“...PLACING ‘DISCOVERY’ AT THE CENTRE OF THE UNDERGRADUATE LEARNING EXPERIENCE AND VIEWING STUDENTS’ ENGAGEMENT IN RESEARCH AS A POTENTIALLY DISTINGUISHING FEATURE OF THE UNDERGRADUATE EXPERIENCE”
–Undergraduate Research & Inquiry Working Group, 2015

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1. Background
As part of developing future research directions, and building on *Forward with Integrity*, the MacPherson Institute for Learning, Innovation & Excellence in Teaching identified six research focus areas:

1. Student engagement, retention, and success;
2. Undergraduate research and inquiry;
3. Technology-enhanced learning;
4. Community-engaged education and global learning;
5. Interdisciplinary teaching and learning; and

Working groups for each topic were formed through an open call to staff, students, and faculty across the university community. The aim of each working group was to explore the topic and make recommendations to the MacPherson Institute on key research priorities. The purpose of this report is to summarize the work and recommendations of the Undergraduate Research and Inquiry (URI) working group.

The URI group met regularly between December 2014 and May 2015. The group consisted of approximately 10 members representing undergraduate and graduate students, faculty, and staff, and was supported by two research assistants. The sub-groups worked fairly autonomously throughout the process, with support from co-chairs and assisted by research assistants. The contributions of each sub-group (3) formed the basis of the final report, along with the valuable feedback of all three external reviewers. In addition, the URI group benefited immensely from the opportunity (February 2015) to discuss our progress and directions and receive feedback from Mick Healey, Higher Educational Researchers and Consultant from the United Kingdom.

2. Introduction
McMaster University has long been recognized as one of Canada’s top research-intensive universities. Graduate programs are well-respected and well-funded, providing a rich academic training environment. At the undergraduate level, McMaster is recognized globally as a leader in the field of inquiry-based learning and research.

Inquiry-based learning has been integrated at all levels of undergraduate education (as a component of a course, the focus of an entire course, and the basis of an entire undergraduate programs) (Justice et al., 2009). Undergraduate research is an equally important component of the undergraduate experience at McMaster University.

As with inquiry, undergraduate research opportunities take many forms, such as self-directed research projects, research courses and practicums as well as opportunities to become members of existing research teams. In fact, according to the annual Maclean’s Canadian University Report, in 2013, our students ranked McMaster University highest overall for student satisfaction in undergraduate research opportunities (MacLean’s University Report, 2012).

Despite recognition as leaders in both undergraduate research and inquiry-based learning, it is unclear how McMaster defines URI and how access to URI opportunities are made available to undergraduate students are across the university. Early in our work, the recognition emerged that a more comprehensive view of existing URI practices at McMaster was necessary to understand what URI means, where URI is happening and to learn where URI can grow and develop to better meet the needs of all undergraduate students. In order to explore this further, the following overarching questions guided the development of this report:

Q: What does URI mean?
Q: Why is URI important?
Q: What are best practices for engaging in URI?
Q: How does McMaster University engage in URI?
3. Literature Review

3.1 What does URI mean?

Following a comprehensive literature review, it became clear that there is no clear, single definition for URI that encompasses what is occurring at postsecondary institutions around the globe. It was also noted that the terms ‘research’ and ‘inquiry’ were often used interchangeably in the literature. However, the most quoted definition of undergraduate research defines it as “an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline” (Council on Undergraduate Research, 2011). Although summative, this definition lacks depth with respect to the diversity of undergraduate research and inquiry approaches found in the literature and appears to restrict it to the discovery research end of the spectrum.

Levy (2009) makes a critical distinction between students’ researching into new knowledge for society (discovery research) or new knowledge for themselves (information research). Some might restrict the term ‘research’ to the former and describe the latter as ‘inquiry’, though there is considerable overlap in how the two terms are described in the literature. Similar sentiments expressed by The Boyer Commission (1998) argue that “The basic idea of learning as inquiry is the same as the idea of research; even though advanced research occurs at advanced levels, undergraduates beginning in the freshman year can learn through research” (p. 17).

