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Uncharted Territory: Curriculum Mapping Multiple Majors Simultaneously

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Uncharted Territory: Curriculum Mapping Multiple Majors Simultaneously

Abstract

Curriculum mapping is the process of creating a visual representation of the teaching and assessment of learning outcomes in a degree, program or major. Best practice recommendations about curriculum mapping typically focus on mapping individual programs. Therefore, many recommendations, such as meeting individually with faculty as they map their course, may not be feasible for large-scale mapping projects. This paper describes the process of a large-scale curriculum mapping project designed to map the Bachelor of Science degree and 24 of its associated majors. The project involved the participation of faculty from three colleges within a research-intensive University to map over 400 courses. We describe the key questions and decisions involved in carrying out the mapping project, our data collection and analysis process, and our dissemination efforts to ensure that the mapping results were used to inform curricular change.

La cartographie de programmes d'études consiste à créer une représentation visuelle de l'enseignement et de l'évaluation des résultats d'apprentissage dans un programme menant à un diplôme, dans un autre programme ou dans une majeure. Les recommandations pour les meilleures pratiques concernant la cartographie de programmes se concentre habituellement sur la cartographie de programmes individuels. Par conséquent, de nombreuses recommandations, telles que la rencontre individuelle avec les professeurs et les professeures alors qu'ils préparent la cartographie de leurs cours ne sont pas toujours possibles dans les cas de très grands projets de cartographie. Cet article décrit le processus d'un grand projet de cartographie de programme d'études conçu pour cartographier un baccalauréat en sciences et 24 de ses majeures associées. Le projet a impliqué la participation de professeurs et de professeures de trois collèges d'une grande université axée sur la recherche pour cartographier plus de 400 cours. Nous décrivons les questions et les décisions clés qui ont permis de mener à bien ce projet de cartographie, nos données et le processus d'analyse, ainsi que nos efforts de dissémination pour assurer que les résultats de la cartographie ont été utilisés pour effectuer les changements aux programmes d'études.

Keywords

curriculum mapping, assessment, learning outcomes, higher education; cartographie de programmes d'études, évaluation, résultats d'apprentissage, enseignement supérieur

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There is growing interest in the scholarship of curriculum practice literature on the systematic investigation of student learning, using methods such as curriculum mapping (Hubball & Gold, 2007; Hubball et al., 2013; O'Neill et al., 2013; Wijngaards-de Meij & Merx, 2018). Curriculum mapping involves creating a visual representation of the extent to which courses within a program or degree teach and assess learning outcomes (LOs), competencies, or skills required for graduates of a program or degree (Harden, 2001). The resulting curriculum maps illustrate an overall snapshot of the intended coverage of LOs, including information about the method, the depth, and sequencing or progression of instruction and assessment within a curriculum (Harden, 2001). Curriculum maps depict this information visually, through matrices (e.g., Joyner, 2016a) or radial diagrams (e.g., Lam & Tsui, 2013) that present the coverage of LOs. This visual representation of the curriculum as a whole allows stakeholders including administrators, instructors and students, to visualize the often-hidden links between the elements of the curriculum (Harden, 2001). The information presented in curriculum maps can help faculty identify gaps and redundancies in the teaching and assessment of LOs within a program. Curriculum maps "make the curriculum visible," making them useful for designing curricula, evaluating alignment (i.e., the coherence between teaching, learning, and assessment), enhancing student learning, and assessing curriculum quality (Wijngaards-de Meij & Merx, 2018).

Curriculum mapping is typically accomplished by collecting data on coverage of LOs by each course, either from the course instructor (e.g., Joyner, 2016a) or through analyses of course outlines or other course materials (e.g., Lam & Tsui, 2013). Curriculum maps may also contain other information including the topics covered in each course (i.e., content mapping) or the level of instruction or assessment. Although curriculum mapping is a widespread practice in higher education, relatively few scholarly articles exist describing the process or offering best practice advice. In fact, in a systematic review of curriculum mapping literature, Ervin et al., (2013) identified only three published papers that explicitly outlined the process of curriculum mapping. They argue that "ad hoc" curriculum mapping, lacking academic rigour, often occurs.

