Carleton UNIVERSITY
Canada's Capital University

Office of the Vice-Provost and
Associate Vice-President (Academic)

Institutional Quality Assurance Process

Interdisciplinary Science and Practice (ISAP)

(Volume I)

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Approvals Table

This table will record that the brief has been approved by: 1) the program lead on behalf of the team; 2) the head of the academic unit or chair of the program committee (in the case of interdisciplinary programs not administered exclusively by one academic unit) on behalf of the unit or program committee; 3) the Faculty Dean(s).

Dr. Julia Wallace	**July 2017**	
Program Lead		**Date**
Dr. Steven Cooke	**July 2017**	
Chair/Director		**Date**
Dr. Dwight Deugo	**July 2017**	
Dean(s):		**Date**

Committees Reviews and Approvals

Vice-Presidents' Academic Research Committee	February 15, 2017
Financial Planning Group	April 24, 2017
Curriculum Committee	August 10, 2017
Faculty Board	August 17, 2017
Carleton University Committee on Quality Assurance	March 15, 2018
Senate Committee on Curriculum, Admissions on Studies Policy	March 20, 2018
Senate Academic Program Committee	March 16, 2018
Senate	
Quality Council	

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A.1. Program overview

Genesis of the New Program

Based on an informal consultation process with colleagues, students, and external employers, we identified an opportunity to blend technical knowledge in the sciences with employer demand for new hires with professional skills such as interpersonal and collaborative workplace aptitudes. Surveys[1] on diverse sector employability factors, especially for recent graduates entering the labour market, highlight employers' increased weighting of the professional skills[2] that are often absent.[3] In designing the **Interdisciplinary Science and Practice** (ISAP)[4] curriculum, we recognized two major motivating factors: student interest in an interdisciplinary science degree and labour market demands.

Employers value the skills of communication, collaboration, and critical inquiry as highly as technical knowledge. Canadian employers have a decided preference for graduates who have an interdisciplinary perspective[5] as well as the capacity to communicate with a diverse population of science- and non-science stakeholders.[6] Similar to the U.S. National Academy for Sciences,[7] the Conference Board of Canada details three essential skill areas for the 21st century: fundamental skills (including communication and problem

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[1] Casner-Lotto, J. & Barrington, L. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century U.S. workforce.* Report by The Conference Board of Canada. http://www.p21.org/storage/documents/FINAL_REPORT_PDF09-29-06.pdf

[2] Finch, D., Hamilton, L., Baldwin, R. and Zehner, M. (2013), "An exploratory study of factors affecting undergraduate employability", *Education + Training*, 55(7), 681-704.

[3] Davidson, K. (2016, August 30). "Employers find 'soft skills' like critical thinking in short supply" in *Wall Street Journal*. http://www.wsj.com/articles/employers-find-soft-skills-like-critical-thinking-in-short-supply-1472549400

[4] NOTE: In several of the supporting documents (e.g., letter of support) the program is referred to as "Science Integration and Application (SCIA)". After consultation with the external site visit committee and the broader academic and stakeholder community we changed the name to Interdisciplinary Science and Practice which is a better reflection of our program.

[5] Hewitt, A. (2016). Developing Canada's future workforce: a survey of large private-sector employers. Business Council of Canada. http://thebusinesscouncil.ca/wp-content/uploads/2016/02/Developing-Canadas-WorkforceMarch.pdf

[6] Hobin, J., Fuhrmann, C., Lindstaedt, B., & Clifford, P. (2012). So you think you have skills. *Science*. http://www.sciencemag.org/careers/2012/09/so-you-think-you-have-skills

[7] National Research Council. (2012). *Education for life and work: developing transferable skills for the 21st century.* Washington, DC. : The National Academies Press.

solving); personal management skills (including lifelong learning); and teamwork skills (including collaboration, organizational skills and project management).[8]

Prior to 2013, one of the options available to students interested in interdisciplinary science was Carleton's Integrated Science program. Students could choose one of nine concentrations: Forensic Science, Health Science, Science Education, Information Science, Information Technology, Science and Ethics, Science and Policy, Science and Technology and Science and the Arts. The Integrated Science program only offered capstone courses (independent study, research essay or research thesis). Approximately half of the 300 students in Integrated Science were enrolled in the health science concentration. With the advent of Carleton's Health Science program in 2014, it was anticipated that many of the students in the Health Science concentration would opt for the new program. In addition, it was recognized that Integrated Science offered access to a multidisciplinary set of courses but did not provide dedicated courses that allowed students to explore interdisciplinary connections among fields. The Integrated Science program was closed to the intake of new students 2013. ISAP was born of a complete restructuring of a program of interdisciplinary study to meet the needs of both students and potential employers.

Through ISAP, our students have the opportunity to integrate concepts and knowledge from different science disciplines and apply them to real world problems from local and global viewpoints. The ISAP program acts as a guide to encourage students to appreciate the relevance of their chosen science disciplines to current societal issues such as food security, cybersecurity, energy sustainability and environmental stewardship, which require cross-disciplinary collaboration on local, national and international levels.[9] ISAP can draw on the vast opportunities and expertise that result from Carleton University being situated in Ottawa - our "Capital Advantage". As guest lecturers or invited speakers, professionals working at the science-policy interface can provide our students with an understanding of current practices. As ISAP evolves, our vision is to enable students to participate in activities, assignments and projects that directly engage with groups in the community, including local and national Indigenous groups.[10] ISAP graduates will be well prepared to balance their specialized technical knowledge with the transferable skills of critical thinking and problem solving, teamwork, and science communication. Not only are these skills highly valued in team members but they are also indispensible for graduates holding future leadership positions. We created ISAP to foster the development of these skills while allowing our

[8] Conference Board of Canada. (n.d.). *Employability skills 2000+.* http://www.conferenceboard.ca/Libraries/EDUC_PUBLIC/esp2000.sflb.

[9] Thompson, J., Grossenbacher-Mansuy, W., Häberli R., Bill, A., Scholz, R., & Welti, M., eds. (2012). *Transdisciplinarity: joint problem solving among science, technology, and society: an effective way for managing complexity*. Berlin: Birkhauser.

[10] Storksdieck, M., Shirk, J., Cappadonna, J., Domroese, M., Gobel, C., Haklay, M., Miller-Rushing, A., Roetman, P., Sbrocchi, C., & Vohland, K. (2016). Associations for Citizen Science: Regional Knowledge, Global Collaboration. *Citizen Science: Theory and Practice, 1*(2):1–10.

students the flexibility to select their focus discipline(s) and build connections across them through the ISAP curriculum.

Principal Goals of the Program

The ISAP curriculum weaves five specific yet interconnected themes throughout its courses:

- meaning, role, and assessment of the scientific approach to critical inquiry and problem solving
- benefits of an interdisciplinary approach in the sciences to address global and local issues
- practical issues of collaboration and project organization in diverse contexts
- effective science communication across science disciplines and with a range of audiences
- ethical standards that inform the behaviour of professionals in a community of practice and as members of society in general

We embedded these themes throughout the program structure of ISAP to facilitate a progressive integration of knowledge and skills and, yet, provide a flexible framework to encourage exploration by our students.

Program Structure

Students in ISAP's 20-credit Honours degree or the 15-credit General degree complete one minor from within the Faculty of Science. We will encourage students in the Honours degree to consider a second minor from any Faculty at Carleton. Activities and assignments throughout the ISAP courses require students to integrate the concepts and approaches across their individual disciplines and to strengthen their capacity for collaboration, critical inquiry, and science communication. To showcase their progress, we will explore the use of supporting frameworks, such as cuPortfolio.[11]

All students in the ISAP Honours and General programs complete eight ISAP courses (0.5 credits each) to develop a strong grounding in the theory and practice of interdisciplinarity, collaboration, science communication, critical inquiry and data analysis. These courses are:

ISAP 1001:	Introduction to Interdisciplinary Science
ISAP 1002:	Seminar in Interdisciplinary Science
ISAP 2001:	Foundations in Critical Inquiry

[11] Carleton University. (2017). About cuPortfolio. https://carleton.ca/cuportfoliosupport/about/

ISAP 2002:	Research Principles for Interdisciplinary Science
ISAP 3001:	Principles and Applications in Data Analysis
ISAP 3002:	Applications in Interdisciplinary Research
ISAP 3003:	Science Communication
ISAP 3004:	Science Policy

We organized each course to introduce new concepts, revisit those from prior courses, and advance the technical and professional skills of our students. By the time our students enroll in ISAP 3002, they will have the background to design a research proposal on a topic that explores a local issue in a global context, such as climate change, resource sustainability, or food systems.

To address the individual preferences of our ISAP students in the Honours stream, the curriculum includes three types of a culminating academic experience. In consultation with the ISAP faculty, a student will choose from one of the following three-capstone options (see Appendix 1):

ISAP 4906:	Group Research Project
ISAP 4907:	Research Essay
ISAP 4908:	Individual Research Project

Appendix 2 (ISAP Course Progressions) illustrates possible paths for ISAP students to complete minor(s). Students who transfer from other programs will be able to complete their first and second year ISAP course requirements concurrently to allow for timely completion of degree requirements. A representative course progression for a student transferring into second year of the ISAP program is also given in Appendix 2.

Creative/Innovative Aspects to ISAP

Often used interchangeably, ISAP views the terms "innovation" and "creativity" as unique but intertwined because "without creativity, no innovation can exist and without innovation, creativity would not have any value".[12] We view innovation in curriculum design as requisite to respond to ongoing changes in the societal, research and employment landscapes while allowing students to select a discipline of their choosing. In creating ISAP, we purposely avoided structuring the curriculum by discipline, which re-enforces the perception of discrete sciences as "silos" and undermines the value of interdisciplinarity.[13]

[12] Sloane, P. (2012). What is the difference between creativity and innovation? *Innovation Excellence*. http://innovationexcellence.com/blog/2012/08/04/whats-the-difference-between-creativity-and-innovation/

[13] Tapscott, D. & Ross, R. (2016, May 7). Breaking research silos to decipher secrets of the brain. *Toronto Star*.

We innovated the conventional science curriculum to entrench the principles and practice of interdisciplinarity in an incremental and continuous process[14] throughout the undergraduate program. Thus, creativity provided the inspiration to re-vision undergraduate science education, while innovation created the path to operationalize the concept. We are confident that our current faculty have the experience to achieve the ISAP objectives for its students and strengthen the visibility and the reputation of Carleton as an interdisciplinary university of the 21st century.[15]

Current National, Provincial and International Programs

We performed a scoping review of science-based interdisciplinary programs that integrate a rigorous discipline-specific program with in-demand professional skills. Leading Canadian universities, including those in Ontario, are responding to this emerging trend with their own distinct visions of interdisciplinary or integrated science programs. At the Eastern Ontario regional level,[16]University of Ottawa,[17] Queen's University,[18] and Trent University[19] focus their undergraduate interdisciplinary programs on Health and Environmental Science. Like ISAP, these programs emphasize critical and creative inquiry, but they do not have ISAP's strongly articulated and specially designed components of science communication and collaboration.

Provincially, the University of Waterloo,[20] through its undergraduate degree in Knowledge Integration, includes discipline-specific science electives in Year 1, but its primary mandate is knowledge mobilization. Brock University[21] offers several undergraduate degrees under the rubric of "integrated studies", including one in science. Although students choose their courses, the program does not include any specifically tailored to interdisciplinarity or the professional skills training and practice that are comparable to the ISAP curriculum.

[14] Centre for Higher Education Practice. (n.d.). Bridging the gap: innovation and creativity in the curriculum. http://www.innovations.ac.uk/btg/resources/publications/innovation.pdf

[15] Wernli, D. & Darbellay, F. (2016). Interdisciplinarity and the 21st century research-intensive university. League of European Research Universities (LERU). http://www.intrepid-cost.eu/wp-content/uploads/2016/12/Interdisciplinarity_and_the_21st_century_research-intensive_university.pdf

[16] Minnes, S. & Douglas, D. (2013). A profile of Eastern Ontario. University of Guelph. http://cdnregdev.ruralresilience.ca/wpcontent/uploads/2013/05/EasternOntarioProfile.pdf

[17] University of Ottawa. (2016). www.uottawa.ca/academic/info/regist/calendars/scien/EVS.html

[18] Queen's University. (2016). www.queensu.ca/calendars/artsci/Bachelor_of_Science__Honours____BSCH_3.html

[19] Trent University (2016). https://www.trentu.ca/futurestudents/degree/environmental-science-studies

[20] University of Waterloo. (2016). https://uwaterloo.ca/knowledge-integration/current-undergraduates/course-offerings/kielective-courses

[21] Brock University. (2016). https://brocku.ca/webcal/2016/undergrad/ints.html

York University[22] has recently developed an undergraduate BSc Honours program in Integrated Science, limiting its cohort intake to a maximum of 50 students. This program is an enriched Year 1 only program, structured around themes such as Mars and the Habitable Planet. During Year 1, Integrated Science students participate in discipline-specific courses (ISCI 1101/1102 Biology and similar ISCI courses in Chemistry, Physics, and Math). York University's program suggests that interdisciplinary concepts are presented within the science discipline-specific courses. In contrast to York University's program, ISAP does not limit the choice of science disciplines and provides students with clearly articulated concept courses for interdisciplinarity, research methods, and science communication. In addition, the ISAP courses thread throughout all years of the General and Honours programs to enable our students to increase their knowledge, capacity for implementation, and appreciation of these concepts.

Western University[23] offers a BSc (Honours) in Integrated Science, but with a degree designation of a specific science discipline. A relatively new entry, with an estimated initial program offering in 2016, this degree admits only direct entry students with a highly competitive admissions process to identify "select" students. In addition to discipline-specific requirements, all Integrated Science students must complete eleven Integrated Science courses, focusing on the scientific process, science-based projects with peers and community partners, and an integrated research project. Unlike Western

University, ISAP has a General BSc option and allows for transfer students. With targeted courses in Science Communication and Science Policy, ISAP's curriculum recognizes that our graduates may enter fields other than scientific research. We will take advantage of the extensive local expertise at the science-policy interface that stems from being in Ottawa to enrich these courses and the overall educational experience of our students. As ISAP's resources and visibility increase, we are anticipating a vibrant community component to engage community partners on local issues with global implications. In this way we will model the principles of "citizen science"/"community science".[24]

McMaster University[25] offers an Integrated Science program that aligns most closely with ISAP's vision. However, typical of the problem-based approach common to many McMaster programs, its BSc (Honours) Integrated Science degree (iSci) limits the cohort intake to 64 students and is available only for direct entry without the option for transfer students. Graduation requires four iSci courses plus a combination of science discipline-specific and open electives. Each of the four iSci courses, one per year, is a multi-credit course structured around themes and delivered through labs, fieldwork, and interactive concept seminars. Each year the credit value of the iSci course decreases, from 8 course equivalents in Year 1 to 4 course equivalents in Year 4, while the number of discipline electives increases from 1 course equivalent

[22] York University. (2016). science.yorku.ca/future-students/integrated-science/

[23] Western University. (2016). http://www.uwo.ca/sci/WISc/

[24] Cornell University. Citizen Science Central. (2017). Defining citizen science and PPSR (Public Participation in Science Research). http://www.birds.cornell.edu/citscitoolkit/about/defining-citizen-science

[25] McMaster University. (2016). http://future.mcmaster.ca/programs/isci/

in Year 1 to 3 course equivalents in Year 4.[26] iSci 4A12, in Year 4, appears to be similar to an Honours thesis.

In contrast to McMaster, ISAP allows for direct entry as well as transfer students, thereby providing an alternative to Carleton's existing science curriculum. Based on our experiences from the Integrated Science program, some students discover their academic interests and career aspirations lie in interdisciplinary science after completing their first year of study. To accommodate these students, ISAP offers both 3- and 4-year options.

On a national level, Mount Saint Vincent University (Nova Scotia),[27] the first Canadian university to offer an undergraduate degree in Science Communication, focuses on general and science-based communication and public relations. This BSc (Honours) requires courses in the sciences (Biology, Chemistry, and Psychology) as a complement to ten courses in Communications and Public Relations. This program, however, appears to be under revision as it is not open to an intake for the 2017/2018 academic year. ISAP integrates the principles and practice of communication across science-based disciplines and with non-science stakeholders throughout its curriculum. At the same time, however, the program enables students to develop these science communication skills, among other transferable skills, in conjunction with a rigorous foundation in their science-based disciplines.

The University of British Columbia offers an IntSci BSc with General and Honours option. The number of students is not disclosed on its website and it appears that the program was first delivered around 2014. This degree allows students to design their own curriculum at the upper level in consultation with a faculty member. All IntSci students must complete a minimum of seven ISCI core course credits from the ten that are available. The ISCI courses include an Interdisciplinary Seminar, a Research Development Retreat, and Field Courses to Hawaii and Iceland. The University of British Columbia also has a Coordinated Science Program (CSP) that is an alternative Year 1 science program for students seeking a broader background in science. CSP students attend the same sections of core courses as students in the traditional science curriculum in Biology, Chemistry, Physics, Math, and Computer Science. In addition, CSP students participate in workshops, limited to no more than thirty students, which include collaborative problem solving and communication. Additional details for the CSP are not currently available.

Unlike the University of British Columbia, ISAP has a required course sequence to ensure that each ISAP student has a consistent grounding in the building blocks for integrating and applying the principles of an interdisciplinary approach. While providing a set framework for the curriculum, ISAP provides appropriate options to encourage its students to pursue their individual areas of interest. Although ISAP does not

[26] McMaster University. (2016). Program structure of iSci. https://www.science.mcmaster.ca/isci/prospective-students/program-structure

[27] Mount Saint Vincent University. (2016). Science Commununication http://www.msvu.ca/en/home/programsdepartments/professionalstudies/Department_of_Communication_Studies/Bachelor_ of_Science_Science_Communication/default.aspx

include field courses, we anticipate that our community-based "citizen science" component will appeal to our students as well as to community members.

Dalhousie University[28] offers a BSc (Honours) with an Integrated Science option. It limits the cohort size to 70 students with a highly competitive and selective admissions process. The Integrated Science course (SCIE 1505) is exclusive to Year 1 before students enter their chosen science-based discipline. In SCIE 1505, students participate in lectures, labs, projects and field trips. In addition, the program requires two terms of Biology and Psychology, one term each of Earth Science, Statistics, and Writing in Science, and one term of Philosophy, specifically the Ethics in Science. At the end of Year 1, students enter one of three options of specialization (Physical Sciences and Engineering, Biomedical Sciences, or Life Sciences), each leading to specializations in different science-based degrees.

The ISAP curriculum, with courses that progressively integrate content, interdisciplinarity, and professional skills, encourages our students to appreciate the ongoing interconnectedness of research disciplines. As they increase their discipline-specific foundational knowledge, through their selected minor(s) and elective courses, each cohort will add to the diversity of resources to bring to a critical assessment of the processes and value of the interdisciplinary approach. In contrast to Dalhousie's program, we anticipate that ISAP graduates may enter broader career environments and, as such, ISAP's framework enables its graduates to develop the skills to interact with a mix of science and non-science stakeholders.

Internationally, institutions such as Kyushu University (Japan)[29] offer broadly based graduate programs in Integrated Sciences that combine select sciences, social sciences, and the humanities to address global issues. Princeton University (New Jersey), through the Lewis-Sigler Institute), has a Year 1 program after which students enter a conventional science-based curriculum. In Year 1, the integrated science courses (ISC 231, ISC 232, ISC 233, and ISC 234) are a four-course sequence that is the equivalent to introductory courses in Physics, Chemistry, Computer Science, and Molecular Biology. ISAP, though, focuses on a set of courses through which interdisciplinarity and the attendant professional skills are discussed and practiced throughout a student's academic experience.

Northwestern University[30] (Evanston, Illinois) offers an Integrated Science Program, which does not appear to award a specific degree, but complements the traditional science curriculum, similar to a minor. Limited to a maximum of 30 students and allowing only direct entry, admission to this program requires a dual application process to the science discipline as well as to the Integrated Science program. The stated mandate of the program is to introduce students to all fields of the natural and mathematical sciences to help them to discover commonalities.

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[28] Dalhousie University. (2017). Integrated Science Program. https://www.dal.ca/faculty/science/integrated-science-program.html

[29] Kyushu University. (2016). Integrated Sciences for a Global Society. http://www.isgs.kyushu-u.ac.jp/en/

[30] Northwestern University. (2017). Integrated Science Program. http://www.isp.northwestern.edu/

Each academic year requires the completion of a preset sequence of Math, Physics, Chemistry, Electrical Engineering and Computer Science, Earth and Planetary Sciences, Statistics, Neurobiology, and Biology courses. In Year 3, students may complete ISP 398 that is an Undergraduate Research Project replacing a maximum of three of the Year 3 courses. The program describes a seminar for integrated science students for each of the three quarters in Year 1. However, the schedule indicates only one freshman seminar in the first quarter and no follow up seminars in the second and third quarters.

Once again, the ISAP curriculum has strongly articulated interdisciplinary courses external to the traditional discipline-based science curriculum. As a degree-granting program, ISAP values interdisciplinarity not as a discrete "add-on",[31] but as meaningful an element as other concepts in the scientific methodology.[32] Because ISAP allows transfer students and offers General and Honours programs, ISAP practices what it preaches by creating an inclusive culture of interdisciplinarity that welcomes all stakeholders.

The EACEA (Education, Audiovisual and Culture Executive Agency) of the European Union reports that policies and practices in the field of integrated science education are rare at the university level.[33] The University of Leicester (UK), similar to McMaster University with which it has an exchange program, [34] was one of the first in Europe to explore interdisciplinary science programming. According to its website, entry into the BSc in Interdisciplinary Science at the University of Leicester is highly competitive and limited to less than fifty direct entry applicants. Delivered through the Centre for Interdisciplinary Science, the curriculum consists of fourteen core modules over three years plus electives as well as a Year 4 Individual Research Project. The core modules are in General Chemistry, Organic Chemistry, Neurophysiology, Organic Chemistry, Analytical Chemistry, Biophysics, Biochemistry, Nanochemistry, and Earth Sciences. The focus at the University of Leicester, similar to that of McMaster University, appears to be on research accomplished through a primarily science-based curriculum.

We created our ISAP curriculum to provide targeted courses to guide our students through the challenges and benefits of interdisciplinarity and its associated skill sets. By recognizing the expertise of faculty colleagues, who deliver the disciplinary science courses in programs spanning the Faculty of Science, to provide students with strong foundational science knowledge, we concentrate on guiding students to identify and use commonalities to explore and explain science-based concepts with respect to local issues and global implications. Because the ISAP program includes a range of students with diverse academic

[31] Gouvea, J., Sawtelle, V., Geller, B., & Turpen, C. (2013). A framework for analyzing interdisciplinary tasks: implications for student learning and curricular design. *CBE Life Sciences Education, 12*(2), 187-205.

[32] Organisation of Economic Development. (2017). PISA 2015 Collaborative problem solving framework. https://www.oecd.org/pisa/pisaproducts/Draft%20PISA%202015%20Collaborative%20Problem%20Solving%20Framework%20.pdf

[33] European Commission. (2012). Science education in Europe: national policies, practices and research. http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/133EN_HI.pdf

[34] Exchange opportunity for Integrated Science students at McMaster and Leicester Universities. https://www.science.mcmaster.ca/isci/prospective-students/isci-exchange-program

and career goals emerging from a science curriculum, we intend our courses to broaden and strengthen the implementation of these core skills. We believe that our program responds to the goals of our new and on-going students by providing them with an appropriate combination of depth and breadth to pursue their goals. Furthermore, we are confident that ISAP will be an asset to Carleton University's reputation for interdisciplinary studies and promote a unique implementation of interdisciplinarity in the Faculty of Science.

Not only does Carleton have proven excellence in the area of interdisciplinary programs,[35] its location in Ottawa offers the ISAP program the "Capital Advantage" for experiential learning and professional networking. ISAP students have easy access to academia, industry, government, not-for-profit and community organizations as potential partners in training and as future employers. These organizations include, but are not limited to: government agencies (Environment Canada, Health Canada, Agriculture and Agri-Food Canada, the Canadian Food Inspection Agency, and the National Research Council), granting agencies (NSERC, CIHR and SSHRC), business (Abbott Laboratories, Iogen, and CoWater International), community or non-governmental organizations (Just Food, Aga Khan Foundation, USC Canada, and Health Bridge), the National Capital Commission, the City of Ottawa and regional municipalities or townships, and public institutions including museums and libraries. Through on-going advising and fulfilling the requisite degree requirements, our graduates will be prepared to enter the labour market in government,[36] industry,[37] or community organizations;[38] continue into professional Mission and strategic directions schools, such as law;[39] participate in specific degree programs (library

[35] Carleton University. (2017). Prospective students. Carleton's Values. Disciplinary excellence and interdisciplinary innovation. https://carleton.ca/prospective/

[36] Government of Canada has 200 Departments, Agencies, Crown Corporations, Special Operating Agencies and related organizations that recruit recent graduates from science programs https://www.canada.ca/en/government/dept.html

[37] Throughout industry, regardless of product or service, recruiters report the value of interdisciplinary and collaborative skills. *The Bloomberg Job Skills Report 2016:* What recruiters want. https://www.bloomberg.com/graphics/2016-job-skills-report/

[38] Although technical skill requirements s may differ depending on the mandate of the community organization, most share common values in the area of "soft" skills. Rodriguez, K. (2016). What top non-profits look for in job applicants. The Economist (2016, May 16). https://execed.economist.com/career-advice/career-hacks/what-top-nonprofits-look-job-applicants

[39] Law schools require an undergraduate degree and encourage students with unique backgrounds to apply. University of Ottawa. Faculty of Law. https://commonlaw.uottawa.ca/en/students/admissions/admissions-criteria

science,[40] teaching,[41] data science,[42] science communication[43]). Without a doubt, ISAP addresses academic and employability gaps for our incoming and current students interested in an interdisciplinary approach coupled with in-demand skill sets.

The new Strategic Mandate Agreement (SMA) was finalized in late 2017 and included space for development of the ISAP program. Moreover, the Chairs and Directors in the Faculty of Science have been consulted (Section H) and acknowledge the need for the ISAP program and support its development.

There are five themes of the new SMA for Carleton as listed below. For each theme we briefly note the ways in which the ISAP program fits with the SMA.

1. Student experience – (student experience, mobilization and experiential learning; professional development and employability): The ISAP program was developed entirely around the notion of providing students with a unique learning experience. From the first year where students will participate in seminar courses which in part will orient them to university life to their group research proposal on community or citizen science projects, students will feel engaged with their peers and connected to the community beyond the classroom. Students will be exposed to a broad base of scientific fundamentals but will also learn about science communication, data and knowledge synthesis, and collaboration with diverse partners. As such, the graduates of ISAP will be in demand by employers.

2. Innovation in teaching and learning excellence – (class-room focused, workplace focused, and community-based focused): The core courses that will be developed by the ISAP faculty members are "anything but textbook" in keeping with the tag line for Carleton. In the ISAP courses the students will be required to think, collaborate, share, and debate with the guidance of faculty members to provide structure. To help position students to achieve their goals following graduation, including future employment, ISAP students will document and reflect on their developing skills using a platform such as cuPortfolio. A key component of the ISAP program is for students to apply their science knowledge and

[40] Graduate programs in Library / Information Sciences admit students who have completed an undergraduate degree in any field. Those with a science background may specialize in library resources in sciences or science communication, as well as any other science or non-science field. McGill University. School of Information Studies. https://www.mcgill.ca/sis/programs/gradcert/admissions

[41] Canadian universities offer M.Ed., PhD, and ED in education. The academic requirement into the Master level is completion of an undergraduate degree. http://www.canadian-universities.net/Universities/Programs/GraduateStudies-Education.html

[42] Graduate programs in data science require a science-based degree with coursework in statistics, computer science, and programming languages. Ryerson University http://www.ryerson.ca/graduate/datascience/admission/

[43] Admission requirements include either a BSc or BA from a relevant field as well as demonstrated capacity in verbal and written communication. Laurentian University. https://laurentian.ca/program/science-communication

skills to issues at a global or local level. An example of this is the third year course, ISAP 3002 (B2) where students work in groups to develop a community based interdisciplinary research project, e.g. a citizen science project. There will be many opportunities to engage with practicing professionals and engage with community members through these group projects.

3. Access and equity: The program is intended to be inherently diverse in that it is interdisciplinary and thus will hopefully attract a diverse study body. There will be flexibility in the program to enable students to choose paths that work for them rather than trying to make them fit a particular mold. The learning objectives of this program have been evaluated by Carleton University's Paul Menton Centre (B4). The program essential requirements were assessed to ensure that all students will have the opportunity to succeed.

4. Research excellence and impact: The faculty members involved with the program have vibrant research programs. Future hires (at the TT professor track) to support ISAP will have research programs that fit with ISAP and its interdisciplinary nature. The scholarly activities that will be undertaken by students in the program (mostly group projects but some may engage in theses) will serve to generate new knowledge or assemble and synthesize existing data. The projects undertaken will be "applied" and involve off-campus partners, contributing to the overall research profile of Carleton and the experience for our students.

5. Innovation, Economic Development and Community Engagement: The ISAP program is innovative in that it was developed after careful evaluation of the handful of peer programs that exist across Canada and beyond. Quite simply, there are few undergrad science programs which enable and encourage students to work and learn across traditional disciplinary boundaries. There is also a strong community engagement component to the program to ensure relevance.

ISAP, as a new program, emerges from our experiences with academic programming that responds to student goals and interests, employer expectations, and local issues with a global perspective. We have grounded the ISAP program in the key themes of science disciplinary knowledge, interdisciplinarity, critical inquiry, collaboration and science communication. With a focus on the integration of theory and practice through experiential learning and real-life situations, our program has the following goals which mirror Carleton's *Strategic Integrated Plan* (SIP). As a result of the ISAP degree, our graduates will have the skills to:

Demonstrate and apply science-based disciplinary knowledge in traditional and non-traditional fields of employment (SIP: Goal 3-1)

Participate as informed community members and professionals to address local and global issues using an interdisciplinary approach, recognizing the contributions of both science and non-science disciplines (SIP: Goal 1-1; Goal 3-2).

Assess stakeholder agendas and determine the most effective modes of communication for knowledge mobilization (SIP: Goal 2-1)

Engage in self-reflection to challenge conventional belief systems leading to peer-to-peer and community engagement to propose innovative and creative responses to local and global sustainability issues (SIP: Goal 3-1)

Contribute to the discussion of the role of the sciences in the 21st century through collaboration across the science disciplines and with the community-at-large (SIP: Goal 2-1)

Prepare for the labour market in a broad range of fields by representing their relevant science-based and transferable professional skills, experiences and accomplishments to prospective employers (SIP: Goal 3-1)

Engage in continuous learning as lifelong learners to broaden and strengthen the scope of their knowledge and skills (SIP: Goal 3-1).

Our comprehensive vision of interdisciplinary science and the newly developed ISAP curriculum will replace the Integrated Science program and offer a new opportunity to science students who have not declared a major. ISAP will further the academic and career objectives of a broader range of students in the Faculty of Science, especially those who are as yet undecided with respect to a specific discipline as well as those seeking a broader experience in the sciences. The program will allow incoming students without a declared major to explore the sciences and gain transferable skills before making an informed decision with respect to their career. At the same time, students interested in transferring from another program will have an alternative to continue their studies by completing their degrees with ISAP courses (SIP: Goal 1-2). As such, the ISAP program will attract new students and provide additional opportunities for continuing students while preparing them for employment or further graduate study in a range of fields. Carleton University, with its rich history in interdisciplinary programs and situation in the National Capital, is ideally positioned to offer the ISAP program. Although other universities are recognizing the value of ISAP-like programming, regionally neither Carleton nor the University of Ottawa offers such a program.

A.2. Relationship to other academic programs at Carleton

Students in the ISAP program will be required to take two credits in experimental science (as defined by the regulations for the Faculty of Science) and complete at least one minor in Science. Students will also be required to take courses in Math, Computer Science and Economics (section B2). These courses are delivered by units outside of the Integrated Science Institute[44]. However, we do not anticipate that ISAP will have a significant impact on other departments and institutes. The projected new enrolment is approximately 40 students per year. Although enrolment in some large first year courses may be capped, we have discussed and received confirmation from the Chairs and Directors in the Faculty of Science, as well as the Department of Economics, that they will allow ISAP students to enroll (see Appendix 7). In

[44] The governance of the proposed ISAP program is described in section C. This governance structure is evolving and any references in this document to the Integrated Science Institute as a governing unit of the ISAP program will be updated accordingly.

addition, because students will have choices in the courses and subjects that they select within the Faculty of Science, the increased enrolment for any particular science course should be minimal.

We also do not anticipate that this program will draw students from existing programs. The students recruited into this program will be those who have made the choice to pursue an interdisciplinary approach to science or those who do not yet want to select one particular discipline. In either case, this program has the potential to bring these students to Carleton, rather than having them choose another institution.

It is not uncommon for interdisciplinary programs such as the previous "Integrated Science" and now ISAP to provide a pathway for students who decide (usually after 1st year) that their initial choice is not the right fit. Some students simply want to take a broader approach to learning while others may transfer in from other programs because they are not having the academic success they desire (e.g., Engineering). This is no way is meant to suggest that ISAP will be a "second chance" program; quite simply, this type of program often resonates with students who want to create a personalized path that builds on their early academic experiences and does not mean having to start from scratch. The flexibility of the program will enable us to support students who otherwise might be lost from Carleton, or potentially the academy, forever. Our current Environmental Science program (ENSC) has approximately 30 students/per year as new intakes plus approximately 10 that transfer from other programs. We anticipate similar trends in ISAP.

Most students in this program will be on a career track rather than targeting graduate school in a traditional science discipline and are better served by a group project capstone that would involve significant interaction with professionals. We will focus on helping students identify the appropriate path (partly through minimum GPAs for 4908s) as is done in other some other units in the Faculty of Science. Through this process, some exceptional students may choose to do an honours project, ISAP 4908, as their capstone course (B2). Integrated Science (previously) and Environmental Science (ongoing) rely on the goodwill of professors in other units in Science and beyond as well as extensive use of adjunct professors. We have found that faculty in other units have always welcomed outstanding students who elect to do an individual research project. Moreover, we anticipate that ISAP students can use their interdisciplinary background to open up new opportunities for faculty. For example, an ISAP student combining a minor in Chemistry with a minor in Business could bring invaluable insights into commercializing a lab discovery.

We look forward to working with other departments on courses of shared interest. For example, we anticipate working with the Department of Physics on a course to introduce our students to Data Science applications in the physical and biological sciences (ISAP 3001). The science policy course (ISAP 3004) is one where we would like to explore a partnership with Faculty of Public Affairs, potentially having the course offered through that Faculty**.** There is also a course in the area of "food security" in development which would be offered jointly by ISAP and ENSC and would be open to students in other units. As we expand our core faculty (through strategic hires), we will be able to identify new opportunities for courses that could be offered to the broader university community. Like the ENSC program, it will be possible to trial courses as "special topics" to refine their content and delivery prior to making them more formal course offerings.

Our vision for the ISAP program is strategically aligned with the Environmental Science program. We both value providing student learning opportunities in community engagement, science communication and science policy. With the proposed new governance structure (C), we anticipate sharing intellectual resources to the benefit of both programs. See Appendix 5 to review ISAP synergies with the Environmental Science Strategic Plan.

B. Program Learning Outcomes and Assessment

B.1. Program learning outcomes and degree level expectations

Students in the ISAP program will take 2.0 credits in Mathematics, Statistics and Computer Science; a minimum of 2.0 credits in experimental sciences; and, at least one minor in a science discipline. This will allow them the flexibility to select the focus discipline(s) that will match their interests and to develop a foundation in science. The ISAP courses will bridge their disciplinary knowledge and broaden their perspectives. The Honours and General programs require 5.0 and 4.0 credits of ISAP courses, respectively.

We crafted the ISAP program as a series of building blocks. Rather than independent courses, each course promotes the program's learning outcomes and its interdisciplinary approach by integrating the content of prior courses to advance our students' knowledge and skill sets. This will allow students to acquire and practice these skills and apply knowledge acquired each year and across their program of study. By embedding ISAP's vision in demonstrable outcomes, our students will graduate with the capacity to articulate their program experience and describe and apply their knowledge, skill sets, and accomplishments.

The primary objective of the ISAP program is to provide a student-centered learning experience from an interdisciplinary perspective for those exploring science disciplines. Throughout all aspects of our curriculum, from content to mentoring, we will introduce students to lifelong learning, professional development, employment pathways, and further academic opportunities. In this fashion, our students will graduate with a balance between technical disciplinary knowledge and in-demand professional skills.

On completing the ISAP program, our students will be able to:

1. Explain the concept and value of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.
2. Apply critical inquiry to question biases, identify credible sources of information, synthesize key points, and distinguish between coincidental, correlational and causal relationships.
3. Explore and critique the impact of scientific advances at the community and global levels to act as informed stakeholders in the decision-making process.
4. Investigate and synthesize aspects of a local issue with global implications and present the results of a review of the issue, recommendation for key stakeholders as participants, proposal for an inclusive consultation process and, an appraisal of potential ethical considerations.

5. Address an issue by identifying a knowledge gap, developing a research question, designing data collection strategies, and identifying and evaluating relevant sources of information, including publically accessible data.
6. Locate and access publically available datasets; design and apply data analysis methodologies; and, interpret the results through training in statistics and computer science.
7. Explain the reciprocal influences of government policy and science on the decision-making process and its outcomes for science and society.
8. Work as a team member, independently and collaboratively, and apply the professional skills of self-reflection, active-listening and respectful negotiation.
9. Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences from the community and across science disciplines.

Each of the program learning outcomes encompasses the full set of the six Degree Level Expectations (DLEs) for undergraduate programs:

1. Depth and breadth of knowledge
2. Knowledge of methodologies
3. Application of knowledge
4. Communication skills
5. Awareness of the limits of knowledge
6. Autonomy and professional capacity

However, the level of emphasis varies and, as such, in Table B.1, the degree level expectations most closely associated are listed for each learning outcome, with the 2-3 key DLE for each presented in **bold text**. Each DLE is assigned to 3-4 program learning outcomes, with the exception of 'autonomy and professional capacity', which is listed 5 times, demonstrating the balance of key skills and knowledge that is inherent in the design of the ISAP program.