The breadth of this spectrum emphasized by Beckman and Hensel (2009) in an approach that maps different dimensions of inquiry and research, illustrates the various tensions that arise in how URI is applied, facilitated, and recognized by students, faculty, and institutions. For instance, some view URI as a student initiated venture, while others view it as a faculty or program driven initiative. Some institutions provide opportunities for all students to participate in some form of URI, while others restrict it to the best and brightest (i.e. honours students and students pursuing a thesis in their final year) in undergraduate degree programs. In some arenas, URI is targeted towards the campus or community audience, while others see URI as successful if formally presented in a professional forum to disciplinary peers (e.g., conference or publication) (Beckman & Hensel, 2009). Even across institutions and within disciplines, there appears immense variability in what is considered URI (Aditomo, Goodyear, Bliuc, & Ellis, 2013).

Ultimately, the literature shows there is no “one size fits all” definition, but rather a need for institutions to develop an inclusive approach that values the range of practices that best fits the campus culture, institutional mission/mandate, and the overall value they place upon URI (Beckman & Hensel, 2009; Elrod et al., 2010). For the purposes of this report, URI includes all aspects of both traditional research and inquiry.

3.2 Why is URI important?

In recent years, URI has received increased attention in the literature and in academic settings. URI has also been incorporated into mission statements and reviews of quality within academic institutions (e.g. Undergraduate Degree Level Expectations). The reasons for this are varied and have been described below at the student and faculty levels.

For students, URI adds a pivotal aspect of engagement to their learning. Students learn the skill of asking research questions, not in a disciplinary vacuum, but within the context of “triggers” (i.e. course themes) (Cuneo, Harnish, Roy & Vajoczki, 2012). Students engaging in undergraduate research report a greater enhancement of cognitive and personal skills and in general higher satisfaction with their undergraduate education (Bauer & Bennett, 2003). Zimbardi and Myatt (2014) support that teaching models of URI where students participate in supervised research were “associated with higher levels of student engagement, increased academic success, and a wider range of student benefits” (p. 233) Other research has similarly shown that lessons learned through research and inquiry, in particular, where students experience how to effectively contribute, share, produce, and disseminate knowledge and information are vital for them to thrive in today’s modern digital world (Ozay, 2012). Wilson et al. (2012) also reports that students participating in undergraduate research are exposed to a “culture” of research that
subsequently results in opportunities to develop skills such as report writing, literature review, working independently and to “think like a researcher” (p. 524).

Likewise, faculty members at research-intensive institutions see several benefits of senior-level undergraduate research projects (Wilson et al., 2012). In particular, Wilson et al., (2012) found that science faculties see URI as an opportunity to prime students for graduate work, while evaluating the suitability of a student for research, (p. 516) through early research exposure and alternative, advanced learning outside of coursework. When well executed, URI enhances both student educational needs, and the faculty research agenda, thereby establishing a partnership of learning (Brew, 2003). In a broader context, URI is seen as developing an avenue for recruiting graduate and post-graduate students who possess the necessary skills to make meaningful research contributions both at McMaster University and beyond.

### 3.3 What are best practices for engaging in URI?

Despite the varied definitions of URI within the literature, there is a plethora of research on best practices for implementing URI. At the level of the institution, research has shown that it is imperative to provide their unique definition and vision of what is meant by inquiry-guided research (Jenkins & Healey, 2012).

Research has also shown that students are more likely to engage in URI if they: perceive value in the experience, develop employable skills, feel a sense of ownership of their work, and/or are part of a program/department culture or expectation of research (Wayment & Dickson, 2008). Craney et al., (2011) argue that URI supports strong relationships between the student and their supervisor that provides particular opportunities for students to disseminate the results of their research (e.g., through a poster, publication, presentation, etc.). Yet, while extracurricular research opportunities (e.g., co-op placements, funded summer research projects, etc.) foster learning, it appears that such opportunities are competitive and favour students with strong GPAs and prior research experience.