Additionally, much of the literature on curriculum mapping focuses on relatively small curriculum mapping projects, such as mapping a single program or major (e.g., Joyner, 2016a; Labouta et al., 2019; Uchiyama & Radin, 2009; Veltri et al., 2011). Recommendations for relatively small-scale curriculum mapping projects may not be feasible for larger mapping initiatives such as mapping a degree that encompasses multiple majors and hundreds of courses. As we began to develop a large-scale curriculum mapping project at our university, we looked to the literature for recommendations on how best to map multiple related majors simultaneously, and we identified a gap in this area. Therefore, we sought to answer the question: How can instructors, staff, or program administrators engage in curriculum mapping of multiple programs, majors, or degrees simultaneously? Specifically, we were interested in questions related to the process of curriculum mapping, from the design of the mapping tool through to putting the results into action. This paper addresses the need for best practice recommendations for curriculum mapping by describing a large-scale mapping project. Our hope is that the curriculum mapping process described here can both contribute to the literature on the scholarship of curriculum practice (Hubball & Gold, 2007) and be used or adapted for mapping other related programs, majors, diplomas, or degrees.

Benefits and Drawbacks of Engaging in Curriculum Mapping

Curriculum mapping initiatives are most effective when all faculty members within a particular department or program are involved (Joyner, 2016b). Curriculum mapping is often considered a tool that can be used to drive discussions about curriculum change, but the interpretation of these maps by faculty is required to transform data into action. By definition, curriculum mapping provides evidence to inform faculty, staff, (and sometimes students) about how courses work together to teach and assess LOs. Arafeh (2016) describes the results of a curriculum mapping project as "clear and cogent, easy to use and delivered useful outcomes-focused information" (p. 606). In a survey of faculty members who participated in a curriculum mapping process, Joyner (2016b) found that faculty agreed that they gained a better understanding of how their course fit into the overall curriculum based on their participation in the mapping process. Ideally then, curriculum maps can be used to inform curricular improvements, for example, by allowing faculty to identify areas of redundancy in the teaching of certain outcomes, which could result in a more streamlined curriculum. Beyond these direct curricular benefits, research shows that faculty who participate in curriculum mapping initiatives report increased collegiality and collaboration (Uchiyama & Radin, 2009). Other benefits include providing faculty with an explicit opportunity to reflect on the curriculum and where their course fits within it. For example, faculty and instructors can use curriculum maps to inform discussions and spark collaboration related to the content (e.g., knowledge, skills, or values) taught, the level of teaching and assessment, and the alignment of teaching and assessment activities.

Curriculum mapping is not a silver bullet, however. There are many challenges associated with conducting successful curriculum mapping projects. For example, faculty may be resistant to mapping efforts and may be concerned that mapping will involve additional work for little reward (Uchiyama & Radin, 2009; Kopera-Frye et al., 2001). Other difficulties involve differences in interpretations of key terms which can make it difficult to conduct quantitative analyses of the curriculum maps (Sumsion & Goodfellow, 2004). It is also important to consider the type of information generated through curriculum mapping because curriculum mapping focused exclusively on outcomes coverage does not "provide needed information about the curricula's exposure to, and use of, topics" (Arafeh, 2016, p. 606).

Literature Review of Best Practices for Engaging in Curriculum Mapping

Recommendations for successful curriculum mapping initiatives highlight the need to secure institutional support and identify faculty and staff champions to lead the process, thus increasing participant buy-in (Harden, 2001). Sumsion and Goodfellow (2004) also provide recommendations for increasing faculty buy-in, including the need to assure faculty that mapping is not intended to be evaluative but simply used to identify patterns across the program. To manage the effort required to undertake a mapping project, Veltri et al., (2011) recommend mapping a maximum of eight LOs at a time. They caution that attempting to map more than eight outcomes at once can be unmanageable for faculty and analysts. In contrast to the directive to simplify the mapping process, other scholars recommend gathering additional data, such as the content and the type and depth of engagement and assessment of student learning to gain a more complete picture of the intended curriculum as delivered to students (Arafeh, 2016). No matter the type or scope of mapping data gathered, scholars tend to agree that curriculum maps are valuable when they are used to encourage faculty to engage in reflective dialog about the curriculum (Lam & Tsui, 2016).

Certain recommendations are relevant for curriculum mapping projects of any scale. For example, mapping both small and large programs require engaged faculty members who see value in the process. However, other recommendations are applicable to small-scale mapping projects but may not be feasible as mapping initiatives grow. For example, in their mapping of a Bachelor of Education program, Sumsion and Goodfellow (2004) conducted individual hour-long consultations with faculty members regarding their responses on the curriculum mapping matrix. These consultations contributed worthwhile additional information to the results of the mapping project, but they would be too labor-intensive for projects involving the mapping of more courses. In another curriculum mapping project that involved mapping ten courses in a Bachelor of Information Science Program, Veltri et al., (2011) recommend having faculty complete a complex mapping matrix consisting of five indicators per outcome per course. Although Veltri et al., (2011) suggested that mapping be limited to a maximum of eight outcomes, this degree of information required for each course could become unmanageable for mapping projects in which faculty are responsible for mapping several courses. This trade-off between feasible mapping processes and gathering useful data is even more pronounced as the size of the mapping project increases.