Table B.1: Learning outcomes and degree level expectations

Learning Outcomes	Degree Level Expectations Met
1. Explain the concept and value of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.	**1. Depth and breadth of knowledge** 3. Application of knowledge **4. Communication skills** 5. Awareness of the limits of knowledge **6. Autonomy and professional capacity**
2. Apply critical inquiry to question biases, identify credible sources of information, synthesize key points, and distinguish between coincidental, correlational and causal relationships.	1. Depth and breadth of knowledge **2. Knowledge of methodologies** 3. Application of knowledge 4. Communication skills **5. Awareness of the limits of knowledge**

	6. Autonomy and professional capacity
3. Explore and critique the impact of scientific advances at the community and global levels to act as informed stakeholders in the decision-making process.	**1. Depth and breadth of knowledge** 3. Application of knowledge 4. Communication skills **5. Awareness of the limits of knowledge** **6. Autonomy and professional capacity**
4. Investigate and synthesize a local issue with global implications and present the results of a review of the issue, recommendation for key stakeholders as participants, proposal for an inclusive consultation process and, an appraisal of potential ethical considerations.	**1. Depth and breadth of knowledge** 2. Knowledge of methodologies **3. Application of knowledge** 4. Communication skills 5. Awareness of the limits of knowledge **6. Autonomy and professional capacity**
5. Address an issue by identifying a knowledge gap, developing a research question, designing data collection strategies, and identifying and evaluating relevant sources of information, including publically accessible data.	1. Depth and breadth of knowledge **2. Knowledge of methodologies** **3. Application of knowledge** 4. Communication skills **5. Awareness of the limits of knowledge** 6. Autonomy and professional capacity
6. Locate and access publically available datasets; design and apply data analysis methodologies; and, interpret the results through training in statistics and computer science.	**2. Knowledge of methodologies** **3. Application of knowledge** 5. Awareness of the limits of knowledge 6. Autonomy and professional capacity
7. Explain the reciprocal influences of government policy and science on the decision-making process and its outcomes for science and society.	1. Depth and breadth of knowledge **3. Application of knowledge** **4. Communication skills** **5. Awareness of the limits of knowledge** 6. Autonomy and professional capacity
8. Work as a team member, independently and collaboratively, and apply the professional skills of self-reflection, active-listening and respectful negotiation.	1. Application of knowledge **4. Communication skills** 5. Awareness of the limits of knowledge **6. Autonomy and professional capacity**
9. Employ appropriate traditional and digital communication tools and styles to engage with a variety	1. Depth and breadth of knowledge 3. Application of knowledge **4. Communication skills**

of audiences from the community and across science disciplines.	5. Awareness of the limits of knowledge **6. Autonomy and professional capacity**

B.2. Program structure and curriculum map

a. Program structure

Emerging from our experience with the Integrated Science program,[45] we have reframed our former multidisciplinary approach into a comprehensive interdisciplinary curriculum. Although the terms, interdisciplinary and multidisciplinary, are often used interchangeably, ISAP differentiates between the concepts[46] which, in turn, distinguishes our current proposal from our prior implementation. The Integrated Science program, which closed to new admissions in 2013, aligned most closely with a multidisciplinary approach. We had offered BSc General and Honours streams with concentrations requiring our students to complete courses from multiple science disciplines. The capstone course for the BSc General was either INSC 3907 (Topics in Integrated Science) or INSC 3909 (Independent Study). Students in the honours stream would do one of INSC 4907 (Honours Essay and Research Proposal) or INSC 4908 (Honours Project). In consultation with faculty from a science-specific discipline, students undertook a project of their own choice, which did not necessarily cross science disciplines.

The ISAP curriculum proposes an interdisciplinary approach. With eight core courses spanning Year 1 through Year 3 and a choice of types of capstone projects for the Honours students in Year 4, we have structured the content and format of the ISAP courses to guide our students in all aspects of interdisciplinarity from critical inquiry to collaborative thinking across the sciences and beyond to interact with non-science stakeholders. Throughout all the topics of our curriculum, our students will explore and assess the uniqueness and commonalities of different science disciplines in order to create new models that would otherwise be unavailable with the lens of just one discipline.[47] Therefore, ISAP's goals align not only with Carleton's Strategic Integrated Plan (SIP) as described in Section A, but also with one of the Faculty of Science's primary imperatives from the Strategic Mandate Agreement[48], that of science interdisciplinarity.

[45] Carleton University. (2017). Integrated Science Institute. (2015-2016). http://calendar.carleton.ca/calendars/2015-2016/undergrad/courses/INSC/

[46] Resnick, J. (2012). Interdisciplinary and multidisciplinary research. https://www.4researchers.org/articles/5213

[47] Newell, W. (2010). Educating for a complex world: integrative learning and interdisciplinary studies. *Liberal Education*, *96*(4), 6-11.

[48] In line with Strategic Mandate Agreement 2.

To provide our students with an experience of science interdisciplinarity without sacrificing disciplinary identity, we have designed a curriculum that is a synergy between foundational skills in a student-chosen science discipline and the highly transferrable skills associated with a collaborative approach. Working within our resources, we will adopt a learner-centered, experiential pedagogy to reach across disciplines and into the community. As we increase our visibility, we will respond to student goals and emerging applications of interdisciplinarity. We will build on our Institute's collaborations with Indigenous groups to introduce students to different "ways of knowing". We anticipate, for example, using "citizen science" and "peer-to-peer science"[49] as innovative means to demystify science through effective communication, to build bridges between our students and the community, and to engage students and community in forging new models of critical analysis. Throughout the ISAP courses, our students will navigate the theory and practice of interdisciplinarity to strengthen their capacity for collaboration, critical inquiry, and science communication. To showcase this, all students in their third year, will contribute to the proposal of an interdisciplinary project (ISAP 3002). We anticipate that our Honours students will develop capstone projects that will reflect their interests from an interdisciplinary perspective, as well as involve them in an aspect of academic-community engagement, such as improving crop yields in community gardens. To showcase their progress, we will explore the use of supporting frameworks, such as cuPortfolio.

We used the 4.0 credits of our ISAP-specific curriculum to create an inclusive framework for consistent and comprehensive blending of interdisciplinarity reflected in collaboration, critical inquiry, and analysis with the fostering of "emotional intelligence" [50] associated with self-awareness, constructive criticism of competing approaches, and social skills[51] of active listening, respectful dialogue, and diplomacy. Overall, we have grounded our pedagogy in a continuum from lecture-style to open-ended student-centered experiential activities to capitalize on "best practices" from each teaching-learning style.[52] In Year 1, ISAP 1001 and ISAP 1002 will use a combination of lecture/presentation and seminar to introduce students to interdisciplinary science and its practical aspects of collaboration, communication, and exploration of the sciences and the scientific process. As our students complete courses in their chosen discipline during Year 2, ISAP 2001 and ISAP 2002 will re-enter and broaden the themes of interdisciplinarity through critical inquiry and research principles. While the sciences share a common method of systematic hypothesis,

[49] Delfanti, A. (2010). Users and peers: from citizen science to P2P science. *Journal of Science Communication, 9*(1), 1-5.

[50] Hagmann, J. & Almenkinders, C. (2003). Developing 'soft skills' in higher education. International Institute for Environment and Development. IIED. *PLA Notes, 48*, 21-25.

[51] Lawlor, B., Farrell, A., Jordan, A., Strawbridge, J., Brabazon, D., Casey, K., & Coughlan, A. (2014). Interdisciplinary communication skills - facilitating students from different disciplines to learn with, from and about each other. *5th International Symposium for Engineering Education*, 1-7.

[52] Lom, B. (2012). Classroom activities: simple strategies to incorporate student-centered activities within undergraduate science lectures. *Journal of Undergraduate Neuroscience Education, 11*(1), 64-71.

experimentation and observation,[53] each discipline has unique strategies and approaches. By Year 3, ISAP students will be well-prepared to use data analysis to explore topics and share interdisciplinary perspectives in ISAP 3001.

By examining complementary and, at times, conflicting datasets from different disciplines, our students will weave together the theoretical and practical concepts from prior courses into the development of ISAP 3002's research proposal. Because the value of data analytics requires dissemination of results, our students will practice effective science communication (ISAP 3003) and discover the cross-influences between science-based data and the decision-making framework for policy (ISAP 3004). The Directed Studies course (ISAP 4901) provides students with the option to explore a topic of particular interest that may not be available through other course options open to them. In Year 4, the Honours year, ISAP students will integrate the concepts and practical aspects of previous ISAP courses to complete a culminating experience or Capstone Project. To address the individual academic preferences and career goals of our ISAP students, we will offer students the choice of a Capstone Project that is a group research project (ISAP 4906), an individual research essay (ISAP 4907), or an individual research project (ISAP 4908). Depending on the topic and design of the Capstone Project, the student will work with the ISAP program advisor to identify an appropriate and willing faculty member as mentor and supervisor.

Thus, the core ISAP courses are:

ISAP 1001: Introduction to Interdisciplinary Science

ISAP 1002: Seminar in Interdisciplinary Science

ISAP 2001: Foundations in Critical Inquiry

ISAP 2002: Research Principles for Interdisciplinary Science

ISAP 3001: Principles and Applications in Data Analysis (runs in the fall term)

ISAP 3002: Applications in Interdisciplinary Research (runs in the winter term)

ISAP 3003: Science Communication (runs in the fall term)

[53] Garland, T. (2016). The scientific method as an ongoing process. University of California. Institute for the Development of Educational Applications.
http://idea.ucr.edu/documents/flash/scientific_method/story_html5.html

ISAP 3004: Science Policy (runs in the winter term)

ISAP 4901: Directed Studies

ISAP 4906: Group Research Project

ISAP 4907: Research Essay

ISAP 4908: Individual Research Project

Course descriptions for these courses can be found in Appendix 1.

Effective training in interdisciplinarity requires that ISAP students have a broad background in the sciences while respecting their individual interests. All students must complete 2.0 credits in an experimental science, as described in the BSc calendar regulations. Because ISAP students will need to develop the capacity to handle and interpret data, not only for our coursework, but also for future employment opportunities, ISAP requires 2.0 credits comprised of STAT 2507 (Introduction to Statistics); one of either Math 1007 or Math 1107 (Introduction to either Calculus or Algebra); COMP 1005 (Introduction to Computer Science); and one of either STAT 2509 (Statistical Modelling) or COMP 1006 (Computational Thinking). Recognizing the value that Economics brings to our curriculum, our students will complete ECON 1000 (Introduction to Economics) in order to appreciate the mechanisms of decision-making in science-based policy.

Students will be required to complete at least one science minor in a discipline of their choice. Although ISAP requires 3.0 credits in the minor, students must fulfill course prerequisites as determined by the discipline's department. We will also encourage our Honours students to consider a second minor, but we will not restrict them to the Faculty of Science should their interests be in a non-science area. We will require, however, that our ISAP students complete 1.0 credit (General) or 2.0 credits (Honours) outside of the Faculty of Science and the Faculty of Engineering.

Thus, all students in the ISAP Honours and General programs will take:

- 2.0 credits in experimental science as defined in the BSc calendar regulations
- 2.0 credits in:
    - 0.5 credits in Statistics (STAT 2507)
    - 0.5 credits in Mathematics (MATH 1007 or MATH 1107)
    - 0.5 credits in Computer Science (COMP 1005)
    - 0.5 credits in Statistics (STAT 2509) or Computer Science (COMP 1006)

- 2.0 credits in courses for the science minor
- 1.0 credits in courses from the Faculty of Science to complete the minor or as a science elective
- 1.0 credit in introductory Economics (ECON 1000)
- 4.0 credits in ISAP courses
- 1.0 credit in elective(s) outside the Faculties of Science and Engineering and Design, as stipulated by the BSc calendar regulations
- 2.0 credits in free elective courses

Students in the 20-credit Honours degree will also take:

- 1.0 credit a Capstone Project (ISAP 4906, 4907 or 4908)
- 1.0 credit in science at the second year level or above
- 1.0 credit in science at the third year level or above
- 1.0 credit in an elective outside of the Faculty of Science and the Faculty of Engineering and Design, as stipulated by the BSc calendar regulations
- 1.0 credits in free elective courses

Appendix 2 (ISAP Course Progressions) illustrates possible paths for ISAP students to complete minor(s).

b. Program curriculum map

In designing the ISAP curriculum, we were guided by four goals to balance science disciplinary identity with interdisciplinary collaboration: (1) a student-centered experience, (2) an authentic interdisciplinary experience throughout all ISAP-specific courses, (3) respect for disciplinary uniqueness and value, and (4) a progressive building to integrate new course content and practice with the building blocks of prior courses.

In Table B.2 we have summarized learning outcomes, associated courses, degree of mastery expected and basic activities and artifacts for the required courses and program elements. Each ISAP course encompasses multiple program learning outcomes. We have provided detail descriptions of the ISAP courses in Appendix 3..

Table B.2: Program curriculum map summary

Learning Outcomes	Program Components	Level (I, R, M)	Activities and Artifacts
1. Explain the concept and value of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.	2.0 credits in experimental science	I	Theory and application including lab work
	Minor in a science discipline	I-R	Theory and application including lab work
	ISAP 1001: Introduction to Interdisciplinary Science	I	Oral presentation on interdisciplinary contribution to a scientific advance.
	ISAP 1002: Seminar in Interdisciplinary Science	I	Diary of a scientific discovery or innovation
	ISAP 2001: Foundations in Critical Inquiry	I&R	Case study and debate
	ISAP 2002: Research Principles for Interdisciplinary Science	R	Explore methods to visualize data
	ISAP 3002: Applications in Interdisciplinary Research	R&M	Group research Proposal
	ISAP 3003: Science Communication	R&M	Evaluate different methods to communicate scientific concepts
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.
2. Apply critical inquiry to question biases, identify credible sources of information, synthesize key points, and distinguish between coincidental, correlational and causal relationships.	ISAP 1001: Introduction to Interdisciplinary Science	I	Opinion piece on scientific topic – identify biases.
	ISAP 1002: Seminar in Interdisciplinary Science	I	Critique media coverage of a science story
	ISAP 2001: Foundations in Critical Inquiry	R	Compare popular and scientific articles
	ISAP 2002: Research Principles for Interdisciplinary Science	I&R	Evaluate published data set
	ISAP 3001: Principles and Applications in Data Analysis	R&M	Assignments to analyze publically available data sets.
	ISAP 3002: Applications in Interdisciplinary Research	M	Group research Proposal

Learning Outcomes	Program Components	Level (I, R, M)	Activities and Artifacts
	ISAP 3004: Science Policy	R	Explore pros and cons of commercialization
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.
	STAT 2507 Introduction to Statistical Modelling	I	Theory and application.
3. Explore and critique the impact of scientific advances at the community and global levels to act as informed stakeholders in the decision-making process.	ECON 1000: Introduction to Economics	I	Theory and Application
	ISAP 1001: Introduction to Interdisciplinary Science	I	Oral presentation on interdisciplinary contribution to a scientific advance.
	ISAP 1002: Seminar in Interdisciplinary Science	I	Oral presentation on innovation and its impact on society
	ISAP 2001: Foundations in Critical Inquiry	R	Debate
	ISAP 3003: Science Communication	R&M	Case study: communicate the impact to different audiences.
	ISAP 3004: Science Policy	M	Role play: stakeholders in public consultation.
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.
4. Investigate and synthesize a local issue with global implications and present the results of a review of the issue, recommendation for key stakeholders as participants, proposal for an inclusive consultation process and, an appraisal of potential ethical considerations.	ISAP 2001: Foundations in Critical Inquiry	I	Case study
	ISAP 2002: Research Principles for Interdisciplinary Science	I&R	Explore a controversial science-based innovation, decision or story.
	ISAP 3002: Applications in Interdisciplinary Research	M	Role play
	ISAP 3004: Science Policy	R	Awareness of relevant policy and players in chosen minor(s).
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.

Learning Outcomes	Program Components	Level (I, R, M)	Activities and Artifacts
5. Address an issue by identifying a knowledge gap, developing a research question, designing data collection strategies, and identifying and evaluating relevant sources of information, including publically accessible data.	ISAP 1002: Seminar in Interdisciplinary Science	I	Diary of a scientific discovery or innovation
	ISAP 2001: Foundations in Critical Inquiry	I&R	Oral presentation on implications on extrapolating based on current knowledge
	ISAP 2002: Research Principles for Interdisciplinary Science	I&R	In groups, frame a research question
	ISAP 3001: Principles and Applications in Data Analysis	R	Survey publically available data-based resources
	ISAP 3002: Applications in Interdisciplinary Research	M	Group research Proposal
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.
6. Locate and access publically available datasets; design and apply data analysis methodologies; and, interpret the results through training in statistics and computer science.	COMP 1005: Introduction to Computer Science I	I	Write scripts demonstrating problem solving and computational thinking
	MATH 1007 Elementary Calculus I or MATH 1107 Linear Algebra I	I	Theory and application.
	ISAP 1001: Introduction to Interdisciplinary Science	I	Describe discipline appropriate databases (e.g. genbank, PDB)
	ISAP 2002: Research Principles for Interdisciplinary Science	I&R	Evaluate a public data set.
	ISAP 3001: Principles and Applications in Data Analysis	R&M	Theory and application . Use of public data sets.
	ISAP 3002: Applications in Interdisciplinary Research	R&M	Group research Proposal
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.

Learning Outcomes	Program Components	Level (I, R, M)	Activities and Artifacts
	STAT 2507 Introduction to Statistical Modelling	I	Theory and application.
7. Explain the reciprocal influences of government policy and science on the decision-making process and its outcomes for science and society.	ECON 1000: Introduction to Economics	I	Theory and Application
	ISAP 2001: Foundations in Critical Inquiry	I	Prepare pamphlet
	ISAP 3004: Science Policy	M	Role play: stakeholders in public consultation.
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.
8. Work as a team member, independently and collaboratively, and apply the professional skills of self-reflection, active-listening and respectful negotiation.	ISAP 1001: Introduction to Interdisciplinary Science	I	Write a summary of a classmate's interests in science
	ISAP 1002: Seminar in Interdisciplinary Science	I	Self reflection of your biases
	ISAP 2002: Research Principles for Interdisciplinary Science	R	Group exercise Theory
	ISAP 3002: Applications in Interdisciplinary Research	M	Group research proposal
	ISAP 3003: Science Communication	R&M	Small group project: compare local and global perspectives on an issue.
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.
9. Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences from the community and across science disciplines.	ISAP 1001: Introduction to Interdisciplinary Science	I	Explaining science to your family
	ISAP 1002: Seminar in Interdisciplinary Science	I	Illustrate the relationship between science fiction and science
	ISAP 2002: Research Principles for Interdisciplinary Science	R	Explore methods to visualize data.
	ISAP 3002: Applications in Interdisciplinary Research	M	Talking to stakeholders

Learning Outcomes	Program Components	Level (I, R, M)	Activities and Artifacts
	ISAP 3003: Science Communication	M	Conduct a risk assessment for a potential hazard and present a plan for communicating risk to a broad public audience.
	ISAP 4906/4907/4908	M	Capstone paper, poster and presentation.

In describing ISAP coursework that supports each learning outcome we identify specific courses, spanning the program that are building blocks to mastery. Learning outcomes span multiple courses, reflecting the students' progress through the curriculum from introductory to mastery levels.

Learning Outcome 1: Explain the concept and value of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.

As a foundation to support ISAP students as they explore interdisciplinarity, the ISAP program requires students take 2.0 credits of experimental science and a minor in at least one science discipline. To engage ISAP students with each other as a means to build bridges across and outside of science disciplines, the curriculum has six key courses distributed over the first three years of our programming. From ISAP's introductory course to the culminating Year 3 and Year 4 coursework, students will enter an environment in which individual interests and experiences contribute to collaborative learning through paired, small group, and large group activities. Our pedagogical framework will enhance the potential for enriched learning, increase the level of engagement with peers and the course content, and promote a safe setting for self-reflection and constructive knowledge building.[54]

ISAP 1001 (Introduction to Interdisciplinary Science) and ISAP 1002 (Seminar in Interdisciplinary Science) will blend lecture-style and seminars to develop collaborative skills, especially in general communication and reflection as students challenge their preconceptions on interdisciplinarity. Capitalizing on a collaborative approach, ISAP 2001 (Foundations in Critical Inquiry) and ISAP 2002 (Research Principles for Interdisciplinary Science) will reframe the foundational concepts into a coherent approach to address real-life science-based topics with local and global implications. At the conclusion of ISAP 2002, students will have mastered aspects of the research project from the identification of a knowledge gap to the development of a viable and ethical research question and methodology. To demonstrate the content integration from prior ISAP courses, students will complete ISAP 3002 (Applications in Interdisciplinary Research) and ISAP 3003 (Science Communication). ISAP 3002 will require students to elaborate aspects of the implementation of a research proposal from review ethics requirements to dissemination strategies

[54] Michael, J. (2006). Where's the evidence that active learning works? *Advances in Physiology Education, 30*, 159-167.

to meet the goals of diverse stakeholders. ISAP 3003 will focus on theory, strategies, tools and application with respect to effective science communication, a critical skill for the undergraduate curriculum.[55] Through experiential activities, case studies, and discussion activities, students will address issues of stakeholder types, goals, and communication styles in order to determine "best practices" for science communication in different formats from traditional to digital. For those students in the Honours stream, achievement of this learning outcome will be the framework for their Capstone Project (ISAP 4906, ISAP 4907, ISAP 4908).

Learning Outcome 2: Apply critical inquiry to question biases, identify credible sources of information, synthesize key points, and distinguish between coincidental, correlational and causal relationships.

Researchers have well documented the value of experiential student-learning, especially at the undergraduate level, [56] to promote deep(er) learning,[57] increase student engagement and develop transferable skills.[58] Often, however, undergraduates enter university without basic critical inquiry skills[59] that are essential in all fields and careers, especially science-specific disciplines of study.[60] Throughout the ISAP curriculum, we will guide students to develop strategies and tools in "conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action"[61]

We will introduce the concept and practice of critical thinking in ISAP 1001 and ISAP 1002 with individual, paired and small group activities designed to broaden our students' recognition of multiple perspectives of the same issue. To provide students with a framework to evaluate research findings, we will introduce

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[55] Brownell, S., Price, J., & Steinman, L. (2013). Science communication to the general public: why we need to teach undergraduate and graduate students this skill as part of their formal scientific training. *Undergraduate Neuroscience Education, 12*(1), 6-10.

[56] Penny, K., Frankel, E., & Mothersill, G. (2012). Curriculum, climate and community: a model for experiential learning in higher education. Ryerson University. http://www.ryerson.ca/content/dam/experiential/Penny,%20Frankel,%20Mothersill_IATED_paper_2012.pdf

[57] Fullan, M. & Langworthy, M. (2014). A rich seam: how new pedagogies find deep learning. Pearson Publications: North York, ON. http://www.michaelfullan.ca/wp-content/uploads/2014/01/3897.Rich_Seam_web.pdf

[58] Experiential Education Working Group. York University. (2013). A case for change: experiential education integration at York University. http://avptl.info.yorku.ca/files/2013/10/2013-10-30-EE-A-Case-for-Change-DRAFT-FOR-CONSULTATIONS.pdf

[59] Pandey, P. (2015). Enhancing critical thinking skills among authoritarian students. *International Journal of Educational Research Studies*, *1*(1), 58-64.

[60] Rowles, J., Morgan, C., Burns, S., & Merchant, C. (2013). Faculty perceptions of critical thinking at a health sciences university. *Journal of the Scholarship of Teaching and Learning*, *13*(4), 21-35.

[61] Scriven, M. & Paul, R. (1987). Defining critical thinking. 8th Annual International Conference on Critical Thinking and Education Reform. http://www.criticalthinking.org/pages/defining-critical-thinking/766

them to statistical methods in STAT 2507. As the students become more accustomed to self-reflection and questioning their biases and those of others, we use techniques, such as case studies, to formalize the concepts of critical inquiry in ISAP 2001 (Foundations in Critical Inquiry) and then to focus on their application from the perspective of interdisciplinary science research in ISAP 2002 (Research Principles for Interdisciplinary Science). By Year 3, ISAP students will be well situated to apply these principles in the field of data analysis to recognize biases, identify credible sources of data, assess the value of data, and interpret the results, especially with respect to coincidental, correlational and causal relationships. In this fashion, our students will complete ISAP 3001 (Principles and Applications in Data Analysis) and ISAP 3002 (Applications in Interdisciplinary Research) having mastered data collection protocols, and data analysis and assessment.

With the critical tools to collect, assess and explain the results of data analysis, ISAP students will examine the impact of evidence-informed data on the decision-making process underpinning science policy in ISAP 3004 (Science Policy). Using case studies, our students will identify and describe the key components of informed decision-making, the stakeholders and their scopes of influence, the role of science-based research, and the challenges and opportunities inherent in transforming science-based evidence into policy.[62] ISAP students in the Honours program will have a framework in which to situate their Capstone Project (ISAP 4906, ISAP 4907, ISAP 4908) and to showcase their mastery of discipline-specific knowledge within an interdisciplinary framework.

Learning Outcome 3: Explore and critique the impact of scientific advances at the community and global levels to act as informed stakeholders in the decision-making process.

ISAP graduates of the 21st century, as citizens and members of a community of practice, will carry the legacy of past scientific advances as they develop skills as future contributors. Scientific advances often generate strong oppositional, and potentially contentious, opinions from within the science community as well as the community-at-large with the potential to influence policy at regional, national, and international levels. As informed stakeholders themselves as well as key informants for other stakeholders, our ISAP students will have tools to compare and assess the immediate and long-range impact of these advances from multiple and contrasting perspectives to account for biases, belief systems, and distracting anecdotal pseudo-science. We anticipate inviting members of our community, including stakeholders from Indigenous groups, to broaden the perspectives of our students.

In Year 2, our students will receive intensive training and practice in higher-order analytical skills associated with critical inquiry through the use of focused content,[63] such as real-life based case studies. With an emphasis on active participation, students in ISAP 2001 (Foundations in Critical Inquiry) will deconstruct scientific advances to identify their component features; identify key arguments; analyze immediate and project long-term impacts; and interpret the local-global interrelationships. Students will

[62] Choi, B. (2005). Twelve essentials of science-based policy. *Preventing Chronic Disease, 2*(4), 1-11.

[63] Nardone, C. & Lee, R. (2011). Critical inquiry across the disciplines: strategies for student-generated problem posing. *College Teaching, 59*, 13-21.

also take ECON 1000 (Introduction to Economics) to learn about decision-making within the framework of limited resources. In the role of stakeholder and key informant, our ISAP students in ISAP 3003 (Science Communication) will learn skills and practice strategies of persuasive communication to articulate their arguments and influence the decision-making process. As a basis for informed-decision making, students in ISAP 3004 (Science Policy) will investigate the reframing of scientific advances as policy and the reciprocity between scientific advances and policy, especially in the areas of implementation and funding. As our Honours students prepare for their capstone projects (ISAP 4906, ISAP 4907, ISAP 4908), they will have the building blocks to identify, research, and present diverse opinions with the ultimate goal to synthesize and engage their "creative intelligence"[64] to recommend an innovative but defensible proposal to bridge an issue with local and global implications.

Learning Outcome 4: Investigate and synthesize a local issue with global implications and present the results of a review of the issue, recommendation for key stakeholders as participants, proposal for an inclusive consultation process and, an appraisal of potential ethical considerations.

Researchers and educators are focusing efforts on linking local and global, often referred to as "glocal" issues,[65] but find that there continues to exist a knowledge gap on describing the relationship and initiatives for a comprehensive approach.[66] "Glocal" issues, such as food and water security, health and well-being, affordable and clean energy, environmental stewardship, climate, responsible industry, and poverty[67] are interconnected, either directly or indirectly, with science thereby linking science, policy and society.[68] To equip our ISAP students with the capacity to address the reciprocity between local issues and global implications, we will introduce our students to the basic components of the research process in ISAP 2001 (Foundations of Critical Inquiry) and ISAP 2002 (Research Principles for Interdisciplinary Science) and then formalize the process in ISAP 3002 (Applications in Interdisciplinary Research), with specific emphasis on the barriers and drivers for an inclusive consultation process.

ISAP graduates may work in community-based organizations, potentially working with vulnerable populations. Through our courses, ISAP students will appreciate the value for an ethical approach, whether mandated or not, to ensure an equitable distribution of responsibilities and rights, protect all

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[64] Ambrose, D. & Sternberg, R. (2016). *Creative Intelligence in the 21st Century : Grappling with Enormous Problems and Huge Opportunities*. Rotterdam: Sense Publishers.

[65] Gupta, J., van der Leeuw, K., & de Moel, H. (2008). Climate change: a 'glocal' problem requiring 'glocal' action. *Environmental Sciences,* 4(3), 139-148.

[66] Rowthorn, V. (2015). Global/local: what does it mean for global health educators and how do we do it? *Annals of Global Health, 81*(5), 593-601.

[67] United Nations. (2015). Sustainable development goals. http://www.un.org/sustainabledevelopment/

[68] Scientific Advisory Board of the Secretary-General of the United Nations. (2015). Science, technology and innovation: critical means of implementation for the SDGs (Sustainable Development Goals). https://en.unesco.org/un-sab/sites/un-sab/files/Final_SAB_PB_MOI.pdf

stakeholders, especially those partners representing vulnerable populations as either researchers or respondents,[69] and to produce an authentic collaborative approach.[70]

Learning Outcome 5: Address an issue by identifying a knowledge gap, developing a research question, designing data collection strategies, and identifying and evaluating relevant sources of information, including publicly accessible data.

With each course introducing new concepts, re-entering lessons learned from prior courses, and integrating the students' command of their respective science discipline, our students will continue to deepen the richness of the research process with a more detailed elaboration of the components. In ISAP 1002 (Seminar in Interdisciplinary Science), students will explore the research process requiring them to identify what the possible steps are. With ISAP 2001 (Foundations in Critical Inquiry) and ISAP 2002 (Research Principles for Interdisciplinary Science), students will examine the interrelationship among the components that contribute to a coherent research approach, especially from the perspective of interdisciplinarity.

Continuing the developmental process, our students will complete ISAP 3001 (Principles and Applications in Data Analysis) and ISAP 3002 (Applications in Interdisciplinary Research) to deconstruct and analyze a current issue from multiple disciplinary perspectives. Activities will require students to review and recommend a feasible knowledge gap; create a relevant research question; identify vested stakeholders within and external to science-based disciplines; and examine and assess credible sources of publicly available data to support a research proposal. Through elaboration and integration of prior content and practice with new knowledge and practice, those ISAP students in our General program will have a solid approach to research with highly transferable collaborative skillsets and those continuing to complete a capstone project (ISAP 4906, ISAP 4907, ISAP 4908) will be well positioned with the tools for success.

Learning Outcome 6: Locate and access publically available datasets; design and apply data analysis methodologies; and, interpret the results through training in statistics and computer science.

Because science research is data dependent, we will introduce our ISAP students to the role and characteristics of credible data sources in ISAP 1001 (Introduction to Interdisciplinary Science). To provide a foundation in mathematical, statistical and computational methods, students will also take MATH 1007 (Elementary Calculus I) or MATH 1107 (Linear Algebra I), STAT 2507 (Introduction to Statistical Modeling) and COMP 1005 (Introduction to Computer Science I). In ISAP 2002 (Research Principles in Interdisciplinary Science), students will determine the role of data in crafting a research proposal, including the ethical issue of the selective use of data to support flawed research.[71] ISAP 3001 (Principles

[69] Minkler, M. (2005). Community-based research partnerships: challenges and opportunities. *Journal of Health Studies, 82*(2), 3-12.

[70] Resnick, D. (2015). What is ethics in research and why is it important? National Institute of Environmental Health Sciences. https://www.niehs.nih.gov/research/resources/bioethics/whatis/

[71] Chakrabarty, K. (2012). Uses and misuses of statistics. Center for Interdisciplinary Mathematical Sciences. https://ideas-repec-org.proxy.bib.uottawa.ca/p/ess/wpaper/id4888.html

and Applications in Data Analysis), the core course in data analysis, will provide ISAP students with strategies to find and assess publicly available datasets; assess their credibility as a research tool; apply appropriate data analysis methodologies in experiential activities; and, interpret the results. From theory to application, our students will understand how to handle data according to professional standards and protocols and have a command of the essential concepts of data analysis. Complemented by ISAP's required coursework in Statistics and Computer Science, our students will have the opportunity to demonstrate their data analysis skills in ISAP 3002 (Applications in Interdisciplinary Research) by incorporating data into their research proposals and using peer-evaluation for constructive criticism. For our ISAP graduates from a General program, they will have a firm understanding of the theory, techniques and application of data analysis. For those continuing to the capstone project (ISAP 4906, ISAP 4907, ISAP 4908), this comprehensive research framework, with a strong focus on data analysis, will ensure that the results of their projects are valid and reliable.

Learning Outcome 7: Explain the reciprocal influences of government policy and science on the decision-making process and its outcomes for science and society.

ISAP students will be introduced to informed decision-making and its impact on local, national and international communities in ECON 1000 (Introduction to Economics). To develop ISAP students' confidence for persuasive science communication to explain, convince and leverage science-informed information for decision making, ISAP students will learn science communication techniques in ISAP 3002 (Science Communication) and continue to implement them in ISAP 3004 (Science Policy). This sequence of courses will provide graduating students with the capacity to contribute in their career of choice and provide Honours students with the tools and structures to continue with the Capstone Project (ISAP 4906, ISAP 4907, ISAP 4908).

With individual and group activities in ISAP 2001 (Foundations in Critical Inquiry), such as case studies and debates, our students will have consistent and continuous opportunities to refine their skills to deconstruct an issue and then to explain the main concepts in language and terms accessible to their audience type. Our focused course, ISAP 3003 (Science Communication), will continue by formalizing the models of science communication and requiring our students to practice multiple forms of written and spoken styles. Not only will our students benefit from the theory of science communication, our consistent emphasis on practice will increase their self-confidence as presenters. By demonstrating different modalities of traditional and digital communication, our students will have the capacity to create inclusive communication practices for public engagement,[72] propose innovative strategies to reach stakeholders,

[72] Hetland, P. (2014). Models in science communication policy. *Nordic Journal of Science and Technology Studies, 2*(2), 6-17.

including those with visual and hearing adaptabilities,[73] and assess the impact of science communication for informed decision-making.[74]

Because communication plays a key role in collaboration, presentation, and dialogue with respect to science policy, students in ISAP 3004 (Science Policy) will demonstrate their mastery of the varied aspects of the policy process with practical application of the techniques of science communication. For graduating students, they will be well prepared to articulate their interests, experiences and achievements to prospective employers. For Honours students, they will have the requisite tools and strategies to present the results of their Capstone Project (ISAP 4906, ISAP 4907, ISAP 4908) in whatever style that is most effective for their purposes and targeted audience.

Learning Outcome 8: Work as a team member, independently and collaboratively, and apply the professional skills of self-reflection, active listening and respectful negotiation.

Interdisciplinarity moves on a continuum from independent activity to varying degrees of collaboration. Although our students will have foundational knowledge in their respective disciplines, they will be required to engage at some point in interdisciplinary collaboration. Throughout our curriculum from ISAP 1001 (Introduction to Interdisciplinary Science) and ISAP 1002 (Seminar in Interdisciplinary Science) to ISAP 3003 (Science Communication) and ISAP 3004 (Science Policy), our students will be deconstructing, discussing and creating potential approaches to society's local-global "wicked problems." These problems, such as food and water security, energy crisis, and environmental stewardship, resist readily available resolution.[75] Only through collaboration and interdisciplinarity at individual, community, national, and global levels and by all stakeholders in the science, social, economic, and political sectors might these problems be approached.

The concept of professional skills, appearing as early as 1972 in U.S. Army documents,[76] remain those skills, attributes and behaviours that enable and enhance interpersonal relationships. In general, these skills include, but are not limited to, respectful communication (written, oral, presentation using diverse media, and active listening); fundamental personal and business etiquette and, when appropriate, acknowledgement of cultural variations; flexibility and adaptability, especially in learning and teaching new skills and approaches; personal and professional integrity; empathy skills; emotional self-control; positive attitude; professionalism; accountability and reliability; individual and team member; positive

[73] Stender, A., Newell, R., Villarreal, E., Swearer, D., Bianco, E., & Ringe, E. (2016). Communicating Science Concepts to Individuals with Visual Impairments Using Short Learning Modules. *Journal of Chemical Engineering, 93*(12), 2052-2057.

[74] Herring, D. (2013). Assessing the impact of science communication. https://www.weblyzard.com/science-communication/

[75] Kolko, J. (2012). *Wicked problems: problems worth solving.* Austin, TX: Austin Center for Design.

[76] Whitmore, P. (1972). What are soft skills? Presented at CONARC Soft Skills Conference. http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA099612

work ethic; and common sense.[77] In an interdisciplinary collaborative environment, the capacity to engage with others in a positive style promotes "team science"[78] and increase the overall capacity to address complex issues.

Using a gradual learning curve, we will introduce our ISAP students to the skills of self-reflection, active listening, and respectful negotiation to explore, assess and navigate interdisciplinarity in the sciences in ISAP 1001 (Introduction to Interdisciplinary Science) and ISAP 1002 (Seminar in Interdisciplinary Science). Through experiential paired and group activities, our students will formalize the attitudes and behaviours associated with professional skills in ISAP 2002 (Research Principles for Interdisciplinary Research). Throughout the activities in ISAP 3002 (Applications in Interdisciplinary Research) and especially in ISAP 3003 (Science Communication), our students will demonstrate mastery of effective professional skills to design collaborative research proposals and deliver the results to engage the audience. For our Honours students, depending on the choice of capstone project (ISAP 4906, ISAP 4907, ISAP 4908), our students will have the opportunity, to one degree or another, to work collaboratively with each other or external stakeholders. Regardless of a student's ultimate path after graduation, these professional skills are highly transferrable and in demand to any sector.[79]

Learning Outcome 9: Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences from the community and across science disciplines.

As a member of an interdisciplinary community of practice, our students will need the technical skills to conduct and assess scientific research, but also the capacity to communicate the results across disciplines and with non-scientific stakeholders. These skills, often rare for incoming undergraduate students, are neither intuitive nor easily mastered,[80] but are in high demand by undergraduates.[81] Acting as mentors, instructional staff for ISAP 1001 (Introduction to Interdisciplinary Science) and ISAP 1002 (Seminar in Interdisciplinary Science) will create learning opportunities for students to overcome their apprehension and acquire, in a structured and protected environment, self-confidence in public speaking, especially with respect to science-based issues. Furthermore, our students will develop tools in different media for effective communication styles.

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[77] Robles, M. (2012). Executive perceptions of the top 10 soft skills needed in today's workplace. *Business Communication Quarterly, 75*(4), 453-465.

[78] Bennett, M., Gadlin, H., & Levine-Finley, S. (2010). Collaboration and team science: a field guide. Maryland: National Institutes of Health.

[79] Daley and Associates. (2016). Soft skills vs hard skills. What's more transferable? http://daleyaa.com/soft-skills-vs-hard-skills-whats-transferable/

[80] Carlgren, T. (2015). Communication, critical thinking, problem solving: a suggested course for all high school students in the 21st century. *Interchange, 44*(1), 63-81.

[81] Marinho, A., Mesquita de Medeiros, A., Gama, A., & Teixeira, L. (2017). Fear of public speaking: perception of college students and correlates. *Journal of Voice, 31*(1), 127:e7-127:e11.

In ISAP 1001 (Introduction to Interdisciplinary Science) and ISAP 1002 (Seminar in Interdisciplinary Science), students will gradually move away from their preferred style of communication to practice and assess different modalities of presentation on the same topic. As students become familiar with research protocols in ISAP 2002 (Research Principles for Interdisciplinary Science) and ISAP 3002 (Applications in Interdisciplinary Research), they will identify which style of communication best suits the purpose and target audience. In ISAP 3003 (Science Communication), we will encourage our students to take controlled risks in testing different traditional and digital communication styles and actively engage them in self- and peer-critiques to evaluate the effectiveness. While recognizing that our students' personalities vary along a continuum from introverted to extraverted, we will ensure that our students will consider the activities and the environment as a safe space to test new approaches. The capacity to communicate, whether as a general professional skill or in the specific arena of science communication, will serve all our graduates as they continue with their careers or exercise the option to complete a capstone project (ISAP 4906, ISAP 4907, ISAP 4908).

