CENTRE FOR TEACHING AND LEARNING

Inquiry-Based Learning and Undergraduate Research:

Approaches and Resources

Prepared by Dr. Corinne Laverty
Centre for Teaching and Learning

January 2019

Table of Contents

Inquiry-based learning in higher education

In a world of ubiquitous and competing information, the ability to pose critical questions and forge a path to answer them has never been more important. Inquiry is identified as a high-impact practice that enables student achievement of learning outcomes and encourages learning persistence (Kuh, 2008; Lopatto, 2010; Charles, 2012; Kuh, O'Donnell, & Schneider, 2017).

Recently there has been a trend in higher education to incorporate inquiry into the core curriculum as opposed to increasing extracurricular opportunities for inquiry and undergraduate research (Cuneo et al, 2012). The benefits of inquiry are reported in numerous studies. Students who engage in inquiry projects are better able to analyze, synthesize, and evaluate information (Laird et al, 2008); develop discipline-specific research skills (Willison, 2012); persist and make intellectual and personal gains (Kuh, 2008; Kuh et al., 2011); demonstrate greater problem-solving and research skills and are more satisfied with their overall educational experience (Brownell and Swaner, 2009; Krause et al., 2008; Healey et al., 2010).

Because Queen's has a reputation as a research-intensive university and many of its undergraduates pursue graduate work, there has been interest in reviewing inquiry-based learning initiatives on campus. In the summer of 2016 an environmental scan was conducted by the Inquiry Working Group to create a picture of inquiry or research-focused assignments across the disciplines. Information used to inform this scan included:

- Course descriptions in the 2015-16 Arts & Science, Engineering, Education, and Health Sciences calendars.
- Departmental web pages.
- Major Maps which include references to research-focused courses.
- Survey and focus groups capturing undergraduate experiences of inquiry.
- Discussions with representatives from ASUS and the AMS.
- Review of references to inquiry-related assignments in past cyclical program reviews.

The scan fulfills a central idea emphasized by the U.S. Council on Undergraduate Research: a first step towards integration of inquiry is to understand what already exists at your institution.

The purpose of this guide is to share examples of inquiry projects, approaches to their design, and the supports students need to complete them successfully.

Inquiry defined in the Queen's context

Many words and phrases are used around the world to describe undergraduate student investigation including inquiry-based learning, undergraduate research, research-based learning, and project work. Following our data collection, we offer this definition of inquiry:

> Inquiry-based learning is a dynamic, iterative, and developmental process whereby students formulate and explore questions of interest and create a final work or product.

Throughout the inquiry process, students build and develop generic and discipline-specific skills. They will draw on diverse forms of information[1] in their exploration, and learn how it can be evaluated, organized, analyzed, synthesized, created, communicated, and applied. This recursive and challenging immersion demands continual reflection, analysis, and synthesis. It ultimately leads to the clarification of ideas and results in a culminating work appropriate to the purpose of the inquiry project. Students and instructors may use a variety of tools to aid in skill development and assessment.

This definition encompasses the spirit of inquiry across disciplines on our campus. Questions are posed and answered. These are not necessarily original research questions as required for an undergraduate thesis which can be categorized as formal "undergraduate research". The Council on Undergraduate Research in the U.S. uses the term inquiry and undergraduate research to refer to original research whereby an original intellectual or creative contribution is made to the discipline.[2]

Inquiry-based learning across Queen's departments

Many departments are pursuing different forms of inquiry in course assessment and describe the process using the terminology of the discipline. Frequently used terms gathered from undergraduate course descriptions and departmental websites include:

- capstone design projects
- problem-based learning
- research-driven projects
- practicum/exchange
- action research
- experiential learning (e.g. fieldwork, labs, tutorials)
- self-directed learning
- independent study
- thesis course
- case-based learning
- active learning
- practical approach (inquiry/problem solving scenarios)

[1] E.g. archival materials, books, quantitative or qualitative data, government publications, newspapers, primary sources, scholarly and popular articles, social media, statistics, websites, regulations and codes.

[2] Council on Undergraduate Research: https://www.cur.org/about_cur/frequently_asked_questions_/

Some academic units lean towards a specific form of inquiry. For example, the Faculty of Engineering focuses on "capstone/design" projects. While rarely using the phrase "inquiry-based learning", Engineering describes its four-year Engineering Design and Practice Sequence using similar language to that of inquiry. The first year of the sequence is a "project-based course [that aims] to promote a sense of curiosity about engineering, and promote creative thought". In second-year design courses, students are taught "problem scoping, creativity, idea generation, engineering ethics, and decision making."[3]

Experiential learning has different meanings across departments and our scan differentiates between opportunities that are internal to a course and happen on campus as opposed to those that are external and happen off campus. Queen's adopted the Association of Experiential Education definition of experiential education describing it as experiences where "the learner is actively engaged in posing questions, investigating, experimenting, being curious, solving problems, assuming responsibility, being creative, and constructing meaning."[4]

Queen's courses are rich with inquiry. Figure 1 provides a rough estimate of courses with inquiry components by discipline.

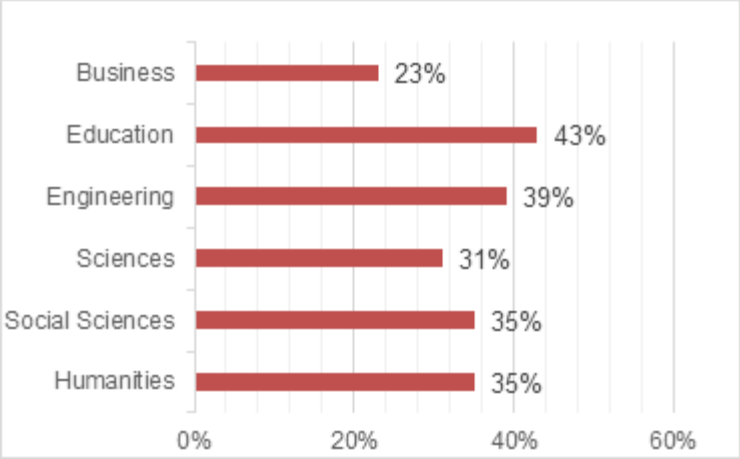


Figure 1. Estimated percentage of courses by discipline that include an inquiry component

NOTE: These are rough estimates based on screening short calendar course descriptions rather than full course syllabi. They provide a general picture of inquiry across disciplines but they do not claim to have captured all instances of inquiry in every course.

This scan does appear to reflect the teaching approaches prevalent within in a specific discipline. For example, they capture the external practica and project requirements in education and engineering. Commerce often interprets inquiry as case-based learning and although this can be inquiry-focused — if students conduct information research to solve questions —business cases may already have pre-determined answers, requiring little extended personal research.

[3] Queen's University. Engineering Design and Practice Sequence. Retrieved from https://my.engineering.queensu.ca/Current-Students/Innovation-in-Education/Engineering-Design-and-Practice.html

[4] Association for Experiential Education. What is experiential education? Retrieved from Association of Experiential Education

Examples of inquiry projects

The following examples of inquiry projects were identified through the open-ended comments on the undergraduate inquiry survey, the focus groups, the review of cyclical program reviews, and work of mouth from student and faculty.

Engineering

Course	Description
APSC 100- *Engineering Practice*	Group projects to design proposals, feasibility studies, and/or prototypes for real world problems. Upper-year engineering student facilitate each group.
CHEE 400- *Technology Engineering and Management (TEAM)*	Multidisciplinary teams work as consultants for industrial and governmental clients to develop problem solving, business analytical skills, and team work.
Mechanical Engineering Collaboration with OT	Collaboration between mechanical engineering and occupational therapy to design assistive technology devices for individuals in the local community.

Humanities

Course	Description
ENGL 467- *Settlers and Indigenous Stories of Kingston/ Cataraqu*i	Research historical sources of indigenous peoples in Kingston. Reflection on perspectives using personal diaries. Development of inquiry and analytical skills.
HIST 312- *Canadian Social History*	Develops skills in primary historical research, histological critique, and communication to share their findings in a seminar presentation.
History 400- *Foucault for Historians Inquiry Project*	Received Principal's Student Inquiry Award for promoting student inquiry. Primary source research on prison newsletters in Kingston, 1950s-1980s.