To alleviate this situation, Healey and Jenkins (2009) urge that educational institutions develop ways in which URI can be integrated into the curriculum, starting as early as first year, to make it accessible to a greater number of students. For example, McMaster University has made strong progress in this area (e.g., first-year inquiry classes in many different programs), but there is a need for a more comprehensive view of existing undergraduate research practices to understand what strengths exists and to learn where URI can grow and develop to better meet the needs of all student needs.

Elrod et al. (2010) provides a pragmatic listing of criteria for garnering successful student research opportunities: 1) Challenge students to confront novel ideas; 2) Engage students in the collection and analysis of original data; 3) Emphasize opportunities for applying research to real contexts or solving real problems; 4) Increase the time students dedicate to the project; 5) Maximize opportunities for students and faculty to interact and engage in substantive matters; 6) Be relevant and interesting to students, and influenced by their ideas to maximize engagement and learning; 7) Provide opportunities for students to receive frequent and meaningful feedback about their work; 8) Increase students ownership of the project over time; 9) Provide an occasion for students to present their work in oral and written formats; and, 10) Allow students to work in teams.

Healey and Jenkins (2009) provide a useful schematic diagram that highlights the complementary relationship between teaching and research, which avoids them being viewed as two separate academic activities. They argue that when designing curriculum, research can be incorporated in different ways depending on the availability of resources, the discipline, the level and skill of students, etc. (see visual representation below). For example, the top quadrants of research-tutored and research-based curricula involve students as active participants in the research, with varying emphasis on research content and research processes and problems. On the other hand, in research-led and research-oriented curricula, students are more passive participants in the research process, but are still involved in various aspects of research, both in terms of content and process.
4. Undergraduate Research & Inquiry at McMaster

In this report, a preliminary scan of URI at McMaster University is provided. Information was gathered through a cursory review of institutional documents (e.g., Forward with Integrity statements, University mission statements, and letters from the President and Provost Offices), faculty homepages (e.g., Social Sciences, Humanities, Science, Health Science, Engineering and Business), departmental undergraduate program links, and course descriptions (e.g., independent research/reading courses; thesis options). The results are framed using the adapted “Characteristics of Excellence in Undergraduate Research” framework and Self Assessment tool (Council on Undergraduate Research) under the following headings:

1. Mission;
2. Infrastructure and Funding sources;
3. Professional Development and Recognition;
4. URI Dissemination;
5. Curricular and Extra-Curricular Research Opportunities; and
6. Assessment and Strategic Planning.

A cautionary note: these results are not meant to be generally interpreted but rather provide preliminary data to shape the recommendations that follow.

4.1 Mission

Undergraduate research and inquiry is soundly supported in the McMaster University Strategic Research Plan (May 2014) and Forward with Integrity Research Task Force Position Paper (May 2012). In fact, these documents reinforce the need to of placing ‘discovery’ at the centre of the undergraduate learning experience and viewing students’ engagement in research as a potentially distinguishing feature of the undergraduate experience. The active participation of undergraduate students in research is viewed as an investment in the development of research capacity among potential graduate students, as well as a way to improve research literacy in the workforce and general public.
At the faculty level, websites for all faculties at McMaster University include a broad mission/vision statement emphasizing the importance of undergraduate research, yet there was a range of specific details provided about the opportunities available for undergraduate students. For example, a few department websites listed general and/or vaguely written statements about research opportunities for interested students to engage in URI, while others included clearly detailed specific opportunities.

At the department level, some sites provided general statements of URI similar to those offered at the university and faculty levels, while others provided clear perspectives on URI and easily accessible links to each opportunity. There was further variation in the usefulness of the links to URI opportunities; some provided specific detailed information and others provided more general campus wide information (i.e. experiential education).

This variation continued at the program and course level. Many courses and some entire programs not only included URI, but rather are based on this concept (e.g. iSci). Based on this very initial preliminary review, there appears to be broad disciplinary participation across faculties in undergraduate student research, although the type and extent of involvement varies greatly, reinforcing the need for greater understanding and a more comprehensive review.

