

# **McMaster Faculty of Engineering Experiential Learning Asset Map:**

## **A guide to the McMaster Engineering Experiential Learning Ecosystem**

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## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

The following is a description of the McMaster Engineering Experiential Learning Ecosystem. Through collaborations among faculty members, staff and students, students have the opportunity to choose from a very broad range of options which enables them to expand and enhance their engineering education and develop the comprehensive “tool kit” necessary for the global engineer in 2025. The McMaster Engineering Experiential Learning Ecosystem enables and encourages students to:

- Take ownership of their learning and learning objectives: students can identify topics they want to explore and skills they want to develop, and identify a personal “learning plan” to achieve these objectives. This “learning plan” may include a combination of learning which takes place both inside and outside of the classroom
- Participate in a range of activities which break down the siloes between engineering disciplines, and which cross disciplinary boundaries to expose students to diverse intellectual approaches and traditions
- Engage in learning activities with a wide range of people and groups, developing empathy and appreciation for diversity including diversity of gender, age, culture, ethnicity, as well as diversity of thought and opinion.
- Participate in different activities as learning goals change and develop: students’ learning and skill development goals change over time; having a broad range of activities to choose from enables students to align activities with changing learning goals
- Seek experiences which suit the individual: for example, both introverts and extroverts will find congenial ways to participate, and ways to succeed.

The McMaster Engineering Experiential Learning Ecosystem focus is on real problems in the real world. This focus

- Integrates learning inside and outside of the classroom: a rigorous, high-quality engineering education that builds deep technical competencies is allied with experiences which teach students about the realities of working in the professional world, and help them to develop the skills necessary to succeed and thrive in a wide range of occupational sectors or as entrepreneurs
- Encourages participation from a wide range of partners: industry, alumni, business, community, entrepreneurs...both local and from around the globe
- Demands that students develop empathy, user-centred thinking, an appreciation of the value of diversity, and a socio-technological consciousness
- Demands that students develop real skills in team work and leadership, based on a foundation of self-awareness and reflection: this makes them capable to lead with sensitivity in a globalized world
- Supports students to develop resiliency, grit, curiosity and creativity to
  - Fail and rebound constructively from failure
  - Persist in the face of significant challenge
  - Continuously learn and grow, personally and professionally
  - Be fearless and creative in the face of rapid social and technical change.

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

Activity	Description	Number of Student participants	Learning Outcomes/ Impact on learning	Industry Involvement?
<b>Co-op / Internship</b>	The Engineering Co-op program is an optional program for students in Engineering and Computer Science programs; it is a mandatory program for students in the Bachelor of Technology program. Students are required to complete 12 months of work experience that is assessed as offering sufficient opportunity for professional and skill development to qualify as a Co-op work term. Junior students are eligible for 4-month work terms; more senior students can engage in work terms of 8, 12 or 16 months.	1368 (2015-2016 academic year). Includes BEng, Computer Science, and BTech students	<ul style="list-style-type: none"> <li>• Learn about, and learn to work to, industry standards and expectations for work and for behaviour</li> <li>• Self-awareness: strengths, learning style, personal team and leadership style, introversion/extroversion, resiliency, ability to cope with stress, frustration and pressure</li> <li>• Relationship development and management</li> <li>• Dealing effectively with diversity: gender, age, cultural, ethnic, thought and opinion</li> <li>• Personal effectiveness skills and self-discipline</li> <li>• Development of professional <i>persona</i></li> <li>• Communication skills on wide range of topics for varied audiences using a range of media</li> <li>• Integration and synthesis of engineering concepts</li> <li>• Integration of engineering concepts with business, human relations, society</li> </ul>	Students engage in work term opportunities offered by hundreds (approximately 700) of different employers in a very wide range of industry and businesses, in Canada and around the world
<b>Undergraduate Summer Research Program</b>	Every summer, undergraduate students are hired as research assistants, working with grad students, post docs and faculty members in research labs. Students come from McMaster Engineering, from other Canadian universities, and from universities around the world. Undergraduate summer research students participate in weekly activities: research seminars, social events, and professional development workshops. The program concludes with a poster symposium and ice cream social.	154 (summer 2016)	<ul style="list-style-type: none"> <li>• As above: all learning outcomes infused with special character of work in a research lab, and being in daily contact with high-level subject matter experts i.e., professors, post docs, PhD students</li> </ul>	Many research projects involve industrial partners: students gain exposure to industrial research problems and gain experience in industry-academic relationship development