Activities and Artifacts Stemming from Learning Outcomes

Underpinning all aspects of interdisciplinarity are critical processing skills, a key capacity to interconnect concepts, theories and approaches across disciplines for collaboration and innovation. While critical processing skills are neither instinctive nor quickly acquired,[82] learning methodologies, activities and assignments all contribute to the maturing of these transferable skills. Throughout the ISAP curriculum, we have adopted an experiential, student-center framework to enable our students to develop and refine critical processing skills through individual, paired and group activities to produce artifacts that substantiate their evolving capacity to discover and interpret information within an interdisciplinary framework.

At its core, ISAP methodology is experiential learning or "learning by doing", preferably through goal-based activities.[83] Although we focus on the experiential student-centered approach, we recognize the value of other strategies, such as lectures[84] and discussion groups, as building blocks to develop multifaceted interdisciplinary critical inquiry. Through assignments, activities, and formative and summative assessments, our students will learn and apply deductive (information-pattern-tentative hypothesis-theory), inductive (theory-hypothesis-observation-confirmation),[85] and abductive (linking-

[82] Ivanitskaya, L., Clark, D., Montgomery, G., & Primeau, R. (2002). Interdisciplinary learning: process and outcomes. *Innovative Higher Education, 27* (2), 95-111.

[83] Reigeluth, C. (2013). Instructional-design theories and models: a new paradigm of instructional theory. Vol. 2. NY: Routledge.

[84] Adsit, J. (2012). Designing and delivering effective lectures. NY: SUNY. http://postdocs.stanford.edu/education/PDFs/2013_PDAC_Jan_18.pdf

[85] Nickerson, R., Perkins, N., & Smith, E. (2014). *The teaching of thinking*. NY: Routledge. DePoy, E. & Gitlin, L. (2015). *Introduction to research: understanding and applying multiple strategies.* NY: Elseiver Health Sciences.

innovative interpretation-best guess) reasoning[86] to real-life science-based issues establishing a structured yet flexible environment.

We will use the methodology that best suits the content, learning outcomes and feedback loops of each course with an iterative loop to maximize experiential learning in order to prepare our students for their careers after Year 3 (General) or for the capstone projects in Year 4 (Honours). In Year 1, we will use a blended approach of lectures and seminar discussion groups[87] to move our students from deductive to inductive reasoning. Lectures will introduce concepts and require students to engage in Bloom's basic skill level of remembering factual information while discussion group activities will require our students to demonstrate Bloom's more advanced levels of understanding with the capacity to reframe and explain these concepts and apply them to new situations. Although lectures and discussion groups will appear in the upper level ISAP courses of Year 2 and Year 3, the activities will increase student autonomy and focus on Bloom's higher levels of critical skills. Using a mentoring model, faculty members will foster our students' capacity to discover innovative interdisciplinary models across science disciplines by guiding their mastery to apply, analyze and evaluate.

Our assignments at the level of recall will focus on quizzes to help students to identify gaps in basic knowledge and provide instructors with feedback for review. Even at this level, however, we will lay the groundwork for more advanced critical thinking with simplified case studies and research assignments. For higher level critical thinking, we will continue with individual, paired and group activities to encourage collaboration and interdisciplinarity and introduce our students to more complex and less structured activities on communication, problem-solving, case studies, goal-oriented research, and creative risk-taking as a building block for innovated approaches.[88] Our assessment tools will emerge from the class activities and assignments, including but not limited to, research-based presentations using traditional and digital media, role playing, debates, and final course projects to integrate concepts within and across courses. Because professional skills is an integral factor for interdisciplinarity, but one that is not easily accessible to assessment, we will encourage students to maintain a journal that will represent their experiences throughout the courses. At the end of their ISAP experience, we will ask require students to summarize and reflect on their expectations, their personal and professional accomplishments throughout the program, and their changing concept of science interdisciplinarity as a result of the program.

As students advance through the ISAP curriculum, they will collect the artifacts of their experience for a variety of purposes. We anticipate that a retrospective review will provide a record of their progress in their understanding of their own science discipline as well as situating it in the interdisciplinary

[86] Kolko, J. (2010). Abductive thinking and sensemaking: The drivers of design synthesis. *MIT's Design Issues, 26*(1), 15-28.

[87] Garside, C. (1996). Look who's talking: a comparison of lecture and group discussion teaching strategies in developing critical thinking skills. *Communication Education, 45*(3), 212-227.

[88] Rolfe, H. (2010). Learning to take risks, learning to succeed. National Endowment for Science, Technology and the Arts. https://www.nesta.org.uk/sites/default/files/learning_to_take_risks_learning_to_succeed.pdf

framework. The ISAP course assignments will be evidence of their mastery and evolving integration of theory and practice, a sample to share with potential employers or future graduate schools. For the ISAP program and faculty members, in consultation with the students either on a course or program basis, this information will help to inform future revisions to the program to strengthen it through continuous quality improvement.

B.3. Program learning outcomes assessment plan

Faculty in the Institute of Integrated Sciences will assume responsibility for the assessment of program learning outcomes. As new faculty are hired, we will promote a collaborative approach to capitalize on diverse perspectives and build internal evaluation capacity.[89] With a limited number of faculty, we will be able to engage in impromptu discussion and formalize our "best practices" as an agenda item at our regular unit meetings.

Our overarching criterion for program evaluation will be the successful progress of our students through the curriculum. ISAP faculty are committed to student-centered learning, one aspect of which is to value our students' perspective on the definition of personal and professional achievement through the learning outcomes. Ideally, we would prefer to model a collaborative style and connect directly with our students through qualitative strategies such as focus groups. This approach, however, is resource-intensive and may not provide a sufficient standard of confidentiality. Thus, we anticipate that, in the beginning, we will meet these challenges with a hybrid of quantitative survey tools with open-ended questions and an invitation to students to volunteer to participate in additional qualitative strategies such as more in-depth discussions. In this fashion, we will establish a breadth of input as well as a depth of details. Regardless of the tool, ISAP faculty members are and will be committed to continuous quality improvement to strengthen the program to benefit the student.

Because the ISAP program will accept transfer students as well as direct entry students, we will need to offer a full curriculum, with the exception of the Capstone Projects (ISAP 4906, ISAP 4907, and ISAP 4908) by Year 2. In Year 3, all ISAP courses will be available. Our projected schedule for program assessment will be:

At the faculty member level, on a continuous basis

At the student level on a course basis with the mandatory university end-of-course evaluation.

At the student level through quantitative and/or qualitative tools developed in-house at the end of Year 2 (2020-2021), at the end of Year 4 (2022-2023) and end of Year 6 (2024-2025) to prepare for the 7-year cyclical review (2025-2026) by Carleton University.

We are confident that our program assessment plan will be inclusive of our diverse student population.

[89] Norton, A., Edwards, B., & Giffin, M. (2016). Narrative review of strategies by organizations for building evaluation capacity. *Evaluation and Program Planning, 58*, 1-19.

The Director of the proposed IEIS will share the results of all assessment tools with the faculty during faculty meetings and, as appropriate, with the students. Through discussions and curriculum review, faculty members will come to a consensus on an action plan to change and/or revise the content and/or format of the courses to ensure the relevancy and appropriate implementation of the courses to align with ISAP's vision and student goals.

In order to encourage ISAP students to develop critical processing skills, our courses' content and delivery will reflect Bloom's taxonomy of learning domains[90] and, as such, our feedback tools will enable students to assess their level of mastery of the theory and application. Each ISAP course reflects Bloom's taxonomy to differing degrees depending on the course objectives, but every course either introduces, re-enters, or demonstrates mastery of one or more levels.

- Level 1 domain of learning is **remembering**, which is the recall of factual information.
- Level 2 is **understanding** or the capacity to synthesize information and then explain the concept either verbally or in writing in a student's own words.
- Level 3 is **applying** as demonstrated by the ability to use a concept in a new situation.
- Level 4 is **analyzing** and the skills to deconstruct a concept into component parts.
- Level 5 is **evaluating** that will require our students to demonstrate the capacity to critique and judge based on a set of criteria.
- Level 6, **creating**, is the most complex whereby the student brings together the prior learning domains to forge a new concept.

In order to provide meaningful feedback to students, we will employ a variety of assessment instruments determined by the course content, its objectives, and student learning styles. These tools may range from conventional quizzes and tests to case studies to the research proposals on innovative interdisciplinary solutions to local, national and global issues and role playing to develop an understanding of diverse stakeholder perspectives (section B2). Because ISAP is designed to be flexible to recognize diverse student interests and learning styles, we will also favour recognizing different strategies for students to demonstrate mastery.[91]

Schedule for learning outcome program evaluation

First evaluation **at the end of the first year of implementation** of the program:

LO 1 Explain the concept and value of interdisciplinarity across the science and with the non-science fields and discuss science-related issues from diverse perspectives.

(ISAP 1001, 1002, 2001, 2002, 3002, 3003)

[90] Armstrong, P. (2017). Bloom's taxonomy. Vanderbilt University. Center for Teaching. https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

[91] Darling-Hammon, L. (2014). *Next generation assessment: moving beyond the bubble test to support 21st century learning.* N.Y.: John Wiley & Sons.

LO 8 Work as a team member, independently and collaboratively, and apply the professional skills of self-reflection, active-listening, and respectful negotiation.

(ISAP 1001, 1002, 2002, 3002, 3003)

LO 9 Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences from the community and across science disciplines.

(ISAP 1001, 1002, 2002, 3002, 3003)

First evaluation at the end of the second year of implementation of the program:

LO 2 Apply critical inquiry to question biases, identify credible sources of information, synthesize key points, and distinguish between coincidental, correlational and causal relationships.
(ISAP 1001, 1002, 2001, 2002, 3001, 3002, 3004)

LO 6 Locate and access publically available datasets, design and apply data analysis methodologies and interpret the results.
(ISAP 1001, 2002, 3001, 3002)

First evaluation at the end of the third year of implementation of the program:

LO 3 Explore and critique the impact of scientific advances at the community and global levels to act as informed stakeholders in the decision-making process.
(ISAP 1001, 1002, 2001, 3003, 3004)

LO 4 Investigate a local issue with global implications and present the results of a review of the issue, the recommendations for key stakeholders as participants, a proposal for an inclusive consultation process and an appraisal of potential ethical considerations.
(ISAP 2001, 2002, 3002, 3004)

LO 5 Address an issue by identifying a knowledge gap, developing a research question, designing data collection strategies, and identifying and evaluating relevant sources of information, including publically accessible data.
(ISAP 1002, 2001, 2002, 3001, 3002)

LO 7 Explain the reciprocal influences of government policy and science on the decision-making process and its outcomes for science and society. (ISAP 2001, 3004)

Courses whose delivery will trigger the first program level learning outcome evaluation for a particular outcome are shown in red.

It is our feeling that each outcome must be evaluated for three consecutive years after the relevant 'triggering' course is introduced in the program. This is particularly relevant to ensure that the outcome is being appropriately reinforced 1001, 1002as the student proceeds through the program. Following this initial period, it should be evaluated after a subsequent period of two years. Evaluation schedules beyond this initial seven year period (and therefore following the fist program review) can be developed based on the nature of any modifications made as a result of this initial schedule.

(Note that it is anticipated that upper year courses will be offered for transfer students one year before their normal implementation for students who entered the program in first year, it is felt that a formal evaluation is not desirable as these students will be achieving the learning outcomes in a somewhat changed manner and order.)

End of program year:	1	2	3	4	5	6	7
LO1	X	X	X	X	X	X	X
LO2		X	X	X		X	
LO3			X	X	X		X
LO4			X	X	X		X
LO5			X	X	X		X
LO6		X	X	X		X	
LO7			X	X	X		X
LO8	X	X	X	X	X	X	X
LO9	X	X	X	X	X	X	X

B.4.Program Essential Requirements

The program essential requirements of the **Interdisciplinary Science and Practice** (ISAP) have been reviewed in consultation with the Paul Menton Centre to ensure capacity for reasonable academic accommodation of students with disabilities, in accordance with the Carleton University Academic Accommodation Policy. The learning outcomes can be attained as outlined in the program description with the use of appropriate academic accommodations.

PREAMBLE

Program essential requirements are defined by the Ontario Human Rights Commission as "the knowledge and skills that must be acquired or demonstrated in order for a student to successfully meet the learning objectives of that… program." The program essential requirements are components that contribute to the achievement of the learning outcomes of the program.

Excerpt from the Ontario Human Rights Commission report: The opportunity to succeed: Achieving barrier-free education for students with disabilities - Post-secondary education

Appropriate accommodations should not lead to lowered standards or outcomes: rather, an appropriate accommodation will enable the student to successfully meet the essential requirements of the program, with no alteration in standards or outcomes, although the manner in which the student demonstrates mastery, knowledge and skills may be altered.

The aim of accommodation in a post-secondary educational context is to provide equal opportunities to all students to enjoy the same level of benefits and privileges and meet the requirements for acquiring an education. Based on these principles, an accommodation will be considered appropriate where it will result in equal opportunity to attain the same level of performance, or enjoy the same level of benefits and privileges experienced by others, or if it is proposed or adopted for the purpose of achieving equal opportunity and meets the individual's disability-related needs. - See more at: http://www.ohrc.on.ca/en/opportunity-succeed-achieving-barrier-free-education-students-disabilities

Paul Menton Centre

The Paul Menton Centre is responsible for assessing requests for academic accommodation of students with disabilities through evaluations that are carried out on an individual basis, in accordance with human rights legislation and University policy, and with the support of relevant, professional/medical documentation. Students will only receive academic accommodation if the functional limitations of their disability impact directly on their academic performance.

C. Governance

The ISAP program will be administered by the Institute of Environmental and Interdisciplinary Science (IEIS). The IEIS Director will oversee the broad operation of the program as well as the assignment of teaching and coordination of contract instructors and teaching assistants. Currently Steven Cooke (primary appointment is ENSC) is operating as Director of ISI and is supporting the development of the ISAP program so that the transition is already underway. The ISAP Program Advisor will be responsible for student advising. In keeping with the practice of other departments in the Faculty of Science, teaching relief for these administrative roles will be required. In addition, the oversight of student e-portfolios across the program and the on-going development of a network of community partners will require significant investment of time, which will need to be offset by management of the teaching load. There will be a shared curriculum committee for ENSC and ISAP emphasizing the extent to which the faculty members within the shared governance unit (i.e., IEIS) will interact. We anticipate that the advising, oversight and administrative roles will rotate among the ISAP faculty (which will become part of the IEIS). The additional faculty positions requested in the budget are necessary to deliver the ISAP program as envisioned. The new faculty will provide the membership for requisite department committees (e.g. curriculum, tenure and promotion – Note – these will be done jointly with the ENSC unit after the merger to form the IEIS), gradually take on increasing responsibilities during the course of the initial 6 years (outlined in table D.1.2). Section B.3 describes the engagement of ISAP faculty with assessment of learning outcomes and the process for accomplishing this. We anticipate that the new instructor will participate in student advising from year one, while each of the two new assistant professors will be given three years with minimal administrative duties in order to establish their research programs and secure funding, as required for their research.

The creation of the Institute of Environmental and Interdisciplinary Science (IESI) constitutes a change in governance requiring the merger of the Institute of Environmental Science (IES) and Integrated Science Institute (ISI) (see below). This merger is currently progressing through appropriate channels (it was first approved by the Science Faculty Board in 2017 and as of January 2018 is making its way to Senate for formal approval) As noted below there is good reason for merging these two units given commonalities in resourcing and the inherent interdisciplinary focus. Currently, ISI has three faculty (Julia Wallace (50%, Susan Aitken 25% and Pamela Wolff (10%)). In addition, there are 3 ENSC faculty members who will be associated with the program (Cooke, Vermaire and Bennett). Julia Wallace, Susan Aitken and Pam Wolff will provide guidance and mentoring to new faculty and take on the primary responsibilities of administration of the program and academic unit for the first 3 years.

Student participation in program evaluation, review and general IEIS meetings will be an important component of the governance structure. Such mechanisms for student participation already exist in ENSC and were previously embedded within ISI such that this will be easy to achieve.

Proposal Text: Merger of the Institute of Environmental Science and the Integrated Science Institute

Environmental Sciences has been developing as an interdisciplinary discipline for many years now. It is highly collaborative, and at Carleton has forged linkages with many academic disciplines. This includes non-zero cross-appointments in academic departments to facilitate research, including Biology, Earth Sciences, and Geography (notable in terms of interdisciplinarity as being a unit in the Faculty of Arts and Social Sciences).

Integrated Science was founded to provide academic programing and curricula for students whose academic interests do not fit within conventional disciplinary boundaries. While the original program was closed, the members of the Institute have been actively developing a new program to meet the goals of students with inter/multi-disciplinary interests and an interest in how science engages with society.

There are synergies between their missions, and intellectual overlap in the faculty members between these two institutes. Further, they share administrative resources. It has become clear that it would make sense to merge these two entities into a single new Institute – the Institute for Environmental and Interdisciplinary Sciences.

The new Institute would have a single Director. Programs under the Institute's responsibilities would maintain their academic distinctiveness (e.g., for recruitment/advertising/budgeting/tracking enrollment and program success) and would be overseen by subcommittees of the Institute (including matters related to learning outcomes and quality assurance), bringing together those participating in the delivery of the programs (there is likely to be overlap in these subcommittees, given common interests). The Institute would also administer the interdisciplinary first year seminar course, NSCI 1000, a course serving students from across the Faculty of Science.

The Director would be a member of the Science Faculty Board Executive (the Chairs and Directors group) and the Institute would function as a single entity for other purposes and responsibilities of academic units under Senate regulations and matters related to collective agreements (e.g., Tenure and Promotion).

Motion: That Faculty Board/Senate approve the creation of the new Institute of Environmental and Interdisciplinary Sciences, merging the existing Institute of Environmental Science and the Integrated Science Institute effective July 1, 2018.

Motion: Conditional upon passage and implementation of the first motion, the Institute of Environmental Science and the Integrated Science Institute be dissolved on June 31, 2018.

D. The Faculty

D.1. Faculty appointed to the unit or program.

The proposed faculty in the ISAP program includes the three faculty members currently appointed to ISI (Julia Wallace, Pam Wolff, and Sue Aitken) and three new faculty positions. The new faculty will have a strong foundation in the sciences with expertise in one or more of the primary themes woven into the ISAP program. The expertise of the three proposed positions will complement that of the current faculty. Rounding out the faculty complement, three additional faculty members in the proposed IEIS (Steven Cooke, Joseph Bennett and Jesse Vermaire) will provide intellectual input into course design and opportunities for student supervision.

Our current faculty members (Table D.1.1) bring disciplinary expertise in the physical and life sciences and have incorporated the principles of interdisciplinary collaboration throughout their respective careers. We comprise a balance of appointments (two full professors, two assistant professors, and two instructors) as well as a gender balance (three women and three men). Our collective experience provides the foundation for the successful implementation of the ISAP program, including mentoring new faculty, crafting the curriculum to benefit our students during their studies and beyond, and to engage with community partners to advance opportunities for our students. To capture the breadth and depth of our current faculty, we have highlighted our experiences in a series of snapshot profiles below.

Table D.1.1: Core program faculty

Faculty Name	Rank	M / F	Appointment Status	Percentage Appointment	Supervision Privileges[1]	Area of Specialization/Field Affiliations
Susan Aitken	Full Professor	F	tenured	100%	D	Biochemistry – enzyme structure-function relationships
Steven Cooke	Full Professor	M	tenured	67%	D	Broad interests in all aspects of aquatic ecology, conservation biology, and human

						dimensions of natural resource management, interdisciplinarity, and the science-policy interface
Joseph Bennett	Assistant Professor	M	preliminary	67%	D	Environmental Science, species invasions, species conservation, spatial statistics, biogeography, applied ecology, evidence synthesis
Jesse Vermaire	Assistant Professor	M	preliminary	80%	D	Aquatic ecosystems and environmental change, citizen Science
Julia Wallace	Instructor III	F	confirmed	50%	U	Physics – magnetic resonance imaging. Science Communication.
Pamela Wolff	Instructor III	F	confirmed	10%	U	Chemistry

[1] D=full privileges; M=full privileges at master's level only; U=undergraduate supervision (typical for Instructors); CD=co-supervision privileges at doctoral level, full privileges at master's level; CDM=co-supervision privileges only at both doctoral and master's level; CM=co-supervision privileges at master's level, no privileges at doctoral level.

Dr. Susan Aitken completed her PhD in Biochemistry in 2000 followed by NSERC-funded postdoctoral work at the University of California (Berkeley), Dr. Aitken joined Carleton University as an Assistant Professor in Biology and Biochemistry in 2003. While maintaining an active research and teaching agenda, Dr. Aitken accepted a variety of administrative appointments including Associate Chair (Graduate Programs, Biology, 2010-2012), the lead developer for the MSc in Health: Science, Health, Science, Technology and Policy (HSTP) as well as guiding the development of the HSTP Institute and its subsequent transition to the Department of Health Sciences (2014). She was Director of the HSTP Institute during its formative years (2012-2014) and later the Chair of the Department of Health Sciences (2014-2016). Concurrently, she was the program lead for the BHSc (2012-2013), which was launched in 2014. Throughout her instructional assignments and curriculum design accomplishments, interdisciplinarity and community engagement have been informing principles. The success of graduate students from the first three cohorts (2013, 2014, and 2015) in transitioning to PhD studies, medical school or permanent careers in the government and not-for-profit sectors speaks to her expertise in crafting effective programs.

Dr. Aitken's innovative instructional approach, leadership in the development of interdisciplinary academic programs, and her commitment to student-centered training and research has been recognized. She received the Research and Academic Excellence Award (2013), the Faculty Graduate Mentoring Award (2010), the Carleton University Teaching Achievement Award (2007-2008) and the Faculty of Science Teaching Award (2006-2007). Although not a formal award, she is particularly pleased with her selection as one of Carleton's "Most Awesome Professors (2007)," a recognition by undergraduate students. In

addition, Dr. Aitken has been active in initiatives including the 321 Contact mentoring program for new faculty (2006-2008) and the Faculty Teaching Certificate (2008-2009). In 2013, Dr. Aitken was nominated and participated as a member of the first Carleton Leader (Level 3) program to develop organizational leadership capacity.

Dr. Steven J. Cooke is currently the Canada Research Chair (Tier II) in Fish Ecology and Conservation Physiology at Carleton University. He began his environmental career as a high school student working seasonally with the Grand River Conservation Authority in Ontario. He completed his undergraduate studies in Environment and Resource Studies at the University of Waterloo. He then stayed at Waterloo for his M.Sc. in Biology before moving to the University of Illinois. For his Ph.D. dissertation, he worked with Dr. David Philipp and Dr. David Wahl at the Illinois Natural History Survey to study the physiological diversity of centrarchid fishes. Dr. Cooke was then an NSERC and Izaak Walton Killam Post Doctoral Fellow at the University of British Columbia between 2002 and 2005 where he worked with Drs. Scott Hinch, Tony Farrell and Mike Healey and conducted research on sockeye salmon migration biology. At UBC he taught courses on conservation biology and fish ecology and management. In 2005, Dr. Cooke accepted a tenure track faculty position at Carleton University in the Institute for Environmental Science and Department of Biology where he is Director of the Fish Ecology and Conservation Physiology Laboratory. Cooke became full Professor in 2016 and currently serves as Director of the Institute for Environmental Science and Director of Integrated Science. Cooke currently supervises 7 post docs and 26 graduate students. Dr. Cooke is also a Research Affiliate at the Illinois Natural History Survey, a Research Associate at the University of British Columbia, and an adjunct professor at the University of Waterloo.

Since arriving at Carleton he has taught undergrad courses in integrated coastal management, aquatic restoration, and environmental science, and graduate courses in advanced fish ecology, applied ecology, conservation science, and experimental marine biology. His laboratory is funded by the Canada Foundation for Innovation, the Ontario Research Fund, and the Natural Sciences and Engineering Research Council of Canada as well as many other government, industry, and NGO partners. Dr. Cooke has over 600 peer reviewed publications in leading fisheries, ecology, conservation, and physiology journals which have been cited more than 18,000 times. Cooke has been active in an editorial capacity. He is founding editor of the Oxford University Press journal “Conservation Physiology” (Impact Factor of 2.3) and is handling editor, associated editor, or board member for Endangered Species Research, Fisheries Research, Restoration Ecology, Environmental Biology of Fishes, Environmental Reviews, and Journal of Animal Biotelemetry. In 2008 he was awarded the Medal from the Fisheries Society of the British Isles in recognition of his contributions to global fisheries issues at an early stage in his career. In 2015 he was selected as an NSERC E.W.R. Steacie Fellow (for the top 6 NSERC researchers under age 40). He was also appointed to the Royal Society of Canada’s College of New Scholars, Artists, and Scientists where he is leader for a project evaluating the role of interdisciplinarity in the Canadian academy.

Dr. Cooke’s lab maintains broad interests in all aspects of aquatic ecology, conservation biology, physiological ecology, animal behaviour and environmental science. Freshwater and marine fishes are used as research models for experiments conducted in laboratory tanks, experimental ponds, and most commonly, field sites. Specific interests are (1) determining the energetic, fitness, and potential evolutionary consequences of a variety of natural (e.g., winter, reproduction) and anthropogenic (e.g.,

angling, environmental pollution) stressors and, (2) understanding the diversity of energetic, physiological, and behavioural responses of fish to stress at the individual, population, and species level. The lab then applies the fundamental knowledge derived from these basic research activities to aid in the conservation and management of aquatic resources. Of late, Dr. Cooke has been involved with defining the new discipline of "conservation physiology" – a field dedicated to understanding the mechanisms underlying conservation problems. Cooke has particular expertise in the study of free-swimming fish in the wild using biotelemetry. He has applied these approaches to a variety of issues, most recently to address issues related to fish passage (including the development of the CanFishPass database for DFO), entrainment and hydropower impacts. Cooke is also well known for his work on catch-and-release science and global recreational fisheries. In that capacity Cooke has been contracted to develop the code of practice for responsible recreational fisheries for the UN FAO. Cooke holds a number of leadership positions including Chair of the Sea Lamprey Research Board of the Great Lakes Fishery Commission and Chair of the Science Advisory Committee for the Ocean Tracking Network. He has served as President of the Canadian Conference for Fisheries Research and the Canadian Aquatic Resources Section of the American Fisheries Society. He is currently President-Elect for the International Section of the American Fisheries Society.

Dr. Joseph Bennett is an Assistant Professor at the Institute of Environmental Science and Department of Biology at Carleton University. He is a co-director of the Geomatics and Landscape Ecology Laboratory (GLEL), and an Associate Editor at the Journal of Applied Ecology. Research in his lab focuses on conservation prioritization, invasion ecology, optimal monitoring, biogeography and spatial statistics. It is funded by individual and industry partnership grants from the Natural Sciences and Engineering Research Council of Canada (NSERC), and by the Ontario Ministry of Natural Resources and Forestry (MNRF). Dr. Bennett has a particular interest in practical questions regarding invasive species control and management to protect threatened species. He also works on theoretical questions regarding the value of monitoring information and the determinants of community assembly in terrestrial and aquatic ecosystems.

Dr. Bennett completed his BSc and MSc at Queen's University, and his PhD at the University of British Columbia, under the supervision of Dr. Peter Arcese. He held a postdoctoral research fellowship at the University of Queensland in Australia under the supervision of Prof. Hugh Possingham, and was awarded a prestigious Banting postdoctoral research fellowship to work at the University of Toronto, which he declined to take up his position at Carleton. His non-academic experience includes working for provincial and federal governments, with non-governmental agencies and as a private consultant. Highlights include consultative research to improve rural water policy in South Africa, promoting the benefits small-scale protected areas in Laos, and designing and conducting environmental monitoring projects to mitigate Arctic contamination. Dr. Bennett has also had the privilege of working with over 30 indigenous communities in Canada and internationally. He incorporates perspectives from these diverse experiences into his teaching and graduate student mentorship.

Dr. Bennett's research has been published in prestigious journals including *Science, Proceedings of the National Academy of Sciences,* and *Nature Ecology and Evolution*, and has been profiled in over 100 media outlets, including the New York Times, VICE, msn.com, CTV News, The Globe and Mail, the Christian

Science Monitor, The Daily Mail, Nature Magazine ("Research Highlight" section), Science Magazine (News section), The Sydney Morning Herald, The Ottawa Citizen, and Foreign Affairs magazine.

Dr. Jesse Vermaire is currently an Assistant Professor with the Institute of Environmental Science and cross-appointed with the Department of Geography and Environmental Studies at Carleton University. Dr. Vermaire heads the Aquatic Ecosystems and Environmental Change Laboratory at Carleton with a research focus on the long-term impacts of human activity on our freshwater resources. He completed his BSc. Honours degree in Biology at the University of Guelph and worked for a year in the agriculture sector and as research assistant at the University of Guelph before beginning his MSc in Biology, with a focus on paleoecology, at the University of New Brunswick in Fredericton. Upon completion of his MSc, Dr. Vermaire began a PhD at McGill University under the supervision of Dr. Irene Gregory-Eaves. His PhD research focused on human impacts on submerged aquatic plants, near-shore habitat, and water quality of lakes in the Eastern Townships of Quebec. Following his PhD from 2010 to 2012 Dr. Vermaire was a FQRNT Postdoctoral Fellow in the Department of Geography at Carleton University under the supervision of Dr. Michael Pisaric where he examined climate change related impacts such as greater storm surge intensity and permafrost thaw, on northern lake ecosystems in Canada's Northwest Territories. From 2012-2013 he then worked as a Watershed Monitoring Specialist for the Credit Valley Conservation Authority before joining Carleton as an Assistant Professor in 2013.

Since arriving at Carleton Dr. Vermaire has taught undergraduate courses in aquatic ecology, environmental science, and resource management as well as graduate courses in limnology and environmental change. He currently supervises eight graduate students (3 PhD and 5 MSc) working on human impacts of freshwater systems ranging from micro-plastics to nutrient enrichment. His laboratory is funded by the Canada Foundation for Innovation, the Ontario Research Fund, and the Natural Sciences and Engineering Research Council of Canada as well as support from research partners in Government and NGOs. Dr. Vermaire has published 20 peer-reviewed scientific articles and numerous reports for government and lake association groups. He maintains research interests in human impacts on near-shore habitat in lake ecosystems, micro-plastic pollution of freshwater, and the environmental impact and recovery of aquatic ecosystems exposed to legacy contamination. He employs a number of approaches ranging from paleolimnology to bioindicators to understand the long-term impacts of human actions on freshwater systems to help inform management and conservation of lakes and rivers in a changing environment.

Dr. Julia Wallace served as Director of the Integrated Science Institute from 2014-2017, and as the associate director before that. She is currently on sabbatical. She has a multidisciplinary background, earning a B.Sc. Honours in Physics and Mathematics (1983), a M.Sc. in Biology (1985), and a Ph.D. in Medical Physics (1996). Her doctoral research involved using mathematical classification methods to distinguish between treatment sensitive and resistant ovarian cancers using their proton magnetic resonance spectra. Following her doctorate, she was a Project Fellow and lab manager at the Carleton Magnetic Resonance Facility (CMRF).

Dr. Wallace joined the instructional staff at Carleton University in 2004 becoming a confirmed (tenured) Instructor in 2009. Dr. Wallace focuses on instructional design, relevant course content and a student-

centered learning environment. In 2007, Dr. Wallace was awarded the Contract Instructor Teaching Award as recognition for her on-going excellence in undergraduate teaching. She has taught courses from the first year to the graduate level and has designed two new courses for the Faculty of Science. Two of the courses Dr. Wallace teaches (NSCI 1000 and INSC 3907) incorporate Science Communication as components. As recognition, Dr. Wallace was invited to review a textbook on science student writing[92].

To remain current in the varied aspects of undergraduate teaching, advising and mentoring, she has completed the Certificate in University Teaching (2010) and the Certificate in Blended and On-line Courses (2015), as well as workshops on topics such as "A Classroom for All Students" (2016), "Teaching First-Year Courses" (2015), and "Creativity in the Classroom" (2017). As part of her 2017-2018 sabbatical plan, Dr Wallace is continuing her professional development by enrolling in the Certificate for Science Communication and Public Engagement at the University of Edinburgh.

Dr. Wallace has been a member of the Ottawa Medical Physics Institute (OMPI) since her graduate student days at Carleton. Through her participation in this active research network, she is able to connect students to research opportunities and create interconnections between the community and the classroom for undergraduate and graduate students.

As an illustration of Dr. Wallace's collaboration on program design, she has worked with the School of Journalism and Communication to propose a concentration in Health Science Journalism (2017). With the initiative for the current ISAP proposal, Dr. Wallace has contacted diverse academic and non-academic stakeholders as key informants. Julia's interest in preparing students for future careers has led her to develop a co-op program for the former Integrated Science program (2012), including the supervision of a Dean's Summer Research Internship student who investigated "Undergraduate Science Students' Perceptions of Future Employment and the Relative Importance of Skills" (2017) and is currently collaborating on a professional practice course for the physics department. In order to showcase student achievements, Dr. Wallace has used cuPortfolio in her first year seminar classes as well as sitting on the cuPortfolio Faculty Learning Community.

At the institutional level, Dr. Wallace is currently participating in the Carleton Leader Program (Level 2). This model, engaging a group of twenty faculty and staff, is designed to promote collaboration and to develop leadership to enhance Carleton's organizational culture. As part of this program, Julia is a member of the Strategic Impact Group working on a student-focused initiative to support students in difficulty or distress.

Pamela Wolff served as Director of the Integrated Science Institute from 2004 to 2014 and since 2014 has continued as Associate Director. She completed her MSc in Chemistry in 1990 and, after working as a Contract Instructor between 1990 and 2001, she joined the Carleton teaching staff as a confirmed Instructor. Her primary appointment is to the Chemistry Department (0.75 FTE), and she is cross-appointed to the Institute of Environmental Science (0.15 FTE) and the ISI (0.1 FTE). Because Pamela has

[92] Northey, Margot, and P. Von Aderkas.(2015). *Making Sense in the Life Sciences: A Student's Guide to Writing and Research*. Don Mills, Ontario: Oxford UP

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considerable experience teaching Introductory Chemistry courses at the first year level, especially to Engineering students, she has served as a textbook reviewer.[93] She has also developed an interdisciplinary course "Natural Laws" at the second-year level as well as a third-year level course in which students are guided in the use of primary scientific literature and the writing a literature review. She has also designed two new courses for the Faculty of Science.

Pamela has reinforced her commitment to undergraduate teaching by earning the Certificate in University Teaching and the Certificate in Blended and On-line teaching, and has completed the graduate-level Seminar in University Teaching (PSYC 6104), offered by the Carleton Psychology Department. She is an active participant in workshops on all aspects of teaching and learning and has been featured by Carleton's Teaching and Learning services in "Chalkboard teaching in the age of technology", an article describing the blending of traditional and digital aspects of teaching .[94] Most recently, Pamela received funding from the Ontario government to develop an on-line open content course for e-Campus Ontario titled "The Laws of Nature Through the Lens of Physics and Chemistry". As an acknowledgement of her commitment to undergraduate teaching, Pamela has received the Faculty of Science Teaching Award (1995) and, in 2016, was selected by students in the Carleton residence community for their student-initiated favourite Faculty Member Award.

With more than 15 years of experience as an undergraduate advisor, Pamela is dedicated to supporting students throughout their academic careers and helping them to reach their full potential. She has extensive experience in academic curriculum management and has served on Science Committee on Academic Planning for most of those years as well as two terms as a member of the Carleton University Senate. Pamela is currently serving on the Senate Academic Governance Committee and is the Faculty of Science representative on the Undergraduate Student Experience Advisory Committee (previously the Working Group on Undergraduate Student Engagement) and the Faculty of Science representative on the University Timetabling Committee.

Pamela is an active advocate of science communication and public engagement, as illustrated by her current role as the host of the Faculty of Science outreach program "Science Café". Beyond the university community, she has experience working with the National Museum of Science and Technology Corporation (NMSTC) as a Science Educator and an Astronomy Educator, developing and delivering astronomy programming for child and adult audiences as well as for public school classes.

The ISI faculty complement is currently 0.85 full-time equivalents (FTE). As noted in Table D.1.1, Julia Wallace is 0.5 FTE in the Institute (Instructor); Pam Wolfe is 0.1 (Instructor); and Sue Aitken is 1.0 FTE (Professor) in the proposed IEIS and is currently 0.25 FTE in ISI. Recognizing that the implementation of all aspects of the ISAP proposed program, including assessment, advising, teaching, hiring and ongoing administration, will require more than 0.85 FTEs, the ISAP proposal includes three new faculty. Our new faculty will have a strong foundation in the sciences with additional expertise in Science Communication

[93] Brown, L. & Holme, T. (2015). *Chemistry for Engineering Students.* Stamford, CT: Cenage Learning.

[94] Hendry, C. (2015). Chalkboard teaching in the age of technology. https://carleton.ca/teachinglearning/2015/chalkboard-teaching-in-the-age-of-technology/

(Instructor, Year 1), Data Science (Assistant Professor, Year 1) and Community Engagement in a science context, such as "Citizen Science" (Assistant Professor, Year 3). It is worth noting that the program received approval from the Carleton Financial Planning Group in November of 2017 which included a formal acknowledgement of the aforementioned new instructional and support staff.

Table D.1.2 illustrates how the teaching and administrative assignments could be distributed during the first six years of program operation. Priorities include mentoring new faculty in course development, student advising and program administration, and providing support for the new assistant professors to develop their research programs. With respect to teaching, each of the new faculty will have the opportunity to teach courses within their expertise:

Instructor

Date to be hired: start of year 1

Expertise: Science Communication

Example course assignment: ISAP 1001 - Introduction to Interdisciplinary Science

ISAP 2001 - Foundations in Critical Inquiry

ISAP 3003 - Science Communication

ISAP 4907 - Capstone Course - Research Essay

This course assignment would ensure that science communication is introduced in the Fall term of the first year and maintained as a theme through the successive years. While one faculty member will coordinate a given fourth year capstone option (e.g. ISAP 4907 in this example), the collaborative design of the program will ensure that faculty will support each other in the delivery of courses at each level, particularly the first year introductory courses and the fourth year capstones. As a result, the instructor with expertise in science communication is assigned the research essay capstone in this example, but s/he would also provide support to faculty and students in the ISAP 4906 and 4908 capstone courses. Similarly, faculty with primary expertise in other areas will support mentoring in ISAP 4907 and other courses, to reflect the interdisciplinary nature of the ISAP program.

Assistant Professor

Date to be hired: start of year 1

Expertise: Data Science

Example course assignment: ISAP 1002 - Seminar in Interdisciplinary Science

ISAP 2001 - Foundations in Critical Inquiry

ISAP 3001 - Principles and Applications in Data Analysis

This course assignment would ensure that elements of data analysis and interpretation are introduced in the first year and re-entered as students progress through to their third year. The new faculty member will benefit from the sharing of expertise with his/her ISI colleagues to develop course material and assignments exploring a range of current topics and introduce students to publicly available datasets.

