FACTS

STEAM FACT SHEET
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TORONTO DISTRICT SCHOOL BOARD'S K-12 PROFESSIONAL LEARNING STRATEGY: INCORPORATING THE ARTS INTO STEM

What is STEAM?

The inclusion of the arts into STEM has resulted in the Science, Technology, Engineering, Arts, and Mathematics (STEAM) approach in teaching and learning. STEAM is a transdisciplinary approach that incorporates a wide variety of knowledge and skills from the STEAM disciplines to problem-solve (Yakman, 2008; Winterman & Malacinski, 2015). One of the main goals of STEAM is to prepare students to solve authentic problems "through innovation, creativity, critical thinking, effective communication, collaboration, and ultimately new knowledge" (Quigley & Herro, 2016, p. 1).

Why move from a STEM to a STEAM approach?

STEM education in Kindergarten to Grade 12 (K-12) education has risen as a response in many educational circles to bolster educational performance and innovative capacity, create a skilled workforce and foster economic prosperity (Bertram, 2014). However, approaching teaching and learning using perspectives from only STEM can result in a narrow approach to problem-solving (Catterall, 2013). Current calls have been made for more inclusive and balanced ways of teaching that include the perspectives and skill sets from a wide variety of disciplines such as the arts, design, and humanities (Brady, 2014; Connor et al., 2015). It should be noted that the arts disciplines in the STEAM approach include the physical arts (e.g., performance and music), visual arts (e.g., painting), and language and liberal arts (e.g., Sociology, Education, Philosophy) (Yakman, 2008).

What are the benefits of the ARTS for students?

Studies have shown that students, especially from low socio-economic groups, who participated in the arts programs, achieved higher GPAs and graduation rates than those who did not participate (Catterall et al., 2012). Other benefits of engaging in the performing and visual arts for students include improved academic achievement (e.g., increased reading comprehension, mathematics skills, and thinking skills), improved social skills, increased motivation for learning, student engagement, and a positive school environment (Deasy, 2002).

What are the benefits of including the ARTS in STEM?

Miller (2016) points out that STEAM promotes divergent and convergent thinking needed for innovation and provides students who are disengaged with STEM due to prior feelings of failure or a fear of STEM, a way to reengage with STEM. The ARTS also enhances learning of STEM content.

- Proponents of the physical and visual arts argue that "artistic expression and principles could assist learners in structuring and organizing ideas, exploring disciplinary and cross-disciplinary connections, and solving scientific problems" (Catterall, 2013, p. 2).
- Recent studies suggest that integrating arts-based teaching into STEM areas results in increased motivation, engagement, and learning of STEM content (Henriksen, 2014).
- Studies show that learning music enhances visual spatial reasoning skills which are applied in STEM (Catterall & Rauscher, 2008).
- Training in the arts (e.g., performance, music) has the potential to enhance long term retention of content (Rinne et al., 2011).
- Integrating language and liberal arts into science resulted in improved achievement in mathematics and science (Miller & Knezek, 2013).

What are effective instructional and learning strategies for STEAM implementation?

- Discipline Integration (transdisciplinary) – uses the viewpoints, perspectives, and solutions from many disciplines to pose and solve problems (Quigley & Herro, 2016).
- Problem-based Learning – uses or designs open-ended scenarios and real-world problems situated in local contexts (Miller & Knezek, 2013; Kim & Song, 2013).
- Technology Integration – lets students use media/technology to solve problems (Miller & Knezek, 2013; Quigley & Herro, 2016).
- Student Choice – provides multiple opportunities for students to choose topic of study, methods of inquiry, type of product, technology, teams, and ways to communicate knowledge (Quigley & Herro, 2016).
- Embedded Formative Assessments – embed formative assessments such as checklists, peer and self-evaluations (Quigley & Herro, 2016).

How to implement STEAM programs in schools?

In light of the disciplinary focus in the majority of K-12 schools, Fredette (2013) provides guidelines for program implementation based on successful STEAM schools.

- Collaboration must take place between teachers from different discipline areas such as music, science, and visual arts. For example, a science, music, and visual arts teacher brainstormed how to teach stages of the growth of a plant from seed to fruit. In music, students created music compositions using digital technology and described how each structural change in the composition was similar to a new stage in the plant life cycle. In art, students used the technique of zooming in to depict the lifecycle.

Create STEAM teams at all levels: community, school (teachers), and classroom (students).

- Collaboration with community organizations to expose students to a range of potential future occupations beyond the norm of doctor, lawyer, and teacher. Innovative occupations such as designing a city with guidance from the city planning department or having the fire department inform about the physical, psychological, ethical, and scientific aspects of a firefighter's job for example.
- Collaboration among students to work in teams.
- Stressing the importance of trying and failing and modeling this to students.

What are some challenges to STEAM implementation?

- Using a transdisciplinary problem solving approach as opposed to a focus on disciplinary content.
- Teachers do not have the expertise in the arts to implement beyond the basic stages of digital/design arts. Teachers will require support from art experts on how to make connections between their content area and the different art forms.
- Difficulty supporting productive collaboration among students (Quigley & Herro, 2016).

Next Steps

This fact sheet has been written to inform policy decisions in regards to the TDSB's *Improving School Effectiveness and Student Achievement & Well Being through Learning Centres Strategy*. Educators and leadership teams will be asked about their view on the topic through surveys and interviews and the results will be released as part of upcoming STEM reporting in the 2016-17 school year.

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