Health Sciences

Course	Description
HLTH 252- *Research Methods*	Goal is to write the introduction to a scientific paper. Research methods course intentionally scaffolds skill development.
KNPE 225- *Advanced Human Physiology*	Groups use scientific literature to work through five real-life physiological problems and includes in-class presentations.
KNPE 352- *Research-Based Internship*	80 practical hours in a specific lab within the School of Kinesiology and Health Studies in conjunction with seminars on research within the faculty.

Life and Physical Sciences

Course	Description
ANAT 216- *Principles of Human Morphology II*	Groups address research questions with upper-year students as facilitators. Includes personal reflections, peer and group evaluation, and presentation.

BIOL 102/103- *Introductory Biology of Cells and Organisms*	Scientific writing and research skills are taught using a scaffolded approach during the lab portion of the course.
ENSC 425- *Ecotoxicology*	Individual information research followed by sharing and formulation of conclusions using group input in a team debate.
ENSC 430- *Honours Project in Environmental Sustainability*	Capstone project alternative to fourth-year thesis where class acts as an environmental consulting firm.
LISC 300- *The Process of Discovery in Biomedical Sciences*	Flipped structure with class time for group problem solving and investigation on a multi-faceted biomedical problem. Presentations in a public forum.
PHYS 250- *Foundations of Experimental Physics*	Lab course focuses on lab techniques, data analysis, and application of physics concepts to report experimental results.

Social Sciences

Course	Description
HLTH 101- *Social Determinants of Health*	Essay writing process is scaffolded to provide feedback on outline, sources, and argument prior to essay deadline.
PSYC 100- *Introduction to the Principles of Psychology*	Students in the course have the option to substitute up to 5% of their exam for volunteering to participate in 5 hours of study time.
SOCY 122- *Introduction to Sociology*	Essay writing process is scaffolded to provide guided support involving an annotated bibliography, thesis statement, draft essay with peer review.

Arts

Course	Description
DRAM 236- *Public Presentation*	An introduction to the principles and skills of preparing and delivering effective oral presentations.

Student perspectives on inquiry-based learning at Queen's

To gather feedback from Queen's students on their inquiry experiences, three members of the Working Group and an undergraduate research assistant[5] surveyed 437 undergraduate students across all programs and conducted two focus groups. Sixty percent of respondents who had participated in an inquiry experience found it to be valuable or very valuable in supporting other inquiry projects and in their own self-development and interests. Quotations taken from open-ended survey comments on the nature of this value follow.

[5] Cory Laverty (CTL), Jackie Druery (Queen's Library), and Vicki Remenda (Associate Dean, Teaching & Learning, Arts & Science), supported by undergraduate research assistant Ramna Safeer.

Application of Knowledge

Exposure to a specific field of research offers insight into current job opportunities and applying course knowledge to real world problems.

- Gave me insight on how to work as a proper team with a real life project.
- The research has allowed me to learn more about my field and is necessary to supplement lectures and tutorials. It gives me the opportunity to explore more topics than professors are able to cover with limited class time.
- I feel as if the report I completed will prepare me for possible responsibilities at future jobs in the chemistry field. Additionally, this assignment helped me realize my interest in environmental science.

Personal Development

Pursuing their own research topics helps uncover interests and direct a career path based on what they liked or did not like about the project.

- It taught me about myself
- My research was on Aboriginals and since I share that heritage it was personally valuable to me. I became more knowledgeable about the world around me and understood what was going on when I heard news stories about the Syrian refugee crisis.
- It gave me the opportunity to explore the topic in a direction of my own interests. I was able to perform my own literary analysis of the play and use my own experience, knowledge, thinking and research that I had conducted to formulate my own interpretations of the work. I was able to compose my own ideas and production of the play based on my own thinking and in partnership with my other group members.

Transferable Skills

Transferable skills such as research techniques, problem solving skills, utilization of resources, critical thinking, data interpretation, time management, reading scientific journals, creativity, and presentation skills are further developed.

- The experience helps to overcome obstacles such as a fear of speaking, intimidation of large projects, low confidence, and lack of autonomy by being pushed out of their comfort zone both personally and academically.
- It has given me valuable research skills as well as opportunities to work on my teamwork and communication skills, and time management.
- It got me interested in the scientific research process. It taught me how to find ways to answer questions through personal observation. The project seemed intimidating at the start, but it showed me that I have the resources to ask and answer my own questions.

- It is always valuable to learn how to research topics using the proper skills, tools and techniques. Working to find proof is challenging but worth every step of the way
- It helped me learn about proofs and see what I knew and didn't know. It also showed me what a university level assignment is like.
- It's good to develop research skills, employers value people who can research and analyze information
- It was good to learn how to do my own research and to support my ideas with existing sources, I just think it would have been cooler to do the report on something that fit better with my personal interests.

Student comments on specific inquiry experiences

Responses from two follow-up focus groups provided specific examples of inquiry assignments and how research skills were developed during the completion of each project. Common themes from these groups are illustrated in Table 1.

Table 1. Quotations from Queen's students from focus groups describing inquiry experiences

Theme	Description	Quotations
Topic selection	Individual choice is motivational.	By the instructors telling you that you can choose any company in the world, you are allowed to explore your intellectual curiosities of how the company works which is really cool. (Commerce)
Scaffolding	Developmental approach with ongoing feedback supports learning.	For example, for my sustainability course, we had four different modules. They're all in the same subject, we research them, and they all lead up to one final infographic. There's a lot of that kind of scaffolded approach. … I find that certain approaches to assignments, where you scaffold it, to be very valuable for personal benefit.
In-course support	More faculty/TA support, especially for those with disabilities. Align TA tutorial and assignment support.	I need a lot of support with writing and research, especially if the questions are too broad. I honestly think the biggest thing for me is more office hours with the TA or the professor. I think a lot of the support needed is clear communication within the TA and professor relationships and have more one-on-one.
Group work	Can be shallow. Using group to share individual research via discussion and debate useful rather than entire group project.	I find that the research done in groups is really shallow and facile and comes out with really poor results. I find that in a lot of courses with group work, we're not really researching any more than the surface I like finding my [own] knowledge and disseminating it in a group and discussing it.

Process skills	Need to be built over time. Range of skills need to be developed and these vary by discipline.	What I find valuable is that we're learning how to do research and what makes for effective research. We're learning how to pick and choose what information is relevant and what should be ignored. I find that there aren't a lot of supports for like the basics, like writing an essay or a thesis or constructing an argument and being able to talk about it for however many pages. (First year)
Product	Variety is motivational.	I think going forward, teachers and professors should have different options of research. In my ancient science class, the professor gave us different options to go about the assignment — we can build a model, or write an essay, or a research paper.
Assignment expectations	Setting clear guidelines clarifies expectations.	I think that the constraints are good guidelines so you know that your research is going in the right direction and you are going to get relevant results. (Commerce)
Course approach	Type of inquiry project varies by discipline.	…. [course] called Design of Manufacturing Process and we're in groups and I feel like it's an inquiry project. We have a client and we have to come up with a solution for them broken down into different reports.... There's no one solution to it. (Engineering)

Academic skill areas identified for continued support

The survey revealed that students feel they would benefit from more support in the development of particular research, writing, and presentation skills. Students were given 19 possible skills and asked to select all those where they would benefit from more support. The top six selections for those who have and have not experienced an inquiry project are illustrated in Figure 2. The skills where support is needed include developing a research question/hypothesis/creative project, designing experiments, analyzing data/information, collecting data and useful information and evaluation of sources and/or scientific studies. The writing skills where more support is needed include preparing a research proposal, editing, clear communication, how/when to cite sources, writing conventions and constructing an outline. Lastly, the presentation skills where students want more support include oral communication, dissemination of research, and organization of the final product. The preferred format for this support was in-class activities, face-to-face workshops, and faculty/graduate/undergraduate mentorship.