4.2 Infrastructure & Funding Sources
There is currently no formal administrative support or research infrastructure for URI across McMaster. While, the Research Office for Administration, Development and Support (ROADS) provides support for faculty and graduate student research, and informally supports student-led ethics applications, it does not formally indicate support for URI.

Similarly, there is limited funding available for URI through the McMaster Undergraduate Student Research Awards (USRA). These funds are intended to cultivate and support research partnerships between faculty members and undergraduate students. Even though external funding is available through national funding providers (e.g., CIHR, NSERC) to support research experiences, it is increasingly competitive.

There appears to be a gap in communication of these research opportunities (i.e. no database of potential external funding sources) thereby students are primarily reliant on advisors, which potentially limits accessibility to a broader number of students. Pockets of funding may exist through various departments and programs; however, it is not widespread.

While there may be infrastructure (space, equipment, library resources etc.) available within individual faculties for URI, there appears no coordinated infrastructure across the university to facilitate it.

4.3 Professional Development and Recognition
As part of the initial scan, there was no evidence of university wide professional development opportunities (workshops, mentoring etc.) to support faculty or students interested in URI at McMaster. A preliminary review did not reveal any awards or formal recognition processes to recognize the efforts of those facilitating URI experiences for students. It is not clear as to whether this happens within individual faculties, as part of the tenure and promotion or career progress and merit (CPM) processes, or in any formal ways. Additional exploration of the policies and procedures is necessary.

4.4 URI Dissemination
Just as there are many approaches to URI within each faculty, there appeared to be several isolated forums for disseminating URI. For example, faculty specific conferences, poster days, journals, discipline specific publications etc. Yet, there does not appear to be any formal mechanisms for disseminating URI between different departments or faculties.
4.5 Curricular & Extra-Curricular Research Opportunities
Curricular and extra-curricular experiences also varied across the university. Within the curriculum, many faculties offered students generalized inquiry classes in their first year. Beyond that, most of the research opportunities campus-wide were available in the third and fourth year. In some faculties these courses were required, while in others they were optional. It does appear as though availability of research integration for undergraduate students was available, but contingent on funding and grant money. These opportunities were also highly variable and included such activities as independent research courses, co-ops, community engagement, and internships.

4.6 Strategic Planning & Assessment
As identified earlier, URI is well supported within the McMaster University Strategic Research Plan (May 2014) and a number of recommendations have been made to support URI within the Forward with Integrity Research Task Force Position Paper (May 2014). These recommendations include building on existing URI experiences and requiring all students to complete a research course early in their studies. These directions state that such background knowledge would provide the foundation for URI experiences in later years for interested students. In terms of assessment, while each faculty may assess student engagement in URI differently, McMaster’s Institutional Quality Assurance process requires all faculties to outline how students are engaging in the components of URI, as outlined in the Undergraduate Degree Level Expectations (cll.mcmaster.ca/COU/degree/undergraduate. html) within their curriculum.

5. Recommendations
Undergraduate research and inquiry is an important topic of strategic importance to McMaster. This topic is part of a wider debate around ‘students and partners’ (Healey et al., 2014) which includes students being partners in their own learning (e.g., peer learning and peer assessment); student undertaking SOTL projects; and students engaged in curriculum design; as well as students undertaking URI projects in their disciplinary areas. The recommendations in this report support undergraduate students as central agents in their own learning, a direction that builds upon the success of the student scholar model at MacPherson.

Based on the literature review and the preliminary internal scan of URI at McMaster, a few recommendations are proposed. These are summarized in Table 1 below. The recommendations focus primarily on development opportunities at McMaster, but also identify preliminary related research questions. In broad terms, the recommendations identify ways to better understand URI on campus to celebrate it and to build on existing strengths and initiatives that can shape a future research agenda.