Assistant Professor

Date to be hired: start of year 3

Expertise: community engagement in a science context, such as "Citizen Science" or Indigenous ways of knowing.

Example course assignment: ISAP 2002 - Research Principles for Interdisciplinary Science

ISAP 3002 - Applications in Interdisciplinary Research

ISAP 4906 - Capstone Course - Group Research Project

The third major thread of the ISAP curriculum is to guide students in making connections across disciplines and between stakeholders, especially the community-at-large. This course assignment will incorporate this theme in courses from Year 1 through to Year 2. Even though one faculty member will be the designated ISAP 4906 (Capstone Project) Supervisor for student groups in a specific research area, s/he will have the support of their ISI colleagues.

These new appointments will complement the disciplinary expertise of Julia Wallace (Physics), Susan Aitken (Biochemistry), and Pamela Wolff (Chemistry) as described in Table D.1.1 and provide operational stability for appropriate course offerings, student advising, and administration of ISAP. Moreover, these assignments relate directly to interests of those currently engaged with the ENSC program. Indeed, future hires in ENSC have been put on hold until ISAP is operational given obvious synergies between the programs. No retirements are anticipated within the first 8 years.

The teaching assignment is 2.25 and 1.5 credits per year for instructors and research faculty, respectively. For practical purposes, the instructor teaching assignment switches between 2.0 and 2.5 credits in alternate years. We provide a sample set of course assignments in Table D.1.2 and the details of ISAP's teaching requirements and resources for the first 6 years of operation in Table D.1.3. The balance of one new instructor and 2 new research faculty, and the timing of their hiring, is planned to ensure stability in core course delivery as well as program administration and student advising. In this fashion, the ISAP program will have the resources to supervise capstone research projects and to meet supervisory and mentoring requirements as enrollments grow during the first 6 years of program operation.

Table D.1.2 illustrates one schema for teaching, advising and administrative assignments over the first 6 years of operation of the ISAP program. We have assigned responsibilities to allow faculty to teach in their primary area of expertise, develop knowledge in complementary areas, through team teaching (or coordination of 2 sections) and collaboration with colleagues, and operational stability, in anticipation of sabbaticals.

Table D.1.2. Example program operation plan for years 1-6.[1]

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
ISAP 1001 2 sections	I-SC & SA	I-SC & JW	I-SC & JW	I-SC & CI	I-SC & CI	I-SC & CI
ISAP 1002 2 sections	I-SC & AP-DS	AP-DS & JW	AP-DS & AP-CS	SA & AP-CS	JWx2	SAx2
ISAP 2001	AP-DS	AP-DS	AP-DS	I-SC	AP-DS	I-SC
ISAP 2002	SA	SA	I-SC	AP-DS	I-SC	AP-DS
ISAP 3001		AP-DS	AP-DS	AP-DS	AP-DS	AP-DS
ISAP 3002		SA	SA	AP-CS	AP-CS	AP-CS
ISAP 3003		I-SC	I-SC	I-SC	I-SC	I-SC
ISAP 3004		CI	CI	CI	CI	CI
ISAP 4906[2] (1.0 credit)			SA & AP-CS	SA & AP-CS	AP-CS	AP-CS & JW
ISAP 4907[2] (1.0 credit)			CI	JW	SA	JW
ISAP 4908 coordination**			PW	PW	PW	PW
NSCI 1000 4 sections	JW & 3xCI	I-SC & 3xCI	I-SC & 3xCI	I-SC & 3xCI	I-SC & 3xCI	I-SC & 3xCI
NSCI coordination	PW	PW	PW	PW	PW	PW
Program administration & advising[†]	JW & I-SC	JW & I-SC	JW & I-SC	JW & AP-DS	I-SC & AP-DS	AP-DS & AP-CS

[1]Assignment legend: JW = Julia Wallace, SA = Sue Aitken, PW = Pam Wolff, I-SC = new instructor (year 1) with expertise in science communication, AP-DS = new assistant professor (year 1) with expertise in data science, AP-CS = new assistant professor with expertise in community engagement in a science context (year 3), and CI = contract instructor. Pam Wolff's duties in this table reflect her 10% appointment to ISI.

[2]ISAP 4906 (group research project) and 4907 (research essay) are faculty-led full-year, 1.0 credit courses and will be scheduled for at least 3 hours per week of class and workshop time. ISAP 4908 (individual research projects) will be coordinated by ISI with students having the option of completing a research project with a faculty member or an adjunct professor of their choice.

[†]In keeping with the practice of other departments in the Faculty of Science, teaching relief of 0.5 credits per year for the ISAP Program Advisor will be required. In addition, the oversight of student e-portfolios across the program and the on-going development of a network of community partners will require significant investment of time, which will need to be offset by management of the teaching load and this is accounted for in the table as a 0.5 credit teaching release in years 1-6.

Julia Wallace, Susan Aitken, Pamela Wolff and Steven Cooke (through a supportive role via ENSC appointment) are experienced in interdisciplinary program administration, student advising, and course coordination, development and delivery. Table D.1.2 shows that, in proportion to their ISI appointment, they will assume these roles for the first few years of program operation, gradually mentoring the new faculty to develop the necessary depth of experience to allow for smooth transitions through sabbaticals. Similarly, the development of ISAP courses will model the principles of faculty collaboration and interdisciplinarity. We will ensure that the courses are developed as a collaborative process and that

teaching assignments will allow the sharing and development of expertise. Thus, we will develop a faculty team that is a balance between diversity and capacity so that we will represent interdisciplinarity without sacrificing the capacity for each faculty member to teach several of the ISAP courses. As Table D.1.2 and Table D.1.3 do not include sabbatical leaves, staffing priorities must recognize that in three of every seven years (based on anticipated sabbatical timing), the ISAP program will require contract instructors to a greater degree than is indicated.

Four sections of the first year Seminars in Science (NSCI 1000) are currently coordinated (0.25 credit) and taught (2.0 credits), for the Faculty of Science, by ISI. The role of the ISI in teaching and coordinating the NSCI 1000 courses is being formalized by the Faculty. As the ISAP program evolves, the NSCI courses form a natural bridge between the ISAP program and its faculty with the broader community of students within the Faculty of Science. The coordination and delivery of NSCI 1000 is included in Table D.1.3.

Table D.1.3. ISAP Teaching and Administrative Resources for Years 1-6.

Credits of teaching or release for administration/advising	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
[1]Seminars in Science (NSCI 1000)	2.25	2.25	2.25	2.25	2.25	2.25
[2]ISAP courses	3.0	5.0	7.0	7.0	7.0	7.0
[†]Release for administration/advising	1.0	1.0	1.0	1.0	1.0	1.0
Total	6.25	8.25	10.25	10.25	10.25	10.25
[3]Current ISI faculty (2.1 FTE in 2017)	2.25	2.75	2.25	2.75	2.25	2.75
[4]New instructor (year 1)	1.5	2.0	2.5	2.0	2.5	2.0
New assistant professor (year 1)	1.0	1.5	1.5	1.5	1.5	1.5
New assistant professor (year 3)			1.0	1.5	1.5	1.5
Contract instructor(s)	1.5	2.0	3.0	2.5	2.5	2.5
Total	6.25	8.25	10.25	10.25	10.25	10.25

[1]The NSCI 1000 first year science seminar course is coordinated and taught by ISI for the Faculty of Science. Pam Wolff's appointment is 10% to ISI and as such she will likely assume the 0.25 credit teaching assignment for coordinating the four 0.5-credit sections Seminars in Science (NSCI 1000) and the Individual Research Projects (ISAP 4908), one of three Year 4 capstone options for students in the ISAP Honours program.

[2]Details of the ISAP courses in Years 1-6 (detailed example presented in table D.1.3):

- To allow students transferring into the ISAP program to take their 1st and 2nd year ISAP courses concurrently, we anticipate offering these 4 courses in Year 1 of program operation, with the 2 credits at the 3000 level and 2 credits at the 4000 level being offered initially in Year 2 and Year 3, respectively.
- We will offer 2 sections each of ISAP 1001 and ISAP 1002 as the anticipated class size will be too large for the seminar and discussion format.
- The full-year Research Essay (ISAP 4907) will be taught as a course and the Group Research Project (ISAP 4906) will be coordinated and supervised by ISI faculty. Both options will be scheduled for at least 3 hours per week of class and workshop time. As such, each of these capstone options are assigned a value of 1.0 credit for teaching assignments.

[3]In keeping with the practice of other departments in the Faculty of Science, teaching relief of 0.5 credits per year for the ISAP Program Advisor will be required. In addition, the oversight of student e-portfolios across the program and the on-going development of a network of community partners will require significant investment of time, which will need to be offset by management of the teaching load and this is accounted for in the table as a 0.5 credit teaching release.

[4]As instructors, Julia Wallace and the new instructor to be hired in Year 1 will have a teaching assignment of 2.25 credits per year. This can be accommodated by alternating years of 4 and 5 half-credit courses, as illustrated in Table D.1.2. Julia Wallace will do 50% of her teaching for the Department of Physics. We anticipate that, given the requirement of course development for all new ISAP courses, the instructor will have a teaching assignment of 1.5 credits in Year 1.

D.2. Faculty research funding.

A large proportion of honours students in the ISAP program are likely to be heading on a career-path and will be afforded professional development and networking opportunities by doing a group project capstone. For those electing to do an honours project, there is capacity within the faculty complement to supervise undergraduate theses. We also expect undergraduate supervisors from outside our unit to welcome exceptional students. The current faculty consists of four research faculty member (Susan Aitken, Steven Cooke, Joseph Bennett, and Jesse Vermaire). Table D.2 lists funding awarded to the research faculty.

Table D.2: Operating Research Funding by Source and Year

Institute of Environmental Science

D2 Table- Environmental Science						
	Internal (Carleton) Grants/Awards	**International sources (excluding US)**	**Tri-Agency (including CRC)**	**US Sources**	**Canadian**	**Grand Total**
2012-2013		3,000	351,707	92,423	229,431	676,561
2013-2014	34,000	18,925	416,013	50,313	22,150	541,401
2014-2015	144,000		271,020		69,385	484,406
2015-2016	104,000		606,247	69,465	788,302	1,568,015
2016-2017	5,000		638,747	78,073	189,500	911,320
Grand Total	**287,000**	**21,925**	**2,283,735**	**290,274**	**1,298,768**	**4,181,702**

**Aitken, Susan, Bennett, Joseph, Cooke, Steven, Vermaire, Jesse, Institute of Environmental Science*

While funding is one measure of research potential, it is not sufficient in itself to indicate faculty potential to integrate research into program delivery. Julia Wallace has supervised eight independent study projects and one Honours thesis and has co-supervised another 30 Honours theses for students in the Integrated Science program (Section D.3). Julia's expertise in medical physics with a focus on radiation therapy (RT) and cancer interventions connects her with researchers at the Ottawa Heart Institute. Through her professional network, she has access to proton magnetic resonance spectroscopy data, which will provide ISAP students with an otherwise inaccessible "big" data biological dataset. She intends to involve ISAP Honours students in the analysis of large longitudinal biological data sets in spectral processing to discriminate between normal and damaged heart tissue. This type of opportunity would otherwise not be available to undergraduate students. Susan Aitken has co-supervised 18 MSc students on 4 group projects in the Health: Science, Technology and Policy program. In similar fashion to these HSTP projects, research projects in ISAP will require minimal funding, as compared to the funding required for infrastructure and consumables for lab-based research programs. Research projects in ISAP will also emphasize the use of publicly available data sets, thereby increasing the opportunities for all students and faculty to participate in research and for faculty to integrate research in their teaching. As the new ISAP faculty are hired, the opportunities for students and faculty to collaborate across disciplines will expand accordingly.

Similarly, Susan Aitken's research in Biochemistry is well suited to creating opportunities for students in the design of research from the formulation of research questions to data analysis, exploring the ever-

growing unrestricted public data sets of biochemical and genetic data (e.g. Genbank supported by the National Centre for Biotechnology Information and the Protein Data Bank delivered by the Research Collaboratory for Structural Bioinformatics). Students with an interest in biochemical systems will have the opportunity to explore and use these and many other rapidly growing publically accessible datasets with tools such as the open-source programming language Python (COMP 1005 and ISAP 2002) and available bioinformatics tools.

D.3. Distribution of thesis supervision.

Our current faculty has made a substantial contribution to the supervision and co-supervision of student research in a broad range of interdisciplinary topics (Table D.3)

D.3 Distribution of thesis supervision

Faculty Name	Rank	Completed				Current			
		Undergraduate	**Master's**	**PhD**	**PDF**	**Undergraduate**	**Master's**	**PhD**	**PDF**
Susan Aitken	Professor	(47)	(12) Biology (18) Health: Science, Technology and Policy (co-supervised group projects)	(4) Biology	0	(3) (1 Biochemistry & 2 Health Sciences)	(2) Biology	(1) Biology	0
Steven Cooke	Full Professor	(62)	(34)	(12)	(17)	(3)	(16)	(10)	(5)
Joseph Bennett	Assistant Professor	(7)	(5)	(2)	(17)	(1)	(16)	(10)	(5)
Jesse Vermaire	Assistant Professor	(17)	(2)			(4)	(2)	(1)	
Julia Wallace[1]	Instructor III	(39)	0	0	0	0	0	0	0

[1] The now discontinued Integrated Science program required that Honours students completing off campus research in partnership with government or community agencies, be co-supervised. Julia Wallace has facilitated this opportunity for off-campus research for 27 students by assuming the role of on-campus supervisor. To ensure a quality experience, she met with each student at least once per month and supported them during the writing of their thesis report and participated in their examination board. She has also supervised two and co-supervised two other honours research projects and supervised 8 students in independent study projects.

While we have demonstrated capacity to supervise undergraduate theses, we do not anticipate that this will be the preferred choice of students. For example, in this year's fourth year cohort of Carleton's new Health Science program, only two students elected to do an honours research project while the remaining eligible honours students competed for field placement opportunities. Honours ISAP students in their third year will be invited to discuss their capstone options. For students choosing an honours research project, we will follow the successful model of the Environmental Science program. A faculty member will be assigned to coordinating the research projects on and off campus. Students, with the help of the coordinator, will meet with on campus professors and adjunct professors. If their research interests align, students will write up a brief description of the proposed project for approval by the faculty coordinator.

D.4. Current teaching assignment

As noted in section Section D.1, courses in the ISAP program will be taught by the three current 0.85 FTE ISI faculty (Julia Wallace, 0.5 FTE, Sue Aitken, 0.25 FTE and Pam Wolff, 0.1 FTE). They will be joined by one new instructor and one new assistant professor in Year 1 and a second new assistant professor in Year 3. The teaching assignments of Instructors is typically 2.25 credits per year and that of research faculty is 1.5 credits per year and with teaching release allocated for administrative duties.

Current faculty have a taught courses from small to large, first year to graduate level, lecture style to group projects. All faculty have experience with smaller seminar style classes courses (NSCI 1000, INSC 3907 and HLTH 5500) which are a model we will use for the first year ISAP courses. These classes emphasize group work, student participation and communication. All faculty have also taught interdisciplinary science courses (NSCI 1000, INSI 2000, INSC 3907, HLTH 5400, and HLTH 5500). Students entering these courses present with diverse backgrounds which can be used to enrich classroom discussions and group projects. Julia and Pam have both taught large, required first year courses (e.g. CHEM 1101, PHYS 1008). Sue has extensive experience running a group research project (HLTH 5500) which is a model for the proposed ISAP courses: ISAP 3002: Applications in Interdisciplinary Research and ISAP 4907: Group Research Project. Julia incorporates in-class analyses, simulations and virtual labs into her thermodynamics course (PHYS 2401) which is a model for our data analysis course, ISAP 3001.

Table D.4: Distribution of Teaching Assignments

Faculty Name	Courses Taught				Notes
	2016-17	2015-16	2014-15	2013-14	
Susan Aitken	Teaching release	**HLTH 5400 HLTH 5500**	**HLTH 5400 HLTH 5500**	**HLTH 5400 HLTH 5500**	• HLTH 5400 is a 1.0 course and HLTH 5500 is the 2.0 credit thesis equivalent. Both were co-instructed. • From 2012-2016 Sue was the **Director of the Health: Science, Technology and Policy Institute and, subsequently, the Chair Department of Health Sciences**, as the former transitioned to a full department with the launch of the Bachelor of Health Science program in Sept 2014. She was also the program development lead for the HSTP MSc program and the BHSc undergraduate program. Her 2016-17 teaching release recognizes the primary role that she played in developing and leading these programs and the Department of Health Sciences (2011-2016).

Julia Wallace	NSCI1000 PHYS2401 PHYS3606 **PHYS 5209**	INSC 3907 NSCI 1000 PHYS 1008 PHYS 2401 PHYS 3606	NSCI 1000 PHYS 1008 PHYS 2401 PHYS 3606 **PHYS 5209**	INSC 3907 NSCI 1000 PHYS 3606 **PHYS 5204**	• All courses are 0.5 credit • Julia's teaching has been divided between Integrated Science, including the first year science seminar (NSCI 1000) and Physics. Julia has courses at all levels including large first year courses and small seminar courses. • Julia was Director of the Integrated Science Institute from 2014-2017.
Pamela Wolff	CHEM1101 CHEM1101 CHEM1101 INSC3907 ISCI2000	CHEM 1101 CHEM 1101 CHEM 1101 INSC 3907 ISCI 2000	CHEM 1101 CHEM 1101 CHEM 1101 INSC3 907 ISCI20 00	CHEM 1005 CHEM 1006 CHEM 1101 INSC 3907 ISCI 2000	• All courses are 0.5 credit • Pam has been the **Associate Director of the Integrated Science Institute** since July 2014 and previously served as the **Director** from 2005-14.

D.5. Contract instructor

The science policy course (ISAP 3004) is one where we would like to explore a partnership with FPA, potentially having the course offered through that Faculty. If that is not possible, it is likely that this course would be assigned to a contract instructor as the new faculty are not expected to possess sufficient background in policy to teach this course. This is a course where Carleton offers the 'Capital Advantage'; there are many potential contract instructors in Ottawa with expertise in the science-policy interface. Carleton's Food and Nutrition program successfully uses contract instructors to teach its policy courses such as FOOD 2003 (Regulation of Canadian Food), FOOD 4001 (Food quality control), FOOD 4102 Current Issues in Canadian Food Governance, Regulation and Policy and FOOD 4103 (Food Safety, Risk Assessment, Communication and Management). Students would benefit from working with professionals employed in the field.

We anticipate the need to offer two sections of the first year ISAP courses (ISAP 1001 and 1002) in order to limit class size to enable a seminar format. As such, while both will initially be designed and taught by ISAP faculty, we anticipate hiring a contract instructor to deliver one section of either of these courses by year 4 (Table D.1.2). The second section will continue to be taught by an ISAP faculty member, thereby providing support for the contract instructor and consistency in course delivery and student experience.

We also anticipate hiring a contract instructor to deliver 1.0 credit of ISAP courses in year 3 as at this point there will not yet be sufficient instructional capacity within ISI. One option is to assign the Research Essay Course (ISAP 4907) to a contract instructor for this year, as shown in Table D.1.2, because there is less course development work for ISAP 4907 than for most of the other ISAP courses.

The Science Seminar course, NSCI 1000, will require three contract instructors each fall term. Similarly to ISAP 1001, an ISAP faculty will be assigned to one (of four) sections of NSCI 1000 each year. This course will also be coordinated by an ISI faculty member and the combination of ISAP coordination and instructional guidance will provide support for the contract instructor team teaching the other sections to achieve consistency in course delivery.

Contract instructors are already routinely hired to teach sections of NSCI 1000 and we don't anticipate any changes to the availability of qualified instructors. Likewise contract instructors are routinely hired in other science units to teach courses during faculty sabbaticals and leaves. We anticipate hiring postdoctoral fellows and local professionals with expertise in the subject area.

Tables D.1.2 and D.1.3 illustrate how new faculty will be mentored to build a depth of administrative experience during the first six years of program operation. As such, ISI and ISAP will be well positioned to accommodate faculty commencing sabbaticals in year 7 and beyond.

E. Program Admission and Enrolment

E.1. Admissions requirements

The admission requirements (Appendix 4) are standard for the majority of BSc programs at Carleton. Therefore, as the first year of the proposed program is similar to that for most other BSc programs, the admission requirements for the BSc will be sufficient to ensure that students are adequately prepared for entry to the proposed undergraduate program.

Entry to the first year of the ISAP will be restricted to the Honours program and students will be required to declare a science minor on entry to the program. During their first year, students will take a range of courses and may discover an interest in a different discipline. Therefore, students may change their science minor during the course of their study.

Admission Requirements

Honours Program

First Year

The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses, which must include Advanced Functions and two of Biology, Chemistry, Earth and Space Sciences or Physics. (Calculus and Vectors is strongly recommended). Prerequisite courses must be at the 4U level with no individual grade below 60%. A 4U course in English is recommended.

Advanced Standing

Students may transfer to the honours program if upon entry they would be in good academic standing.

General Program

Access to the General degree is limited to students who apply to transfer.

Admission Requirement and Program Completion

The admission requirements provide students with sufficient background in science and mathematics to allow them to successfully complete their first foundational year, and progress into second and subsequent years.

E.2. Class sizes and course and program capacity

Section E.3. provides rationale for the projected enrollment of 60 students per year and the anticipated breakdown of 40 students entering from high school, with an additional 20 students transferring from other universities or programs at Carleton. As described in section B.2, the ISAP courses are structured to maximize opportunities for experiential learning of skills including communication, critical analysis and interdisciplinary collaboration. This is particularly important in the first year ISAP courses where students are presented with their first opportunity to develop these skills. Tables B.2.1 and B.2.2 demonstrate that we have anticipated the need to offer two sections each of ISAP 1001 and 1002 in order to maintain class sizes of no more than 30 students. This foundation will enable students to move into larger classes of up to 60 students in second and third year. With a class size of 60 students, it is still possible for the instructor to interact regularly with students as individuals and in groups. The range of learning opportunities, activities and assignments illustrated in section B.2 (and appendix 3) will provide the ISAP students will a rich learning environment. Our ability to deliver the ISAP courses, as envisioned, is reliant on the requested new faculty (described in the business plan and section D.1) as well as access to teaching assistants to support the delivery of courses. As the program reaches year 3 of operation upper year ISAP students can be hired as teaching assistants for the first and possibly second year, courses. However, graduate level teaching assistants will also be required and as there is no graduate program associated with the Integrated Science Institute, these students must be provided by other programs. The source of these teaching assistants is not necessarily limited to programs in Science, depending on the ISAP course. The ENSC program has a history of hiring TAs from various units in Science and we have support from the Dean of Science to continue with this approach. Under the current graduate student funding models (for last 10+ yrs) there is often a surplus of TAs such that it is relatively easy to find highly qualified TAs and do so without influencing the ability of other units to support their courses.

E.3. Projected enrolment

ISAP is a new program for Carleton and will draw students who are interested in interdisciplinary science enhanced by learning in science communication and knowledge translation. To project the enrolment, we looked at the enrolment in similar programs in Southern Ontario. We further supported our projected numbers with enrollment figures from former Integrated Science program as well as students who come to Carleton as undeclared science students.

Two of the programs in Ontario who provide enrollment information on their website are McMaster University's Integrated Science program, iSci[95] and Western University's Integrated Science program, WiSc[96]. Both iSci and WiSc are highly competitive programs and cap their student intake at 64 and 60 students respectively.

Prior to the closure of Integrated Science in 2013, students who were interested in interdisciplinary science could enroll in Integrated Science or as an undeclared science student. During the last four years of new registrations to Carleton's Integrated Science program, an average of 24 students per year registered in Integrated Science programs other than the Health Science concentration. These students wanted flexibility in their study of science, rather than a focus on a specific discipline. With the closure of the Integrated Science program, Carleton does not currently have a science program to accommodate these students.

Additionally, over the last 5 years, on average, 20 students per year have enrolled at Carleton University as undeclared science students. Over and above this number, 125 student per year are approved to attend as undeclared students but chose not to. These students are applying as undeclared students in spite of limited marketing of this option to potential students compared to programs within the Faculty of Science. Students apply to undeclared science for many reasons, but often want to study science without narrowing their field to a specific discipline. Based on years of experience speaking to prospective students at recruitment events and advising undeclared students, a role that is currently undertaken by ISI faculty, we understand that many of these students are also looking for the type of interconnecting and skill building core courses that we have embedded in the ISAP program.

Based on the enrolment in comparable programs in Ontario and these historical enrolment figures we estimate that the student demand for an interdisciplinary science program is 40 or more students per year who are not enrolling in current programs within the Faculty of Science. Depending on recruitment initiatives, this number would be expected to increase as the program becomes more visible. Therefore, we have made conservative estimates of 20 and 30 new to Carleton students entering this program in years 1 and 2, with a steady incoming cohort of at least 40 new students per year by the third year. Based on the experience of IS, we also anticipate that an average of at least 20 students per year will transfer into ISAP from other programs, thereby reducing attrition within the Faculty of Science.

Following from the discussion of student interest in an interdisciplinary science program, and buffering our estimates of student numbers during the first two years to allow time for awareness of the ISAP program to build, we anticipate that student numbers for the first three years of program operation will be:

Year 1: 20 new (honours) and 10 transferring to ISAP (honours or general)

Year 2: 30 new (honours) and 15 transferring to ISAP (honours or general)

Year 3: 40 new (honours) and 20 transferring to ISAP (honours or general)

The cumulative program enrollments, based on these numbers are presented in Table E.3.

[95] https://www.science.mcmaster.ca/isci/prospective-students/admission-requirements-2
[96] http://www.uwo.ca/sci/WISc/admission/index.html

Table E.3. Total cumulative program enrollments in ISAP

Credits of teaching or release for administration/advising	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
New students	20	50	90	130	150	160
*Transferring students	10	25	35	40	40	40
Total	30	75	125	170	190	200

*To calculate student numbers the assumption is that students are transferring into Year 2 of the ISAP program. To simplify budget calculations, we made the assumption that students would transfer into the 15-credit general program. However, we anticipate that, in reality, students will transfer into both the General and Honours ISAP programs.

New students are those who are new to Carleton and starting the ISAP program in first year. Transferring students are those changing from other programs at Carleton. It is also likely that students will transfer from undergraduate programs at other universities, but for the purpose of simplicity in the business plan, we have focused on the retention aspect (i.e. transfers from other Carleton programs).

F. Student Experience and Satisfaction

F.1. Student orientation, advising, and mentoring

As is done with students in our Environmental Science program, students entering the ISAP program in their first year will participate in university and program orientation activities during orientation week. These activities run the week before classes start and will introduce new students to faculty, staff and students in the program. Ongoing orientation will be done during the first year seminar (ISAP 1001) which is designed to introduce and orient students to the university, the program and an interdisciplinary approach to science.

We will support and encourage the development of a student society. We can use the existing Environmental Science Student Association (ESSA) as a successful model. ESSA holds weekly meetings, organizes trips and invited talks, designs personalized clothing and organizes philanthropic events. Currently they promote themselves via a Facebook group and email.

Our student resource room is an important space for students to gather, share ideas, receive peer mentoring and as such provides an ongoing engagement opportunity.

Student advising will primarily be done by the ISAP program advisor with support from the institute's administrator and Carleton's Academic Advising Centre. Current faculty in Integrated Science have extensive experience advising students in interdisciplinary programs (Integrated Science, Environmental Science and Health Sciences) as well as students entering their first year as undeclared students (section D). Students identified as at academic risk in their first year will receive an invitation from the Student

Science Success Centre to participate in peer mentoring sessions to help them reach their academic goals. [97] Mentoring opportunities will also be threaded throughout the program. From the small seminar courses in first year to the capstone courses in fourth year, students will be mentored by their instructors. We plan to explore a platform such as cuPortfolio that will allow student to showcase and reflect on their skills and this platform will serve as a mentoring opportunity for students as well.

Up-to-date program information will be available to students on an ISAP website. Additional or time sensitive information will be sent to students through their Carleton email. Once the student society is up and running, announcements and employment news will also be posted on the society website or Facebook page.

[97] https://sssc.carleton.ca

F.2. Career paths of graduates

In reviewing post-graduation trends for our students in the Integrated Studies degree from 2011 through 2016, we anticipate that our ISAP students will experience similar post-graduation trends, as they transition to careers or post-graduate study.[98] From 2011 through 2016, the program had 247 graduates, of which 109 or approximately 45% graduated with a BSc (General) and 138 or approximately 55% graduated with a BSc (Honours). A similar mix of graduates from the General and Honours degrees continued with post-graduate, at Masters and PhD levels, or professional programs including, but not limited, to the following areas of specialization, as well as one Fulbright Scholar. Many of these areas represent more than one of our graduates.

Biomedical Engineering (MSc)	-	University of Edinburgh (UK)
Business Administration (MBA)	-	University of Toronto
Dentistry (DMD)	-	McGill University
Journalism (MA)	-	Ryerson University
Management Science (MSc)	-	Western University (Ivey School of Business)
Medicine (MD)	-	University of Ottawa
Molecular Biology (MSc)	-	University of Leuven (Belgium)
Neuroscience (MSc and PhD)	-	Queen's University
Nursing (RN)	-	Queen's University
Pharmacology (PhD)	-	University of Toronto
Public Health Administration (MPH)	-	University of Toronto

[98] Santos, A. (2016). Data on post-graduation activities of Integrated Sciences Institute's students: 2011-2016. Prepared for the Integrated Sciences Institute, Carleton University.

Based on information about ISI graduates, those choosing to start their careers through employment are working in industry, research, education, and health, including but not limited to:

TYPE	COMPANY
High Tech	Acer, Blackberry, Broadband
Government Agencies	Agri-Canada, Canadian Food Inspection Agency, Canadian Nuclear Safety, Statistics Canada, Department of National Defense
Health Services Organizations	Alberta Health Services, Children's Hospital of Eastern Ontario, King Faisal Hospital and Research Centre
Financial Services	Bank of Montreal, Toronto-Dominion Bank, Scotia Bank, Sun Life Assurance
Industry – Chemical	Crop-Life Canada, Monsanto
Industry – Energy	DNV.GL (Norway), Hydro One
Not-for-profit Organizations	Society of Obstetricians and Gynecologists of Canada, Salvation Army
Research Organizations	National Research Council of Canada, Ottawa Hospital Research Institute, Canadian Agency for Drugs and Technologies in Health, Medical Research Council
Industry – Pharmaceuticals	Pfizer

Graduates of the Integrated Science program occupy a variety of roles within these different sectors, including but not limited to:

- Human Resources, Financial Services, and Administrative Managers and Supervisors
- Software, Hardware and Systems Designers
- Scientific and Technical Research Program Officers in government, industry and not-for-profit organizations
- Data Managers and Quality Control Supervisors
- Lab and Forensic Technologists
- Educators and Science Communicators
- Self-employed business owners

These sectors and roles, however, do not fully represent the broad scope of opportunities awaiting our ISAP graduates who will have a broader and richer interdisciplinary and collaborative curriculum. With appropriate advising and completion of the required courses, our students may enter fields from A to Z including, but not limited to, Audiology, Biology, Business, Data Science, Environmental Science and Stewardship, Food Studies, Genetic Counselling, Medicine, Optometry, Urban Agriculture, Veterinary Medicine, and Zoology representing a broad spectrum of the "sciences".[99] A snapshot review of the market for entry-level positions for new science graduates is positive and reveals a broad range of sectors. Although this snapshot is not exhaustive, it does provide a sample of the diversity of positions available in Ottawa at the entry-level as of July 2017.

Agriculture Research	Syngenta
Colleges and universities (non-faculty)	University Health Network
Energy	Suncor Energy
Environmental research organizations	Vineland Research Pinchin AE Comm
Financial institutions	TD Bank
Food and beverage industry	McCormick Labatt Breweries PepsiCo
Healthcare facilities	CHEO St. Joseph Health Centre The Ottawa Hospital Royal Ottawa Hospital
Manufacturing	Dupont Noblegen, Inc.
Non-profit organizations	Ontario Greenhouse Vegetable Growers Canadian Diabetes Association Medical Council of Canada
Pharmaceutical companies	Pharma Medica Emblem Cannabis

[99] Sandstrom, Gregory. 2012. How many 'sciences' are there? *Social Epistemology Review and Reply Collective* 1 (10): 4-15.

	Abbott Laboratories
Public access centres	Royal Ontario Museum Canadian Museum of Nature
Public/private research incubators/think tanks	Idea Couture Conference Board of Canada National Research Council of Canada
Publications (science/science for the community)	Norton Rose Fulbright Online Media The Conversation Canada Mad Science Metrix
Regional, provincial, federal government agencies	City of Ottawa Public Health Ontario Environment and Climate Change Canada
Research institutes	Lunenfeld-Tanenbaum Research Institute Bruyere Research Institute

Within these sectors, there is a diversity of types of positions, each with a new hire requirement of a BSc. For some, the requirement is a BSc in any field and for others, such as science-specific industry, is the need for a BSc in a specific field of specialty:

Clinical Informatics Specialist

Logistics Specialist

Laboratory Informatics Specialist

Science Library Specialist

Environmental Health and Safety Specialist

Research Coordinator

Energy and Environment Analyst

Clinical Research Associate

Science Educator/Interpreter

Communications Officer

Science Writer

(Big) Data Science Specialist

Science Advisor

For those ISAP graduates who wish to combine their science background in a non-science field, there are diverse career options, some of which require further credentials. These include:

Law

Business Administration

Education

Human Resources

Journalism

Public Policy

Risk/Disaster Management

Public Relations and Communication

Program Evaluation

Social Sciences

Humanities

Financial Services / Banking

Rural Studies

The program is designed such that they will be appropriately prepared for the many positions that focus on the application of science to the problems of today and tomorrow, and integration of different disciplinary domains and forms of knowledge. Indeed, the hallmark of the ISAP program is the development of so called "soft-skills" and the ability of ISAP graduates to work across boundaries that often constrain students graduating from a program focused on a single scholarly domain. Many of the job descriptions in science today require competency in stakeholder engagement, conflict resolution, knowledge mobilization, policy development and analysis, and manipulation and analysis of large and complex data sets. Our graduates will be well trained to enter the labour market in government,[100]

[100] There are more than 200 Government of Canada Departments, Agencies, Crown Corporations, Special Operating Agencies and other related organizations, many of which actively recruit recent graduates from all types of science-based programs, including those with an interdisciplinary focus. https://www.canada.ca/en/government/dept.html

industry,[101] or community organizations[102]; continue into professional schools, such as law;[103] or enter graduate programs either in interdisciplinary sciences[104] or discipline-specific degree programs (*e.g.* library science,[105] teaching,[106] data science,[107] science communication[108]). ISAP fulfills academic and employability gaps for our incoming and current students interested in an interdisciplinary approach and in-demand career skill sets.

G. Resources

G.1. Support and technical staff

We have included a 0.5 FTE level 7 administrative position who will report to the Institute Administrator in Year 3 of the ISAP business plan.The support staff will contribute to day-to-day program administration (e.g., maintaining website, assisting students with registration, maintaining student files, developing contracts for contract instructors) and serve as an "open door" (Mon to Fri, business hours) for students to ask routine questions. The support staff also assist with budgeting and tracking expenses, recruitment and retention activities, and coordinating with administrators from our sister units (e.g., Chemistry, Biology, etc.).

ISI currently shares one Level 8 administrator (Michelle Santoianni) with the Institute of Environmental Science and with Technology, Society and Environment Studies. Michelle is both the Institute and

[101] Throughout industry regardless of product or service, recruiters report the need for interdisciplinary and collaborative skillsets. The Bloomberg Job Skills Report 2016: What recruiters want. https://www.bloomberg.com/graphics/2016-job-skills-report/

[102] Although technical skill requirements s may differ depending on the mandate of the community organization, most share common values in the area of "soft" skills. Rodriguez, K. (2016). What top non-profits look for in job applicants. The Economist (2016, May 16). https://execed.economist.com/career-advice/career-hacks/what-top-nonprofits-look-job-applicants

[103] Law schools require an undergraduate degree and encourage students with unique backgrounds to apply. University of Ottawa. Faculty of Law. https://commonlaw.uottawa.ca/en/students/admissions/admissions-criteria

[104] University of British Columbia offers MSc and PhD degrees in interdisciplinary studies in which students create their own programs tailored to their specific interests. https://www.grad.ubc.ca/prospective-students/graduate-degree-programs/master-of-science-interdisciplinary-studies)

[105] Graduate programs in Library / Information Sciences admit students who have completed an undergraduate degree in any field. Those with a science background may specialize in library resources in sciences or science communication, as well as any other science or non-science field. McGill University. School of Information Studies. https://www.mcgill.ca/sis/programs/gradcert/admissions

[106] Canada offers multiple universities with M.Ed., PhD, and ED in education. The only academic requirement into the Master level is completion of an undergraduate degree. http://www.canadian-universities.net/Universities/Programs/Graduate-Studies-Education.html

[107] Graduate programs in data science require a science-based degree with coursework in statistics, computer science, and programming languages. Ryerson University. http://www.ryerson.ca/graduate/datascience/admission/

[108] Admission requirements include either a BSc or BA from a relevant field as well as demonstrated capacity in verbal and written communication. Laurentian University. https://laurentian.ca/program/science-communication

Undergraduate Program Administrator for these academic units and programs. The concept of "sharing" between the various units will also be simplified in the next year as we merge these units under a common governance framework (i.e., the Institute of Environmental and Interdisciplinary Sciences).

G.2. Space

The Integrated Science Institute is located in the recently added space on the 4th floor of the Herzberg Building. An additional three faculty offices on this floor will be required for the new instructor and assistant professors. Given that 2/3 of the new faculty would have research programs, these research-active faculty would require cross-appointments into appropriate programs to secure research space and graduate supervision rights. The specific appointments (and thus their space needs) will be dictated by their research interests.

Students in the Integrated Science program share access to room 4440 with students in the Environmental Sciences program. We are proposing that this access will transfer to students in the ISAP program. With the forthcoming merger of governance structures for Environmental Science and ISI (which will become ISAP), the majority of the space in this "wing" will be devoted to this group of scholars and the students. This will provide opportunities for extensive interaction between faculty members and students. There will also be access to other resources that extend beyond the Science Faculty to include communal writing spaces in the School of Journalism and Communication.

Currently, there is also a "social" gathering space with chairs and couches where students can interact with each other more informally. It is also worth noting that the Library has a unique group learning space (called the Discovery Centre) which can be used by students and faculty members.

a. Laboratory facilities (as applicable)

At this time, we do not anticipate a need to access computer labs for access to CuNet resources. See below (2b) for additional information related to access to labs/research space on and off campus.

b. Unit/program and affiliated research facilities (as applicable)

As the program develops, there will be extensive community engagement such that the "world" becomes the lab for our students. Carleton has a strong track-record of integrating research and teaching at the undergraduate level (not just at the graduate level). This has been demonstrated by undergraduate students in programs such as ISI and Environmental Science publishing their undergrad thesis projects in peer-reviewed journals. Access to research infrastructure will enable our students to understand how the science that they will apply (a focus of the program) is generated.