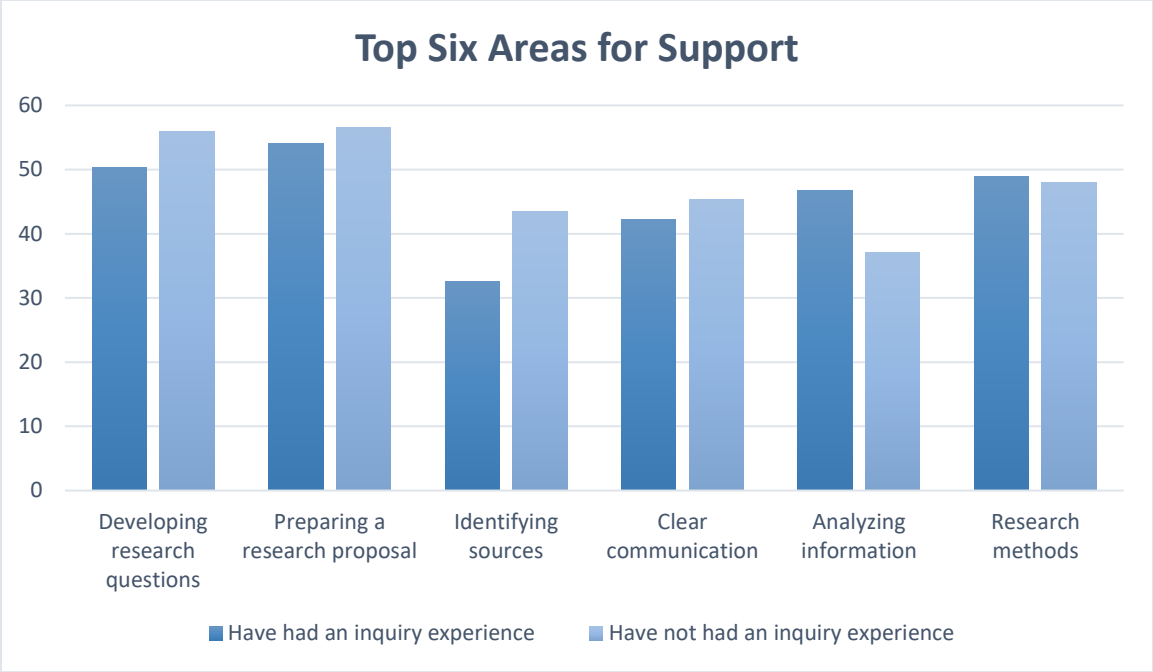


Figure 2. Top six support areas for developing research and writing skills comparing students who have/have not had inquiry experiences.

Supports for inquiry-based learning across campus

Personal Help

Individual liaison librarians are assigned to every Queen's academic unit and are available to introduce and review inquiry skills appropriate to specific assignments. They also provide online subject guides and tutorials to disciplinary research tools and resources.

Many students noted in the survey that they wanted more faculty and Teaching Assistant office hours to support inquiry projects.

Writing Centre

As a part of Student Academic Success Services (SASS), the Writing Centre team provides assistance through one-on-one appointments and on-site or in-class workshops. Their goal is to improve students writing skills at any stage of the process.

Forums for sharing inquiry projects at Queen's

- Inquiry@Queens: An annual event where students describe their work via short presentations, panels, or posters.
- Other venues for disseminating results include these student-run journals:
  - *ASUS Journal of Indigenous Studies*: forum for discussing colonialism and settler colonialism in Canada and all aspects of Indigenous life.
  - *DATA Journal*: a faculty-reviewed scientific journal specializing in all aspects of undergraduate-level computing research and project development.

- *Politicus*: An undergraduate research journal focusing on political and international affairs.
- *Queen's Science Undergraduate Research Journal*: A peer- and faculty-reviewed undergraduate journal focusing on biochemistry and life sciences.
- *The Undergraduate Review*: An annual arts and literature publication showcasing creative work in art, fiction, and music. Website is currently unavailable.

Adaptive Technology Centre

The Adaptive Technology Centre supports students with a physical or learning disability, injury, concussion, or mental health disorder. Supports include note taking services, speech-to-text and text-to-speech software, recording devices, or organizational assistance.

Research Hub

The Research Hub is an ASUS initiative launched in January 2017. It is intended as a site for faculty to post research opportunities inviting student involvement.

Extracurricular and summer opportunities

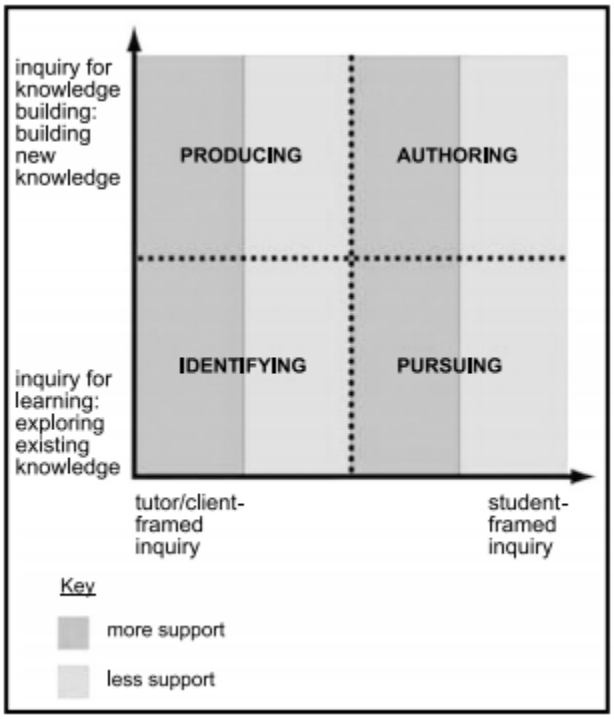
- The Undergraduate Student Summer Research Fellowship (USSRF) offered 19 positions on campus and three at the Bader International Study Centre in 2017.
- NSERC Undergraduate Student Research Awards offered in most science and engineering departments.
- ASUS Student Research Grants are awarded each term to support a research project.
- The Summer Work Experience Program placed 172 students in 2016 and some were research related.
- Queen's Undergraduate Internship Program offers a 12-16 month paid internship for students in Engineering, Arts & science, and Computing and may involve research.
- Queen's Journal: A student-run newspaper hires students to investigate and report on local and international issues.
- Queen's Model United Nations: Students represent different countries and organizations while discussing real-world issues and events.
- Lab Volunteers: Students are exposed to different research processes and specific lab techniques in an area of personal interest.

Frameworks for inquiry

In designing inquiry assignments, there are several frameworks that can help identify different types of inquiry skills and they are developed across a program.

Inquiry Development Framework

The model by Levy and Petrulis (2012) in Figure 3 visualizes a continuum of inquiry and the levels of support that accompany each stage. The "Identifying" stage involves "information research" where students answer questions that are set by the instructor. When students reach the "Authoring" stage, they are posing their own original questions that contribute new knowledge to the field.



Identifying: Students pursue information research that collates and analyzes known answers to questions posed by the instructor.

Pursuing: Students pursue information research that collates and analyzes known answers to the questions they pose.

Producing: Students pursue original research questions posed by the instructor.

Authoring: Students pursue original research based on their own questions.

Figure 3. A model of inquiry-based learning for higher education.

Researcher Skill Development Framework

In thinking beyond whether inquiry questions will be faculty- or student-led and whether they are open or closed-ended, instructors should identify which inquiry skills are needed to complete a project and the level of inquiry skills that students have achieved prior to the start of the project. The Researcher Skill Development Framework (Willison and O'Regan, 2008) presents a continuum of inquiry skills across six facets of research (Figure 4)[6]:

- Embark and clarify: determine need and pose research question respecting ethical, cultural, social and team considerations.
- Find and generate: locate sources of information and data using suitable methodology
- Evaluate and reflect: assess the credibility of sources
- Organize and manage: demonstrate information storage, retrieval, and citation
- Analyse and synthesize: critique and compare sources
- Communicate and apply: Disseminate research and mobilize learning to specific audiences.

The Framework traces each facet across seven levels of development from first-year postsecondary education through to post-doctoral study.