In this paper, we describe a large-scale curriculum mapping process undertaken at the University of Guelph. The aim of this project was to map the Bachelor of Science (B.Sc.) degree and its 26 associated majors. We describe the challenges and advantages associated with undertaking a large-scale curriculum mapping project. We first discuss the key questions we asked and the decisions we made to engage in the mapping project. Next, we describe the process of data collection, analysis, and dissemination to the departments that we used. We conclude with recommendations for other institutions considering engaging in a similar project.

Case Description

At the University of Guelph, undergraduate students can earn a B.Sc. degree in one of 26 different 4-year majors (e.g., Physics, Zoology, Plant Science). To promote consistency in expectations across the 26 majors, the B.Sc. Program Committee developed 13 program learning outcomes (PLOs) that any graduate with a B.Sc. degree will demonstrate (see Appendix A for the B.Sc. Program Learning Outcomes). These 13 PLOs are grouped into six different categories and align with the institution's overall Undergraduate Degree Learning Outcomes (see Appendix B for the Undergraduate Degree Learning Outcomes). All majors awarding a B.Sc. degree use the 13 B.Sc. PLOs and can add additional major-specific learning outcomes (MLOs) within the six categories to provide additional context about the unique skills and abilities that their graduates can expect to obtain (see https://www.uoguelph.ca/ada-cbs/teaching-and-learning/learning-outcomes#major-specific for MLOs).

A curriculum mapping project team, inclusive of the Associate Dean Academic and Academic Program Manager from the College of Biological Sciences, an Educational Developer and Educational Analyst from the Office of Teaching and Learning undertook the task of mapping all B.Sc. majors in one effort[1]. The overarching goal of this collaborative, large-scale curriculum mapping initiative was to gather data on each of the over 450 required and restricted elective (i.e.,

[1] Two majors had recently completed a similar mapping project, and were not included in the large-scale project, resulting in 24 majors mapped.

a course which must be chosen from a stated list) courses to visualize the teaching and assessment of the PLOs and MLOs for each B.Sc. major.

These mapping efforts were complicated by the fact that many 1st and 2nd year science courses teach foundational science knowledge and skills and are therefore required for students in multiple majors. For example, students in 15 of the 26 B.Sc. majors are required to take the 1st year biology course Discovering Biodiversity. This core science requirement for B.Sc. students ensures that all students receive a consistent foundation in the sciences, but it also makes mapping the courses difficult because course instructors for the foundational courses could conceivably receive dozens of requests to map their course to the outcomes of dozens of majors. The curriculum mapping project team grappled with how to capture accurate information about these courses, without overwhelming instructors with an unwieldy mapping process.

With little guidance in the literature on how to map multiple majors simultaneously, we envisioned a multi-staged project that would take place over 18 months. To carry-out this mapping project, the team moved through four phases: (1) Project Planning, (2) Data Collection, (3) Data Analysis and Dissemination, and (4) Departmental Action. A description of each of these four phases follows. We include decision points, communication and project leadership approaches, analytic and reporting strategies, and project logistics.

Phase 1: Project Planning

The curriculum mapping team aimed to empower and not alienate faculty. Therefore, prior to collecting information from instructors *en masse*, the project team established project goals, designed and piloted a survey, and determined an appropriate communication strategy. Table 1 provides further detail regarding critical logistical decisions that were made during this project.

Developing Project Goals

The project team established the following goals for the curriculum mapping project: (a) to provide information about the intended teaching and assessment of PLOs and MLOs for the BSc and all associated majors, (b) to confirm that the project aligned with other curriculum review initiatives, and (c) to ensure that the information obtained from the curriculum mapping project would be used to inform curricular improvements. The first project goal of gathering information about the coverage of learning outcomes arose because the core B.Sc. PLOs and each of the associated MLOs had recently been established. With these learning outcomes in place, we felt that collecting data on the intended teaching and assessment of those outcomes was an important next step to determine whether each major delivered a curriculum that provides students with the opportunity to achieve the intended outcomes. Curriculum mapping is a critical step in ensuring that the planned curriculum is being enacted as intended by instructors (Harden, 2001). Therefore, the curriculum maps would provide data about how courses in each major work together to teach and assess the intended learning outcomes.