We anticipate students in the ISAP program will have numerous opportunities to interact with professors and use resources from various units that fit with their own interests. As was the case with ISI (and is the norm for Environmental Science), the students will have access to faculty members and thus their lab/research spaces in many units across campus. Carleton (especially within the Faculty of Science) has a culture of mentoring students across units. For example, a student from ISI would have perhaps

volunteered in a lab in Chemistry in 2nd year, registered for an independent study with a professor in Chemical Engineering in 3rd year, and had their Honours thesis supervised by a professor with a primary appointment to Biochemistry. These cross-faculty relationships enriched the academic experience for ISI students. Carleton has done well with infrastructure support from entities such as the Canada Foundation for Innovation such that students will have access to cutting-edge infrastructure. For example, Cooke and Vermaire are co-applicants on a multi-institutional CFI that was just funded at a level of ~$16 million which will provide access to state of the art instrumentation for biological and chemical monitoring. In addition, Carleton has formalized relationships with the University of Ottawa (there are a number of joint institutes such as the "Ottawa-Carleton Institute of Biology") as well as allied agencies such as the National Research Council, Health Canada, and Agriculture Canada which give our students access to researchers (with adjunct status in various units) and research infrastructure.

c. University and unit/program computer facilities and computing resources (as applicable)

The ISAP 3001 (Principles and Applications in Data Analysis) course ideally requires access to a university computer lab facility. We anticipate emphasizing publically available data sources as well as software (e.g. the statistical package R, the macromolecular visualization software pymol, the python programing suite) and may also rely on software accessible through university site license (e.g. the statistical analysis packages SAS and SPSS). The ISAP 2001 (Foundations in Critical Inquiry) and ISAP 3002 (Applications in Interdisciplinary Research) courses both include a 2-hour workshop that would be facilitated by occasional access to computer lab facilities, as required.

An expectation of the ISAP program is that students will often work collaboratively and that many students now bring their laptop computer to class. As such, it will be possible to assign in-class collaborative activities, as appropriate to the subject, requiring access to at least one computer for research, data analysis, note taking, etc. Should this prove a challenge it will be possible to book computer lab space through Carleton's scheduling and examination services.

Access to computer workstations and laptop loans on campus has increased in recent years such that computer access is generally no longer an issue for students. This is exemplified by the range of multimedia resources available through the Discovery Centre in the Carleton Library.

G.3. Library Resources

The Library report is prepared by the librarian or subject specialist responsible for the subject area(s) covered by the program, using a common template developed from guidelines established by the Ontario Council of University Libraries. The main purpose of the report is to specify whether any new resources or services are necessary in order to support the program, for example, whether the Library needs to purchase new books or subscribe to new journals or electronic resources.

The librarians and subject specialists preparing the reports rely on their own professional experience with collecting resources in the subject areas in order to make assessments about whether there are gaps in the collection that need to be filled in order to provide the appropriate teaching and research support for new, modified, or reviewed programs. They consult various sources for information about published resources in the subject area, including the database maintained by the Library's main monographs vendor, publishers' lists and websites, handbooks and guides to the literature, the library collections of universities that offer the program, various specialized sites relevant to the subject from professional societies and organizations, as well as basic information available in tools such as Google Scholar or generally on the web. They also generally consult faculty members (e.g., the Library representative or the department chair) to discuss their assessment of the strengths and gaps. The Library makes a clear distinction between those resources which are essential to the program and those which are simply "nice to have." Generally speaking, the reports list only the essential resources, with costing obtained from the vendors or agents from which the Library would obtain the materials: each item is listed and costed individually and the total amount is recorded in the report.

The report also provides context by providing information about the following, when possible or applicable: percentage of top-ranked journals which the Library subscribes to in the subject area(s); how much funds have been spent in the past fiscal year on e-resources, journals, and printed books in support of the subjects covered by the program; how much funds have been spent in the past 8 years on printed monographs for the program; specialized collections in archives, maps, data, and government information; instruction, teaching, and practicums carried out by Library staff in the classroom or in the Library; highlights from the Library website (e.g., links for subject and course guides and to online tutorials); research partnerships between the Library and the department or program; research consultations; help desk visits; and selected detailed statistical information about the Library.

The Report from the Library is included as **Appendix 6** of the self-study.

An analysis of Carleton University Library's information resources and services in support of the ISAP program demonstrates that the Library does not require any additional funds to support it.

PREAMBLE

The Library report is prepared by the librarian or subject specialist responsible for the subject area(s) covered by the program, using a common template developed from guidelines established by the Ontario Council of University Libraries. The main purpose of the report is to specify whether any new resources or services are necessary in order to support the program, for example, whether the Library needs to purchase new books or subscribe to new journals or electronic resources.

The librarians and subject specialists preparing the reports rely on their own professional experience with collecting resources in the subject areas in order to make assessments about whether there are gaps in the collection that need to be filled in order to provide the appropriate teaching and research support for new, modified, or reviewed programs. They consult various sources for information about published resources in the subject area, including the database maintained by the Library's main monographs vendor, publishers' lists and websites, handbooks and guides to the literature, the library collections of

universities that offer the program, various specialized sites relevant to the subject from professional societies and organizations, as well as basic information available in tools such as Google Scholar or generally on the web. They also generally consult faculty members (e.g., the Library representative or the department chair) to discuss their assessment of the strengths and gaps. The Library makes a clear distinction between those resources which are essential to the program and those which are simply "nice to have." Generally speaking, the reports list only the essential resources, with costing obtained from the vendors or agents from which the Library would obtain the materials: each item is listed and costed individually and the total amount is recorded in the report.

The report also provides context by providing information about the following, when possible or applicable: percentage of top-ranked journals which the Library subscribes to in the subject area(s); how much funds have been spent in the past fiscal year on e-resources, journals, and printed books in support of the subjects covered by the program; how much funds have been spent in the past 8 years on printed monographs for the program; specialized collections in archives, maps, data, and government information; instruction, teaching, and practicums carried out by Library staff in the classroom or in the Library; highlights from the Library website (e.g., links for subject and course guides and to online tutorials); research partnerships between the Library and the department or program; research consultations; help desk visits; and selected detailed statistical information about the Library.

H. Development of the Self-Study

The discontinuation of intake for the Integrated Sciences degree as of fall 2013 created a programming gap for those students who were interested in exploring more than one discipline within in the Faculty of Science. Recognizing the demand for an interdisciplinary science-based stream from students and other Chairs and Directors in the Faculty of Science, Malcolm Butler, the Dean of the Faculty of Science, approached the Director of the Integrated Sciences Institute (ISI), Julia Wallace, in early part of 2016 to initiate the process to develop a re-envisioned curriculum identified as the **Interdisciplinary Science and Practice** (ISAP). Relying on an extensive background in undergraduate instruction, innovative programming design, and proposal writing, Julia Wallace asked Sue Aitken, an ISI faculty member, to undertake tasks associated with the organization, writing, and final production of the documentation. In consultation with Pam Wolff, the Associate Director of ISI, with expertise in Carleton University's regulations for degree approval, the preliminary phase for the proposal was set in motion.

From November 2016 until May 2017, Julia Wallace and Sue Aitken continued the design process in consultation with Malcolm Butler to ensure that it aligned with Carleton University's *Strategic Implementation Plan* and the *Strategic Mandate Agreement* as well as the strategic priorities of the Faculty of Science. During this timeframe, the milestones included:

- **10-March 2016**

  Event: Chairs and Directors Meeting: Malcolm Butler (Dean, Faculty of Sciences) introduced the possibility for a future interdisciplinary sciences degree and encouraged faculty members to volunteer to provide input.

Result: Chairs were asked to identify someone to represent their unit in discussions about the proposed new interdisciplinary BSc and provide this information to Julia Wallace

- **17- March-2016 through Nov-17-2016**

  Purpose: Blue Sky Discussions

  Participants: Pat Farrell, Special Advisor to the Dean, March 17th, 2016

  John Stead, Chair, Department of Neuroscience, May 20th, 2016

  Doug Howe, Director, School of Computer Science, May 20th, 2016

  John Stead, Chair, Department of Neuroscience and Kim Matheson, Canada Research Fellow, Department of Neuroscience, May 31st, 2016

  Naomi Cappuccino, Associate Professor, Department of Biology, June 7th 2016

  Steve Cooke, Director, Institute of Environmental Science, (discussions via email in early June),

- **27-October-2016**

  Event: At the Faculty of Science Chairs and Directors Retreat, Malcolm Butler (Dean, Faculty of Science) encouraged members to contribute ideas for the new interdisciplinary sciences degree.

- **8-November-2016**

  Purpose: To discuss program approval process and review template documents

  Result: Established protocols, deliverables and a tentative timeline

  Participants: Robyn Green, PhD (Program Officer, Office of the Vice-Provost and Associate Vice-President Academic); Andrea Thompson, PhD (Program Assessment Specialist, Office of the Vice-Provost and Associate Vice-President Academic); Julia Wallace, PhD (Director, Institute of Integrated Sciences); Sue Aitken, PhD (Professor, Institute of Integrated Sciences); Pam Wolff, MSc (Associated Director, Institute of Integrated Sciences); Michelle Santoianni (Administrator, Institute of Integrated Science)

- **10-Nov-2016**

  Event: Meeting to explore a future interdisciplinary sciences degree

  Results: Agreement to the value of the degree for students, Faculty of Science, and Carleton University

Participants: Julia Wallace, PhD (Director, Institute of Integrated Sciences); Sue Aitken, PhD (Professor, Institute of Integrated Sciences); Pam Wolff, MSc (Associated Director, Institute of Integrated Sciences); Steve Cooke (Director, Institute of Environmental Science).

- **18-November-2016**

  Purpose: Workshop to discuss learning outcomes

  Result: Suggestions to explore the vision, curriculum, course and resources

  Participants: Andrea Thompson, PhD (Program Assessment Specialist, Office of the Vice-Provost and Associate Vice-President Academic); Julia Wallace, PhD (Director, Institute of Integrated Sciences); Sue Aitken, PhD (Professor, Institute of Integrated Sciences); Pam Wolff, MSc (Associated Director, Institute of Integrated Sciences); Michelle Santoianni (Administrator for the Institute of Integrated Science)

- **January 2017**

  Event: Review to identify existing integrated sciences programs and/or degrees at regional, provincial, national and international levels.

- **13-January-2017**

  Event: Meeting with Chris Worswick (Chair, Department of Economics) to discuss inclusion of ECON 1000 as a required component of the ISAP program and options for students interested in a minor in Economics.

- **18-January-2017**

  Event: Received Business Plan from Bruce Winer, Assistant Vice President (Institutional Research and Planning)

- **January 2017**

  Event: Completed environmental scan of current provincial, national and international degrees in Interdisciplinary Science

- **15-February-2017**

  Event: Approval of the Executive Summary by the Vice-Presidents' Academic Research Council (VPARC)

- **February 2017**

  Event: Completed and analyzed 6-year (2011-2016) trend for post-graduation employment and future education for students from the current Integrated Sciences Institute (Section F)

- **February 2017**

  Event: Compiled admission and enrollment numbers from the Office of Institutional Research and Planning (OIRP)

- **March 2017**

  Event: Compilation and analysis options and entrance requirements for graduates with a BSc (Honours) in Integrated Sciences for graduate student and professional credentialing.

- **14-March-2017 through 10-August-2017**

  Event: Discussions with Chairs and Directors in the Faculty of Science with the Director of the Integrated Science Institute

  Participants:

  14-March-2017 Iain Lambert, Chair, Biology

  Result: Approval letter received 5-May-2017

  14-March-2017 Steve Cooke, Director, Institute of Environmental Science

  Result: Approval letter received 16-April-2017

  29-March-2017 Bob Crutchley, Chair, Chemistry

  Result: Approval letter received 26-April-2017

  29-March-2017 Doug Howe, Director, School of Computer Science

  31-March-2017 Alain Bellerive, Chair, Physics

  Result: Approval letter received 20-May-2017

  02-April-2017 David Amundsen, Acting Director, School of Mathematics and Statistics

  Result: Approval letter received 02-April-2017

  10-April-2017 John Stead, Chair, Neuroscience

  Result: Approval letter received 21-April-2017

  10-August-2017 Bill Willmore, Director, Institute of Biochemistry

  Result: Approval letter received

  10-August-2017 Darish Motazedian, Chair, Earth Sciences

  Result: Approval letter received 11-August-2017

- **20-April-2017**

  Event: Chairs and Directors Meeting: The progress of the proposed new program was discussed and chairs and directors were encouraged to speak to Malcolm Butler if they have any questions or concerns.

- **10-August-2017**

  Event: Submission of Proposal to The Science Committee on Academic Planning, Science Faculty Board and Carleton University Committee on Quality Assurance

  Outcome: Unanimous support for the proposal to move forward to Science Faculty Board.

Throughout the process, we consulted with faculty members in all the science units for their insights into the vision, learning objectives, curriculum design, and interconnection between ISAP and the other divisions in the Faculty of Science. Because many undergraduates enter their careers directly after their BSc, we wanted to ensure that our programming met the demands of future employers. With this in mind, we used our networks to connect with government agencies, healthcare organizations, industry, and not-for-profit groups, to determine technical knowledge and professional skill requirements.

In designing the ISAP vision and curriculum, we use an iterative approach to ensure the authenticity of the program as interdisciplinary, the structure as complementary with other units in the Faculty of Science, and the delivery in method and content to address each student's interests and maximize their abilities for future employment or advanced post-graduate studies.

Appendix 1 ISAP Calendar Entries

Integrated Science Institute
(Faculty of Science)
4442 Herzberg Bldg.
613-520-4461

This section presents the requirements for programs in:

- **Interdisciplinary Science and Practice** B.Sc. Honours
- **Interdisciplinary Science and Practice** B.Sc. General

Program Requirements

Course Categories

The **Interdisciplinary Science and Practice** program description makes use of the following course categories:

Free Electives (see Academic Regulations for the B.Sc.)

Experimental Science Courses (see Academic Regulations for the B.Sc.)

Minors in the Faculty of Science

Biochemistry

Biology

Chemistry

Computer Science

Earth Sciences: Earth Resources and Processes

Food Science

Geography

Geomatics

Mathematics

Neuroscience and Mental Health

Physical Geography

Physics

Statistics

Interdisciplinary Science and Practice
B.Sc. Honours (20.0 credits)

A. Credits Included in the Major CGPA (10.0 credits)

1.	4.0 credits in:		4.0
	ISAP 1001 [0.**5**]	**Introduction to Interdisciplinary Science**	
	ISAP 1002 [0.**5**]	**Seminar in Interdisciplinary Science**	
	ISAP 2001 [0.**5**]	**Foundations in Critical Enquiry**	
	ISAP 2002 [0.**5**]	**Research Principles for Interdisciplinary Science**	
	ISAP 3001 [0.**5**]	**Principles and Applications in Data Analysis**	
	ISAP 3002 [0.**5**]	**Applications in Interdisciplinary Research**	
	ISAP 3003 **[0.5]**	**Science Communication**	
	ISAP 3004 [0.**5**]	**Science Policy**	
2.	1.0 credit from:		1.0
	ISAP 4906 [**1**.0]	**Group Research Project**	
	ISAP 4907 [**1**.0]	**Research Essay**	
	ISAP 4908 [**1**.0]	**Individual Research Project**	
3.	1.0 credit in:		1.0
	COMP 1005 [0.5]	Introduction to Computer Science I	
	STAT 2507 [0.5]	Introduction to Statistical Modeling I	
4.	0.5 credit from:		0.5
	MATH 1007 [0.5]	Elementary Calculus I	
	MATH 1107 [0.5]	Linear Algebra I	
5.	0.5 credit from:		0.5
	COMP 1006 [0.5]	Introduction to Computer Science II	
	STAT 2509 [0.5]	Introduction to Statistical Modeling II	
6.	1.0 credit at the 2000 level or above from the Faculty of Science		1.0
7.	2.0 credits at the 3000-level or above from the Faculty of Science		2.0

B. Credits Not Included in the Major CGPA (10.0 credits)

8.	1.0 credit in:		1.0
	ECON 1000 [1.0]	Introduction to Economics	
9.	2.0 credits in Approved Experimental Science Courses as defined in the Regulations for the Bachelor of Science		2.0
10.	2.0 credits at the 2000-level or above from the Faculty of Science		2.0
11.	2.0 credits in approved courses outside the faculties of Science and Engineering and Design as defined in the Regulations for the Bachelor of Science. NOTE: Students in the **ISAP** program may not use NSCI 1000 in this category		2.0
12.	3.0 credits in free electives.		3.0
13.	Students are required to complete one minor from the Faculty of Science. A second minor (from any faculty including Science) is encouraged. Students should consult with their academic advisor to ensure compliance with this requirement.		
Total Credits			**20**.0

Interdisciplinary Science and Practice
B.Sc. General (15.0 credits)

A. Credits Included in the Major CGPA (**8**.0 credits)

1. 4.0 credits in:		4.0
ISAP 1001 [0.**5**]	**Introduction to Interdisciplinary Science**	
ISAP 1002 [0.**5**]	**Seminar in Interdisciplinary Science**	
ISAP 2001 [0.**5**]	**Foundations in Critical Enquiry**	
ISAP 2002 [0.**5**]	**Research Principles for Interdisciplinary Science**	
ISAP 3001 [0.**5**]	**Principles and Applications in Data Analysis**	
ISAP 3002 [0.**5**]	**Applications in Interdisciplinary Research**	
ISAP 3003 **[0.5]**	**Science Communication**	
ISAP 3004 [0.**5**]	**Science Policy**	
2. 1.0 credit in:		1.0
COMP 1005 [0.5]	Introduction to Computer Science I	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
3. 0.5 credit from:		0.5
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
4. 0.5 credit from:		0.5
COMP 1006 [0.5]	Introduction to Computer Science II	
STAT 2509 [0.5]	Introduction to Statistical Modeling II	
5. 1.0 credit at the 2000-level or above from the Faculty of Science		1.0
6. 1.0 credit at the 3000-level or above from the Faculty of Science		1.0

B. Credits Not Included in the Major CGPA (7.0 credits)

7. 1.0 credit in:		
ECON 1000 [1.0]	Introduction to Economics	1.0
8. 2.0 credits in Approved Experimental Science Courses as defined in the Regulations for the Bachelor of Science		2.0
9. 1.0 credit at the 2000-level or above from the Faculty of Science		1.0
10. 1.0 credit in Approved Courses Outside the Faculties of Science and Engineering and Design as defined in the Regulations for the Bachelor of Science. Note: students in the **ISAP** program may not use NSCI 1000 in this category.		**1**.0
11. 2.0 credits in free electives.		2.0
12. Students are required to complete one Minor from the Faculty of Science. A second minor from outside the faculty of Science may be possible. Students should consult with their academic advisor to ensure compliance with this requirement.		
Total Credits		**15**.0

Course Descriptions

ISAP 1001 [0.5 credit]

Introduction to Interdisciplinary Science

Course description: What is interdisciplinarity and what are the challenges and opportunities of collaboration within and across disciplines in science and beyond? Topics include types of biases, public datasets and science communication.

Prerequisite(s): none

Lectures and discussion three hours per week

ISAP 1002 [0.5 credit]

Seminar in Interdisciplinary Science

Course description: We will explore the role of interdisciplinarity in discovery and innovation and discuss selected issues facing society and the role of science. Topics include finding information, collaboration and science communication tools.

Prerequisites: ISAP 1001

Seminar three hours per week

ISAP 2001 [0.5 credit]

Foundations in Critical Inquiry

Course description: What is science and the scientific method? Topics include the scientific method, credible sources of information, knowledge gaps, the impact of scientific discoveries, and discussion of their local and global implications.

Prerequisites: ISAP 1002 or permission of the Institute

Lecture three hours per week, workshop two hours per week

ISAP 2002 [0.5 credit]

Research Principles for Interdisciplinary Science

Course description: We will explore how research is conducted. Topics we will discuss include publically available databases, the role of communication in research, stakeholders and participants, and the process of identifying a knowledge gap and developing a research question.

Prerequisites: ISAP 2001 or permission of the Institute

Lecture three hours per week

ISAP 3001 [0.5 credit]

Principles and Applications in Data Analysis

Course description: Development of strategies for obtaining and analyzing data. Topics include survey of publicly available science-data resources, identification of coincidental, correlational and causal relationships, statistical data-analysis techniques, concepts of risk and error propagation in measured and calculated values. Applications in the physical and biological sciences.

Prerequisites: ISAP 2002, COMP 1005 and STAT 2507

Lecture three hours per week, workshop two hours per week

ISAP 3002 [0.5 credit]

Applications in Interdisciplinary Research

Course description: We bring together skills from the ISAP courses and apply them to develop a research proposal. Topics include research ethics, identification of stakeholders, inclusive consultation, collaboration and dissemination strategies.

Prerequisites: ISAP 2002

Lecture three hours per week, workshop two hours per week

ISAP 3003 [0.5 credit]

Science Communication

Course description: How is science perceived and how has science been communicated? Using case studies, we will assess examples of science communication with varying outcomes. Topics include the principles of effective science communication, the range of tools available and knowing your audience.

Prerequisites: ISAP 2002

Lecture and seminar three hours per week

ISAP 3004 [0.5 credit]

Science Policy

Course description: We will explore how science-related policy is developed and the impact of policy on science. Topics will include policy frameworks, stakeholder roles, power relationships, commercialization and the funding of science.

Prerequisites: ISAP 3003

Lecture and seminar three hours per week

ISAP 4901 [0.5 credit]

Directed Studies

Course description: Independent or group study, open to third- and fourth-year students to explore a particular topic, in consultation with a Faculty supervisor. May include directed reading, written assignments, tutorials, laboratory or field work.

Prerequisites: 3rd year standing in the ISAP program and permission of the instructor

ISAP 4906 [1.0 credit]

Capstone Course - Group Research Project

Course description: Students will collaborate on a project that addresses a real-world issue in a team environment. Focus includes design and completion of a research project, development of communication, critical inquiry, data analysis and research skills and the opportunity to develop initiative, creativity and self-reliance.

Prerequisites: 4th year standing in the ISAP (Honours) program and permission of the Institute of Integrated Sciences.

Precludes additional credit for ISAP 4906 or ISAP 4908.

Lecture, seminar and workshop four hours per week, as scheduled by the instructor.

ISAP 4907 [1.0 credit]

Capstone Course - Research Essay

Course description: A substantial, independent essay or research proposal based critical review and research proposal, using library, database and/or bioinformatic resources, under the direct supervision of the instructor. Topics include identification and critical review of resources, development of writing skills and formulation of research question and strategy.

Precludes additional credit for ISAP 4907 or ISAP 4908

Prerequisites: 4th year standing in the ISAP (Honours) program.

Lecture, seminar and workshop four hours per week, as scheduled by the instructor.

ISAP 4908 [1.0 credit]

Capstone Course - Individual Research Project

Course description: An independent research project under the direct supervision of a faculty adviser. Evaluation is based on a written thesis and a poster presentation.

Precludes additional credit for ISAP 4906 or ISAP 4907.

Prerequisites: 4th year standing in the ISAP (Honours) program, a major CGPA 9.0, and permission of the Integrated Science Institute.

Lectures and discussion as scheduled by the course coordinator; other hours as arranged with the faculty advisor.

Appendix 2 ISAP Course Progressions

The following 3 diagrams illustrate the way in which students can combine the program requirements described in the Executive Summary in order to accommodate up to two minors for students in the Honours program and one minor for students in the General program. The fourth diagram illustrates a representative course progression for a student who transfers from another program in science, in this example a BSc in Biology, and still complete the ISAP program within four year.

<table>
<tr><th colspan="4">Bachelor of Science- Interdisciplinary Science and Practice - Honours with two science minors</th></tr>
<tr><th>Year One</th><th>Year Two</th><th>Year Three</th><th>Year Four</th></tr>
<tr><td>ISAP 1001 [0.5 cr]</td><td>ISAP 2001 [0.5 cr]</td><td>ISAP 3001 [0.5 cr]</td><td rowspan="2">ISAP 4906/4908/4909 [1.0 cr]</td></tr>
<tr><td>ISAP 1002 [0.5 cr]</td><td>ISAP 2002 [0.5 cr]</td><td>ISAP 3002 [0.5 cr]</td></tr>
<tr><td rowspan="2">First year exptl science [1.0 cr] MINOR 1</td><td rowspan="2">Introductory Economics [1.0 cr]</td><td>ISAP 3003 [0.5 cr]</td><td rowspan="2">Science 3rd year or higher [1.0 cr] MINOR 1</td></tr>
<tr><td>ISAP 3004 [0.5 cr]</td></tr>
<tr><td rowspan="2">First year exptl science [1.0 cr] MINOR 2</td><td>Computer Science [0.5 cr]</td><td rowspan="2">Science 2nd year or higher [1.0 cr] MINOR 2</td><td rowspan="2">Science 2nd year or higher [1.0 cr] MINOR 2</td></tr>
<tr><td>Computer Science or Statistics [0.5]</td></tr>
<tr><td>First year mathematics [0.5 cr]</td><td rowspan="2">Science 2nd year or higher [1.0 cr] MINOR 1</td><td rowspan="2">Science 3rd year or higher [1.0 cr] MINOR 1</td><td rowspan="2">Science 3rd year or higher [1.0 cr] MINOR 2</td></tr>
<tr><td>Introductory statistics [0.5 cr]</td></tr>
<tr><td>elective [1.0 cr]</td><td>elective [1.0 cr]</td><td>elective outside the Faculties of Science and Engineering and Design [1.0 cr]</td><td>elective outside the Faculties of Science and Engineering and Design [1.0 cr]</td></tr>
</table>

<table>
<tr><th colspan="4">Bachelor of Science- Interdisciplinary Science and Practice - Honours one science and one non-science minor</th></tr>
<tr><th>Year One</th><th>Year Two</th><th>Year Three</th><th>Year Four</th></tr>
<tr><td>ISAP 1001 [0.5 cr]</td><td>ISAP 2001 [0.5 cr]</td><td>ISAP 3001 [0.5 cr]</td><td rowspan="2">ISAP 4906/4908/4909 [1.0 cr]</td></tr>
<tr><td>ISAP 1002 [0.5 cr]</td><td>ISAP 2002 [0.5 cr]</td><td>ISAP 3002 [0.5 cr]</td></tr>
<tr><td rowspan="2">First year exptl science [1.0 cr] MINOR 1</td><td rowspan="2">Introductory Economics [1.0 cr]</td><td>ISAP 3003 [0.5 cr]</td><td rowspan="2">Science 3rd year or higher [1.0 cr] MINOR 1</td></tr>
<tr><td>ISAP 3004 [0.5 cr]</td></tr>
<tr><td rowspan="2">First year exptl science [1.0 cr]</td><td>Computer Science [0.5 cr]</td><td rowspan="2">Science 3rd year or higher [1.0 cr]</td><td rowspan="2">elective [1.0 cr] (can be used for non-science MINOR 2)</td></tr>
<tr><td>Computer Science or Statistics [0.5]</td></tr>
<tr><td>First year mathematics [0.5 cr]</td><td rowspan="2">Science 2nd year or higher [1.0 cr] MINOR 1</td><td rowspan="2">Science 2nd year or higher [1.0 cr] MINOR 1</td><td rowspan="2">elective [1.0 cr](can be used for non-science MINOR 2)</td></tr>
<tr><td>Introductory statistics [0.5 cr]</td></tr>
<tr><td>electives [1.0 cr]</td><td>elective [1.0 cr] (can be used for non-science MINOR 2)</td><td>elective [1.0 cr](can be used for non-science MINOR 2)</td><td>elective [1.0 cr]</td></tr>
</table>

<table>
<tr><th colspan="3">Bachelor of Science- Interdisciplinary Science and Practice - General</th></tr>
<tr><th>Year One</th><th>Year Two</th><th>Year Three</th></tr>
<tr><td>ISAP 1001 [0.5 cr]</td><td>ISAP 2001 [0.5 cr]</td><td>ISAP 3001 [0.5 cr]</td></tr>
<tr><td>ISAP 1002 [0.5 cr]</td><td>ISAP 2002 [0.5 cr]</td><td>ISAP 3002 [0.5 cr]</td></tr>
<tr><td rowspan="2">First year exptl science [1.0 cr] MINOR</td><td rowspan="2">Introductory Economics [1.0 cr]</td><td>ISAP 3003 [0.5 cr]</td></tr>
<tr><td>ISAP 3004 [0.5 cr]</td></tr>
<tr><td rowspan="2">First year exptl science [1.0 cr]</td><td>Computer Science [0.5 cr]</td><td rowspan="2">Science 2nd year or higher MINOR</td></tr>
<tr><td>Computer Science or Statistics [0.5]</td></tr>
<tr><td>First year mathematics [0.5 cr]</td><td rowspan="2">Science 2nd year or higher [1.0 cr] MINOR</td><td rowspan="2">Science 3rd year or higher MINOR</td></tr>
<tr><td>Introductory statistics [0.5 cr]</td></tr>
<tr><td>electives [1.0 cr]</td><td>elective [1.0 cr]</td><td>elective outside the Faculties of Science and Engineering and Design [1.0 cr]</td></tr>
</table>

Course progression for a student transferring into an Honours BSc in Interdiscipinary Science and Practice with two minors after completing first year of a BSc in Biology			
Year 1	Year 2	Year 3	Year 4
Elective: BIOL 1105	ISAP 2001	ISAP 3001	ISAP 490x [1.0]
COMP 1006	ISAP 2002	ISAP 3002	
COMP 1005	STAT 2507	ISAP 3003	SCIENCE 3000+ BIOL 3000+
MATH 1007	ISAP 1001	ISAP 3004	SCIENCE 3000+ BIOL 3000+
Elective	ISAP 1002	SCIENCE 3000+ CHEM 3201	Non-Science
Elective	SCIENCE 2000+ BIOL 2000+	SCIENCE 3000+ CHEM 3202/3800	Non-Science
BIOL 1103	SCIENCE 2000+ CHEM 2203	SCIENCE 2000+ BIOL 2000+	Non-Science
BIOL 1104	SCIENCE 2000+ CHEM 2204	SCIENCE 2000+ BIOL 2000+	Free elective CHEM 2000+
CHEM 1001	ECON 1000 [1.0]	SCIENCE 2000+ BIOL 2000+	Free elective CHEM 2000+
CHEM 1002		Non-Science	Free elective

Courses in red and green have been shifted relative to a direct-entry ISAP pattern.
Chemistry minor
Biology minor

Appendix 3 Course Descriptions and Learning Objectives

BOLD TEXT INDICATES ELEMENTS OF THE LEARNING OUTCOMES RELEVANT TO EACH COURSE AND UNDERLINED TEXT IDENTIFIES PRIMARY ELEMENTS

ISAP 1001: Introduction to Interdisciplinary Science

Course description: What is interdisciplinarity and what are the challenges and opportunities of collaboration within and across disciplines in science and beyond? Topics include types of biases, public datasets and science communication.

Applicable program learning outcomes:

1. **Explain the concept** and value **of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.**
2. Apply critical inquiry to **question biases, identify credible sources of information**, synthesize key points, and distinguish between coincidental, correlational and causal relationships.
3. **Explore** and critique **the impact of scientific advances at the community and global levels** to act as informed stakeholders in the decision-making process.
6. Locate and **access publically available datasets**; design and apply data analysis methodologies; and, interpret the results through training in statistics and computer science.
8. **Work as a team member, independently and collaboratively**, and **apply the professional skills of self-reflection, active-listening** and respectful negotiation.
9. **Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences from the community** and across science disciplines.

The transition from high school to university can be a daunting one. Students must acclimatize to different academic standards and course delivery methods while often feeling socially isolated. With these challenges in mind, our first year ISAP courses will be small seminar-style courses with weekly in-class activities. Projects will be assigned that can help students bridge the transition while assessing learning. †

Examples of Activities and Assignments

- Put the course objectives in your own words and explain what they mean to you. [This activity is the first step in a program long goal to ensure students can articulate what they are learning in their courses]
- In small groups (3-4 students per group) find and research a scientific advance. Prepare and deliver an oral presentation about the disciplines that contributed to the advance and its impact at the local or global level. [1 & 3]

- Write a short opinion piece describing an interdisciplinary topic such as food security, sustainability (energy, forestry, mining) or climate change and identify your perspectives and biases. [2 & 8]
- Select a publically available dataset from the list provided (e.g. genbank, PDB). Write a description of the dataset in terms of size, variables, source, how the data was collected and any research questions that have been developed. [6]
- Working in pairs, write a summary of your partner's interests in science. Identify where their interests overlap your own. [8]
- In small groups, prepare an oral presentation that explains a science issue to a non-science expert, for example a family member. [9]

In addition, weekly in-class activities will be assigned that allow students to gain familiarity and expertise with spreadsheet programs. These activities will be useful skills for their first year experimental science courses. They will also support the development of data analysis skills working toward using publically available datasets. [6]

† The learning objectives are numbered 1 – 9. Following the description of each sample assignment, the number corresponding to the appropriate learning outcome is indicated in square brackets. Within each learning objective, the underlined bold text indicates the specific learning objective assessed in the activities/assignments. Bold text indicates learning outcomes that are introduced in the assessments.

ISAP 1002: Seminar in Interdisciplinary Science

Course description: We will explore the role of interdisciplinarity in discovery and innovation and discuss selected issues facing society and the role of science. Topics include finding information, collaboration and science communication tools.

Applicable program learning outcomes:

1. **Explain the concept** and value **of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.**
2. Apply critical inquiry to **question biases, identify credible sources of information,** synthesize key points, and distinguish between coincidental, correlational and causal relationships.
3. **Explore and critique the impact of scientific advances at the community and global levels** to act as informed stakeholders in the decision-making process.

5. Address an issue by **identifying a knowledge gap**, developing a research question, designing data collection strategies, and identifying and evaluating relevant sources of information, including publically accessible data.

8. **Work as a team member, independently and collaboratively**, and **apply the professional skills of self-reflection, active-listening** and respectful negotiation.
9. **Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences** from the community and **across science disciplines**.

Examples of Activities and Assignments

- Over the semester, keep a diary of science related discoveries and innovations that interest you. Reflect on which scientific field(s) contributed to the discovery/innovation. Evaluate whether progress was impacted by a knowledge gap. [1,3 & 5]
- Find media coverage of a science story and the corresponding scholarly source of information. Answer the following questions:

- what information was included by the media and what was left out?
- is the information in the popular article/video clip accurate?
- who was the intended audience of each article? [2,3&5]

- Prepare a presentation on a scientific discovery or innovation and its impact on society. [3]
- In an online chatroom, submit discussion questions following peer presentations. Selected questions will be addressed during the following class. [8]
- Using your choice of medium (film, cartoon, blog entry…) illustrate the relationship between science fiction and science. Comment on whether science fiction shows how science is perceived. [2&9]

ISAP 2001: Foundations in Critical Inquiry

Course description: What is science and the scientific method? Topics include the scientific method, credible sources of information, knowledge gaps, the impact of scientific discoveries, and discussion of their local and global implications.

Applicable program learning outcomes:

1. **Explain the** concept and **value of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.**
2. **Apply critical inquiry to question biases, identify credible sources of information, synthesize key points**, and distinguish between coincidental, correlational and causal relationships.
3. **Explore and critique the impact of scientific advances at the community and global levels to act as informed stakeholders in the decision-making process.**
4. **Investigate a local issue with global implications** and present the results of a review of the issue, recommendation for key stakeholders as participants, proposal for an inclusive consultation process and, an appraisal of potential ethical considerations.

5. **Address an issue by identifying a knowledge gap**, developing a research question, designing data collection strategies, and **identifying and evaluating relevant sources of information, including publically accessible data.**
7. Explain the **reciprocal influences of government policy and science on the decision-making process** and its outcomes for science and society.

In their second year, students will be given fewer assignments than in their first year. This will allow students time to delve more deeply into the subject material.

Examples of Activities and Assignments

- Find and compare four different popular and scholarly publications on a scientific discovery or innovation. Evaluate how scholarly and popular publications differ and what arguments and evidence each type of work uses. Identify the intended audience for each work and discuss whether the publication is written to influence or inform. [2&3]
- In small groups, select a case study that illustrates the need for communication between the science community and the public (e.g. deep radioactive waste storage).
    - As a group, present to the class the question you are investigating (e.g. how do we dispose of nuclear waste) and describe the scientific contributions from different disciplines that must be considered. Include an exploration of the scientific process and discuss any knowledge gaps (e.g. what are the implications of extrapolating into the future based our current knowledge).
    - Write an analysis of the local and global implications of decisions based on scientific data. Include in your analysis the decision making process (e.g. public consultation) and suggest how this process can be improved.
    - Prepare a pamphlet targeted at the public that describes the scientific basis of the decision.
    - Select the role of either a community stakeholder or scientist and prepare for an in-class debate on the issues informing a decision. [1,3,4,5,7]

ISAP 2002: Research Principles for Interdisciplinary Science

Course description: We will explore how research is conducted. Topics we will discuss include publically available databases, the role of communication in research, stakeholders and participants, and the process of identifying a knowledge gap and developing a research question.

Applicable program learning outcomes:

1. **Explain the concept and value of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.**
2. **Apply critical inquiry to question biases, identify credible sources of information, synthesize key points**, and distinguish between coincidental, correlational and causal relationships.

4. **Investigate a local issue with global implications and present the results of a review of the issue, recommendation for key stakeholders as participants**, proposal for an inclusive consultation process **and, an appraisal of potential ethical considerations.**
5. **Address an issue by identifying a knowledge gap, developing a research question, designing data collection strategies**, and identifying and evaluating relevant sources of information, including publically accessible data.
6. **Locate and access publically available datasets; design** and apply **data analysis methodologies;** and, interpret the results through training in statistics and computer science.
8. **Work as a team member, independently and collaboratively, and apply the professional skills of self-reflection, active-listening and respectful negotiation.**
9. **Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences from** the community and **across science disciplines.**

Examples of Activities and Assignments

- Find and describe a public dataset. In your description, include the people or group responsible for creating and maintaining the dataset, the revision history, project funding, ethical considerations, scope and limitations. Discuss who could and who does use it. [2&6]
- In a group, explore the limits of knowledge on an interdisciplinary topic and frame a research question to address it. [1,5,8]
- Explore a controversial science-based innovation, decision or story. Using popular and scholarly publications, identify different perspectives on the topic. Compare the arguments and evidence each type of publication uses? Recommend a communication strategy that may reduce the negative public reaction. [4&9]
- Take a concept or innovation from one science discipline and explain how it would be useful for scientists researching in another science discipline. [1&9]
- In a series of weekly activities, explore different methods of visualizing data. [1, 6&9]

ISAP 3001: Principles and Applications in Data Analysis

Course description: Development of strategies for obtaining and analyzing data. Topics include survey of publicly available science-data resources, identification of coincidental, correlational and causal relationships, statistical data-analysis techniques, concepts of risk and error propagation in measured and calculated values. Applications in the physical and biological sciences.