[6] The Researcher Skill development Framework is freely downloadable at https://www.adelaide.edu.au/rsd/

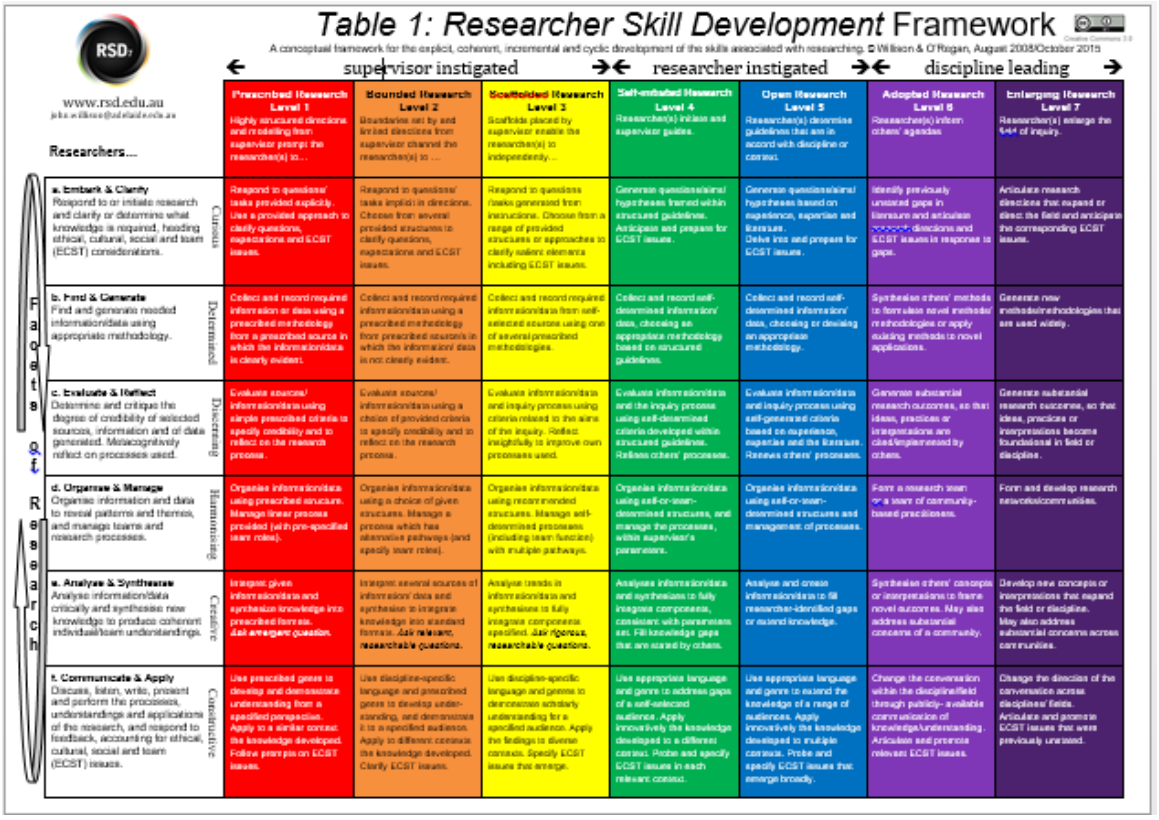
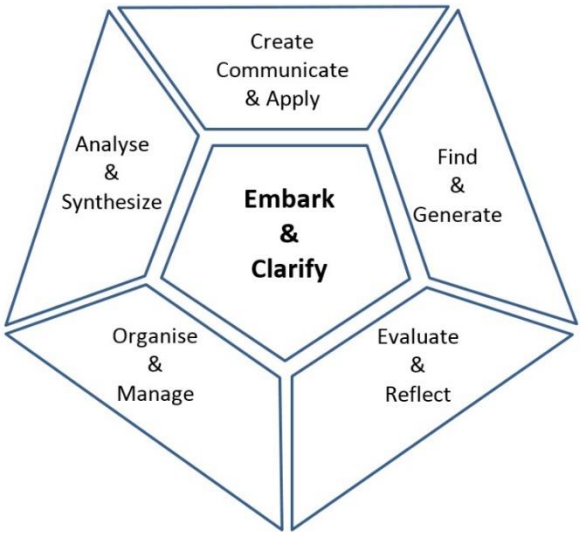


Figure 4. The [Researcher Skill Development Framework](#) (Willison & O'Regan, 2008)

Willison represents the six facets of research in the form of a pentagon, also referred to as a "gem" (Figure 5). This visual is used to orient students to the inquiry process and describe the activities associated with each stage.



The pentagon or "gem" illustrates the facets of research appearing down the left side of the skill framework above. It functions as a conceptual guide during the research process. Embark and Clarify is both starting point and central touchstone throughout the iterative process as learning deepens and evolves.

Figure 5. Inquiry process illustrated with six facets of research (Willison & O'Regan, 2015)

Checklist for designing inquiry assignments

A content analysis of 191 course-related research assignments on 28 college campuses across the U.S. noted certain trends in the expectations communicated to undergraduates (Head & Eisenberg, 2010). Descriptions tend to focus on what the finished product should look like but do not explicitly support the advancement of process skills. Drawing on this analysis of assignment handouts, the following checklist lists elements that can be included on handouts to help students further develop their skills.

Inquiry Assignment Design Checklist	
Provide context	State how the assignment relates to course material and include "big picture" and inquiry-skill development context.
Describe the assignment	Deconstruct components. Discuss academic integrity as it relates to the assignment; forms of support; and if collaboration is encouraged.
Set inquiry outcomes	Write inquiry outcomes suited to students' developmental level and course requirements. Model and discuss these in class.
Discuss inquiry tools	Discuss finding tools such as discipline-specific databases. Specify types of resources appropriate for the assignment.
Track and reflect on the research process	Include a research journal to reflect on patterns, gaps, and challenges that can be followed up on in class.
Share projects	Provide opportunities to report on product and process such as one-minute summaries, Inquiry@Queen's, public forum, or debate.
Scaffold the inquiry process	Split assignment into tasks and give feedback at each stage. Example: find five sources - class sets evaluation criteria - analyze a single
Set citation style	Name citation style and give link to tutorial on library website. Use citation management software if extended research involved.
Assess process and product	Rubrics are helpful especially when they are reviewed before the assignment so students know how they will be graded.

Examples of inquiry skill outcomes

The Willison Framework in Figure 4 lists a range of inquiry learning outcomes. For disciplinary examples, consult professional and association standards, the undergraduate-degree learning expectations (UDLEs), and topic-specific curricula and rubrics. Using the stages of inquiry as defined by Willison in Figure 5, other examples of inquiry learning outcomes follow.

Embark & Clarify	• Develop a researchable question derived from a general topic assigned by the instructor. • Identify the types of evidence that will be needed to address the question or problem. • Is there an audience for this investigation such as a community partner or local association? • Determine the roles for group members when completing an inquiry project as a team. • Discuss aspects of academic integrity as they relate to the assignment. Consult the CTL guide to Academic Integrity Educational Resources.
Find & Generate	• Compile a range of topical resources in various formats (e.g., multimedia, website, data set, scholarly articles) in order to assess how they support personal learning. • Identify the purpose of citation tracking and tracing references in order to broaden a search for related information. • Distinguish between a popular and a scholarly article in order to compare their characteristics. • Differentiate between primary and secondary sources in order to compare how they contribute to the research task.
Evaluate & Reflect	• Describe criteria used to make information selections in order to evaluate information tools, resources, and search strategies. • Investigate the scope, content, and organization of information retrieval systems in order to select a tool that suits information needs for their research and their discipline. • Compare the strengths and weaknesses of four research tools in order to maximize the identification of relevant resources • Evaluate the relevance, validity and authority of various resources in order to understand the limitations of searching Google for a specific type of information.

Organize & Manage	• Create an account for a citation manager such as Mendeley or Zotero as a means to share resources for a group project. • Review Creative Commons attribution rights and how to search for works licensed for reuse.
Analyse & Sythesize	• Review the Turnitin Originality Report to check your work for use of quotations and citations. See the CTL Academic integrity guide which includes In-class activities for Turnitin. • Complete a paraphrasing exercise in class to practice expressing ideas in your own words. • Compare the evidence and perspectives in two different information sources using set criteria.
Create, Communicate, & Apply	• Share your project in the form of a poster presentation at Inquiry@Queen's. • Discuss disciplinary practices for disseminating information and mobilizing knowledge and research.

