: Reflect on and identify ways to share learning.

Gr. 7-9 Science/Technology: Assess, investigate, and demonstrate their understanding.
Gr. 7-9 Math Process Exp.: Apply and develop problem solving strategies as they pose, solve and conduct real world investigations.
Gr. 7 - 9 Media Literacy: Reflect on and identify their strengths as media interpreters and creators.

What do we need to implement STEM in our learning environments?

Real life experiences in cross curricular design that invite connections to community and society focused on STEM.
Encourage student identity as a STEM learner and leader.
Develop student self-efficacy to own their learning though engagement and valuing of the process and outcome of experience.
Learner engages in reflection through self and peer assessment; combined with timely and effective descriptive feedback that moves their learning forward.

Learning tasks and resources are equitable and reflect a range of student experiences, backgrounds, abilities, interests, and learning styles.
Real world problems connect and enhance students’ appreciation of the role of STEM in their lives and impact on their local community and world.
Opportunities to design learning experiences similar to experts in the field of STEM.
Self-reflection, peer assessments and teacher descriptive feedback directly address students' thinking about the problem solving process and their learning goals for next steps.
**Learning Skills**

| Initiative: Use design process to ideate, refine and create. |
| Critical Consciousness: Consider socio-political, ethical, and technical issues inherent in STEM design principles. |
| Collaboration: Varied roles, work toward common goals that express student thinking/voice in face-to-face and electronic media. |
| Application: Inquiry model as part of the design process. |

| Curriculum Connections |
| (Based on Math, Science and Technology Gr. 10-12) |
| Reason, reflect, monitor and communicate thinking as they solve problems. |
| Communicate for a variety of purposes and audiences, make conceptual and procedural connections across subjects. |
| Use student inquiry to make connections between technology, society and the environment. |

**What do we need to implement STEM in our learning environments?**

| Challenge the mainstream representations in STEM and include diverse voices and people that represent the diversity within the content areas. |
| Engage students in their learning through authentic experiences that can question and/or challenge traditional paradigms. |
| Provide opportunities for students who may be traditionally under-represented in STEM careers to investigate career pathways. |
| Integrate numeracy and literacy during student inquiry in STEM. |
| Ensure high expectations for all students to participate and succeed in STEM education and Design Thinking. |

**Additional Resources**

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What are emerging STEM competencies that could lead to a sustainable livelihood?

- Research & Information Fluency
  Using technology to gather, evaluate and use data to plan and conduct research or inquiry.

- Critical Thinking & Problem Solving
  Thinking critically to manage projects, solve problems, and make informed decisions using digital tools and resources.

- Communication & Collaboration
  Working collaboratively, using digital tools and environments to support individual learning and contribute to the learning of others.

- Digital Citizenship
  Understanding human, cultural and societal issues related to technology and practice legal, ethical and safe behavior.

- Creativity & Innovation
  Demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.

Learning Skills

- observe and identify appropriate technologies for a specific purpose
- participate in a digital simulation or game to explore concepts or determine outcomes
- observe modelled communication and collaboration in an online environment
- create original works as a means of personal or group expression
- apply existing knowledge to generate new ideas, processes, or products

Curriculum Connections

- participate in a digital simulation or game to explore concepts or determine outcomes
- locate and organize information from primary and secondary sources
- use online learning to support and extend personal learning
- apply existing knowledge to generate new ideas, products or processes
- identify Creative Commons sharing icons and begin to understand their context.

What do we need to implement STEM in our learning environments?

- Computer or tablet with internet access
- Data projector
- Collaborative learning
- Opportunities to communicate and collaborate using digital tools (i.e. Google Apps for Education, Desire2Learn) - both at home & at school
- Use of SAMR model to self-assess role of technology for tasks
- Copy of TDSB’s ICT Standards Design
### Grades 4 - 6

#### Learning Skills
- Observe and identify appropriate technologies for a specific purpose (Critical Thinking)
- Decide which sources best support an inquiry question (Research)
- Network with others locally and globally through safe and responsible online communication (Digital Citizenship)

#### Curriculum Connections
- Search, read and note take information from a variety of digital sources
- Adhere to a project plan to develop a solution or complete a project
- Participate in a digital simulation or game to explore concepts or determine outcomes
- Use online learning to support and extend personal learning
- Understand and recognize the importance of intellectual and creative property in digital environment.

### Grades 7 - 9

#### Learning Skills
- Participate in a digital simulation or game to explore concepts and/or determine outcomes
- Plan and manage activities to develop a solution or complete a project
- Participate in a digital simulation to explore concepts or determine outcomes
- Recognize and understand the importance of intellectual and creative property in a digital environment
- Participate and collaborate in an online classroom to support and extend learning

#### Curriculum Connections
- Search, read and note take information from a variety of digital sources
- Adhere to a project plan to develop a solution or complete a project
- Participate in a digital simulation to explore concepts or determine outcomes
- Use online learning to support and extend personal learning
- Understand and recognize the importance of intellectual property in digital environment including Creative Commons

### What do we need to implement STEM in our learning environments?

#### Grades 4 - 6
- Internet capable devices
- Collaborative learning
- Inquiry based learning
- Use of SAMR model to self-assess role of technology for tasks
- Copy of TDSB’s ICT Standards

#### Grades 7 - 9
- Computer or tablet with internet access
- Data projector
- Understanding of potential careers related to technology
- Professional Learning support in new technologies and digital tools
- Opportunities to communicate and collaborate using digital tools (i.e. Google Apps for Education) - both at home & at school
- Copy of TDSB’s ICT Standards
### Learning Skills
- Design and organize project duties and timelines and share with a partner
- Collaborate and create in online environments to construct and share knowledge
- Evaluate the validity of online information and share with a partner
- Understand and apply the importance of intellectual property in a digital environment and use digital images, music, and/or video in compliance with copyright law

### Curriculum Connections
- Use a variety of problem-solving strategies to solve different types of problems independently and as part of a team
- Apply standard project management techniques in the context of a student-managed team project
- Analyse ethical issues and propose strategies to encourage ethical practices related to the use of computers

### Additional Resources
- TDSB’s ICT Standards - [www.tdsb.on.ca/ictstandards](http://www.tdsb.on.ca/ictstandards)
- TDSB Computer Studies Program Guide: [https://docs.google.com/a/tdsb.on.ca/file/d/0B8Fi5ZRAh472b1ZvM3VFVUQza1k/edit](https://docs.google.com/a/tdsb.on.ca/file/d/0B8Fi5ZRAh472b1ZvM3VFVUQza1k/edit)
- Scratch - [http://scratch.mit.edu/](http://scratch.mit.edu/)
- California Department of Education - STEM: [http://www.cde.ca.gov/pd/ca/sc/stemintrod.asp](http://www.cde.ca.gov/pd/ca/sc/stemintrod.asp)
- Colorado Department of Education: STEM Sample Curriculum: [http://cde.state.co.us/standardsandinstruction/curriculum/stem](http://cde.state.co.us/standardsandinstruction/curriculum/stem)
- PBS Kids: Design Squad Nation - [http://pbskids.org/designsquad](http://pbskids.org/designsquad)