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

<p><b>Undergraduate Entrepreneurship Co-op program</b></p>	<p>Students will gain Co-op credit for either working on a startup or developing their own startup. In addition to developing the startup company, students will participate in a mandatory weekly seminar / instructional series.</p>	<p>3 (pilot summer 2016); goal 30 for summer 2017</p>	<p>As above, with additional learning outcomes:</p> <ul style="list-style-type: none"> <li>• Understanding the iterative product / process development cycle</li> <li>• Learning to fail quickly and constructively, and to pivot based on lessons learned</li> <li>• Developing sound understanding of user requirements and user values</li> <li>• Developing the ability to integrate business acumen at every stage of startup evolution</li> <li>• Understanding of the entrepreneurial ecosystem, and supports, resources, personal attributes required for success</li> <li>• Developing resiliency, ability to cope with stress, frustration and pressure, learning from failure</li> </ul>	<p>Students either work for a startup company, or work on their own startup company. Industry / business / community partners participate as mentors</p>
<p><b>Student clubs, teams, societies</b></p>	<p>Active McMaster Engineering clubs, teams and societies includes:</p> <p><b>1. Groups:</b>                  McMaster Engineering Society                  National Society for Black Engineers                  EngiQueers                  Women in Engineering                  Engineering Musical                  Engineers Without Borders                  FIRST Robotics Mentoring Initiative                  Energy Club                  Arduino Club                  McMaster Engineering Custom Vehicle Team (MecVT)                  Chem-E-Car</p> <p><b>2. Department- or program-based societies:</b> 14 societies (includes First Year Society, Engineering and Management society, etc.)</p>	<p>500-600 undergraduate students</p>	<ul style="list-style-type: none"> <li>• Self-awareness: self as team member (strengths, weaknesses); self as team leader (strengths, weaknesses)</li> <li>• Emotional intelligence: understand self and understand others: understand why/how self and others work together (or don't); understand how self contributes to effective / dysfunctional teams work and leadership and how to improve</li> <li>• Communication skills: ability to tailor communication style and medium for specific audience; ability to take instruction and give instruction; ability to communicate with diverse groups</li> <li>• Ability to embrace diversity: gender, age, cultural, ethnic, thought and opinion</li> <li>• Integration and synthesis of engineering concepts</li> <li>• Self-directed learning</li> <li>• Ability to think and act as entrepreneurs: understanding that each club, team, society operates as a small business: integration of technical concepts with business acumen</li> </ul>	<p>There is considerable industry involvement with clubs and teams: most clubs have industry sponsors, most clubs run industry / career events, many clubs have industry partners who work directly with the student clubs and teams and provide training and other supports</p>