Scaffolding the development of inquiry skills

Scaffolding describes the supports that assist learners in reaching skill levels beyond their current abilities. It draws on the work of Vygotsky and the Zone of Proximal Development which describes the space between a learner's current skill level and the next skill level that the learner cannot reach without assistance. Essential to scaffolding is fading the support inversely to the learners' acquisition of the skill that is being supported (Belland, 2014).

Figure 6 shows Van de Pol's conceptual model of scaffolding illustrating the gradual release of support.

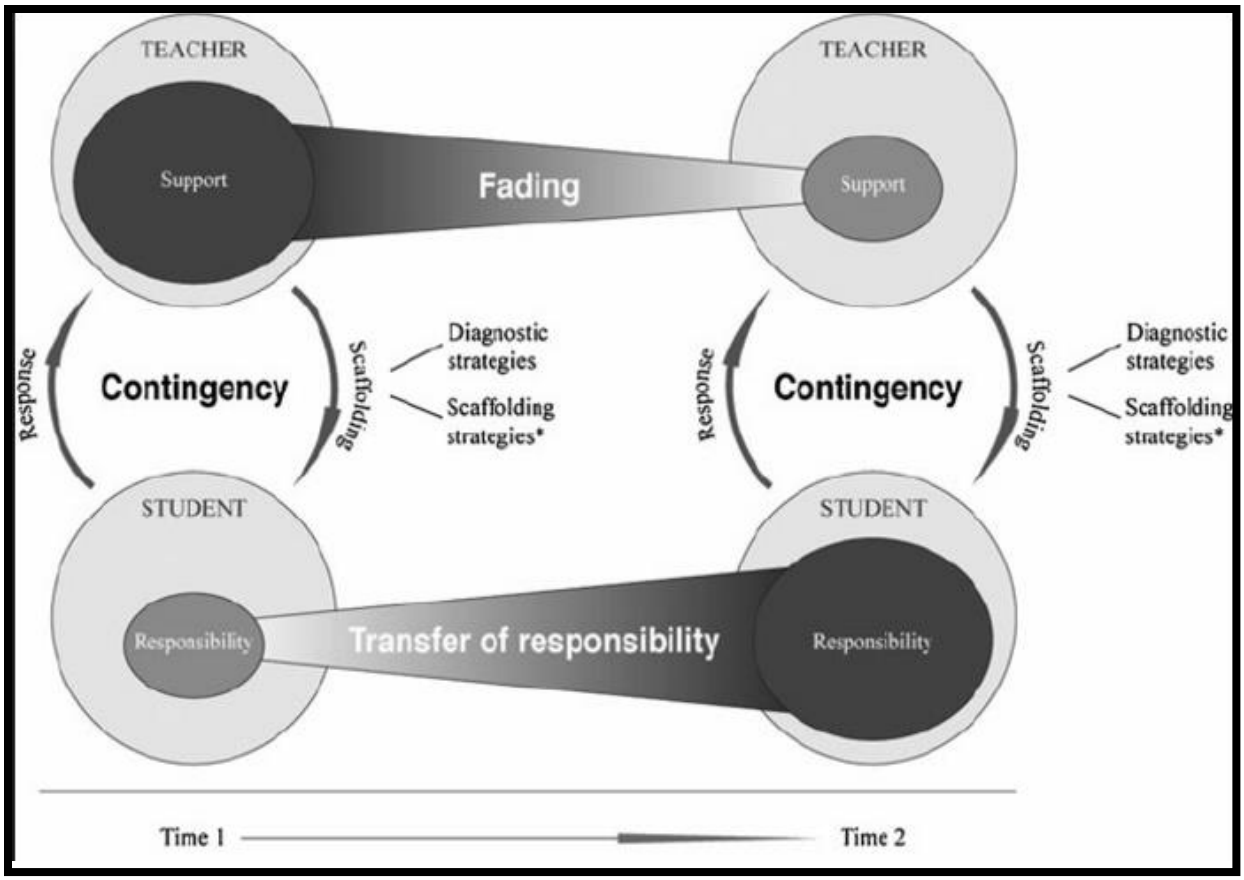


Figure 6. Conceptual model of scaffolding (Van de Pol et al., 2010)

Cognitive apprenticeship is a process by which learners learn from a more experienced person by way of cognitive and metacognitive skills and processes. Stages, as described by Dennen and Burner (2007) include:

- *Modeling:* Demonstrating the thinking process
- *Coaching:* Assisting and supporting student cognitive activities as needed (includes scaffolding)
- *Reflection:* Self-analysis and assessment
- *Articulation:* Verbalizing the results of reflection
- *Exploration:* Formation and testing of one's own hypotheses

Examples of what scaffolding might look like in your course is illustrated in the following figure of course components: course materials, modelling, reflection, task structure, reviewing, and assessment.

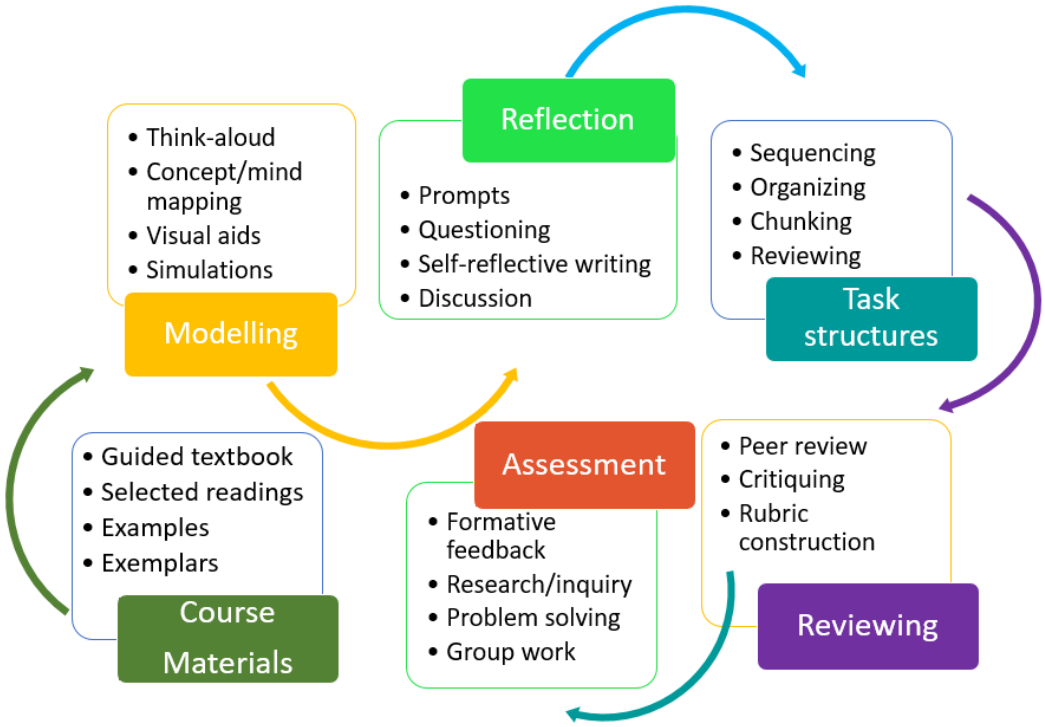


Figure 7. Possible approaches to scaffolding within a course

The following chart illustrates how inquiry skills can be developed over an entire program. This is an appropriate task during a curriculum review process where faculty have an opportunity to consider how development of core skills is scaffolded over four years so students have sufficient practice and feedback to master important research skills.