Applicable program learning outcomes:

2. **Apply critical inquiry to question biases, identify credible sources of information, synthesize key points, and distinguish between coincidental, correlational and causal relationships.**
5. Address an issue by identifying a knowledge gap, developing a research question, designing data collection strategies, and **identifying and evaluating relevant sources of information, including publically accessible data.**
6. **Locate and access publically available datasets; design and apply data analysis methodologies; and, interpret the results through training in statistics and computer science.**

Examples of Activities and Assignments

- Given a set data-based examples, describe the observed relationships as coincidental, correlational or causal. Propose and design follow-up experiments to probe correlational versus false correlational relationships. [2]
- Given a research question, find relevant public datasets and explain their value and limitations. [2&5]
- Select relevant data from a publically available database and apply skills learned in courses including statistics and computer science to analyze and interpret the results [6]

ISAP 3002: Applications in Interdisciplinary Research

Course description: We bring together skills from the ISAP courses and apply them to develop a research proposal. Topics include research ethics, identification of stakeholders, inclusive consultation, collaboration and dissemination strategies.

Applicable program learning outcomes:

1. **Explain the concept and value of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.**
2. **Apply critical inquiry to question biases, identify credible sources of information, synthesize key points, and distinguish between coincidental, correlational and causal relationships.**
4. **Investigate a local issue with global implications and present the results of a review of the issue, recommendation for key stakeholders as participants, proposal for an inclusive consultation process and, an appraisal of potential ethical considerations.**
5. **Address an issue by identifying a knowledge gap, developing a research question, designing data collection strategies, and identifying and evaluating relevant sources of information, including publically accessible data.**
6. **Locate and access publically available datasets; design and apply data analysis methodologies;** and, interpret the results through training in statistics and computer science.

8. **Work as a team member, independently and collaboratively, and apply the professional skills of self-reflection, active-listening and respectful negotiation.**
9. **Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences from the community and across science disciplines.**

This course performs the dual role of capstone project for students enrolled in the general program as well as a preparation course for students doing their fourth year honours thesis, project or essay. The culminating project, a research proposal, will be developed throughout the term. The process of preparing a research proposal will be broken down into discrete steps that form the basis of the assignments and activities throughout the term. [All learning outcomes will be assessed]

Examples of Activities and Assignments

- Develop a research proposal for a community-engagement or citizen science project. You will be assigned components of the proposal throughout the term. Your final submission will comprise revised drafts of your assignments organized as a comprehensive research proposal. Weekly assignments may include:
  - identifying a knowledge gap
  - formulating a community-based or citizen science research question
  - exploring methods and approaches related to the research question
  - outlining your research proposal
  - completing a stakeholder analysis and outlining the consultation process
  - completing an ethics application
  - outlining and giving examples of an appropriate dissemination plan
- In groups, prepare a detailed background analysis of the relevant community or stakeholder group associated with your research proposal. Develop character profiles for members within the community group for an in-class role playing exercise.
- Write a reflection on your understanding of interdisciplinary science and research, how it is conducted and how your understanding has changed since taking ISAP 1001.

ISAP 3003: Science Communication

Course description: How is science perceived and how has science been communicated? Using case studies, we will assess examples of science communication with varying outcomes. Topics include the principles of effective science communication, the range of tools available and knowing your audience.

Applicable program learning outcomes:

1. **Explain the concept and value of interdisciplinarity across the sciences and with the non-science fields and discuss science-related issues from diverse perspectives.**
3. **Explore and critique the impact of scientific advances at the community and global levels to act as informed stakeholders in the decision-making process.**
8. **Work as a team member, independently and collaboratively, and apply the professional skills of self-reflection, active-listening and respectful negotiation.**
9. **Employ appropriate traditional and digital communication tools and styles to engage with a variety of audiences from the community and across science disciplines.**

Throughout the course, the theory and practice of science communication will be examined.

Examples of Activities and Assignments

- Prepare and deliver a series of four presentations on a science-based topic using different communication methods (written, oral, social media and a mode of your choosing). Identify diverse audiences for your topic and choose the appropriate communication method for each group. [1&9]
- Working in small groups, select a science-based issue (e.g. renewable energy, food security, cybersecurity). In a presentation to the class, introduce your topic and compare local and global perspectives on the issue.[3,8,9]
- In class groups, analyze a case study where science communication was not effective. Identify where the communication broke down. [3]
- Design a hands on presentation for elementary school students [9]
- In pairs, conduct a risk assessment for a potential hazard or known risk and present a plan for communicating risk to a broad public audience.

ISAP 3004: Science Policy

Course description: We will explore how science-related policy is developed and the impact of policy on science. Topics will include policy frameworks, stakeholder roles, power relationships, commercialization and the funding of science.

Applicable program learning outcomes:

2. **Apply critical inquiry to question biases, identify credible sources of information, synthesize key points**, and distinguish between coincidental, correlational and causal relationships.
3. **Explore and critique the impact of scientific advances at the community and global levels to act as informed stakeholders in the decision-making process.**

4. **Investigate a local issue with global implications and present the results of a review of the issue, recommendation for key stakeholders as participants, proposal for an inclusive consultation process and, an appraisal of potential ethical considerations.**
7. **Explain the reciprocal influences of government policy and science on the decision-making process and its outcomes for science and society.**

Examples of Activities and Assignments

- Prepare a briefing note on an issue related to science that is likely to have both community supporters and detractors (e.g finding a site to dispose of nuclear waste). Write the briefing note concisely (no more than 1000 words excluding references) with a senior official as the intended reader. [2,3,4,7]
- Find an example in your area of interest of where the potential for commercialization has driven funding for science and present an analysis of the pros and cons of commercialization versus public funding models. [2,3,4,7]
- Select one of the assigned readings on principles and processes of decision-making and policy formulation and present a critique to the class. Prepare questions for the class that you can use to initiate a class discussion. [2,3,4,7]
- Develop a character for a role-playing activity. Choose one of the relevant stakeholders in a public consultation where research has been conducted and the community is being consulted (e.g. finding a site for nuclear waste storage). Write a summary of this activity including an analysis of the power relationships involved and how they impact the decision making process. [2,3,4,7]

ISAP 4901 [0.5 credit]

Directed Studies

Course description: Independent or group study, open to third- and fourth-year students to explore a particular topic, in consultation with a Faculty supervisor. May include directed reading, written assignments, tutorials, laboratory or field work.

Prerequisites: 3rd year standing in the ISAP program and permission of the instructor

ISAP 4906 [1.0 credit]

Capstone Course - Group Research Project

Course description: Students will collaborate on a project that addresses a real-world issue in a team environment. Focus includes design and completion of a research project, development of

communication, critical inquiry, data analysis and research skills and the opportunity to develop initiative, creativity and self-reliance.

Prerequisites: 4th year standing in the ISAP (Honours) program and permission of the Institute of Integrated Sciences.

Precludes additional credit for ISAP 4906 or ISAP 4908.

Lecture, seminar and workshop four hours per week, as scheduled by the instructor.

ISAP 4907 [1.0 credit]

Capstone Course - Research Essay

Course description: A substantial, independent essay or research proposal based critical review and research proposal, using library, database and/or bioinformatic resources, under the direct supervision of the instructor. Topics include identification and critical review of resources, development of writing skills and formulation of research question and strategy.

Precludes additional credit for ISAP 4907 or ISAP 4908

Prerequisites: 4th year standing in the ISAP (Honours) program.

Lecture, seminar and workshop four hours per week, as scheduled by the instructor.

ISAP 4908 [1.0 credit]

Capstone Course - Individual Research Project

Course description: An independent research project under the direct supervision of a faculty adviser. Evaluation is based on a written thesis and a poster presentation.

Precludes additional credit for ISAP 4906 or ISAP 4907.

Prerequisites: 4th year standing in the ISAP (Honours) program and permission of the Institute of Integrated Sciences.

Lectures and discussion as scheduled by the course coordinator; other hours as arranged with the faculty advisor.

Appendix 4 Admissions Regulations

ADMISSIONS REGULATIONS

Interdisciplinary science and practice

Degrees

- B..Sc. (Honours)
- B..Sc. (General)

Admission Requirements

*Honours Program**

First Year
The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses, which must include Advanced Functions and two of Biology, Chemistry, Earth and Space Sciences or Physics. (Calculus and Vectors is strongly recommended). Prerequisite courses must be at the 4U level with no individual grade below 60%. A 4U course in English is recommended.

Advanced Standing

Students may transfer to the honours program if upon entry they would be in good academic standing.

General Program

Access to the General degree is limited to students who apply to transfer.

*Note - in Carleton's 2018 Viewbook, the minimum cutoff range for students applying for a BSc Honours degree is 78-82[109]. Students applying to take an honours BSc in ISAP will also need to meet this requirement.

[109] https://admissions.carleton.ca/guides/GeneralViewbook.pdf

Appendix 5

Institute of Environmental Science Strategic Plan for 2017-2022

DRAFT – Note – this will be refined based on input from the ECO Canada site assessment

Preamble

The Institute of Environmental Science at Carleton University has undertaken a strategic planning exercise to steer the activities of the academic unit and its programming from 2015 to 2020 and beyond. This new Plan builds on the many successes within the institute but recognizes the opportunity to grow and strengthen our program and team to better serve the students, the university, and the profession and help to understand and solve complex environmental problems while training the next generation of environmental scientists. In particular, the plan is intended to address weaknesses and opportunities identified during the accreditation process by ECO Canada where the Hons B.Sc. program in Env Sci was evaluated (in 2012) as well as the Quality Assurance Process that Env Sci completed in 2015. In addition, the plan is linked to the Carleton University "Strategic Integrated Plan (SIP)" given the interdisciplinary nature of the Env Science program and the emphasis on themes such as sustainability and community engagement. Quoting from the SIP, "Carleton will conduct research, develop programs and undertake other initiatives that foster further understanding of community strengths, needs and interests, build community capacity and enhance community sustainability". It is important to recognize that the Env Science program at Carleton is an undergraduate program but its members maintain active research programs that engage undergrads, graduate students and a variety of partners and stakeholders. This plan acknowledges that the primary vision of the institute continues to be based around excellence in undergraduate education while also recognizing that innovations in research and relevant professional service by the members enhance teaching and training as well as enhancing the profile of the Institute, the Faculty of Science and Carleton University. This document is written such that it includes some specific implementation elements but recognizes that the implementation plan will evolve and should be re-examined yearly as part of the annual program of work (with associated annual budget request to the Dean of Science) by the Director and the members of the Institute.

Objectives

To position the Institute of Environmental Science at Carleton University as the Canadian leader in the interdisciplinary training of environmental scientists who have the necessary skills and competencies to understand and solve complex environmental problems and become the leaders of tomorrow.

To ensure that graduates are empowered to affect change through an evidence-based approach to environmental science.

To build the research profile of the institute, its members and its trainees by conducting innovative interdisciplinary scientific research that addresses regional, national and international environmental issues.

To serve as a nexus for teaching, research and outreach in the broad theme of "environment" at Carleton University by strengthening relationships with other units, allied agencies, and partners in Ottawa and beyond.

Vision

Our vision for the institute is one that is student-centered where there is a seamless interface between teaching, learning, research and outreach with a focus on being relevant and responsive to the environmental challenges that face society regionally, nationally and internationally.

Activities that should be pursued during the tenure of this strategic plan:

Evaluate programming and delivery in the core undergraduate programs given the current increased level of enrolment (which is putting some strain on the program) in order to maintain and improve the quality of the program

- Identify the practical cohort size given the emphasis on hands-on experiences and extensive interaction with faculty (use such information to identify intake limits or for case for more faculty)
- Consider developing new courses on interdisciplinary topics such as wetland science, restoration ecology and emerging topics in environmental science that are not well-covered elsewhere
- Collaborate with the Institute for Integrated Science and other partners to explore means of increasing exposure of Env Science students to policy, science communication, stewardship, and human dimensions science
- Place greater emphasis on the practicum course to provide students with relevant career skills

Initiate a hiring program that involves cross-appointments and that is consistent with our need to increase research and teaching capacity in the strategic topics outlined below

Increase opportunities for students to interact with peers and network with professionals and engaged partners, learn about their profession, and generate/apply new knowledge

- Develop a student-driven seminar series
- Strengthen the "year" rep program so that students in 1st and 2nd year are more engaged with the Environmental Science Student Association and the ENSC program
- Deliver workshops on topics identified by students such as "how to get into grad school"
- Facilitate opportunities related to #Scicomm
- Encourage thesis students to work with their mentors and partners to develop publication-quality research (and to actually submit work to peer reviewed outlets)

Strengthen outreach activities to better serve the public with respect to the environment and that will lead to partnerships with stakeholders

- Expand the social media presence of the Institute, its members, and the students in the program

- Develop means of engaging partners involved in the “group projects” course throughout the entire year
- Create networking opportunities that connect faculty, students, and external partners

Encourage interdisciplinarity with respect to teaching and research

- Development of capstone course that brings together students in Env Studies and Env Science
- Encourage undergraduate thesis projects that involve co-supervision by faculty members with different types of expertise
- Seek a mechanism to bring members of the institute together to explore research opportunities
- Enable students to explore “non traditional” thesis projects where the end product is not necessarily a written document (e.g., video product)

Formalize practices and procedures for the functioning of the Institute that ensure accountability, transparency and collaborative team work

- Build a network of affiliates (i.e., adjunct professors) in partner agencies/organizations to expose students to more real-work experiences
- Forge stronger partnerships with the Institute of Integrated Science including the potential for shared governance structures/leadership

Consider developing a professional M.Sc. in Env Science program around the themes of environmental stewardship and management

Strategic Directions

There are a number of core research and teaching strengths within the Institute. Several of these themes have direct links to the “SIP” document that serves as the Carleton University Strategic Vision. Future teaching activities (e.g., course development and revision), program expansion (e.g., graduate program), hiring (e.g., Canada Research Chairs, tenure track faculty), and collaborative research projects (e.g., joint funding applications by members of the Institute) should to the extent possible focus on these strategic directions:

- Environmental Aspects of Large-Scale Development Projects
- Traditional Knowledge and Citizen Science
- Knowledge Mobilization and Science Communication
- Health and the Environment
- Evidence Synthesis and Risk Assessment
- Food Security and the Environment
- Ecosystem Restoration
- Terrestrial-Aquatic Ecosystem Connectivity
- Global Environmental Change

Appendix 6: Library Report

Institutional Quality Assurance Process

Library Report for Interdisciplinary Science and Practice

New Program

Date: 27 February 2017

Compiled by: Vanessa Lawrence, Science Librarian
Scott Turner, Subject Specialist (Journalism, Communication)
Heather MacDonald, Health & Biosciences Librarian

Submitted to: John Shepherd, Vice-Provost and Associate Vice-President (Academic)

cc

Julia Wallace, Director, Integrated Science Institute
Malcolm Butler, Dean of Science
Christina Noja, Acting Manager, Office of the Vice-Provost and Associate Vice-President (Academic)
Robyn Green, Program Officer, Office of the Vice-Provost and Associate Vice-President (Academic)
Wayne Jones, University Librarian
David Sharp, Head, Collection Development and Acquisitions
Colleen Neely, Assessment Projects Librarian

Overview and Recommendations

An analysis of Carleton University Library's information resources and services in support of the program demonstrates that the Library does not require additional funds to support it.

Library Collections

Subject Specific

The Library's collection includes resources to support the new Interdisciplinary Science and Practice program. These include 58 of the top-ranked 60 journals in Journal Citation Reports, classified under the subject categories: communication, history & philosophy of science, and science education.

Journal Citation Reports Subject Heading(s)	Percentage of Top-Ranked 20 Journals
Communication	100%
Education, Scientific Disciplines	90%
History & Philosophy of Science	100%

Students in the Interdisciplinary Science and Practice program will also select a minor from the Faculty of Science. The library collections in the areas of study that students may choose from are also strong. The collection includes many of the top-ranked journals in Journal Citation Reports, classified under the subject categories listed in the table below.

Journal Citation Reports Subject Heading(s)	Percentage of Top-Ranked 20 Journals
Biology, Biochemistry & Molecular Biology, Biotechnology & Applied Microbiology, Cell Biology, Developmental Biology, Ecology, Entomology, Evolutionary Biology, Fisheries, Genetics & Heredity, Marine & Freshwater Biology, Mathematical & Computational Biology, Microbiology, Mycology, Physiology, Plant Sciences, Zoology	70%
Chemistry: Analytical, Applied, Inorganic & Nuclear, Medical, Multidisciplinary, Organic, Physical	95%
Computer Science: Artificial Intelligence, Cybernetics, Hardware & Architecture, Information Systems, Interdisciplinary Applications, Software Engineering, Theory & Methods	90%

Earth Science: Geochemistry & Geophysics, Geology, Geosciences Multidisciplinary	85%
Food Science & Technology	95%
Mathematics, Mathematics Applied	85%
Neurosciences	100%
Physics: Applied, Atomic Molecular & Chemical, Condensed Matter, Fluids & Plasmas, Mathematical, Multidisciplinary, Nuclear, Particles & Fields	85%
Statistics & Probability	95%

During the 2015/2016 academic year, the Library's spending for collections in all areas was about $6.1 million. About $2.5 million was spent on general electronic resources which benefit all subject areas. In addition to that amount, the following table shows the amounts spent on electronic resources (databases, journals, ebooks, indexes), print journals, and monographs cumulatively in all areas of science:

Library Collections Spending, 2015/2016	**Electronic Resources**	**Print Journals**	**Monographs**
Science (Total)	$1,275,945.52	$9,614.88	$68,029.25

In addition to subject-specific monograph purchases to support different areas of the sciences, the Library's spending on monographs in the general area of science in the past eight years has been as follows:

Library Collections Spending, Monographs								
Subject	**2008/2009**	**2009/2010**	**2010/2011**	**2011/2012**	**2012/2013**	**2013/2014**	**2014/2015**	**2015/2016**
Science, general	$13,338.84	not available	$9,668.33	$9,249.89	$13,424.57	$5,500.85	$8,144.83	$872.61

Teaching, Learning, and Research

The information-literate student is one who is able to access information efficiently, critically assess it, assimilate and synthesize it effectively. The Library's programs and services are grounded in Ontario's Quality Assurance Framework, articulated in *Ensuring the Value of Univeristy Degrees in Ontario*, the Council of Ontario Universities' guide to degree level expectations in the province.

The Librarians and Subject Specialists work collaboratively with faculty to address students' information competencies through a number of methods, including the following.

Instruction, Teaching, and Practicums

The total number of in-class instruction sessions provided by Library staff in all subject areas during 2015/2016 was 479, and the total number of students attending was 18,338. There were a total of 12 practicums (hands-on learning opportunities, critical enquiry projects) in all subject areas. The Librarians and Subject Specialists design classes and practicum opportunities to meet the needs of specific assignments and course requirements while addressing broad learning objectives.

Librarians currently provide workshops and grade an assignment for each section of NSCI 1000, an interdisciplinary science course currently offered through the Integrated Science Institute.

Learning Support – Provided Online

The Library website (library.carleton.ca) is designed to support each step of the research process: identifying, accessing, borrowing, evaluating, and citing resources. Google Analytics recorded almost 1 million visits to the Library website during 2015/2016. Library users can now easily conduct a comprehensive search of the entire collection using the new Summon search interface.

Highlights of the Library website include:

- Quick and detailed subject guides to support research in numerous areas of scientific study including Biology, Chemistry, Earth Sciences, Mathematics and Statistics, and Neuroscience.
- Detailed subject guides to support research in Communication, Science and Technology: Public Policy and Statistics, Data Studies, and Data Visualization
- Course guide for NSCI 1000: Seminar in Science
- Course guide for JOUR 4201: Specialized Reporting – Science Reporting

Services and Spaces

Individual Research Consultations

Library staff provided 6,613 individual research consultations in total in 2015/2016 for all faculties. Consultations can be scheduled for quantitative and qualitative research, as well as for GIS support.

Research Help Desks

Onsite research help is also available at three service points: the main Research Help desk, the MADGIC (Maps, Data, and Government Information Centre), and the Archives help desks. The main and MADGIC desks are open seven days a week during the fall and winter terms, and are supplemented with phone, email, and chat reference services. These three service points had a total of 11,314 visits in 2015/16.

General Information about the Library

The Library underwent extensive renovations in 2012-13, including two additions (West and East), and extensive renovations to the interiors. The East addition consists of five storeys of renovated space, totaling 28,500 square feet, punctuated by a large new reading room on the main floor, an Ottawa Community Resource Room, and an open-concept façade from top to bottom. The West addition consists of a two-storey addition, Levels 4 and 5, totaling 45,700 square feet of new library space. The

new design for the fourth and fifth floor addition located at the rear of the building includes expanded group study rooms, digital media study rooms, the Discovery Centre with three innovative learning labs, and a special collections study area. Throughout the existing portion of the library, approximately 34,700 square feet was renovated, creating many modernized departmental spaces, including Reference Services, MADGIC, ARC, Reserves, and Interlibrary Loans.

The Discovery Centre is a 9,500 square foot collaborative workspace for undergraduate research. This dynamic learning environment is outfitted with ergonomic, accessible and stylish furniture as well as state-of-the-art technology. Complete with three Library Laboratories (a gaming lab, a learning lab, and a multimedia lab), this multi-purpose space can be adapted to suit a wide range of needs.

The Library's collection includes 1,069,744 printed monographs and 811,272 e-books, and licensed access to 72,709 electronic journals. In addition, the Library has substantial collections of government documents and other resources, maps, data, rare books and other special research collections, printed journals, archives, theses, multimedia resources (audio, DVD, streaming video), musical scores, computer games, as well as licensed access to a broad range of fulltext and indexing databases. For a snapshot of details, see Appendix.

Subject specialists and liaison librarians, working with faculty members and coordinated by the Head of Collection Development and Acquisitions, build and maintain the Library's collection by developing subject-specific collection policies which guide the systematic selection of materials. The Library also provides a request form on its website where a user may suggest a book or other item for purchase. Although the majority of monographs are collected in print format, the library is increasing its e-book collections. Students and faculty already have access to many e-books in a wide range of subjects and disciplines.

In order to enhance its purchasing power (particularly for electronic resources), the Library is an active member of two major cooperative partnerships: the Ontario Council of University Libraries (OCUL), a consortium of the 21 academic libraries in the province; and the Canadian Research Knowledge Network (CRKN), a consortium of 75 academic libraries across the country.

The Library's annual acquisitions budget for the 2016/2017 fiscal year is $6 million, and its staffing and operating budget is $10.9 million.

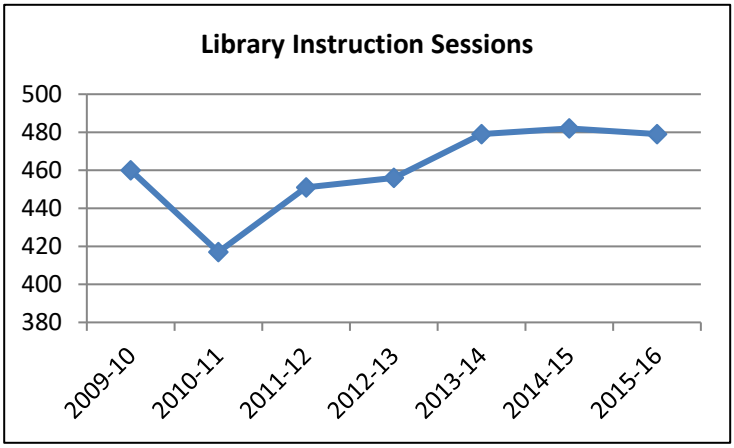
The Library acquisitions budget is not protected from inflation, exchange rates, or cuts, which often challenges the Library's ability to provide all the necessary resources in support of teaching, learning, and research at Carleton. Consideration of the funds necessary for the Library's acquisitions budget is part of the academic planning and Quality Assurance processes for new programs. In relation to other Canadian academic libraries, Carleton's acquisitions budget is small, and comparisons on specific metrics also generally place Carleton at the back. Carleton's budget has increased by about 36% since 1999/2000 – slightly less than the increase in the national average of academic library budgets over the same period. But the the main problem is that Carleton's dollar amount is historically small in comparison to the national average, and since 1999/2000 it has not been catching up: it remains at about 52% (Carleton = about $5.4 million and the national average = about $10.3 million as of 2013/2014, the latest year for which comparative figures are available). The Library is dedicated to regular assessment of its resources and services. Staff use an assortment of qualitative and quantitative techniques to evaluate collections and services in order to make sound decisions within budget parameters.

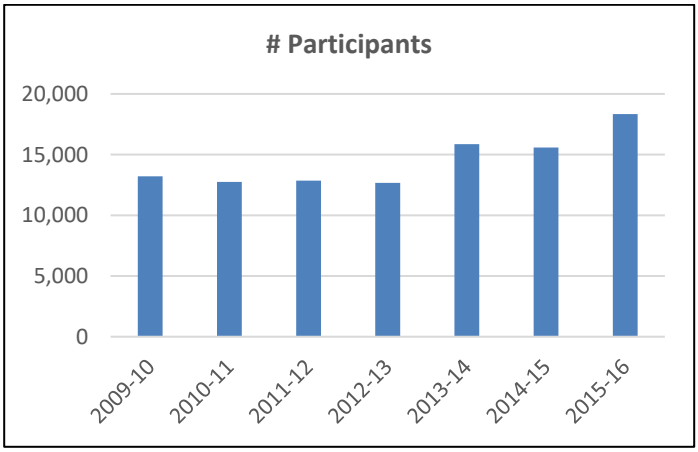
The Library strongly supports the principles and practices of open access. The University's institutional repository, CURVE, was established in 2011 and is maintained by the Library. It includes not only a growing archive of the broad intellectual output of the University, but also digitized versions of most of the theses accepted at Carleton since 1955 – and as of 2014 houses all new Carleton theses deposited electronically. The Library contributes to CURIE, the University's program to provide funding for faculty and researchers who are publishing in open access journals, and also hosts 6 OA journals online using the Open Journal Systems management and publishing system.

AT A GLANCE: CARLETON UNIVERSITY LIBRARY

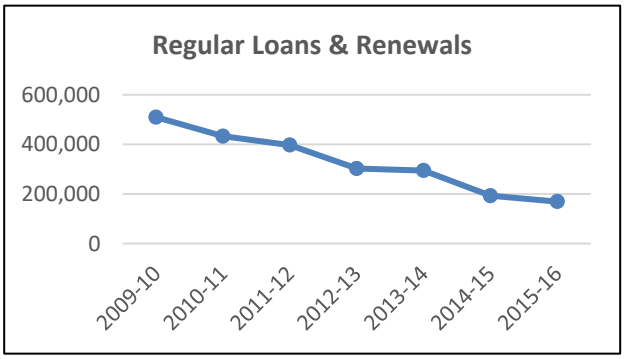
Statistics as of May 1, 2016 except where indicated.

Teaching, Learning, & Research





Research Experience



Highlights:

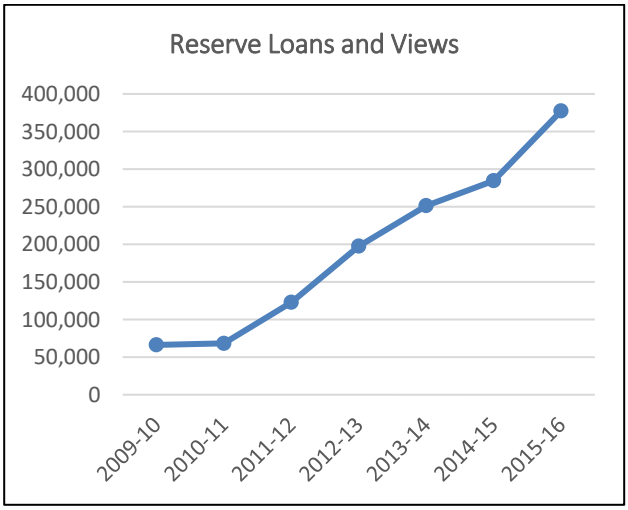
- CURVE - Carleton's Institutional Repository
- Open Access Funding for Faculty, Staff, & Students
- Research Data Management Training
- Open Access Awards for Graduate Students
- Discovery Centre for Undergraduate Research & Engagement
- Professional Skills Training for Graduate Students

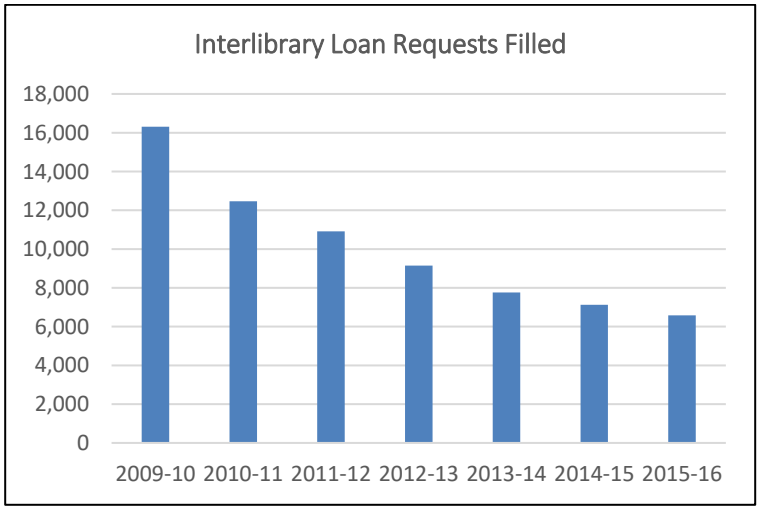
Electronic Usage

E-journal downloads (2015):
1,669,404

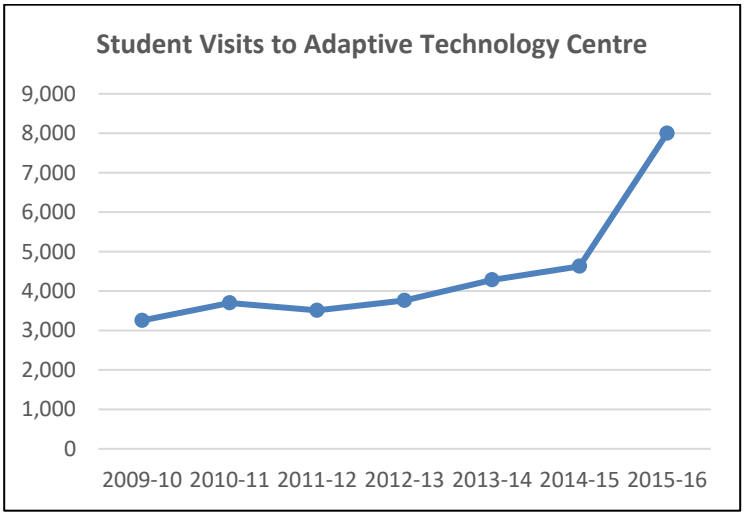
E-book uses (packages) (2015):
806,700

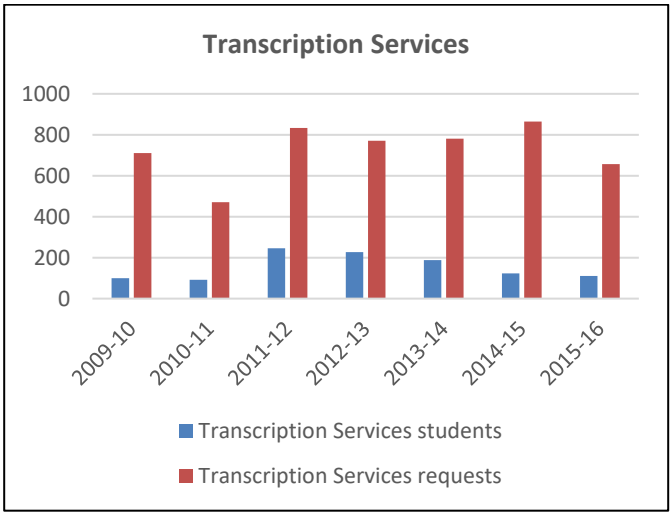
Library Web Visits (2015-16):
1 million





Student Learning Experience





Highlights:

- Over 1.3 million visits in a year
- 2,000 seats
- 178 workstations
- Group & graduate study rooms
- Innovative Study areas
- Adaptive Technology Centre
- 24 hour access at peak times

Organizational Excellence

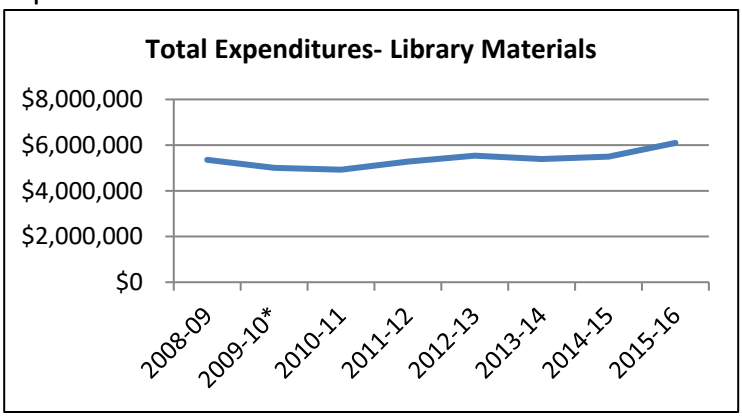
Collection Facts

# Print Volumes	1.8 million
# Manuscripts & Archives	1659.4 linear metres
Percentage of Total Collection Budget Allocated to E-Resources	81%
# Cartographic Materials	162,000
# E-books	811,272
# E- Journals	72,709

Ranking & Comparisons

Globe & Mail 2016 Canadian University Report	
Average	Library Resource Spending
Maclean's - Comprehensive Universities (2016)	
5th/15	Library Expenses
14th/15	Library Acquisitions
Carleton Service Satisfaction- Students (2014)	
8.6/10	Overall satisfaction- Library
Carleton Service Satisfaction- Employees (2015)	
8.6/10	Overall satisfaction- Library

Expenditures



Library collection expenditures (2013/14) *(Cdn Assoc of Research Libraries- latest figures)*	Carleton = $5,401,807 National Average = $10,389,197
Library collections expenditure as a percentage of University budget (2013/2014) *(CARL- latest figures)*	Carleton = 1.51% National Average = 1.75%

**Amount as of April 9, 2010*

Appendix 7 Letters from Chairs and Directors of Sister Units

Below is a list of the units who offer either required courses listed in the program or offer science minors which are a key component of the program. We are including letters supporting course access and support for the proposed program.

Office of the Dean of Science

Institute of Biochemistry

Department of Biology

Department of Chemistry

School of Computer Science

Department of Earth Sciences

Department of Economics

Institute of Environmental Science

School of Mathematics and Statistics

Department of Neuroscience

Department of Physics

Office of the Dean of Science
3230 Herzberg Laboratories
1125 Colonel By Drive
Ottawa, ON K1S 586 Canada
Tel: (613) 520-4388
Fax: (613) 520-4389
odscience@carleton.ca
www.carleton.ca/science

Date: 16 March 2018
To: CUCQA, Carleton University
From: Dwight Deugo, Interim Dean of Science, Faculty of Science, Carleton University

---

Dear CUCQA,

I fully support the new program proposal for Interdisciplinary Science and Practice (ISAP). I feel the interdisciplinary nature of the program will enable students taking it to increase their capacity to understand multiple viewpoints on a given topic while developing the fundamental skills of problem solving, personal management, evidence synthesis and teamwork. In addition, ISAP's communication component is a step forward in preparing students to be able to communicate science to the global community.

The introduction of the new program is important to the Faculty of Science. Science has well over 100 undeclared first-year Science students. These are students that often don't want to commit to a specific program and many times are just looking for a broader view of Science. ISAP help to fill this void and the one left by the closure of our integrated science program. ISAP also increases our competitive offering in the corresponding area against other universities. ISAP goes well beyond our old integrated science program by embedding the theory and practice of collaboration, communication, and critical inquiry throughout all of its new courses. These are the skills that employers are looking for and the ones ISAP will provide.

In principle, new faculty and administrative hires are approved for ISAP, but will always be subject to budgetary and financial constraints. As the program reaches year 3 of operation upper year ISAP students can be hired as teaching assistants. Until that time, and given the interdisciplinary Science nature of the program, students are available from other programs in Science to meet the demand.

Environmental Science has been developing as an interdisciplinary discipline for many

years. Integrated Science was founded at Carleton to provide academic programing and curricula for students whose academic interests do not fit within conventional disciplinary boundaries. The Institute of Environmental Science and the Integrated Science Institute have merged into The Institute of Environmental and Interdisciplinary Sciences, increasing the synergies between the two institutes and the intellectual overlap in the faculty, and permitting the sharing of the administrative resources. The new institute provides the home for ISAP.

Please let me know if you have any questions.

Sincerely,

Dwight Deugo,
Interim Dean, Faculty of Science.

Carleton UNIVERSITY

1125 Colonel By Drive, Ottawa, Ontario, Canada K1S 5B6

Dr. William Willmore
Professor and Director
Institute of Biochemistry
Departments of Biology and Chemistry
Office: Nesbitt 316 (613) 520-2600 ext. 1211
Lab: Nesbitt 323A (613) 520-2600 ext. 1220
Fax: (613) 520-3539
Email: Bill_Willmore@carleton.ca
Webpage: http-server.carleton.ca/~bwillmor
Skype: william.willmore
Twitter: Bill Willmore@billwillmore

March 16, 2018

Julia Wallace, PhD
Integrated Science Institute
Carleton University
4431 Herzberg Laboratories
Ottawa, ON K1S 5B6

Dear Julia,

On behalf of the Institute of Biochemistry, I am writing to confirm our support for the proposed Interdisciplinary Science and Practice (ISAP) program. ISAP responds to an emerging need for graduates with skills in science communication and interdisciplinary collaboration. As such, ISAP will be a welcomed asset to the Faculty of Science.

The structure of the ISAP program is unique in the Faculty of Science. We understand that ISAP students must have at least one minor in a science discipline. Although, currently, Biochemistry does not have a Minor, ISAP students will be given permission to take courses in Biochemistry, given that they have the prerequisites. Biochemistry will be developing a Minor, and this will be available to ISAP students in the future. Also, Faculty members in Biochemistry can supervise ISAP students undertaking their Individual Research Projects (ISAP 4908).

We look forward to collaborating with your faculty to create new opportunities for students in the ISAP and Biochemistry programs.

Sincerely,

Bill Willmore

William Willmore, Ph.D.
Professor and Director
Institute of Biochemistry
Departments of Biology and Chemistry
Carleton University

Carleton UNIVERSITY
Canada's Capital University

1125 Colonel By Drive. Ottawa, ON, K1S 5B6

Dr. Owen Rowland
Professor of Biology and Biochemistry
Chair of Biology
Department of Biology
Tel: (613) 520-2600 x4213
E-mail: owen.rowland@carleton.ca

March 16th, 2018

To: Julia Wallace, PhD Director
Integrated Science Institute
Carleton University
442 Herzberg Laboratories
Ottawa, ON K1S 5B6

Dear Julia,

On behalf of the Department of Biology, I am writing to confirm our support for the proposed Interdisciplinary Science and Practice (ISAP) program. ISAP responds to an emerging need for graduates with skills in science communication and interdisciplinary collaboration in order to address major questions facing researchers and society. We look forward to collaborating with your faculty to create new opportunities for students in the ISAP and Biology programs.