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

	<p><b>3. Teams</b> (regularly participate in team-based competitions)</p> <p>Baja Racing Team Concrete Toboggan Solar Car PhaseOne (formerly HackitMac) EcoCar3 Formula Electric</p>			
<b>MacChangers</b>	<p>MacChangers is an extracurricular activity that provides resources, coaching and support to interdisciplinary teams of students as they work together to create innovative and realistic changes that will contribute to positive change both locally and globally. Students build professional skills in research, teamwork, project management and communication while tackling one of the National Academy of Engineering's Grand Challenges- the most complex and pressing problems confronting society.</p>	<p>25 students from Engineering and other Faculties</p>	<ul style="list-style-type: none"> <li>• Skills in team building and leadership</li> <li>• Self-directed learning: students are required to take ownership of team activities and projects and be accountable for meeting deadlines and deliverables</li> <li>• Skills in problem identification and problem solving</li> <li>• Skills in a range of research techniques</li> <li>• Communication skills: able to communicate effectively across disciplinary boundaries and with a range of subject matter experts; ability to develop and deliver high-quality presentation on project</li> <li>• Comfort in an interdisciplinary environment: exposure to a range of intellectual approaches: concepts, vocabulary, world views</li> <li>• Achieve results in an environment characterized by diversity</li> </ul>	<p>Students connect with subject matter experts both inside and outside of the university; industry and community partners</p>
<b>Community-engaged student projects</b>	<p>Students participate in extracurricular activities in the community; activities include:</p> <ul style="list-style-type: none"> <li>○ teaching elementary and secondary school students about STEM</li> <li>○ working on technology-related projects for community groups e.g., building a weather station for a neighbourhood association</li> </ul>	<p>Approximately 150 students</p>	<ul style="list-style-type: none"> <li>• Teamwork and leadership skills</li> <li>• Communication skills: ability to tailor communication style and medium for specific audience; ability to take instruction and give instruction; ability to communicate with diverse groups – particularly to groups with little technical knowledge</li> <li>• Skills in developing empathy, and an understanding of human values and needs in a particular context</li> <li>• Understanding the need for, and how to, develop “appropriate technological solutions” in a particular context</li> </ul>	<p>Projects are typically undertaken in partnership with a community partner e.g., a non-profit agency, school or community group</p>

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

<p><b>Design competitions</b></p>	<ul style="list-style-type: none"> <li>• McMaster Engineering Competition</li> <li>• Hackathons, including DeltaHacks</li> <li>• Troitsky Bridge-building competition</li> <li>• Mechanical Contractors' Association Competition</li> <li>• Team races / competition events:             <ul style="list-style-type: none"> <li>○ EcoCar3</li> <li>○ Formula Electric</li> <li>○ Baja Racing Team</li> <li>○ Solar Car</li> <li>○ Concrete Toboggan</li> <li>○ Earthquake Engineering Seismic Design</li> </ul> </li> </ul>	<p>Approximately 450 students</p>	<ul style="list-style-type: none"> <li>• Team work and leadership skills</li> <li>• Communication: to work effectively with team members in highly stressful circumstances; the ability to quickly develop and deliver persuasive and compelling presentations</li> <li>• Resiliency; ability to work collaboratively and achieve results under pressure; learn to fail quickly and pivot; accept constructive criticism</li> <li>• Learn industry standards and apply them</li> <li>• Integration and synthesis of engineering concepts</li> <li>• Integration of engineering concepts with business acumen and analysis: thinking as technical entrepreneurs in solution development</li> </ul>	<p>There is significant industry participation: industry reps act as judges and competition sponsors; many competitions also host career fairs which attract employers seeking to hire engineering students</p>
<p><b>Case competitions</b></p>	<ul style="list-style-type: none"> <li>• Engineering and Commerce Case Competition</li> <li>• MARS Apprentice</li> <li>• Hack the City</li> </ul>	<p>Approximately 150 students</p>	<ul style="list-style-type: none"> <li>• Team work and leadership skills</li> <li>• Communication skills: to work effectively with team members in highly stressful circumstances; the ability to quickly develop and deliver persuasive and compelling presentations</li> <li>• Resiliency; ability to work collaboratively and achieve results under pressure; learn to fail quickly and pivot; accept constructive criticism</li> <li>• Learn industry standards and apply them</li> <li>• Integration and synthesis of engineering concepts</li> <li>• Integration of engineering concepts with business acumen and analysis: adding an entrepreneurial dimension to solution</li> </ul>	<p>Industry and business representatives provide cases, act as judges, and mentor students</p>