Table 2. Building inquiry skills *developmentally* over a 4-year program

	Year 1	Year 2	Year 3	Year 4
Inquiry topics	Prescribed inquiry questions, topics, sources. Highly structured. Concept of "information research" is introduced. Bounded Inquiry Topics	Students choose focus from prescribed topics. Learning how to develop an inquiry question. Group projects. →	Students generate inquiry questions independently. Investigate sources to identify gaps in research literature.	Generate research questions requiring original data/evidence/ critique; contribute to disciplinary knowledge base Open Research Topics
Scaffold skill development	Introductory inquiry skills (e.g. subject databases; disciplinary writing; academic integrity).	Build on skills (e.g. source evaluation; diverse perspectives; organizing / managing information)	Build on skills (e.g. advanced information tools; different forms of writing; ethical considerations)	Broad application of inquiry skills; knowledge mobilization – bringing information to interested audiences

Focus on Process	Formative feedback on low stakes assignments and in-class activities. Marks for process.	Scaffold assignments: e.g. topic description - inquiry questions – literature review – sample proposal.	Scaffold assignments: e.g. inquiry questions – literature review – peer review – reflection on process.	Capstone project shared publicly (e.g. community; stakeholders; Inquiry@Queen's)
Assessment products	Articulate inquiry skills for assessment. Prescribed format for final product. Assignments designed in partnership with librarian to consider available resources.	Research methods courses introduced. Choice of options for final product.	Format of final product has variety of options and is shared (e.g. in-class, Inquiry@Queen's)	Format of final product is open; knowledge mobilization to communities; thesis formats are evolving.
Support	TA coaching. Librarian and writing experts come to class; they also mentor TAs in research skill development for first year students.	TA / senior undergraduates coaching. Library modules/podcasts/ guides in onQ.	TA / senior undergraduates coaching. Librarians mentor TAs. Peer feedback.	Faculty mentorship during Individual inquiry projects or thesis

Within a single inquiry project, learning could be scaffolded across the process using the following approaches where in-class feedback is given via working in pairs, groups, or whole-class discussion.

Formulate inquiry questions

Apply a process for formulating research questions (Adapted from Blaikie, Norman. 2010. *Designing Social Research*. Malden, MA: Polity Press):

- Brainstorm on every possible question related to the problem
- Group questions under themes
- Separate your What, How, and Why questions
- Separate major and subsidiary questions
- Eliminate unnecessary questions
- Operationalize any theoretical or technical terms. That is, define terminology and how you are interpreting specific concepts. Students must fully understand the meaning of the questions they are posing because it will shape the direction of the type of information they will seek, where they will look for it, and how they will evaluate it.

Develop research skills

- Invite students to share aspects of the research process that they find difficult.
- Unpack one (or more) of the core information literacy concepts below as it pertains to the research assignment.
- Consider breaking down the assignment into chunks: developing a research plan with timelines; completing an annotated bibliography with peer review of citations in class; giving peer/TA feedback on first draft; giving a one-minute presentation in class; contributing a poster at Inquiry@Queen's.

Table 3. Six key information literacy concepts identified by the Association of College and Research Libraries (2015).

Scholarship is a conversation	**Research as inquiry**	**Authority is constructed and contextual**
Scholarship is a form of sustained discourse within a learning community where new knowledge is shared, debated, and grown as we learn from one another.	Research is an iterative process and depends on asking increasingly complex questions within a single project and over time as others build on your work.	How we determine the authority of information depends on its origin, the context in which it was created, and how we will use the information.
Format as a process	**Searching as exploration**	**Information has value**
We need to be mindful that the form in which information is delivered tells us about the process by which that information was constructed.	Finding information involves searching that is nonlinear and iterative but also calls for strategy in terms of our choice of information tools and approaches.	Information is power. It enables learning, persuasion, and influence. As information consumers and creators, we must give credit, and use it ethically and wisely.

Unpack academic integrity

- Discuss what academic integrity means in your discipline and how it relates to the specific inquiry assignment at hand.
- Introduce case-based scenarios such as those described in the CTL Academic Integrity Guide for discussion.
- Review different ways to take notes and approaches to summarizing information.
- Discuss the concept of plagiarism and accidental plagiarism and how to avoid it.
- Demonstrate how to keep track of research citations (or better – invite a librarian to demonstrate the most recent forms of software that Queen's subscribes to for that purpose).
- Demonstrate how to use Turnitin using the CTL Academic Integrity Guide so students can check their own "originality reports".

Map an information-gathering strategy

- Invite a librarian to walk students through an approach to gathering and evaluating information for their project.

- Create a map of the types of research tools that will be used during the project and the form of information they offer. For example, you will need statistics on xxx which will be found using xxx database which is listed in xxx on the library website or at xxx institutional site. You will also need to explore grey literature which means xxx and here are approaches to finding this form of information. Your will need to locate works by Indigenous authors and here are strategies for identifying these writers.
- Have students search for a useful article on their topic and demonstrate the strategy they used to find and evaluate it.

Evaluate information sources

- Have students work in groups to determine criteria for evaluating the types of information needed for their projects.
- Discussion around "fake news" can be illuminating to reflect on the channels by which we receive information and the means by which we assess whether something is actually true.
- While academic assignments reinforce the use of "scholarly" works,
- Discuss the process of peer review but also how that process privileges certain forms of information.

Review inquiry project evaluation rubrics

- Model how to apply a rubric to a work sample from a previous year.
- Review the criteria for a rubric to assess an upcoming project.
- Students participate in describing rubric evaluation criteria.
- Peer review for the first draft of a paper is done in class.
- Peer review for the citations in a bibliography is done in class.
- Use mini-lessons to give feedback on one element in the rubric.
- Students score their own projects using the rubric.

Assessing inquiry skills with rubrics

Constructivist learning theorists encourages learners and educators to view feedback as a system of learning, rather than as discreet episodes of teachers "telling" learners about their performance. What types of feedback do students find useful? What types of feedback help to improve performance going forward?

There are several principles for giving effective feedback (Molloy & Boud, 2014):

- Creating learner disposition for seeking feedback
- Orientation to the purpose of feedback in learning
- Explicit, nested, iterative tasks
- Practising judgement

Rubrics are one method to provide learning feedback and are especially useful for inquiry projects. A rubric is a set of statements that describe what learning looks like at different levels of learning across several specific learning criteria. These descriptions help students to understand the criteria on which they will be assessed and the level of learning that is required to achieve a specific grade for that learning. Rubrics help instructors articulate what they want students to be able to demonstrate with their learning and they also enable markers to assign grades consistently based on specific attributes.

VALUE rubrics

Many rubrics are freely available in the web. For example, a set of rubrics was developed by the American Association for Colleges & Universities: VALUE Rubrics (Valid Assessment of Learning in Undergraduate Education) https://www.aacu.org/value/rubrics. Teams of educators from over 100 postsecondary institutions engaged over many months to develop 16 VALUE rubrics as listed below.

Intellectual and Practical Skills	Personal and Social Responsibility	Integrative and Applied Learning
Inquiry and analysis		
Critical thinking	Civic engagement—local and global	Integrative learning
Creative thinking	Intercultural knowledge and competence	
Written communication	Ethical reasoning	
Oral communication	Foundations and skills for lifelong learning	
Reading	Global learning	
Quantitative literacy		
Information literacy		
Teamwork		
Problem solving		

Rubric development

There are many approaches to creating your own rubric. Here is one approach you might try:

- Collect student work and sort into different quality ranges.
- Assign keywords to each groups, both positives and negatives.
- Consider outcomes for your particular assignment.
- Review rubric examples from your discipline/VALUE rubrics
- Determine criteria that you want to assess (e.g. knowledge, skills, attitudes)
- Determine number of levels of performance (three or four?)
- Write level descriptions drawing on exemplars

Writing rubric descriptions appears straightforward at first glance, but it is deceptively difficult. The purpose of the descriptions is to convey to students what learning at a specific level looks like in words that they can understand. The following example, taken from one criteria within the Information Literacy VALUE rubric, may result in various student interpretations. It is

important to take the time to get feedback from students on the rubric you construct to ensure mutual understanding.

Table 4. One criteria and its descriptions taken from the Information Literacy VALUE rubric.

Criteria	Capstone Level 4	Milestones Level 3	Milestones Level 2	Benchmark Level 1
Evaluate Information and its Sources Critically	Thoroughly (systematically and methodically) analyzes own and others' assumptions and carefully evaluates the relevance of contexts when presenting a position.	Identifies own and others' assumptions and several relevant contexts when presenting a position.	Questions some assumptions. Identifies several relevant contexts when presenting a position. May be more aware of others' assumptions than one's own (or vice versa).	Shows an emerging awareness of present assumptions (sometimes labels assertions as assumptions). Begins to identify some contexts when presenting a position.