The structure of the ISAP program is unique in the Faculty of Science. We understand that ISAP students must have at least one minor in a science discipline. Therefore, I am confirming that our Department will give ISAP students the equivalent registration priority as other students in BSc programs requiring Biology courses as part of their major. In particular, ISAP students will be allowed to register in BIOL 1103 and BIOL 1104. In addition, for ISAP students completing a minor in Food Science and Nutrition, these students will have similar status for registering in BIOL 1103. ISAP students will also have access to a range of upper level courses that will allow them to complete their minor in Biology, although there may be limitations to the number of students that can be accommodated in courses with a required laboratory.

I look forward to the implementation of ISAP and seeing the interdisciplinary perspective that ISAP students will bring to our student population in Biology.

Sincerely,

Owen Rowland, Ph.D.
Chair, Department of Biology
Carleton University

Carleton UNIVERSITY
Canada's Capital University

Department of Chemistry
203 Steacie Building
1125 Colonel By Drive
Ottawa, Canada K1S 5B6
Tel: (613) 520-3534
chemistry@carleton.ca
http://carleton.ca/chemistry

March 12, 2018

Julia Wallace, PhD
Director
Interdisciplinary Science and Practice
Carleton University

Dear Julia,

On behalf of the Department of Chemistry, I am writing to express support for the proposed to Interdisciplinary Science and Practice (ISAP) program.

We understand that ISCP students must have at least one minor in a science discipline. Therefore, I am confirming that our Department will give ISCP students the equivalent registration priority as other students in BSc programs requiring Chemistry courses as part of their major. In particular, ISCP students with the appropriate high school prerequisites will be allowed to register in CHEM 1001 and CHEM 1002. Otherwise, ISCP students will be allowed to register in CHEM 1005 or CHEM 1006. Provided ISCP students possess the necessary prerequisites, they will have access to a range of upper level courses to complete their minor in Chemistry.

I look forward to the implementation of ISAP program and seeing the interdisciplinary perspective that ISAP students will bring to our student population in Chemistry.

Sincerely,

Dr. Robert J. Crutchley
Professor and Chair
Department of Chemistry

Carleton UNIVERSITY
Canada's Capital University

1125 Colonel By Drive, Ottawa, ON K1S 5B6

School of Computer Science
4135 Herzberg Laboratories
1125 Colonel By Drive
Ottawa, ON
K1S5B6

March 16th, 2018

Julia Wallace, PhD
Integrated Science Institute
Carleton University
442 Herzberg Laboratories
Ottawa, ON K1S 5B6

Dear Julia,

On behalf of the School of Computer Science, I am writing to express support for the proposed Interdisciplinary Science and Practice (ISAP) program. ISAP responds to an emerging need for skills in science communication, interdisciplinary collaboration and data analysis to address the major questions facing researchers and society. As such, ISAP will provide both a resource within the Faculty of Science and training not currently available. We look forward to working with your faculty in order to create new opportunities for students in the ISAP and Computer Science programs.

I am confirming that our School will give ISAP students the equivalent registration priority as other students in BSc programs requiring Computer Science courses as part of their major. In particular, ISAP students will be allowed to register in COMP 1005 and COMP 1006.

I look forward to the implementation of ISAP and seeing the interdisciplinary perspective that ISAP students will bring to our student population in Computer Science.

Sincerely,

Douglas J. Howe

Douglas Howe, PhD
Director
School of Computer Science
Carleton University
5302 Herzberg Laboratories
Ottawa, ON K1S 5B6

Carleton UNIVERSITY
Canada's Capital University

Department of Earth Sciences
Carleton University
2115 Herzberg Laboratories
1125 Colonel By Drive
Ottawa, ON K1S 5B6
Tel: (613) 520 2600, ext. 5633
Fax: (613) 520 5613
www.earthsci.carleton.ca

March 16, 2018
Julia Wallace, PhD
Integrated Science Institute
Carleton University
4431 Herzberg Laboratories
Ottawa, ON K1S 5B6

Dear Julia,

On behalf of the Department of Earth Sciences, I am writing to express support for the proposed Interdisciplinary Science and Practice (ISAP) program. ISAP responds to an emerging need for skills in science communication and interdisciplinary collaboration to address major issues and questions facing researchers and society. As such, ISAP will provide both a resource within the Faculty of Science and training not currently available. We look forward to working with your faculty in order to create new opportunities for students in the ISAP and Earth Sciences programs.

The structure of the ISAP program is unique in the Faculty of Science. We understand that ISAP students must have at least one minor in a science discipline. Therefore, I am confirming that our Department will give ISAP students the equivalent registration priority as other students in BSc programs requiring Earth Sciences courses as part of their major. In particular, ISAP students will be allowed to register in ERTH 1006 and ERTH 1009. Students will also have access to a range of upper level courses to complete a minor in Earth Sciences.

I look forward to the implementation of ISAP and seeing the interdisciplinary perspective that ISAP students will bring to our student population in Earth Sciences.

Sincerely,

Dariush Motazedian
Professor & Chair, Department of Earth Sciences
http://mypage.science.carleton.ca/~dariush
Phone: (613) 520-2600 ext. 8769 (Sheila Thayer)
Fax: (613) 520-5613
Couriers to: Department of Earth Sciences
Rm 2115 Herzberg Building, Ottawa K1S 5B6 (613)520-5633

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Fax: (613) 520-3906
www.carleton.ca/economics/

March 13, 2018

Julia Wallace, PhD
Director
Integrated Science Institute
Carleton University
442 Herzberg Laboratories
Ottawa, ON K1S 5B6

Dear Julia,

On behalf of the Department of Economics, I am writing to confirm our support for the proposed Interdisciplinary Science and Practice (ISAP) program.

One of the required courses in the propsed ISAP program is ECON 1000. I am confirming that our department will give ISAP students access to this course. I also understand that ISAP students must have at one minor in a science discipline and are encouraged to take a second minor in any discipline. A minor in economics would be a good fit for this program. Scientific discovery and innovation are important drivers of economic growth, while policy decisions must be based on sound economic principles. ISAP graduates with a strong academic grounding in both will be well positioned to make sound decisions in the tech sector, and to contribute to the formulation and interpretation of science policy.

I look forward to the implementation of ISAP and seeing the interdisciplinary perspective that ISAP students will bring to our student population in Economics.

Sincerely,

Christopher Worswick
Professor and Chair
Department of Economics
Carleton University
C879 Loeb Building
Ottawa, ON K1S 5B6

Institute of Environmental Science
Institute of Integrated Science
1125 Colonel By Drive
Ottawa, ON, Canada K1S 5B6
Tel: (613) 867-6711

March 9, 2018

Re: Letter of Support for the new BSc program in Interdisciplinary Science and Practice

Dear Program Evaluation Team:

On behalf of the Institute of Environmental Science and the Institute of Integrated Science I am pleased to provide an enthusiastic letter of support for the new BSc program in Interdisciplinary Science and Practice (ISAP). This program was developed by a team of faculty members in these two units. Indeed, given the growing connection and common interests between those in Environmental Science and Integrated Science we will be coming together as of July 1 2018 as a new consolidated unit called "the Institute of Environmental and Interdisciplinary Sciences". As outlined in the proposal, we developed this program because it responds to an emerging need for skills in science communication, interdisciplinary collaboration and data analysis/synthesis to address the major questions facing researchers and society. As such, ISAP will provide both a resource within the Faculty of Science and training not currently available. Our new unit will be responsible for the administration of this new ISAP program. We are thrilled to have the opportunity to share the ISAP program with you and are keen to welcome our first cohort in the near future.

Sincerely,

Dr. Steven J. Cooke, FRCGS
Director of the Institute of Environmental Science and the Institute of Integrated Science
Canada Research Chair and Professor of Environmental Science and Biology
Cell = 613 867 6711

Carleton UNIVERSITY
Canada's Capital University

Office of the Director
School of Mathematics and Statistics
4302D Herzberg Laboratories
1125 Colonel By Drive
Ottawa, ON, K1S 5B6 Canada
Tel: (613) 520-3531
Fax: (613) 520-3536
Email: ms-dir@math.carleton.ca
Web Site: http://www.math.carleton.ca

March 14, 2018

Steven Cooke, PhD
Acting Director
Integrated Science Institute
Carleton University
442 Herzberg Laboratories
Ottawa, ON K1S 5B6

Dear Dr. Cooke,

On behalf of the School of Mathematics and Statistics, I am writing to express support for the proposed Interdisciplinary Science and Practice (ISAP) program. ISAP responds to an emerging need for skills in data analysis and the tools to communicate the results for an interdisciplinary approach to major issues facing researchers and society. We look forward to ways to collaborate with your faculty in order to create new opportunities for students in the ISAP and Mathematics/Statistics programs.

The structure of the ISAP program is unique in the Faculty of Science. We understand that ISAP students must have at least one minor in a science discipline. Therefore, I am confirming that our School will give ISAP students the equivalent registration priority as other students in BSc. programs requiring Mathematics/Statistics courses as part of their major. In particular, ISAP students will be allowed to register in MATH 1007, MATH 1107, STAT 2507, and STAT 2509. In addition, ISAP students completing a minor in Physics will have a similar registration priority for MATH 1004 and Math 1104. Students will also have access to the courses required to complete a minor in Mathematics or Statistics.

I look forward to the implementation of ISAP and seeing the integration of Mathematics/Statistics in the interdisciplinary perspective.

Sincerely,

Paul Mezo
Director
School of Mathematics and Statistics
Carleton University
4302 Herzberg Laboratories
Ottawa, ON K1S 5B6

Carleton UNIVERSITY
Canada's Capital University

Department of Neuroscience
5303 Health Science Building
1125 Colonel By Drive
Ottawa, Canada K1S 5B6
Tel: (613) 520-2600 x8774

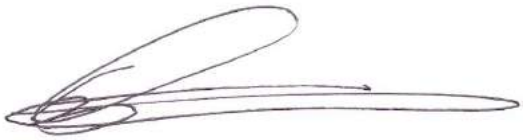
March 13 2018

Julia Wallace, PhD
Director
Integrated Science Institute
Carleton University
442 Herzberg Laboratories
Ottawa, ON K1S 5B6

Dear Julia,

On behalf of the Department of Neuroscience, I can confirm that students in the proposed **Interdisciplinary Science and Practice** (ISAP) program will have the same priority status in registering for NEUR courses as other non-NEUR students in the B.Sc. program. The structure of the ISAP program is unique in the Faculty of Science. We understand that ISAP students must have at least one minor in a science discipline. ISAP students are therefore welcome to register in the Minor in Neuroscience and Mental Health. In particular, ISAP students will be allowed to register in NEUR 1202 and NEUR 1203. Students will also have access to a range of upper level courses to complete their minor in Neuroscience, where they fully satisfy course pre-requisites.

Yours sincerely



John Stead
Chair, Department of Neuroscience

Department of Physics
3302 Herzberg Laboratories
1125 Colonel by Drive
Ottawa, ON K1S 5B6
CANADA
Tel: (613) 520-4320

March 16th, 2018

To: Julia Wallace, PhD, Director Integrated Science Institute
Carleton University, 442 Herzberg Laboratories, Ottawa, ON, K1S 5B6

Dear Julia,

On behalf of the Department of Physics, I am writing to express support for the proposed Interdisciplinary Science and Practice (ISAP) program. ISAP responds to an emerging need for skills in science communication, interdisciplinary collaboration and data analysis to address major questions facing scientists, researchers and society in general. As such, ISAP will provide both a resource within the Faculty of Science and training not currently available. I am looking forward to working with you, and with colleagues from the Faculty of Science, in order to create new opportunities for students in the ISAP and Physics programs. The Department of Physics is particularly interested to develop courses in the connection with numerical and data mining methods needed by a large fraction of future students that will be employed in industry, research laboratories, gouvernement agencies, academia and the privitate sector to either work with measuring devices, solve techinical problems based on scientific facts or interpret data of all types.

The structure of the ISAP program is unique in the Faculty of Science. I understand that ISAP students must have at least one minor in a science discipline. Therefore, I am confirming that our Department will give ISAP students the equivalent registration priority as other students in BSc programs requiring Physics as part of their major. In particular, ISAP students will be allowed to register in PHYS 1007 and PHYS 1008. Students will also have access to a range of upper level courses to complete a minor in Physics.

I look forward to the implementation of ISAP and seeing the interdisciplinary perspective that ISAP students will bring to our student population in Physics and at Carleton University.

Sincerely,

Alain Bellerive, Canada Research Professor
Chair, Department of Physics, Carleton University
3302 Herzberg Laboratories, Ottawa, ON, K1S 5B6

CC: Dwight Deugo, Interim Dean of Science, Carleton University

Review of the New Program Proposal in Science: Integration and Application

Discussant's Report
January 2, 2018
Adrian Chan, Department of Systems and Computer Engineering

Summary

Carleton University has an Integrated Science program, which was closed to new admissions in 2013. Rather than attempting to modify this program, a new program Science: Integration and Application (SCIA) is being proposed. SCIA is vastly different as compared to the Integrated Science program, focused on an interdisciplinary approach, with a progressively integrated program content that builds the knowledge, skills, and attitudes for critical scientific inquiry and problem solving, and so-called "soft skills" (e.g., communication, problem solving, personal management, teamwork, project management). The proposed new program consists of a 20-credit Honours and 15-credit General degree; the latter available only for transfer students.

Distinctiveness and Strengths

The self-study does an excellent job at reviewing related programs regionally, provincially, nationally, and internationally. In addition, the self-study highlights the distinctiveness of the proposed SCIA program, including: a fully interdisciplinary program, focus on "soft skills", and progressively integrated program content.

A number of other existing related programs were noted to have a "highly competitive and selective admissions progress" and target "high achieving students". The manner in which this is conveyed suggests the proposed SCIA program will not be competitive and selective, and does not target "high achieving students", which does not seem to be true.

Strategic Alignment

The proposed SCIA program is well-aligned with the Strategic Integrated Plan. The self-study refers to the 2014-2017 Strategic Mandate Agreement. With the new 2017-2020 Strategic Mandate Agreement approved, some of this text could be updated appropriately. At a minimum, the self-study should differentiate which Strategic Mandate Agreement the proposal is referring to in the text.

Learning Outcomes

The learning outcomes are well articulated. The curriculum mapping is well explained and justified, and the assessment plan is reasonable.

The program may wish to consider how students can be involved directly in the program improvements and governance (e.g., student representatives in the curriculum committee). This would allow for a constant student voice and perspective to inform the program.

It is noted that learning outcomes are presented as: "On completing the SCIA courses, our students will be able to"; however, as program learning outcomes, one would expect this to be "On completing the SCIA program", rather than its courses.

Program Structure

The program structure is sensible and does a good job serving the learning outcomes. The program, however, may have rigidity that could cause issues in student progression. For example, the SCIA courses are heavily dependent upon each other, via prerequisites. Students who do not complete one of these courses (e.g., fail, abandon due to medical reasons), could face an entire year delay in program progression. It is also unclear how transfer students would be accommodated (if a student transfers into the program to start their second year, it would seem they would require at least another four years to complete the program because of course sequencing).

Admissions

The admissions requirements are similar to other B.Sc. programs and are reasonable.

Governance

SCIA will be governed by a newly proposed Institute of Environmental and Interdisciplinary Studies, which will also govern the existing Environmental Studies program. The shared governance structure is explained by the shared, overlapping interests, and well-justified in terms of experience in delivering such interdisciplinary programs and efficient use of resources.

The governance section is difficult to understand. Some clarity could be given by specifying the structure of the proposed Institute of Environmental and Interdisciplinary Studies before given the background on the state of the current governance structure and the transition plan. It is noted that there will be a shared curriculum committee for ENSC and SCIA, although it also indicates that programs will be overseen by "subcommittees of the Institute". It would be also helpful to indicate the administrative support in this section.

Confusion is exacerbated by the variety of terms (e.g., Environmental Sciences, ENSC unit, ENSC program, IEC, ISI, IEIS, IS, Integrated Science program, Institute of Integrated Science, Integrated Science Institute), which are not used in a consistent manner throughout the document.

Faculty

The faculty complement appears appropriate. The program depends on three new hired (two in year 1 and one in year 3), which would be good to include in Table D.1.1 to give a full picture of the core program faculty. It is unclear from the self-study if funding for these new hires is confirmed, which is important given that the program is heavily dependent upon them.

It is not clear how the SCIA 3004 Science Policy course will be taught. The self-study notes that there is an exploration of a partnership with the Faculty of Public Affairs or having a contract instructor. As a core course to the program, it would be important that the program solidify a plan.

The proposed faculty complement is sufficient but, as noted in the self-study, will require consideration when there are sabbaticals or other leaves. Would there be an adequate pool of suitable contract instructors when required?

The current faculty have a short biography for each individual, included in the self-study, which can either be removed or moved into an Appendix.

Students

The program estimates 20 new students in its first year, plus 10 transfer students, reaching a steady state of 40 new students a year, plus 20 transfer students. By year 6, the total program enrolment is estimated to be 200 students. Non-transfer students are anticipated to be net new enrolments, many of which may have enrolled with the Integrated Sciences program which was closed to new admissions in 2013. The self-study notes "an average of 24 students per year registered in Integrated Science programs other than the Health Science concentration"; presumably, these are new enrolments, giving a total of around 100 students (including the total enrollment numbers in the self-study would be helpful). It is not clear why it is believe SCIA will generated so much more interest, as compared to the Integrated Science program; some explanation is warranted.

Table E.3 is confusing. For example, the row "New students" is the cumulative program enrollment a students that were not transfer students. The table could be improved, perhaps by separating out a row to indicate the new incoming students (transfer and non-transfer students), versus the cumulative program enrollment numbers of that year.

Resources

Similar to the governance section, this section could be made clearer by specifying at the beginning what administrative resources the Institute of Environmental and Interdisciplinary Studies will have. After, the self-study can explain the current state of administrative resources and the transition plan.

It is unclear whether the current Integrated Science Institute administrator will be providing support for the SCIA program and if the 0.5 FTE undergraduate administrated, planned for year 3, will be in addition or as a replacement. It is also unclear whether the funding for the new 0.5 FTE is approved or not.

The self-study notes that the program requires an active learning space but does not indicate any commitment by the university to have such a space available for the program. It should be clear how this requirement is going to be met.

The self-study also notes the need for teaching assistants to support program delivery; however, the self-study does not note a commitment by the Faculty of Science to make available of teaching assistant resources. This is of particular concern since there is no associated graduate program to directly draw upon.

General Comments

Overall, the self-study is well-structured, providing a good explanation of the program and a convincing justification. With the closure of the Integrated Sciences program, there is a gap within the available academic programming at Carleton University. The SCIA program is a thoughtful proposal that fills this gap, and should effectively meet the needs and desires of students and their future employers.

Summary of Recommendations

1. Consider the effects of course scheduling and sequencing in terms of student progression and how transfer students could be accommodated.

2. Confirm whether resources for new faculty and administrative hires are approved.

3. Determine how SCIA 3004 Science Policy will be offered.

4. Discuss the availability of suitable contract instructors when needed (e.g., sabbaticals, leaves).

5. Justify the enrolment estimates (previous enrolment numbers from the Integrated Science program could be used).

6. Clarify (and confirm) the need and availability of the required active learning space.

7. Confirm the availability of teaching assistant resources.

8. Clarify Section C: Governance

9. Revisit the wording in Section A.3, which inadvertently suggests the proposed SCIA program will not be competitive and selective, and does not target "high achieving students".

10. Appropriately update the self-study with the new 2017-2020 Strategic Mandate Agreement.

11. Consider how students can be involved directly in the program improvements and governance

12. Consider rewording learning outcomes from "On completing the SCIA courses" to "On completing the SCIA program"

Recommendations on External Reviewers

While there were a number of potential external reviewers indicated (more than the requested 10), the vast majority were from Ontario.

One of the following two reviewers would be suitable and are outside of Ontario:

1. Terre Satterfield (UBC)

2. Sarah Gretton (Leicester, UK)

Assuming a reviewer from outside of Ontario is found, the following reviewers are recommended in the following order:

1. Carolyn Eyles (McMaster)

2. Katie Plaisance (Waterloo)

3. Gail Fraser (York)

4. Stephen Murphy (Waterloo)

5. Denis Maxwell (Western)

6. David Pearson (Laurentian)

BSc in Science: Integration and Application

February 15th & 16th 2018

External Reviewers: Dr. David Pearson, Laurentian University and Dr. Denis Maxwell, University of Western Ontario

Internal Reviewer: Dr. Maria DeRosa, Professor, Department of Chemistry and Biochemistry

Time	Thursday, February 15th, 2018	Location
9:00 – 10:00	Dr. Adrian Chan, Assistant Vice-President (Academic)	421D Tory Building
10:05 - 10:35	Dr. Dwight Deugo, Dean of Science	3230 Herzberg
10:45-11:30	Meeting with department Chair: Dr. Steven Cooke	4435 Herzberg Building
11:30-11:50	Meeting with Dr. Jesse Vermaire, Assistant Professor Environmental Science, Geography and Environmental Studies	4435 Herzberg Building
12:00-1:15	Lunch Names of attendees from unit: Dr. Steven Cooke & Dr. Jesse Vermaire	Baker's Grill, 4th floor University Centre
1:30-2:30	Meeting with Environmental Science and Integrated Science Students	4435 Herzberg Building
2:30-3:00	Meeting with Administrator: Michelle Santoianni	4435 Herzberg Building
3:00-4:00	Tour facilities: Dr. Steven Cooke	
5:30	Dinner- Erling's Variety Names of attendees from unit: Dr. Steven Cooke, Dr. Jesse Vermaire	Erlings Variety 255 Strathcona (at Bank) http://www.erlingsvariety.com/
Time	**Friday, February 16th, 2018**	**Location**
9:30-10:30	Meeting with Program Leads: Dr. Julia Wallace, Dr. Pam Wolff & Dr. Susan Aitken	4435 Herzberg Building
10:30-11:30	External Reviewers Meeting to prepare report	4435 Herzberg Building
11:45 – 1:00	Lunch Names of attendees from unit: Dr. Julia Wallace, Dr. Pam Wolff & Dr. Susan Aitken	Baker's Grill, 4th floor University Centre
1:00 – 2:00	Dr. Lorraine Dyke Vice –Provost & Associate Vice-President (Academic)	421D Tory Building

Baker's Grill lunch reservation is under: Vice-Provost SCIA

Review of the New Program Proposal in Science: Integration and Application

Discussant's Report
January 2, 2018
Adrian Chan, Department of Systems and Computer Engineering

Summary

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2. Confirm whether resources for new faculty and administrative hires are approved.

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3. Gail Fraser (York)

4. Stephen Murphy (Waterloo)

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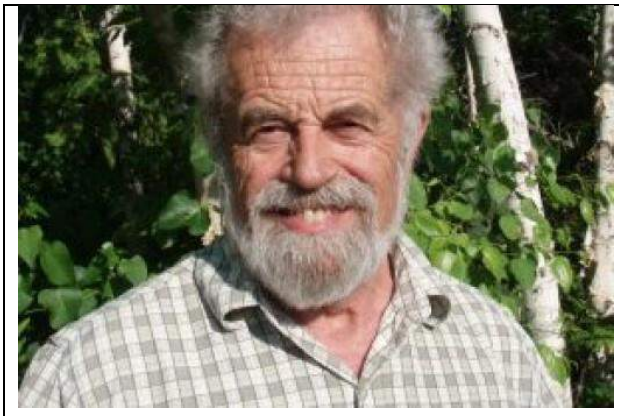
External reviewers for the BSC program in Science: Integration and Application

	**Dr. David Pearson** is an earth scientist and Professor in the School of the Environment at Laurentian University. He was the Project Director and then founding Director of Science North from 1980 to 1986 and has hosted two science television series: "Understanding the Earth" for TV Ontario, and "Down to Earth" for Mid-Canada Television, as well as a weekly radio spot, "Radio Lab", on CBC Northern Ontario Radio. He received the Ward Neale Medal from the Geological Association of Canada for promotion of the Earth Sciences in Canada in 2001 and the McNeil medal for science communication from the Royal Society of Canada in 2003. From 2002 to 2007 David chaired the Ontario office of the Canadian Climate Impacts and Adaptation Research Network, co-chaired the Ontario Expert Panel on Climate Change Adaptation, and chaired the Far North Science Advisory Panel for the Ontario Government that released its report "Science for a Changing Far North" in 2010. He is currently working with remote far north Ontario First Nation communities to determine the likely impacts of climate change and potential adaptation options.
	Dr. Denis Maxwell Denis Maxwell received his PhD at Western University in the area of photosynthesis. After post-doctoral training at Michigan State University, he was a faculty member at the University of New Brunswick before moving back to Western in 2003. His research program has been focused on the regulation of mitochondrial metabolism and gene expression in response to environmental stress in green algae. Over the course of his tenure at Western, Dr. Maxwell has become more and more passionate about teaching and undergraduate curriculum development. He has served as Undergraduate Chair in Biology and over the past few years he has led the development of the new Integrated Science honors program, serving as the program's first director. Since July 1, 2017 Professor Maxwell has served as Assistant Dean for the Faculty of Science with a portfolio that is focused on first-year studies and recruitment.

REPORT OF THE EXTERNAL REVIEWERS FOR THE PROPOSED NEW "BSC IN SCIENCE: INTEGRATION AND APPLICATION" AS PART OF THE INSTITUTIONAL QUALITY ASSURANCE PROCESS AT CARLETON UNIVERSITY

Dr. David Pearson, Laurentian University

Dr. Denis Maxwell, Western University

Dr. Maria DeRosa, Internal Reviewer, Department of Chemistry

Site visit: February 15-16, 2018

We have prepared this report after a thorough review of the Self-Study document and the compiled curriculum vitae of the faculty and staff supporting the program. As well, the document was informed by interviews and a tour of relevant facilities during the visit.

OUTLINE OF VISIT

- Dr. Adrian Chan, Assistant Vice-President (Academic)
- Dr. Dwight Duego, Dean of Science
- Dr. Steven Cooke, Program director
- Dr. Jesse Vermaire, Assistant Professor, Environmental Science, Geography, and Environmental Studies Ms. Michelle Santoianni, Academic Advisor
- Dr. Julia Wallace (Instructor III), Pam Wolff (Instructor III), Dr. Susan Aitken (Professor), Program Leads
- Students in Environmental Science and the former Integrated Science - Ms. Nicole Maillette, Ms. Ana Santos, Ms. Sabrina Reaume, Mr. Hassan Ali Zafar, Mr. Daniel Burnside.
- Dr. Lorraine Dyke, Vice-Provost and Associate Vice President (Academic)

We toured the Library and its group project and study spaces, and the Science Student Success Centre with Dr. Cooke. We also visited a Chemistry teaching laboratory with Dr. DeRosa

SUMMARY AND KEY RECOMMENDATIONS

The Science: Integration and Application program sets out a curriculum that is ambitious yet distinctive compared to integrated science program's offered at other universities in Ontario. Its strength lies in combining a strong science education with additional learning outcomes related to professional skills development. The program has two key facets, which are critical to interdisciplinary, low enrollment programs. First, the program's curriculum is built around a unique set of courses that are only available to students in the program (SCIA has eight of these, that span the first three years of study). Second, the program will have dedicated study space that allows for students in the program to interact outside of the classroom. Both of these facets allow for the development and nurturing of community among the students in each year of the program. These facets were lacking in the discontinued program. SCIA directly addresses the concerns of both the workplace and government that an undergraduate education needs to develop competencies related to professional skills that are on par with efforts to develop technical proficiencies. In this regard, the University should take advantage of this and position the program as a unique interdisciplinary science education.

We articulate five recommendations:

1. The current name of the proposed program does not accurately reflect the program. The name should be changed to BSc in Interdisciplinary Science and Communication. We provide commentary on this issue throughout the document but it is directly addressed at the end of the document under the heading: Criterion Specific to New Programs.
2. The term "soft skills" should be eliminated from the proposal and not used to describe or promote the program or used in teaching. The skills that come from team work, group projects and carefully designed communication are professional skills and have been recognized as such by the TriCouncil for over ten years.
3. The unique perspectives of Indigenous people should be included in the program.
4. The cumulative benefit of the program, with its emphasis in group learning, mentorship for success, and communication, should be recognized as cultivating leadership skills in the highest quality graduates.
5. The self-study document makes mention of the "Capital Advantage" that the SCIA program offers its students. Yet, the document fails to articulate in any meaningful way how this advantage will be made available to students in the program.

We discuss the rationale behind these recommendations in the following sections which we have organized around the questions in the Terms of Reference but want to emphasize our key recommendations here.

THE PROGRAM

Do the program's intellectual profile and learning outcomes serve the mission, and strategic and academic plans of Carleton University or Dominican University College?

The learning outcomes for the program align with the mission and goals of the institution as articulated by Carleton's Strategic Mandate Agreement (SMA). There is clear evidence in the self-study document (SSD) that the program has components that fit well within the five major themes of the SMA. The strongest links seem to be related to (i) student experience and (ii) the development of innovation in teaching and learning excellence.

It is less obvious how research excellence of the faculty involved in the program will *directly* impact *all* students in the program. As well, it is not well articulated how the SMA theme of "Innovation, Economic Development and Community Engagement" is addressed in any explicit way by the program. Developing clear experiential opportunities for students that align with the advantage of being in the nation's capital, for example, would help with this.

Do the program's intellectual profile and learning outcomes match the teaching and research strengths of the academic unit(s)?

The instructor expertise brought to bear on the program is particular powerful in the diversity of expertise that it represents. Some faculty has strong interdisciplinary research programs that can provide some students with unique learning opportunities, while others have distinctly different expertise in the use of innovative teaching strategies. From our discussions with faculty and with the principal academic advisor to students in the program, as well as seeing the Science Student Success Centre in action, we believe there is a very good match between the teaching and research strengths and the intellectual profile and learning outcomes of the unit.

Are the program's intellectual profile, curriculum and learning outcomes appropriate in relation to the current international, national, provincial profile of the discipline or interdisciplinary area?

Many universities have recently developed, or are considering, integrated science programs. One commonly articulated goal is a means to break away from the siloing of subjects that is typical of an undergraduate science education and instead provide students a mechanism to understand the connectivity among the sciences. Such an approach is seen as essential for addressing many of today's more pressing questions (e.g. climate change), which are fundamentally interdisciplinary. Many of these other integrated science programs achieve this by having unique core courses where students learn the fundamentals of the sciences (e.g. mathematics, chemistry, biology, physics) in an rigorous yet genuinely integrated fashion. Examples of these courses include McMaster's ISci 1A24 and Western's Integrated Science 1001X . Interestingly, this is not the approach taken with the SCIA program. While students are required to take two credits in experimental science and complete a least one minor in Science, these core science courses fall outside of the

program, taught presumably by faculty who are not required to teach in an integrated manner.

As discussed in the SSD, there may be some integration of the sciences in the senior group or individual projects. But this is not until Year three, and it is not clear that integration of the sciences is a major theme. For example, SCIA 4908 (Individual Research Project) seems to be similar to a senior research project that one would pursue in a typical science program —there is nothing specifically integrative about a 4908 project. In general, it seems that *all* students in the program will not be exposed to interdisciplinary core science instruction or research as part of the program.

While the lack of integrated core science courses could be levied as a valid criticism of the program, after the site visit, it is not seen as shortcoming. The distinctive nature of the program, that is not borne in its current title, is the connections made to professional skill development. The *integrated* nature of the program is somewhat a departure from what students get in other, similarly named programs, and that is a concern with regard to recruitment.

The focus on professional skill development within the context of a strong science education provides a uniqueness to the program that may not have been realized during its development. This distinctiveness seems to align well with the type of student the program aims to attract. As mentioned in the SSD, "most students in this program will be on a career track rather than targeting graduate school".

In discussing the program with a select group of undergraduates (some in the discontinued program, others in Environmental Sciences), it was clear that they saw great value in the professional skills they have had to develop over their undergraduate career. There was clear consensus among this group that these skills were valued over technical competencies, which they thought could be more readily learned "on the job".

Are the program's intellectual profile and learning outcomes distinctive in relation to those of comparable programs in Ontario and nationally?

Not sure about the intellectual profile being distinctive — but, yes, certainly the focus on professional skills development makes SCIA a departure from many other integrated science programs (as discussed above).

Are the program's learning outcomes consistent with the Undergraduate Degree Level Expectations, as appropriate?

The program defines nine learning outcomes. These outcomes do map well onto the six degree level expectation categories as articulated by Ontario Universities Council on Quality Assurance. As expected, and as discussed in the Self-Study document, not all outcomes align with all the degree level expectations to the same extent.

Are the methods for assessing program learning outcomes appropriate (please see also 3.8.8.7. below)?

Yes. We do not see any issues in the proposed methods of assessment, which are varied.

Does the program contain any unique curriculum, program innovations or creative components?

The program does have a series of courses that one does not see in other similar programs. Courses that develop critical inquiry and communication skills along with science policy seem collectively to be unique to the program. As well, a unique aspect of the program's design is the focus on building competencies from one year to the next, as opposed to providing stand-alone siloed courses. This concept of "building blocks" seems particularly innovative. As articulated in the SSD, an interdisciplinary approach builds from year to year. The flexibility available to students to design their own distinctive programs (their science major) outside of the program-specific courses may not be unique but it will certainly make the program attractive to a wider range of students.

Components the reviewers would like to see added

The unique perspectives of Indigenous people should be included in the program. Not through adding a course but by inviting members of nearby First Nations and others, from government or academia with first-hand experience of applying indigenous ways of knowing and collaborative projects, to speak with students. Advice could be sought from experienced First Nation community members close to Ottawa. One faculty member in the program already has experience of relationship building and respectful indigenous collaboration in his research. There is also an outstanding indigenous graduate student studying in the laboratory of the program chair. The seeds of a valuable opportunity are evident.

The program mentions the "capital advantage" but that idea is not flushed out in the SSD as well as it could. When the external reviewer, Maria DeRosa, was late for our initial meeting because she was rushing back from Parliament was a glaring example of the huge advantage Carleton has by being in Ottawa. With a program that will be emphasizing communication skills and collaboration and policy, the program could not be situated in a more ideal institution. It is incumbent upon the leadership of the program to make the linkages with government stronger by finding space in the curriculum for all its students to interact more directly with governmental bodies.

PROGRAM CONTENT

Is the program appropriately designed and structured to achieve the learning outcomes?

The learning outcomes as articulated in the SSD are met, as mentioned above, through a progressive building, year to year approach that culminates in many cases with Mastery in Year 3 or 4. The learning outcomes are explicitly linked to the SCIA specific courses that all students in the program are required to take.

In the case of undergraduate programs, is there evidence of planning for adequate numbers and quantity of planned/anticipated class sizes, provision of supervision of experiential learning opportunities and the role of adjunct and part-time faculty?

Enrollment in the program is capped at about 60 students per year, which seems reasonable. The instructor resources and spaces allocated for the program certainly seem to be in line with a total carrying capacity of about 240 students.

Does the program have an appropriate mode or modes of delivery?

Yes

Is there a clear indication of essential requirements?

Yes

GOVERNANCE

Does the program have an appropriate governance and administrative structure?

We do not have any major concerns here even though the governance is not perhaps as clear as typical programs at other institutions. This is understandable given that there are changes in governance moving through the approval process. We found the use and distinctions between institutes and departments somewhat confusing, and even the signage on the 4th floor of the Herzberg Building where we met seemed to lack consistency.

We agree with the development of the Institute of Environmental and Interdisciplinary Science (IESI), which would oversee both Environmental Sciences and this program. As mentioned in the SSD, the Institute would allow for a shared curriculum committee along with shared administrative and counselling duties, which would seem to make the best use of limited resources. As well, this program would gain from the wealth of experience and success of the Environmental Sciences program.

THE FACULTY

Are there definitions and use of indicators that provide evidence of quality of the faculty (e.g. qualifications, research, innovations and scholarly record, appropriateness of collective faculty experience to contribute substantively to the proposed program)?

A review of the curriculum vitarum shows that the faculty and support staff affiliated with the program have particularly strong qualifications, with noted diversity in expertise. But perhaps even more important, and what was evident during the site visit, is the collegiality and sense of working as a team that seems pervasive among the group.

Is there evidence of how supervisory loads will be distributed, and the qualifications and appointment status of faculty who will provide instruction and supervision?

This may be more intended for graduate programs. Insofar as it applies to this program we heard nothing from students or faculty that indicated any issues.

Is there evidence of adequate mentoring programs for junior faculty?

It is not explicitly stated in the self-study how junior faculty will be mentored. However, like many similar institutions the collegiality among faculty is high and we are confident this extends to mentoring for junior faculty.

ADMISSION REQUIREMENTS

Are the admission requirements appropriate for the learning outcomes established for the completion of the program?

That the admission requirements for the program match those for most programs of the Faculty of Science seems to be appropriate. However, with a particular focus on communication, it is surprising that English (ENG4U) is not required for admission (as an aside, it is required for all programs in Science at Western). There was a fair amount of discussion about admission requirements during the site visit (e.g. "important to not set the bar too low"). Having distinct admission requirements would flag the program as being distinct from other programs in Science, which is an important factor to consider. There was further discussion as to the usefulness of a supplemental application (McMaster and Western require this for their integrated science programs) to allow the admission group to better assess the suitability of applicants for this specific program. This is a concern, but like all programs admission criteria can be adjusted once the governance of the program gets a clear sense of the kind of student they are attracting with the current admission criteria.

Are the admission requirements such that a student entering the program can expect to complete it successfully and in a timely fashion; are requirements additional or alternative to the foundational requirements (for example, second language competence) appropriate; are all admission requirements (e.g., minimum graduate point average, language proficiency, previous degrees) sufficiently well explained?

We think the current admission requirements are adequate given the curriculum. However, as discussed above, the program will likely have to revisit admission criteria in order to select those students, in particular, who will not only excel in the program, but push the program towards excellence. Success of almost all programs is heavily dependent on attracting the best students.

THE STUDENTS

Is there evidence of clear communication between students, faculty and programs and university administration (e.g., handbook for students with program details, processes, important deadlines, etc.; a web site; listserv)?

It is hard to address this question, as with a new program many of these links have yet to be formally put in place. But in talking to students who are part of the old integrated Science program and others in Environmental Science, it is clear that there is a strong culture of open communication between faculty and students. In particular, the open-door sensibility that exists, allowing for both advising and mentoring, seems to be excellent.

Is there evidence of program structure and faculty research that will ensure the intellectual quality of the student experience?

It seems clear that students will have opportunities to undertake research in the labs of faculty members aligned with the program.

Given the advising, mentoring and support provided by the program and the university more generally through its academic services, will students in the program have a satisfactory educational experience?

The quality of advice and mentoring provided to students by the program is outstanding.

Are the methods of student evaluation appropriate given admission requirements, degree level expectations, and learning outcomes; are there sufficient plans for documenting and demonstrating the level of performance of students consistent with the ~~Graduate Degree Level Expectations and~~ Undergraduate Degree Level Expectations?

Yes. The documentation we received is clear on this question.

Will the program prepare students adequately for their chosen career path following graduation with respect to careers for which the program could reasonably be expected to provide a preparation?