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

<b>Hackathons</b>	DeltaHacks (Hacking for Change) is the annual hackathon organized by PhaseOne, a McMaster Engineering club. Hundreds of students spend a weekend of non-stop hacking to create innovative solutions to challenges in technology, health care, society.	Approximately 400+ (students from McMaster and other institutions)	<ul style="list-style-type: none"> <li>As above, plus grit and endurance to succeed in challenging physical circumstances.</li> <li>Integration of engineering concepts with business acumen and analysis as well as consideration of positive social change: adding a socio-technological-entrepreneurial dimension to solution</li> </ul>	Industry, business and community partners submit challenges / problems for student teams
<b>Student ambassador initiatives</b>	Engineering students are actively engaged as student ambassadors. They interact with prospective students and their families, teachers and guidance counsellors; they run tours; they create and deliver interactive workshops for elementary and secondary school students, and run summer STEM camps, some of which are designed and delivered for young women and girls and Indigenous youth.	Approximately 200 student ambassadors	<ul style="list-style-type: none"> <li>Communication skills: ability to adapt message and tone to suit needs of different audiences</li> <li>As mentor: listening skills, empathy, communication, problem solving, coaching and teaching</li> <li>Team work and leadership skills</li> <li>Relationship skills</li> <li>As a mentee: communication, listening, self-awareness, change management</li> </ul>	
<b>Innovation and Society Innovation Challenges</b>	<b>Innovation and Society Living Learning Community</b> A living-learning community (LLC) is a residence-based environment. Participants in the Innovation and Society LLC have access to programming geared towards engineers while living in a community that fosters interdisciplinary relationships. Programming opportunities specific to engineers include engineering-focused field trips, academic skills support, faculty visits in residence, career planning groups and a formalized mentorship program. Students participate in a series of Innovation Challenges with prizes for the best innovation solution as well as the best reflection.	190 Engineering students	<ul style="list-style-type: none"> <li>Comfort in an interdisciplinary environment: exposure to a range of intellectual approaches: concepts, vocabulary, world views</li> <li>Achieve results in an environment characterized by diversity</li> <li>Team work and leadership skills</li> <li>Self-awareness: strengths, learning style, personal team and leadership style, introversion/extroversion, resiliency, ability to cope with stress, frustration and pressure</li> <li>Relationship development and management</li> <li>Problem identification and solution; critical thinking</li> </ul>	Guest speakers from Hatch, Ontario Power Generation, City of Hamilton; Innovation challenges designed, delivered and judged by industry partners, ranging from startup companies to large multinationals e.g., General Motors

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

<b>Undergraduate TAs / Instructional Interns</b>	<p>A substantial number of courses are supported by undergraduate TAs who receive considerable training. Engineering 1 courses are supported by a number of full-time Instructional Interns (Engineering Co-op students) who develop instructional activities, deliver labs, mentor students, grade assignments</p>	<p>Student numbers to be determined</p>	<ul style="list-style-type: none"> <li>• Communication skills: ability to adapt message and tone to suit needs of different audiences, and listeners with varying degrees of comprehension</li> <li>• Creativity to develop new and effective instructional activity, and to provide course content and examples that illuminate and illustrate engineering principles and concepts</li> <li>• As mentor: listening skills, empathy, communication, problem solving, coaching and teaching</li> <li>• Team work and leadership skills</li> <li>• Relationship skills: how to develop positive relationships while being in a position of authority / influence</li> </ul>	<p>Courses may have industry involvement.</p>
<b>Project-based courses</b>	<p>There are numerous project-based courses in each Engineering department. Many of these projects are focused on industry problems.</p>	<p>Student numbers to be determined</p>	<ul style="list-style-type: none"> <li>• Team work and leadership skills</li> <li>• Integration and synthesis of engineering concepts</li> <li>• Skills in problem identification and problem solving</li> </ul>	<p>Varied: many projects are focused on industry-based projects; many may be early-stage student startups</p>
<b>Final-year capstone projects</b>	<p>All Engineering students must participate in a final capstone project course. Capstone projects are required to be team-based, and focused on an open-ended complex problem.</p>	<p>All final year students – this year, approximately 700 students</p>	<ul style="list-style-type: none"> <li>• Team work and leadership skills</li> <li>• Communication: to work effectively with team members in high-stakes circumstances; the ability to develop and deliver presentations which meet industry standards</li> <li>• Resiliency; ability to work collaboratively and achieve results under pressure</li> <li>• Skills in problem identification and problem solving</li> <li>• Learn industry standards and apply them</li> <li>• Integration and synthesis of engineering concepts</li> <li>• Integration of engineering concepts with business acumen and analysis, adding an entrepreneurial dimension to solution</li> </ul>	<p>Varied: many projects are focused on industry-based projects; many may be early-stage student startups</p>



## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

<b>Exchange programs</b>	The Faculty of Engineering has entered into a number of exchange agreements with other institutions from around the world. The majority of these are academic exchanges.	Student numbers to be determined	<ul style="list-style-type: none"> <li>• Self-awareness: strengths, learning style, personal team and leadership style, introversion/extroversion, resiliency, ability to cope with stress, frustration and pressure</li> <li>• Comfort in a culturally- and perhaps linguistically-unfamiliar environment: exposure to a range of intellectual approaches; concepts, vocabulary, world views</li> <li>• Dealing effectively with diversity: gender, age, cultural, ethnic, thought and opinion</li> <li>• Personal effectiveness skills and self-discipline; self-reliance</li> </ul>	
<b>ENG 4EX3</b>	A new technical elective course, to be first offered in September 2017. Students will be given academic credit for participation in extracurricular activities which pass rigorous standards for technical content	Student numbers to be determined	<ul style="list-style-type: none"> <li>• Learn industry standards and apply them</li> <li>• Integration and synthesis of engineering concepts</li> <li>• Skills in problem identification and problem solving</li> <li>• Skills in execution and meeting high standards for deliverables</li> </ul>	Depending on the nature of the student's work, there may be industry involvement
<b>SELECT (Student Engagement, Leadership Education, Career Training)</b>	<p>A program intended to help engineering students to:</p> <ul style="list-style-type: none"> <li>• Understand the specialized nature of leadership in the context of the profession of engineering</li> <li>• Create awareness of the skills necessary for personal and professional effectiveness and help students to develop these skills while in school, providing a head start on career development</li> <li>• Develop a leadership toolkit that can support success in the classroom, in student leadership roles, and in professional careers</li> </ul> <p>Students work through engineering leadership development exercises and problems, coached by engineering alumni, industry partners, and others who work with engineers.</p>	During 2015-2016 academic year, approximately 100 students participated	<ul style="list-style-type: none"> <li>• Leadership skills</li> <li>• Self-awareness: personal effectiveness skills to lead self and others</li> <li>• Integration of different ways of thinking about engineering concepts and engineering practice</li> <li>• Deepen understanding of engineering ethics and integrity</li> </ul>	Each SELECT session includes an industry panel – 50-60 industry partners regularly participate as panelists and coaches

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

<p><b>Professional Development program for clubs, teams, societies</b></p>	<p>Students, particularly club and team executives, participate in training and receive coaching. Training topics include: team development, leadership, recruiting, external relations, knowledge transfer and succession planning.</p>	<p>Approximately 200 student participants over the course of the academic year</p>	<ul style="list-style-type: none"> <li>• Learn about, and learn to work to, industry standards and expectations for professionalism; understand how to apply them in a student team context</li> <li>• Self-awareness: strengths, learning style, personal team and leadership style, introversion/extroversion, resiliency, ability to cope with stress, frustration and pressure</li> <li>• Develop skills in managing self and managing others</li> <li>• Team building and leadership skills</li> <li>• Understanding of, and development of, processes and protocols for recruiting new members, managing external relations, succession planning and knowledge transfer</li> <li>• Understanding business management and entrepreneurial thinking</li> </ul>	<p>Some industry participation in leadership skills development</p>
<p><b>Hatch Centre</b></p>	<p>Expected to open during 2017, The Gerald Hatch Center for Engineering Experiential Learning will be a multi-storey facility located adjacent to the John Hodgins Engineering Building. The centre will serve as a common meeting ground for Engineering students from all disciplines. It will provide a home for student clubs and societies, collaborative workspaces, display and demonstration spaces, areas for students to meet, relax and work together, as well as selected student services. Intended to enhance the student learning experience in the Faculty of Engineering, the proposed Hatch Centre building will provide a venue for hands-on learning as well as serving as a living laboratory for sustainable building technologies.</p>	<p>All Engineering students are expected to use the Centre: approximately 5000 undergraduates</p>	<ul style="list-style-type: none"> <li>• Team building and leadership skills</li> <li>• Development of hands-on technical skills through training in the safe operation of hand tools, power tools and other equipment; learn about how to match procedure and equipment with desired outcome</li> <li>• Communication skills: ability to communicate with diverse groups</li> <li>• Ability to embrace diversity: gender, age, cultural, ethnic, thought and opinion</li> <li>• Integration and synthesis of engineering concepts</li> <li>• Self-directed learning</li> <li>• Facilities management, including policy development for user groups</li> </ul>	<p>We anticipate that industry partners and potential employers will expand their involvement with our students: the Hatch Centre offers a central space for industry to maximize and optimize their relationships with students through sponsorship, training, professional and skills development initiatives.</p>