BASICS rubric builder

A rubric building, created as part of a Queen's learning outcomes project, can be found at http://www.queensu.ca/qloa/assessment-tools/basics/. Click "View List" in the upper menu to see examples of rubrics.

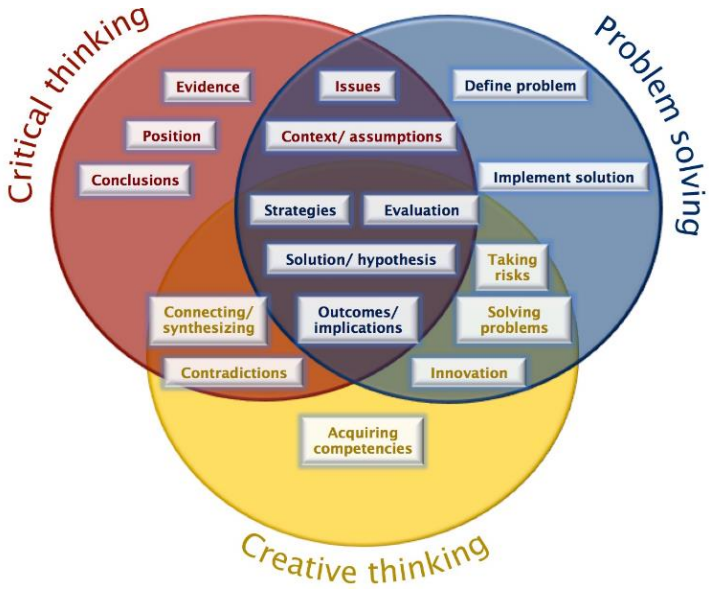


Figure 8. The rubric builder provides prompts to create a rubric oriented to: critical thinking, problem solving, or creative thinking.

The ICE model (Ideas, Connections, Extensions)

Levels of learning in rubrics may be reflected in numbers (Levels 1-4) or in words (Capstone – Milestones – Benchmark; minimal – developing – satisfactory -exemplary). The ICE model invites us to reorient our thinking about learning as a transformative and qualitative experience rather than as a quantitative and behavioural one. It presents learning on an easily memorable continuum where student learning deepens over time as it develops. The language of ICE may

be easier for students to understand and it provides a positive language to describe learning (ideas – connections – extensions) as opposed to evaluative levels such as minimal, unacceptable, satisfactory, etc. Table 5 illustrates stages of learning in the ICE model and Table 6 provides an example of an ICE rubric.

Table 5. The stages of the ICE model as developed by Fostaty young and Wilson (2000).

Ideas	**Connections**	**Extensions**
Knowing about	Understanding how and why	Thinking beyond
• Remember and understand • Factual recall of basic information • Grasp elemental concepts, ideas, principles, trends • Building blocks of learning	• Recognize general ideas across different contexts • Demonstrate relationships and connections among concepts • Connect prior knowledge and experience	• Evaluate and create • Predict future outcomes • Propose solutions • Justify a position • Evaluate outcomes • Design/ build something • Changing contexts • Aha and so what of learning

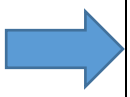
Table 6. An ICE rubric for the assessment of student portfolios (Strong & Fostaty Young, 2011).

	Ideas (50-64%)	**Connections (65-79%)**	**Extensions (80-100%)**
Content	■ Offers a basic description (gives a list) of topics covered in classes each week, by providing a content list of course materials ■ Uses classroom generated examples to demonstrate examples of what was learned ■ Statements of personal opinions. "I did …, " "We learned ...," etc.	■ Addresses a focus question or problem, connecting topics by posing solutions to and reflections on materials learned in classes ■ Connects ideas by supporting them with evidence drawn from classes "That is similar to … ," "The reason might be … ," "We learned it this way…," etc.	■ The writer demonstrates critical thinking. ■ Applies material to unique situations, showing evidence of careful reflection and creativity ■ Relates personal learning to other parts of the course, program and/or professional life "If I applied that idea to…then … ," "A better approach for me may be to… , " "I would predict that next time…." "I would have preferred to learn it this way… ," etc.
Clarity	■ Terminology and concepts are clearly defined ■ Makes accurate statements about the topics discussed ■ Logical, coherent presentation of ideas through writing ■ Writing does not interfere with the ability to convey ideas	■ Connects ideas to each other ■ Connects classroom concepts to external situations or events ■ Helps audiences make connections to their own situations ■ Writing enhances the reader's ability to understand the writer's thought process	■ Extrapolates understanding to new situations ■ Writing shows evidence of careful consideration towards the reader's ability to comprehend the writer's personal learning

Future Directions for Inquiry

In taking a developmental approach to inquiry, some universities are setting a goal to move from an inquiry-oriented to an inquiry-grounded approach in the classroom and across a program (Figure 9). This emphasizes a developmental approach whereby inquiry skills, such as finding, evaluating, synthesizing, and communicating information, are built gradually over the duration of a program as students practice and hone their abilities.

Table 7. An inquiry-oriented versus an inquiry-grounded approach

Inquiry Oriented		**Inquiry Grounded**
Outcomes directed at final product		Outcomes directed at developing process skills
Faculty focus topics in assignments		Students determine topics with support of faculty
Research opportunities for some students, especially summer internships		All undergraduate students experience inquiry projects throughout a degree program
Disciplinary research not introduced in a specific first-year course and linked to an inquiry project		Initiation to disciplinary research begins in a targeted course in first year and students complete an "information research" project to gather, evaluate, and synthesize information
Discipline focused		Move towards interdisciplinarity where problems and perspectives from multiple disciplines are interwoven
Individual work		Movement towards collaborative projects and engagement with local, national, and/or international communities
Assumption that inquiry skills are developed independently by students		Program curriculum describe inquiry skills in the discipline and articulate how they are being developed during a degree
Student work not disseminated or shared with others		Movement towards disseminating project work on campus and/or other interested audiences locally or worldwide

Recommendations

The Queen's Inquiry Working Group Report (2018) offered a number of recommendations to support a move towards adopting inquiry as a signature pedagogy. Inquiry learning is supported by instructors and researchers, while being driven by the curiosity, creativity, and energy of students. It is a form of learning where personal interest, culture, and experience can be encouraged and celebrated. It is an inclusive approach to learning when it calls on the personal interests, experiences, and perspectives of the individual. It prepares students to become informed citizens. The following recommendations support inquiry experiences for all undergraduate students.

Defining Inquiry

1. Adopt a common general definition for inquiry that makes sense for students and provide examples of inquiry-based learning models across a range of disciplines.

2. Encourage departments to describe the inquiry process from a disciplinary perspective and provide links to inquiry opportunities on their websites such as courses that are inquiry-focused and the Undergraduate Research Hub.

Student Experience of Inquiry

3. Identify inquiry-focused courses in course descriptions and syllabi so they can be easily identified by students.

4. Develop mechanisms to inform students about what inquiry is, how it can help them in their future professional and personal lives, and how it is central to the mission of a Queen's University education.

5. Launch the Advanced Research Skills Certificate under development in the Faculty of Arts and Science and ensure that students understand the benefit of this certificate.

Faculty Experience of Inquiry

6. Adopt a developmental approach to building inquiry skills across a degree.

7. Offer opportunities for a culminating inquiry project in the final year so students can apply the inquiry skills they have built over the preceding years.

8. Ensure that formative and summative assessment practices support the growth of student inquiry skills.

9. Provide support for faculty to develop and assess inquiry assignments via the CTL website.

Campus Supports

10. Further integrate liaison librarian partnerships into departments to discuss and implement mechanisms for supporting inquiry and information literacy skills.

11. Ensure that inquiry supports (e.g. Library, Writing Centre) are embedded into onQ and related course materials.

12. Continue to encourage and value co-curricular experiences related to inquiry skill development, disseminating the results of inquiry projects, and increasing awareness of inquiry opportunities within departments, on campus, and in the community. Current mechanisms include:
    - Inquiry@Queen's
    - Queen's student journals
    - Major Maps
    - Undergraduate Research Hub

13. Expand Inquiry@Queen's as a means to disseminate and celebrate inquiry projects across campus. This could include showcasing the student journals already sharing inquiry results and how Queen`s Library supports new open access journal creation.