The SSD mentions that "most students in the program will be on a career track rather than targeting graduate school in a traditional science discipline". This is quite telling and suggests that students attracted to the program will have very clear career goals that seem distinct from those attracting to other integrated science programs. The focus on professional skill development will undoubtedly prepare graduates for a huge array of careers some of which may not be directly related to science. McMaster has Self-study Yes. However, one of the strengths of the programs is the very extensive variety of possible career paths.

RESOURCES

Is the program adequately resourced, including a sufficient number of faculty with acceptable levels of teaching expertise and competence, and of continuing research and publishing activity?

The SSD articulates the faculty resources involved in the program, there does seem to be sufficient instructor resources. As well, the wide range of expertise of the faculty will expose students to a broad range of teaching styles and should enrich their learning experiences.

Does the program have sufficient support staff, sufficient space, and sufficient library, laboratory and technological resources?

Given the projected steady-state enrollment numbers and particular focus of the program, the resources currently available or planned are sufficient for the program to be successful. The program *does not* rely on unique laboratory spaces, which is common with other integrated science programs. Instead the program will rely heavily of institutional facilities that are already in place (e.g. library and collaborative study space). One key facet that seen as key for a program like this is a common space that is designated solely for students in the program. This is a key facet of the integrated science programs at Western and McMaster and is identified by students in the programs as essential to building and maintaining a sense of community.

CRITERION SPECIFIC TO NEW PROGRAMS

Are the degree program's nomenclature and acronym appropriate (for example, Master's of Cognitive Science, M.Cog.Sci.)?

We recommend that the proposed program be called **BSc in Interdisciplinary Science and Communication.** This could be abbreviated as BI Sci.Com. We have presented our reasons for recommending this name in the introduction to our report. We believe this name is more understandable than "BSc in Science: Integration and Application". It is also a better reflection of the proposed content and anticipated outcomes implicit in the design of the curriculum. In other words, it is more accurate. Furthermore, it became clear during our discussion with students, that a major attraction for them is the flexibility in ways of building on the required minor in science with either more science or courses from other disciplines. We believe that is best described as interdisciplinary.

A change in name also clearly separates the new program from the Integrated Science program closed in 2013. The legacy of that program includes very useful experience for the faculty who will form the core in the new one. However, we believe the new name will help eliminate confusion and enable a fresh start with a fresh identity

Including **"Communication"** in the name emphasizes the role of communication in up to date and forward-looking science programs. The TriCouncil's recognition of communication as the most important professional skill in graduate programs can equally well be recognized in the senior courses in undergraduate programs, especially those that are interdisciplinary. This addition to the name also recognizes an opportunity for a distinctive characteristic offered by the science communication capacity and active commitment to professional development in that area, by one of the key instructors and by a senior professor in the program.

March 7th, 2018

Dr. Lorraine Dyke
Vice-Provost and Associate Vice-President (Academic)
Carleton University

Dear Dr. Dyke

Re: Response to the External Reviewers' Report on the proposed program in Interdisciplinary Science and Practice at Carleton University

Thank you to Dr. David Pearson of Laurentian University and Dr. Dennis Maxwell of Western University for their excellent review of the proposed Interdisciplinary Science and Practice program.

Recommendations from the External Reviewers	**Response from Program Leads**
The current name of the proposed program does not accurately reflect the program. The name should be changed to BSc in Interdisciplinary Science and Communication.	Agreed – We have abandoned the "placeholder" Science Integration and Application (SCIA) as per the suggestion. We consulted with the program reviewers and also engaged a group of on and off campus folks active in this topical area. We appreciate the suggested title and opted for a slight modification – to "Interdisciplinary Science and Practice" (ISAP). We found the term "communication" to be somewhat disingenuous given that there is only a single required course on #scicomm. The word "practice" is broad and captures exactly what we want to do – have science feed in to inform practice. For the record, ISAP is a neutral acronym (nothing sketchy appears when one searches for that term). We have removed all mention of SCIA in the document BUT added a NOTE that the term SCIA was used in early iterations and may appear in some of the support letters and appendices.
The term "soft skills" should be eliminated from the proposal and not used to describe or promote the program or used in teaching. The skills that come from team work, group projects and carefully designed	Agreed – Changed to "professional skills" throughout.

communication are professional skills and have been recognized as such by the TriCouncil for over ten years.	
The unique perspectives of Indigenous people should be included in the program.	Agreed – We have now made specific reference to imparting on students the value of "different ways of knowing". Carleton has an expanding program in Indigenous Studies which will benefit the ISAP students in the long run as course offerings increase. We will encourage students to take course offerings from Indigenous Studies to complement what we will cover in the core ISAP courses.
The cumulative benefit of the program, with its emphasis in group learning, mentorship for success, and communication, should be recognized as cultivating leadership skills in the highest quality graduates.	Agreed - We have attempted to incorporate this comment (not as direct as the others). We have modified text in several places to address this suggestion.
The self-study document makes mention of the "Capital Advantage" that the SCIA (now ISAP) program offers its students. Yet, the document fails to articulate in any meaningful way how this advantage will be made available to students in the program.	Agreed – We have now made specific mention of how the "Capital Advantage" will benefit the students. Specifically, we make connections to the physical location of Carleton and our unique ability to engage with diverse partners (i.e., potential employers!) in government, NGOs and industry associations. There is simply no better place in Canada to learn about the science-policy interface given ability to interact with parliamentarians, staffers, decision makers, and science advisors.

Sincerely,

Dr. Steven Cooke

Dr. Julia Wallace

New Program Proposal in Interdisciplinary Science and Practice

Discussant's Report on the Response to the External Reviewers Report
March 7, 2018
Adrian Chan, Department of Systems and Computer Engineering

The proposed program B.Sc. in Interdisciplinary Science and Practice (ISAP) had a site visit on February 15-16, 2018. Note that proposed program was named the B.Sc. in Science: Integration and Application (SCIA) but the program name was changed based on recommendations from the External Reviewers Report. The External Reviewers Dr. David Pearson, Laurentian University, and Dr. Denis Maxwell, Western University, submitted their External Reviewers Report on March 4, 2018. The unit responded to the External Reviewers Report on March 7, 2018.

The External Reviewers Report remarked that the proposed ISAP program "sets out a curriculum that is ambitious yet distinctive compared to integrated science program's offered at other universities in Ontario." It also noted "two key facets [of the proposed ISAP program], which are critical to interdisciplinary, low enrollment programs":

1. the program is built around a unique set of courses available only to students in the ISAP program; and

2. dedicated study space that allow for students to interact with each other outside of the classroom

There were five main recommendations in the External Reviewers Report:

1. The current name of the proposed program [Science: Integration and Application] does not accurately reflect the program. The name should be changed to BSc in Interdisciplinary Science and Communication. We provide commentary on this issue throughout the document but it is directly addressed at the end of the document under the heading: Criterion Specific to New Programs.

2. The term "soft skills" should be eliminated from the proposal and not used to describe or promote the program or used in teaching. The skills that come from team work, group projects and carefully designed communication are professional skills and have been recognized as such by the TriCouncil for over ten years.

3. The unique perspectives of Indigenous people should be included in the program.

4. The cumulative benefit of the program, with its emphasis in group learning, mentorship for success, and communication, should be recognized as cultivating leadership skills in the highest quality graduates.

5. The self-study document makes mention of the "Capital Advantage" that the [ISAP] program offers its students. Yet, the document fails to articulate in any meaningful way how this advantage will be made available to students in the program.

In addition, the External Reviewers Report notes a concern regarding the program admissions criteria; specifically, "with a particular focus on communication, it is surprising that English (ENG4U) is not required for admission [to the ISAP program]."

The unit addressed each recommendation.

1. The unit did change the proposed program name, noting that the unit was also not satisfied with the name Science: Integration and Application (SCIA) and considered the name as a "placeholder name"; however, the unit did not use the External Reviewers' recommendation of B.Sc. in Interdisciplinary Science and Communication. The proposed name B.Sc. in Interdisciplinary Science and Practice is understandable and does appear to reflect the program accurately. The use of the term "Practice" instead of the suggested "Communication" is well explained in the unit's response.

2. The unit removed the term "soft skills", replacing it with "professional skills".

3. The program proposal has moved away from the term "First Nations groups" to "Indigenous groups", which is more inclusive. The expected Assistant Professor hire (start of year 3) has been modified to specify expertise in "community engagement in a science context, such as "Citizen Science" or Indigenous ways of knowing"; previously, "Indigenous ways of knowing" was not included. The proposal modifications do not describe how the unique perspectives of Indigenous people would be included in the program any further. The response does note a commitment to encourage students to take course offerings from Indigenous Studies. It is noted that the core faculty members, include Dr. Joseph Bennett who has extensive experience and expertise working with Indigenous communities in Canada and internationally, suggesting good knowledge and capacity. The unit should keep this recommendation front of mind as the program is being implemented. Perhaps over time, the unit could seek ways of indigenizing the curriculum in an integrated manner.

4. The revised program proposal does acknowledge that the skills developed by the students in the ISAP program are "are also indispensible for graduates holding future leadership positions." The unit should remember this recommendation as the program is being implemented.

5. The program proposal expands on the "Capital Advantage", including having access to "guest lecturers or invited speakers, professionals working at the science-policy interface can provide our students with an understanding of current practices." The proposal could arguably emphasize the "Capital Advantage" even more; however, more importantly is actually using the "Capital Advantage", during the program implementation, to the benefit of the students. The members of the units have a good record of engaging with the external community in Ottawa and this is not anticipated to be a concern.

There was a concern raised in the External Reviewers Report with the admissions requirements (specifically not requiring English (ENG4U)); however, the unit did not revise their admissions requirements. This is acceptable. The External Reviewers Report acknowledges that, while this is a concern, the admissions requirements seem adequate for the given curriculum, and adjustments to the admissions criteria can take place one the program has a better idea of the students it is attracting with the current criteria.

Overall, the External Reviewers Report was very positive about the proposed ISAP program. Substantive changes, beyond the proposed program name, were not anticipated. The unit has addressed positively the recommendations raised in the External Reviewers Report.

The proposed program B.Sc. in Interdisciplinary Science and Practice can be Recommended to Proceed.

Carleton UNIVERSITY
Canada's Capital University

Office of the Vice-Provost and
Associate Vice-President (Academic)

memorandum

Date: March 16th, 2018

To: Dr. Steven Cooke, Director, Institute of Environmental Science
Acting Director, Institute of Integrated Science

From: Dr. Lorraine Dyke, Vice-Provost and Associate Vice-President (Academic); Chair, Carleton University Committee on Quality Assurance

Cc: Dr. Jerry Tomberlin, Interim Provost and Vice-President (Academic)
Dr. Adrian Chan, Assistant Vice-President, Office of the Vice Provost and Associate Vice President (Academic)
Dr. Dwight Deugo, Interim Dean, Faculty of Science
Christina Noja, Manager, Office of the Vice-Provost and Associate Vice-President (Academic)
Dr. Robyn Green, Program Officer, Office of the Vice-Provost and Associate Vice- President (Academic)

RE: Outcome of New Program Proposal

The Carleton University Committee on Quality Assurance (CUCQA) met on **March 14th, 2018** to consider the unit's Response to the External Reviewers' report for the following new program proposal:

- **B.Sc. Hons and Gen., Interdisciplinary Science and Practice**

In accordance with article 3.5.6 of Carleton's Institutional Quality Assurance Process, the Carleton University Committee on Quality Assurance has categorised the program as "**Recommended to commence**".

The External Reviewers' Report made a number of recommendations noting (p. 2):

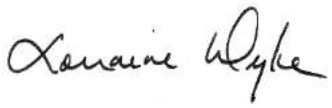
1. The current name of the proposed program ("Science: Integration and Application") does not accurately reflect the program. The name should be changed to BSc in Interdisciplinary Science and Communication.
2. The term "soft skills" should be eliminated from the proposal and not used to describe or promote the program or used in teaching. The skills that come from team work, group projects and carefully designed communication are professional skills and have been recognized as such by the Tri-Council for over ten years.
3. The unique perspectives of Indigenous peoples should be included in the program.

4. The cumulative benefit of the program, with its emphasis in group learning, mentorship for success, and communication, should be recognized as cultivating leadership skills in the highest quality graduates.
5. The self-study document makes mention of the "Capital Advantage" that the SCIA program offers its students. Yet, the document fails to articulate in any meaningful way how this advantage will be made available to students in the program.

The unit's Response to the External Reviewer's Report addressed all of the above points.

The Committee wishes to thank the unit for their submission and congratulate the unit on a successful new program proposal. In addition to CUCQA approval, the program was approved by the Senate Academic Programs Committee (SAPC) on **March 15th, 2018.** The next stage in the new program approval process is the submission of the new program brief to Carleton University Senate (**March 23rd, 2018**). Before the program can be advertised and officially commence, approval from both the Ontario Universities' Council on Quality Assurance and the Ministry of Advanced Education and Skills Development is required. Both of these submissions will occur in April 2018. The earliest expected result from the Ontario Universities' Council on Quality Assurance is May 2018 and from the Ministry of Advanced Education and Skills Development is August 2018.

Please do not hesitate to contact me should you have any questions or concerns.



Vice-Provost & Associate Vice-President (Academic)
Professor, Management and Strategy

Program Change Request

New Program Proposal

Date Submitted: 01/30/18 3:32 pm

Viewing: **TBD-1811 : Interdisciplinary Science and Practice B.Sc. Honours**

Last edit: 03/08/18 3:19 pm

Last modified by: christinanoja

Changes proposed by: michellesantoianni

In Workflow

1. **ISCS ChairDir UG**
2. **ENVS ChairDir UG**
3. **SCI Dean**
4. **SCI FCC**
5. **SCI FBoard**
6. **CUCQA**
7. Future Cycle
8. PRE SCCASP
9. SCCASP
10. SAPC
11. Senate
12. PRE CalEditor
13. CalEditor

Approval Path

1. 01/19/18 11:27 am Mike Labreque (mikelabreque): Rollback to Initiator
2. 01/30/18 12:07 pm Julia Wallace (juliawallace): Rollback to Initiator
3. 01/30/18 4:09 pm Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
4. 01/30/18 6:12 pm Steven Cooke (stevencooke): Approved for ENVS ChairDir UG
5. 01/30/18 6:40 pm Patrice Smith (patricesmith): Approved for SCI Dean
6. 02/01/18 2:20 pm Patrice Smith (patricesmith): Approved for SCI FCC
7. 02/15/18 2:21 pm Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	majormod
Program Code	TBD-1811
Level	Undergraduate
Faculty	Faculty of Science
Academic Unit	Institute of Environmental Science Integrated Science Institute
Degree	Bachelor of Science Honours
Title	Interdisciplinary Science and Practice B.Sc. Honours

Program Requirements

Interdisciplinary Science and Practice B.Sc. Honours (20.0 credits)

A. Credits Included in the Major CGPA (10.0 credits)		
1. 4.0 credits in:		**4.0**
ISAP 1001 [0.0]	**Introduction to Interdisciplinary Science**	
ISAP 1002 [0.0]	**Seminar in Interdisciplinary Science**	
ISAP 2001 [0.0]	**Foundations in Critical Inquiry**	
ISAP 2002 [0.0]	**Research Principles for Interdisciplinary Science**	
ISAP 3001 [0.0]	**Principles and Applications in Data Analysis**	
ISAP 3002 [0.0]	**Applications in Interdisciplinary Research**	
ISAP 3003 [0.0]	**Science Communication**	
ISAP 3004 [0.0]	**Science Policy**	
2. 1.0 credit from:		**1.0**
ISAP 4906 [0.0]	**Capstone Course - Group Research Project**	
ISAP 4907 [0.0]	**Capstone Course - Research Essay**	
ISAP 4908 [0.0]	**Capstone Course - Individual Research Project**	
3. 1.0 credit in:		**1.0**
COMP 1005 [0.5]	**Introduction to Computer Science I**	
STAT 2507 [0.5]	**Introduction to Statistical Modeling I**	
4. 0.5 credit from:		**0.5**
MATH 1007 [0.5]	**Elementary Calculus I**	
MATH 1107 [0.5]	**Linear Algebra I**	
5. 0.5 credit from:		**0.5**
COMP 1006 [0.5]	**Introduction to Computer Science II**	
STAT 2509 [0.5]	**Introduction to Statistical Modeling II**	

6. 1.0 credit from the Faculty of Science at the 2000 level or higher	**1.0**
7. 2.0 credits from the Faculty of Science at the 3000 level or higher	**2.0**
B. Credits Not Included in the Major CGPA (10.0 credits)	
8. 1.0 credit in:	**1.0**
ECON 1000 [1.0] Introduction to Economics	
9. 2.0 credits in Approved Experimental Science Courses as defined in the Regulations for the Bachelor of Science	**2.0**
10. 2.0 credits from the Faculty of Science at the 2000 level or higher	**2.0**
11. 2.0 credit in Approved courses outside the Faculties of Science and Engineering and Design, as defined in the Regulations for the Bachelor of Science. Note: students in the ISAP program may not use NSCI 1000 in this category.	**2.0**
12. 3.0 credits in free electives	**3.0**
12. Students are required to complete one minor from the Faculty of Science. A second minor (from any faculty, including Science) is encouraged. Students should consult with their academic advisor to ensure compliance with this requirement.	
Total Credits	20.0

New Resources	Contract Instructor Faculty Space Support Staff/Admin. Staff Teaching Assistant
Summary	New Science program for students with interest in science and interdisciplinary subjects. ISAP graduates will be well prepared to balance their specialized technical knowledge with the transferable skills of critical thinking and problem solving, teamwork, and science communication.
Rationale	In designing the Interdisciplinary Science and Practice(ISAP) curriculum, we identified two major motivating factors: student interest in an interdisciplinary science degree and labour market demands. Through ISAP, students will have the opportunity to integrate concepts and knowledge erent science disciplines and apply them to real world problems through local and global perspectives. The ISAP program will guide students to appreciate the relevance of their chosen science disciplines to current issues, such as food security, cybersecurity, energy sustainability and environmental stewardship, which require cross-disciplinary collaboration on local, national and international levels. As ISAP evolves, our vision is to enable students to participate in assignments that will directly engage them with the community. ISAP graduates will be well prepared to balance their specialized technical knowledge with the transferable skills of critical thinking and problem solving, teamwork, and science communication.
Transition/Implementation	New program, fall admission for 2019.

Program reviewer comments	**mikelabreque (01/19/18 11:27 am):** Rollback: Hi Michelle, I am rolling this back to you for review. I re-entered the program with proper formatting. Also, it should be submitted as a minor modification. **juliawallace (01/30/18 12:07 pm):** Rollback: The program requirements section is empty. Is this correct? **danbegin (03/08/18 11:42 am):** Changed the title to Interdisciplinary Science and Practice

Key: 1811

Program Change Request

New Program Proposal

Date Submitted: 01/19/18 1:05 pm

Viewing: **TBD-1812 : Interdisciplinary Science and Practice B.Sc. General**

Last edit: 03/08/18 3:20 pm

Last modified by: christinanoja

Changes proposed by: michellesantoianni

In Workflow

1. **ISCS ChairDir UG**
2. **ENVS ChairDir UG**
3. **SCI Dean**
4. **SCI FCC**
5. **SCI FBoard**
6. **CUCQA**
7. Future Cycle
8. PRE SCCASP
9. SCCASP
10. SAPC
11. Senate
12. PRE CalEditor
13. CalEditor

Approval Path

1. 01/19/18 11:27 am Mike Labreque (mikelabreque): Rollback to Initiator
2. 01/19/18 11:52 am Mike Labreque (mikelabreque): Rollback to Initiator
3. 01/30/18 12:02 pm Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
4. 01/30/18 6:12 pm Steven Cooke (stevencooke): Approved for ENVS ChairDir UG
5. 01/30/18 6:40 pm Patrice Smith (patricesmith): Approved for SCI Dean
6. 02/01/18 2:19 pm Patrice Smith (patricesmith): Approved for SCI FCC
7. 02/15/18 2:21 pm Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	majormod
Program Code	TBD-1812
Level	Undergraduate
Faculty	Faculty of Science
Academic Unit	Institute of Environmental Science Integrated Science Institute
Degree	Bachelor of Science General
Title	Interdisciplinary Science and Practice B.Sc. General

Program Requirements

Interdisciplinary Science and Practice B.Sc. General (15.0 credits)

A. Credits Included in the Major CGPA (8.0 credits)		
1. 4.0 credits in:		**4.0**
ISAP 1001 [0.0]	**Introduction to Interdisciplinary Science**	
ISAP 1002 [0.0]	**Seminar in Interdisciplinary Science**	
ISAP 2001 [0.0]	**Foundations in Critical Inquiry**	
ISAP 2002 [0.0]	**Research Principles for Interdisciplinary Science**	
ISAP 3001 [0.0]	**Principles and Applications in Data Analysis**	
ISAP 3002 [0.0]	**Applications in Interdisciplinary Research**	
ISAP 3003 [0.0]	**Science Communication**	
ISAP 3004 [0.0]	**Science Policy**	
2. 1.0 credit in:		**1.0**
COMP 1005 [0.5]	**Introduction to Computer Science I**	
STAT 2507 [0.5]	**Introduction to Statistical Modeling I**	
3. 0.5 credit from:		**0.5**
MATH 1007 [0.5]	**Elementary Calculus I**	
MATH 1107 [0.5]	**Linear Algebra I**	
4. 0.5 credit from:		**0.5**
COMP 1006 [0.5]	**Introduction to Computer Science II**	
STAT 2509 [0.5]	**Introduction to Statistical Modeling II**	
5. 1.0 credit from the Faculty of Science at the 2000 level or higher		**1.0**
6. 1.0 credit from the Faculty of Science at the 3000 level or higher		**1.0**
B. Credits Not Included in the Major CGPA (7.0 credits)		
7. 1.0 credit in:		**1.0**

ECON 1000 [1.0]	**Introduction to Economics**	
8. 2.0 credits in Approved Experimental Science Courses as defined in the Regulations for the Bachelor of Science		**2.0**
9. 1.0 credit from the Faculty of Science at the 2000 level or higher		**1.0**
10. 1.0 credit in Approved courses outside the Faculties of Science and Engineering and Design, as defined in the Regulations for the Bachelor of Science. Note: students in the ISAP program may not use NSCI 1000 in this category.		**1.0**
11. 2.0 credits in free electives		**2.0**
12. Students are required to complete one Minor from the Faculty of Science. A second Minor from outside the Faculty of Science may be possible. Students should consult with their academic advisor to ensure compliance with this requirement.		
Total Credits		15.0

New Resources	Contract Instructor Faculty Space Support Staff/Admin. Staff Teaching Assistant
Summary	New Science program for students with interest in science and interdisciplinary subjects. ISAP graduates will be well prepared to balance their specialized technical knowledge with the transferable skills of critical thinking and problem solving, teamwork, and science communication.
Rationale	In designing the Interdisciplinary Science and Practice (ISAP) curriculum, we identified two major motivating factors: student interest in an interdisciplinary science degree and labour market demands. Through ISAP, students will have the opportunity to integrate concepts and knowledge erent science disciplines and apply them to real world problems through local and global perspectives. The ISAP program will guide students to appreciate the relevance of their chosen science disciplines to current issues, such as food security, cybersecurity, energy sustainability and environmental stewardship, which require cross-disciplinary collaboration on local, national and international levels. As ISAP evolves, our vision is to enable students to participate in assignments that will directly engage them with the community. ISAP graduates will be well prepared to balance their specialized technical knowledge with the transferable skills of critical thinking and problem solving, teamwork, and science communication.
Transition/Implementation	New program, fall admission for 2019

Program reviewer comments	**mikelabreque (01/19/18 11:27 am):** Rollback: Hi Michelle, I am rolling this back to you for review. I re-entered the program with proper formatting. Also, it should be submitted as a minor modification. **mikelabreque (01/19/18 11:52 am):** Rollback: Rollback, as requested. **danbegin (03/08/18 11:40 am):** Change the title to Interdisciplinary Science and Practice.

Key: 1812

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:31 pm

Viewing: ISAP 1001 : Introduction to Interdisciplinary Science

Last edit: 03/06/18 3:00 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours Interdisciplinary Science and Practice B.Sc. General

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 11:46 am
   Julia Wallace
   (juliawallace): Approved
   for ISCS ChairDir UG
2. 01/30/18 11:56 am
   Michelle Santoianni
   (michellesantoianni):
   Rollback to Initiator
3. 01/30/18 4:00 pm
   Julia Wallace
   (juliawallace): Approved
   for ISCS ChairDir UG
4. 02/01/18 2:18 pm
   Patrice Smith
   (patricesmith): Approved
   for SCI FCC
5. 02/15/18 2:21 pm
   Patrice Smith
   (patricesmith): Approved
   for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Faculty
Level	Undergraduate
Course Code	ISAP
Course Number	1001

Title	Introduction to Interdisciplinary Science
Title (short)	Intro Interdisciplinary Sci
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute
Credit Value	0.50
Course Description	What is interdisciplinarity and what are the challenges and opportunities of collaboration within and across disciplines in science and beyond? Topics include types of biases, public datasets and science communication.
Prerequisite(s)	
Class Format	Lectures and discussion three hours per week.
Precluded Courses	
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Discussion Group Lecture
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	new core courses required only for students admitted to SCIA program. The transition from high school to university can be a daunting one. Students must acclimatize to different academic standards and course delivery methods while often feeling socially isolated. With these challenges in mind, our first year SCIA courses will be small seminar-style courses with weekly in-class activities. Projects will be assigned that can help students bridge the transition while assessing learning.
Course reviewer comments	**michellesantoianni (01/30/18 11:56 am):** Rollback: I need to correct this one. **danbegin (03/06/18 3:00 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9418
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:31 pm

Viewing: ISAP 1002 : Seminar in Interdisciplinary Science

Last edit: 03/06/18 3:01 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours Interdisciplinary Science and Practice B.Sc. General

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 11:47 am
   Julia Wallace
   (juliawallace): Approved
   for ISCS ChairDir UG
2. 01/30/18 11:57 am
   Michelle Santoianni
   (michellesantoianni):
   Rollback to Initiator
3. 01/30/18 4:00 pm
   Julia Wallace
   (juliawallace): Approved
   for ISCS ChairDir UG
4. 02/01/18 2:18 pm
   Patrice Smith
   (patricesmith): Approved
   for SCI FCC
5. 02/15/18 2:21 pm
   Patrice Smith
   (patricesmith): Approved
   for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Faculty
Level	Undergraduate
Course Code	ISAP
Course Number	1002

Title	Seminar in Interdisciplinary Science
Title (short)	Sem Interdisciplinary Sci
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute
Credit Value	0.50
Course Description	Exploring the role of interdisciplinarity in discovery and innovation, and discussion of selected issues facing society and the role of science. Topics include finding information, collaboration and science communication tools.
Prerequisite(s)	SCIA 1001.
Class Format	Seminar three hours per week.
Precluded Courses	
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Seminar
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	new core courses required only for students admitted to SCIA program. The transition from high school to university can be a daunting one. Students must acclimatize to different academic standards and course delivery methods while often feeling socially isolated. With these challenges in mind, our first year SCIA courses will be small seminar-style courses with weekly in-class activities. Projects will be assigned that can help students bridge the transition while assessing learning.
Course reviewer comments	**michellesantoianni (01/30/18 11:57 am):** Rollback: correction **danbegin (03/06/18 3:01 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9419
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:31 pm

Viewing: ISAP 2001 : Foundations in Critical Inquiry

Last edit: 03/06/18 3:01 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours Interdisciplinary Science and Practice B.Sc. General

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:01 pm
   Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
2. 02/01/18 2:18 pm
   Patrice Smith (patricesmith): Approved for SCI FCC
3. 02/15/18 2:21 pm
   Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Faculty
Level	Undergraduate
Course Code	ISAP
Course Number	2001
Title	Foundations in Critical Inquiry
Title (short)	Found. Critical Inquiry
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	0.50
Course Description	What is science and the scientific method? Topics include the scientific method, credible sources of information, knowledge gaps, the impact of scientific discoveries, and discussion of their local and global implications.
Prerequisite(s)	SCIA 1002 or permission of the Institute.
Class Format	Lecture three hours per week, workshop two hours per week.
Precluded Courses	
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Lecture Workshop
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	new core courses required only for students admitted to SCIA program.
Course reviewer comments	**danbegin (03/06/18 3:01 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9420
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:30 pm

Viewing: ISAP 2002 : Research Principles for Interdisciplinary Science

Last edit: 03/06/18 3:02 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours Interdisciplinary Science and Practice B.Sc. General

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:02 pm Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
2. 02/01/18 2:18 pm Patrice Smith (patricesmith): Approved for SCI FCC
3. 02/15/18 2:21 pm Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Faculty
Level	Undergraduate
Course Code	ISAP
Course Number	2002
Title	Research Principles for Interdisciplinary Science
Title (short)	Rsrch Princ Intdsplnary Sci
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	0.50
Course Description	Exploring how research is conducted. Topics include publicly available databases, the role of communication in research, stakeholders and participants, and the process of identifying knowledge gaps and developing research questions.
Prerequisite(s)	SCIA 2001 or permission of the Institute.
Class Format	Lecture three hours per week.
Precluded Courses	
Also listed as	
Piggybacked Courses	

Grade Mode	Standard Letter Grade
Schedule Type	Lecture
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).
Course reviewer comments	**danbegin (03/06/18 3:02 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9421
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:30 pm

Viewing: ISAP 3001 : Principles and Applications in Data Analysis

Last edit: 03/06/18 3:02 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours Interdisciplinary Science and Practice B.Sc. General

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:03 pm
   Julia Wallace
   (juliawallace): Approved
   for ISCS ChairDir UG
2. 02/01/18 2:19 pm
   Patrice Smith
   (patricesmith): Approved
   for SCI FCC
3. 02/15/18 2:21 pm
   Patrice Smith
   (patricesmith): Approved
   for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Faculty
Level	Undergraduate
Course Code	ISAP
Course Number	3001
Title	Principles and Applications in Data Analysis
Title (short)	Prncples/Apps in Data Analysis
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	0.50
Course Description	Development of strategies for obtaining and analyzing data. Topics include: survey of publicly available science-data resources; identification of coincidental, correlational and causal relationships; statistical data-analysis techniques; concepts of risk and error propagation in measured and calculated values. Applications in the physical and biological sciences.
Prerequisite(s)	SCIA 2002, COMP 1005 and STAT 2507.
Class Format	Lecture three hours per week, workshop two hours per week.
Precluded Courses	
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Lecture Workshop
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).
Course reviewer comments	**danbegin (03/06/18 3:02 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9422
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:29 pm

Viewing: ISAP 3002 : Applications in Interdisciplinary Research

Last edit: 03/06/18 3:02 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours Interdisciplinary Science and Practice B.Sc. General

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:04 pm Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
2. 02/01/18 2:19 pm Patrice Smith (patricesmith): Approved for SCI FCC
3. 02/15/18 2:21 pm Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Faculty
Level	Undergraduate
Course Code	ISAP
Course Number	3002
Title	Applications in Interdisciplinary Research
Title (short)	App. Interdisciplinary Rsrch
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	0.50
Course Description	Application of skills from Science Integration and Application (SCIA) courses to develop a research proposal. Topics include: research ethics; identification of stakeholders; inclusive consultation, collaboration and dissemination strategies.
Prerequisite(s)	SCIA 2002.
Class Format	Lecture three hours per week, workshop two hours per week.
Precluded Courses	
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Lecture Workshop
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).
Course reviewer comments	**danbegin (03/06/18 3:02 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9423
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:29 pm

Viewing: ISAP 3003 : Science Communication

Last edit: 03/06/18 3:03 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours Interdisciplinary Science and Practice B.Sc. General

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:04 pm
   Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
2. 02/01/18 2:19 pm
   Patrice Smith (patricesmith): Approved for SCI FCC
3. 02/15/18 2:21 pm
   Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Faculty
Level	Undergraduate
Course Code	ISAP
Course Number	3003
Title	Science Communication
Title (short)	Science Communication
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	0.50
Course Description	How is science perceived and how has science been communicated? Students will use case studies to assess examples of science communication with varying outcomes. Topics include the principles of effective science communication, the range of tools available, and knowing the audience.
Prerequisite(s)	SCIA 2002.
Class Format	Lecture and seminar three hours per week.
Precluded Courses	
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Lecture Seminar
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).
Course reviewer comments	**danbegin (03/06/18 3:03 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9424
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:29 pm

Viewing: ISAP 3004 : Science Policy

Last edit: 03/06/18 3:03 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours Interdisciplinary Science and Practice B.Sc. General

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:05 pm
   Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
2. 02/01/18 2:19 pm
   Patrice Smith (patricesmith): Approved for SCI FCC
3. 02/15/18 2:21 pm
   Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Contract Instructor
Level	Undergraduate
Course Code	ISAP
Course Number	3004
Title	Science Policy
Title (short)	Science Policy
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	0.50
Course Description	Exploration of how science-related policy is developed and the impact of policy on science. Topics will include policy frameworks, stakeholder roles, power relationships, commercialization and the funding of science.
Prerequisite(s)	SCIA 3003.
Class Format	Lecture and seminar three hours per week.
Precluded Courses	
Also listed as	
Piggybacked Courses	

Grade Mode	Standard Letter Grade
Schedule Type	Lecture Seminar
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).

Course reviewer comments	**danbegin (03/06/18 3:03 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9425
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:27 pm

Viewing: ISAP 4901 : Directed Studies

Last edit: 03/06/18 3:03 pm

Changes proposed by: michellesantoianni

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:05 pm
   Julia Wallace
   (juliawallace): Approved
   for ISCS ChairDir UG
2. 02/01/18 2:19 pm
   Patrice Smith
   (patricesmith): Approved
   for SCI FCC
3. 02/15/18 2:21 pm
   Patrice Smith
   (patricesmith): Approved
   for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	No New Resources
Level	Undergraduate
Course Code	ISAP
Course Number	4901
Title	Directed Studies
Title (short)	Directed Studies
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	0.50
Course Description	Independent or group study, open to third- and fourth-year students to explore a particular topic, in consultation with a Faculty supervisor. May include directed reading, written assignments, tutorials, laboratory or field work.
Prerequisite(s)	3rd-year standing in the Science: Integration and Application (SCIA) program and permission of the instructor.
Class Format	independent study
Precluded Courses	
Also listed as	
Piggybacked Courses	

Grade Mode	Standard Letter Grade
Schedule Type	Independent Study
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).

Course reviewer comments	**danbegin (03/06/18 3:03 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9426
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:26 pm

Viewing: ISAP 4906 : Capstone Course - Group Research Project

Last edit: 03/06/18 3:04 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:06 pm Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
2. 02/01/18 2:18 pm Patrice Smith (patricesmith): Rollback to ISCS ChairDir UG for SCI FCC
3. 02/01/18 2:20 pm Pamela Wolff (pamelawolff): Approved for ISCS ChairDir UG
4. 02/06/18 9:42 am Patrice Smith (patricesmith): Approved for SCI FCC
5. 02/15/18 2:21 pm Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Faculty
Level	Undergraduate
Course Code	ISAP
Course Number	4906

Title	Capstone Course - Group Research Project
Title (short)	Capstone Grp Rsrch Project
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute
Credit Value	1.0
Course Description	Students will collaborate on a project that addresses a real-world issue in a team environment. Focus includes: design and completion of a research project; development of communication, critical inquiry, data analysis and research skills; and the opportunity to develop initiative, creativity and self-reliance.
Prerequisite(s)	4th-year standing in the Honours Science: Integration and Application (SCIA) program and permission of the Institute.
Class Format	Lecture, seminar and workshop four hours per week, as scheduled by the instructor.
Precluded Courses	SCIA 4907, SCIA 4908.
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Lecture Seminar Workshop
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).
Course reviewer comments	**patricesmith (02/01/18 2:18 pm):** Rollback: Minor change in preclusion statement SCIA 4906 to be changed to SCIA4907 (in the SCIA4906 course details) **danbegin (03/06/18 3:04 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9427
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:26 pm

Viewing: ISAP 4907 : Capstone Course - Research Essay

Last edit: 03/06/18 3:04 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:06 pm Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
2. 02/01/18 2:19 pm Patrice Smith (patricesmith): Approved for SCI FCC
3. 02/15/18 2:21 pm Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	Contract Instructor
Level	Undergraduate
Course Code	ISAP
Course Number	4907
Title	Capstone Course - Research Essay
Title (short)	Capstone Rsrch Essay
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	1.0
Course Description	A substantial, independent essay or research proposal-based critical review and research proposal, using library, database and/or bioinformatic resources, under the direct supervision of the instructor. Topics include identification and critical review of resources, development of writing skills and formulation of research question and strategy.
Prerequisite(s)	4th-year standing in the Honours Science: Integration and Application (SCIA) program.
Class Format	Lecture, seminar and workshop four hours per week, as scheduled by the instructor.
Precluded Courses	SCIA 4906, SCIA 4908.
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Lecture Seminar Workshop
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).
Course reviewer comments	**danbegin (03/06/18 3:04 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9428
Not an admin

Course Change Request

New Course Proposal

Date Submitted: 01/30/18 3:25 pm

Viewing: ISAP 4908 : Capstone Course - Individual Research Project

Last edit: 03/06/18 3:04 pm

Changes proposed by: michellesantoianni

Programs referencing this course	Interdisciplinary Science and Practice B.Sc. Honours

In Workflow

1. **ISCS ChairDir UG**
2. **SCI FCC**
3. **SCI FBoard**
4. **Future Cycle**
5. PRE SCCASP
6. SCCASP
7. Banner

Approval Path

1. 01/30/18 4:07 pm Julia Wallace (juliawallace): Approved for ISCS ChairDir UG
2. 02/01/18 2:19 pm Patrice Smith (patricesmith): Approved for SCI FCC
3. 02/15/18 2:21 pm Patrice Smith (patricesmith): Approved for SCI FBoard

Effective Date	2019-20
Workflow	minormod
New Resources	No New Resources
Level	Undergraduate
Course Code	ISAP
Course Number	4908
Title	Capstone Course - Individual Research Project
Title (short)	Capstone Indiv. Rsrch Project
Faculty	Faculty of Science
Academic Unit	Integrated Science Institute

Credit Value	1.0
Course Description	An independent research project under the direct supervision of a faculty adviser. Evaluation is based on a written thesis and a poster presentation.
Prerequisite(s)	4th-year standing in the Honours Science: Integration and Application (SCIA) program, a major CGPA of 9.0 or higher, and permission of the Institute.
Class Format	Lectures and discussion as scheduled by the course coordinator; other hours as arranged with the faculty advisor.
Precluded Courses	SCIA 4906, SCIA 4907.
Also listed as	
Piggybacked Courses	
Grade Mode	Standard Letter Grade
Schedule Type	Discussion Group Lecture
Unpaid Placment	No
Summary	new core course for SCIA program
Rationale for new course	New program with 4.0 core credits (8 courses) in areas of interdisciplinary science, science communications, community engagements. Students in SCIA program will take a core SCIA course each term along with their other required science courses and the course requirements in their chosen minor(s).
Course reviewer comments	**danbegin (03/06/18 3:04 pm):** Course Subject changed from SCIA to ISAP (Interdisciplinary Science and Practice)

Key: 9429
Not an admin