Table 1: Roadmap for URI at McMaster University

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<tr>
<th>5.1 Create a clear vision of UR at the institutional level</th>
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<td>5.2 Explore the diversity of URI at McMaster</td>
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<td>7. Increase funding opportunities for students; and</td>
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<tr>
<td>8. Develop central ways of disseminating URI–e.g. undergraduate research conference, institutional journals etc.</td>
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5.1 Create a Clear Vision of URI at the Institutional Level
Given the history of inquiry at McMaster, and the wide range of URI activities taking place, the suggestion to put URI at the centre of McMaster’s Institutional Strategy identified in the Strategic Research Plan makes good sense. A stronger emphasis on URI would set McMaster apart at the national and international level, and create a unique opportunity for undergraduate students. For this to happen, a clear vision and development plan needs to be identified at the institutional level. As an example, at University College London (UCL), Michael Arthur, the president and provost stated “At University College London, our top strategic priority for the next 20 years is to close the divide between teaching and research. We want to integrate research into every stage of an undergraduate degree, moving from research-led to research-based teaching” (Arthur, 2014).

A clear vision of URI at McMaster could easily build upon the existing strengths in undergraduate research and inquiry as well as provide a beacon for a future research agenda. Models such as Healey and Jenkins (2009) would provide a framework for displaying illustrative summary descriptions of the broad continuum of activities that constitute URI within the McMaster context. A strategy for creating experiences for all undergraduate students to engage in some aspect of URI, would make accessible and broaden opportunities to develop skills and knowledge beyond McMaster University. As Brew (2007) notes “for the students who are the professionals of the future, developing the ability to investigate problems, make judgments based on sound evidence, take decisions on a rational basis, and understand what they are doing and why is vital.

Research and inquiry is not just for those who choose to pursue an academic career. It is central to professional life in the twenty-first century” (p. 7). By providing students with the tools for success in research early in their undergraduate education (i.e. first and second year) and then establishing strong research programs (supported by faculty), students are in an ideal position to develop the competences they need to develop throughout their university careers and to navigate life experiences.

In developing this vision, best practices for integrating URI both within the curriculum and through extra-curricular opportunities for interested students need to be considered. Several strategies have been outlined in the Strategic Research Plan (e.g. level 2 research course in each academic discipline, interdisciplinary research institutes around thematic and leading edge areas of research, multi-disciplinary research-based communities of practice, engaging with graduate students etc.), and are discussed in the best practices section of this report, which the working group supports.

5.2 Explore the Diversity of URI at McMaster
While an initial scan of URI at McMaster was completed for the purposes of developing recommendations for this report, a more thorough exploration is required to fully understand current practices and student experiences of URI. Conducting a more formal assessment of the status of URI at McMaster University by employing frameworks (e.g., Elrod, 2010; Healey & Jenkins, 2009) could organize the collection of information about the nature of URI activities and build an important foundation for developing future empirical research ideas.

It would be important for the scan to include diverse methods (survey, focus groups, document analysis etc.) and build upon existing documentation (i.e. Institutional Quality Assurance Process). For example, a focus group would be an appropriate first step given the exploratory nature of this work, as it may give more concrete ideas about what kind of evidence is appropriate and available to estimate the frequency of URI activities. Once key ideas emerge, they can be used as the basis for developing a survey instrument to engage a broader number of stakeholders about such issues as ‘quality’ and ‘type’ of URI activities within department boundaries and across McMaster as a whole. Finally, existing practices may be mapped across the continuum of opportunities falling under the umbrella of URI at McMaster.

In parallel with the preliminary scan, a number of research questions emerged under the following sub-headings:
1. Faculty and Student Perceptions of URI; 
2. Processes Surrounding URI; and 
3. Outcomes of URI. 

### 5.2.1 Faculty and Student Perceptions of URI

While an internal scan of URI practices at McMaster would assist in documenting current initiatives, investigating student and faculty perceptions would add substantial weight to URI at McMaster. Potential research questions include:

1. What do faculty (both those that supervise undergraduate students and those who do not) perceive as barriers and facilitators to undergraduate research and inquiry?
2. What do students (both those that have participated in undergraduate research and inquiry and those who have not) perceive as barriers and facilitators to undergraduate research and inquiry?