Infrastructure

14. Within the Office of the Provost (Teaching & Learning), consider appropriate mechanisms, such as an advisory committee structure, to document, promote, encourage, and support the development of inquiry-based assignments and more formal undergraduate research opportunities at Queen's.

15. Develop metrics for undergraduate participation in inquiry assignments and formal research projects.

16. Develop branding that underscores the importance of inquiry skills as a means for connecting students to personal interests and experiences as well as preparing them for the world of work and the world of research.

17. Create additional reward structures for undergraduate students, faculty, and graduate students who engage in supporting undergraduate inquiry, along the lines of the Principal's Teaching Awards.

References

Almagno, S. (2016). Rubrics: An undervalued teaching tool. Faculty Focus. Retrieved from https://www.facultyfocus.com/articles/effective-teaching-strategies/rubrics-an-undervalued-teaching-tool/

Association of College and Research Libraries. (2015). *Framework for information literacy for higher education*. Chicago, IL: ACRL.

Belland, B. R. (2014). Scaffolding: Definition, current debates, and future directions. In *Handbook of research on educational communications and technology* (pp. 505-518). New York: Springer.

Bennett, S. (2009). Libraries and learning: A history of paradigm change. *Portal: Libraries and the Academy, 9*(2), 181–197.

Blaikie, Norman. 2010. *Designing Social Research*. Malden, MA: Polity Press.

Brown, K., & Malenfant, K. J. (2016). *Documented library contributions to student learning and success: Building evidence with team-based assessment in action campus projects*. Chicago, IL: Association of College & University Libraries. www.ala.org/acrl/files/issues/value/contributions_y2.pdf

Brownell, J. E., & Swaner, L. E. (2009). High-impact practices: Applying the learning outcomes literature to the development of successful campus programs. *Peer Review*, *11*(2), 26.

Bundy, A. (2004). *Beyond information: The academic library as educational change agent*. Paper presented at the 7th International Bielefeld Conference, Bielefeld, Germany.

Charles, D. (2012). "Boyer reconsidered": Fostering students' scholarly habits of mind and models of practice. *International Journal for the Scholarship of Teaching and Learning, 6*(1), 16.

Cuneo, C., Harnish, D., Roy, D., & Vajoczki, S. (2012). Lessons learned: The McMaster inquiry story from innovation to institutionalization. *New Directions for Teaching and Learning*, *2012*(129), 93-104.

Dawson, P. (2017). Assessment rubrics: Towards clearer and more replicable design, research and practice. *Assessment & Evaluation in Higher Education*, *42*(3), 347-360.

Dennen, V. P., & Burner, K. J. (2007). The cognitive apprenticeship model in educational practice. *Handbook of research on educational communications and technology*, 425–439. New York: Springer.

Dickenson, D. (2006). *How academic libraries help faculty teach and students learn: The Colorado academic library impact study.* Retrieved from http://www.lrs.org/documents/academic/ALIS_final.pdf

Fostaty Young, S. & Wilson, R.J. (2000). *Assessment and learning: The ICE approach*. Winnipeg, MB: Portage and Main Press.

Gilchrist, D., & Oakleaf, M. (2012). *An essential partner: The librarian's role in student learning assessment*. *NILOA Occasional Paper*, (14). Urbana, IL: University for Illinois and Indiana University, National Institute for Learning Outcomes Assessment.

Head, A. J. (2012). *Learning curve: How college graduates solve information problems once they join the workplace.* Project Information Literacy Research Report. Seattle, WA: University of Washington. Retrieved from http://projectinfolit.org/images/pdfs/pil_fall2012_workplacestudy_fullreport_revised.pdf

Head, A. J. & Eisenberg, M. B. (2010). *Assigning inquiry: How handouts for research assignments guide today's college students*. Project Information Literacy Progress Report. Seattle, WA: University of Washington Information iSchool.

Healey, M. (2005). Linking research and teaching exploring disciplinary spaces and the role of inquiry-based learning. *Reshaping the university: new relationships between research, scholarship and teaching*, 67-78.

Healey, M., Jordan, F., Pell, B., & Short, C. (2010). The research–teaching nexus: a case study of students' awareness, experiences and perceptions of research. *Innovations in Education and Teaching International*, *47*(2), 235-246.

Healey, M., Jenkins, A., & Lea, J. (2014). Developing research-based curricula in college-based higher education. *York: HEA*.

Jenkins, A., & Healey, M. (2009). Developing the student as a researcher through the curriculum. *Innovations in Practice*, *2*(1), 3-15.

Justice, C., Rice, J., Roy, D., Hudspith, B., & Jenkins, H. (2009). Inquiry-based learning in higher education: administrators' perspectives on integrating inquiry pedagogy into the curriculum. *Higher Education*, *58*(6), 841-855.

Krause, K. L., Green, A., Arkoudis, S., James, R., Jennings, C., & McCulloch, R. (2008). *The Teaching–research nexus: A guide for academics and policy-makers in higher education*. Retrieved from http://trnexus.edu.au/index.php [accessed 8 November 2011].

Kuh, G. D. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter*. Washington, DC: *Association of American Colleges and Universities*.

Kuh, G. D., Kinzie, J., Buckley, J. A., Bridges, B. K., & Hayek, J. C. (2011). *Piecing together the student success puzzle: research, propositions, and recommendations: ASHE Higher Education Report* (Vol. 116). John Wiley & Sons.

Kuh, G. D., O'Donnell, K., & Schneider, C. G. (2017). HIPs at ten. *Change: The Magazine of Higher Education, 49*(5).

Levy, P., & Petrulis, R. (2012). How do first-year university students experience inquiry and research, and what are the implications for the practice of inquiry-based learning*? Studies in Higher Education, 37*(1), 85-101. 10.1080/03075079.2010.499166

Lopatto, D. (2010). Undergraduate research as a high-impact student experience. *Peer Review*, *12*(2), 27.

Lundstrom, K., Diekema, A. R., Leary, H., Haderlie, S., & Holliday, W. (2015). Teaching and learning information synthesis: An intervention and rubric based assessment. *Communications in Information Literacy*, *9*(1), 60-82.

Martinovic, D., & Freiman, V. (2013). *Digital skills development for future needs of the Canadian labour market (*pp. 1-71). Final report to the Social Sciences and Humanities Research Council. Retrieved from http://cronus.uwindsor.ca/users/d/dragana/main.nsf/main/1CA3F7FD606C8BC785257C9D004CC13B?OpenDocument

Molloy, E., & Boud, D. (2014). Feedback models for learning, teaching and performance. In Spector, J. M., Merrill, D., Elen, J., Bishop, M.J. (Eds.) *Handbook of research on educational communications and technology* (pp. 413 – 424). Fourth Edition. New York: Springer. DOI 10.1007/978-1-4614-3185-5_33

Ohio State University Libraries. (2016). Choosing & Using Sources: A Guide to Academic Research. Retrieved from https://osu.pb.unizin.org/choosingsources/. Also see the accompanying Instructor's Resource at https://library.osu.edu/blogs/instructorresources/

Strong, D. S., & Young, S. F. (2011). Effectively assessing professional engineering skills. *Proceedings of the Canadian Engineering Education Association.*

Timmerman, B. E. C., Strickland, D. C., Johnson, R. L., & Payne, J. R. (2011). Development of a 'universal' rubric for assessing undergraduates' scientific reasoning skills using scientific writing. *Assessment & Evaluation in Higher Education*, *36*(5), 509-547.

Van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher-student interaction: A decade of research. *Educational Psychology Review, 22(3*), 271-296.

Willison, J. W. (2012). When academics integrate research skill development in the curriculum. *Higher Education Research & Development*, *31*(6), 905-919.

Willison, J., & O'Regan, K. (2008). *Researcher skill development framework*. Retrieved from https://www.adelaide.edu.au/rsd/framework/rsd7/

Acknowledgements

I would like to express my sincere gratitude to two summer research students, Ramna Safeer and Lindsay Lew. Ramna and Lindsay worked with me on the environmental scan and gathering of student research perspectives and made sure I was capturing the student voice. They are two remarkable young women.