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

<p><b>Makerspace – Thode Library</b></p>	<p>Soon to be opened: the makerspace will include equipment to support design / prototyping activities for student projects</p>	<p>Open to students across the University</p>	<ul style="list-style-type: none"> <li>• Development of hands-on technical skills through training in the safe operation of hand tools, power tools and other equipment; learn about how to match procedure and equipment with desired outcome</li> <li>• Ability to embrace diversity: gender, age, cultural, ethnic, thought and opinion</li> <li>• Communication skills: able to communicate effectively across disciplinary boundaries</li> <li>• Self-directed learning</li> <li>• Ability to think and act broadly as entrepreneurs: cross-disciplinary exposure integrates technical concepts, business acumen and societal context in product and process development</li> </ul>	<p>Students may be working on industry-based projects; they may also be developing products for their own startups</p>
<p><b>Co-curricular record</b></p>	<p>In development for students in the Faculty of Engineering: to be implemented during 2017-2018 academic year</p>	<p>Anticipate approximately 20% of Engineering students at full implementation</p>	<ul style="list-style-type: none"> <li>• Understanding of how a range of activities contributes to the development of a comprehensive engineering tool kit</li> <li>• Development and ownership of personal learning and learning objectives</li> <li>• Participation promotes student engagement and life-long learning</li> <li>• Student-identified enhancements to engineering education</li> </ul>	<p>Activities included in the co-curricular record may have their source in industry / business / community environment</p>

## McMaster Faculty of Engineering Experiential Learning Asset Map: A guide to the McMaster Engineering Experiential Learning Ecosystem

<p><b>Student peer-to-peer learning</b></p>	<ul style="list-style-type: none"> <li>• MES Tutoring program – students tutor other students. Students are approved to be tutors by the office of the Associate Dean, Academic</li> <li>• Club-led tutorials / seminars: student club members create and deliver tutorials / challenges / seminars on issues of interest to club/team activities. These are typically focused on technical topics. Clubs which do this regularly include:             <ul style="list-style-type: none"> <li>○ EcoCar3 team</li> <li>○ Formula Electric team</li> <li>○ PhaseOne</li> <li>○ Arduino club</li> <li>○ Water Network Student Chapter</li> <li>○ Heavy Construction Internship Student Chapter</li> <li>○ Solar Car team</li> <li>○ IEEE Student Branch</li> <li>○ ACM Student Branch</li> <li>○ Women in Science and Engineering (WiSE)</li> <li>○ Engineers Without Borders</li> <li>○ Engineering Graduate Society (grad student society delivers a peer-led professional skills training program)</li> <li>○ McMaster Design League</li> </ul> </li> </ul>	<p>Approximately 400 students</p>	<ul style="list-style-type: none"> <li>• Development and ownership of personal learning and learning objectives</li> <li>• Participation promotes student engagement and life-long learning</li> <li>• Student-identified enhancements to engineering education</li> <li>• Team and leadership skills</li> <li>• Seeking meaningful feedback from others</li> <li>• Communication skills, and the ability to engage in knowledge transfer</li> <li>• Project / logistics management</li> <li>• Integration and synthesis of engineering technical concepts to identify and solve problems</li> <li>• Problem identification and problem solving</li> </ul>	<p>Industry involvement will vary: some club-led sessions will include industry reps who work with students to help to develop training; students and industry partners will also co-develop and co-deliver programming</p>
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