### 5.2.2 URI Infrastructure

A number of research questions also emerged regarding current processes that surround URI at McMaster, including connecting students with URI opportunities, faculty development, program-specific initiatives, the role of graduate students etc. These questions include:

1. What does McMaster currently do to advertise/promote research opportunities? Is this done centrally or individually by units/departments? How do current students find out about the opportunities that are available?
2. What kinds of development opportunities do faculty need to help them better navigate undergraduate research and inquiry (both in terms of course development and working with student researchers directly)? What exists already?
3. Are policies in the tenure and promotion documents included that encourage or recognize faculty who engage students in undergraduate research?
4. Do programs/departments integrate research into their curricula? If so, how? If not, why?
5. Are graduate students currently involved in URI?
6. Do existing administrative structures facilitate or constrain research and inquiry activities?

### 5.2.3 URI Outcomes

While the literature supports numerous positive outcomes from adopting URI within the institution, examining the actual outcomes from current URI practices is identified as an important measure. Possible research questions include:

1. What tangible outcomes (e.g., posters, abstracts, manuscripts, attending conferences, publications, etc.) do students gain from engaging in URI? How does this compare to their expectations and/to faculty expectations?
2. What are student/faculty perceptions of the benefits experienced from participating in URI?
3. What was memorable/rewarding about the URI experience for students/faculty?
4. Are undergraduate student research skills evaluated?

To answer these questions a variety of qualitative and quantitative research methodologies could be adopted. An online open-comment questionnaire, in which faculty/students discuss their experiences, could be used. Focus groups could expand on the themes brought forth in the review or questionnaire. By developing a McMaster specific case study of URI, the university can begin to address how the organizational structure of the university may benefit from URI practices that are occurring globally. It would also allow decision-makers at McMaster to align and address concerns of URI already addressed by other universities following a similar model of URI. Understanding how McMaster URI policies are similar or different to other institutions would be beneficial in gaining a broader understanding of the impacts and benefits of facilitating undergraduate research.
5.3 Celebrate/Showcase URI at McMaster
While the extent to which URI is fully integrated at McMaster is yet to be determined, there is still much to celebrate. To showcase and celebrate current initiatives already happening across the university, a McMaster Undergraduate Research Day is suggested. Such an event could be used to share McMaster’s vision for URI (once established) as well as create a forum to learn about URI at McMaster and create connections across the university for future collaboration. This ‘research day’ provides an opportunity to share current practices, highlight resources and supports for URI, interact with students, and to celebrate URI strengths at McMaster. The event could also develop into an annual McMaster Undergraduate Research Conference as seen at other Universities both nationally and internationally.

5.4 Develop an Infrastructure to Support URI at McMaster
While much is happening at McMaster related to URI, it appears to occur in isolation or within separate faculties and programs. As identified in the FWI Research Task Force Report, the lack of coherent planning is not only inefficient, it undermines and weakens the collective research enterprise of the University and has the effect of making research appear to be distant and inaccessible to many students. Creation of an infrastructure to increase accessibility of URI to all students is needed. This infrastructure is not meant to duplicate or remove existing departmental experiences, but rather to support these initiatives to increase communication about URI and opportunities across the university.

Consideration of the types of infrastructure that support URI may include:

1. Develop a central website that allows students to view research opportunities at McMaster University;
2. Create a “how-to” guide for students interested in becoming involved in URI;
3. Develop and/or support interdisciplinary communities of practice focused on undergraduate research;
4. Create opportunities for informal conversations between students and researchers through community spaces;
5. Develop workshops for students and faculty on topics related to URI;
6. Give recognition to students and faculty engaged in URI;
7. Increase funding opportunities for students; and
8. Develop central ways of disseminating URI—e.g. undergraduate research conference, institutional journals etc.

These types of support may be best managed in a centralized location and communicated to all students.

Undergraduate research and inquiry is an important topic of strategic importance to McMaster. This topic is part of a wider debate around ‘students and partners’ (Healey et al., 2014) which includes students being partners in their own learning (e.g., peer learning and peer assessment); student undertaking SOTL projects; and students engaged in curriculum design; as well as students undertaking URI projects in their disciplinary areas. The recommendations in this report support undergraduate students as central agents in their own learning, a direction that builds upon the success of the student scholar model at the MacPherson Institute.
References