Table 1
Logistical Questions and Decisions about the Approach to Curriculum Mapping

Logistical Question	Approach Taken for B.Sc. Mapping Project	Rationale for Decision
What courses will be included in the mapping project?	All required and “restricted elective” (a course which must be chosen from a stated group of courses to satisfy the program requirements) courses for the 24 B.Sc. majors Elective (a course acceptable within the program but chosen at the discretion of the student) courses were excluded	Students can choose from lists of restricted electives. Arguably, therefore, these courses should be relatively equivalent. Restricted elective courses were included to provide data to compare the relative contributions of each course to the PLOs and MLOs. Electives were excluded because their purpose is to provide breadth, not to contribute directly to PLOs and MLOs for the B.Sc. majors.
What is the best method for collecting data for each course?	A customized mapping survey	A customized mapping survey was determined to be the most feasible data collection strategy. The survey was customized to lead respondents through the mapping process for the PLOs and MLOs for the majors associated with their specific course. This level of customization would not be feasible with a static spreadsheet.
Who is responsible for providing mapping data?	Course instructors who teach a required or restricted elective course In the case of co-taught courses, instructors were encouraged to map the course together	Course instructors were thought to be the experts on their course, which would result in accurate data. Mapping by a third party (e.g., the program chair or an educational developer) using knowledge of the program or course outlines was not feasible because of the large number of courses to be mapped. Mapping by the instructor ensured that most instructors only had to map 1 to 3 courses per semester.

Logistical Question	Approach Taken for B.Sc. Mapping Project	Rationale for Decision
When should the course information be collected?	Over the course of the Fall and Winter semester of one academic year Instructors were asked to complete the survey during the primary semester the course is delivered	Mapping during the semester when the course was taught ensured that instructors had current knowledge of the course. It also limited the number of mapping surveys an instructor was asked to complete each semester.
How can we minimize instructor burden for core 1st and 2nd year science courses that map to multiple majors?	Limit data collection for core 1st and 2nd year courses in the following ways: **1st year:** Map only to 13 B.Sc. PLOs **2nd year:** Map to 13 B.Sc. PLOs and to majors within the department that offers the course (e.g., 2nd year Chemistry courses mapped only to majors offered by the Chemistry department) **3rd and 4th year courses:** Map to 13 B.Sc. PLOs and to all associated MLOs	These delineations were intended to keep data collection manageable for instructors in 1st and 2nd year courses, therefore increasing instructor buy-in. Many 1st year courses are intended to teach foundational concepts in chemistry, biology, physics, and mathematics and are common to students across 10 or more majors. Therefore, 1st and 2nd year courses were not expected to contribute strongly to major-specific outcomes. We determined that asking instructors to map their courses to so many MLOs would be too labor-intensive and would decrease participation in the mapping project.
What is the balance of standardization vs. tailored data collection and reporting that is feasible for each program?	Focused on a standardized approach, while sharing raw data with program chairs and curriculum committee members so they could create their own custom analysis	Using a standardized approach to data collection and analysis allowed for the timely completion of the mapping project. Providing raw mapping data to the faculty allowed them to perform customized analyses relevant to their major.

To address the second goal, we considered how the project would complement other curricular review initiatives at the University, including quality assurance reviews. It was important that the project would work with departmental curriculum review initiatives and institutional quality assurance processes rather than compete with or duplicate these efforts. To achieve this goal, we reviewed program, institutional, and provincial requirements related to curricular review, to ensure that the data we gathered would provide acceptable information that could be used for multiple purposes. Although we recognize that curriculum maps represent a snapshot in time, and should be revisited relatively frequently, we wanted to ensure that data collected could be used for multiple purposes, so that faculty would not have to map their courses slightly differently to meet requirements that we had overlooked.

Given the considerable effort involved in mapping all 24 majors simultaneously, the final goal of the project was that the resulting curriculum maps would be used to inform curricular changes and not simply put on a shelf. To increase the usefulness of the curriculum mapping information, the project team facilitated curriculum mapping data analysis retreats with representatives from each major. The team also produced workbooks as opposed to reports to guide faculty through the mapping information and encourage them to reflect and act on the information contained in the maps. During this initial planning and decision-making phase, the project team communicated with key stakeholders including the B.Sc. Program Committee, department chairs, curriculum chairs, and Associate Deans Academic of other Colleges that deliver B.Sc. programs. Gathering input, concerns, and suggestions from these key stakeholders at this stage was conducted with the dual purpose of gathering information to enhance the project and increase awareness of the upcoming project.

Survey Design and Pilot

One of the key considerations in designing the large-scale curriculum mapping project was determining how to collect data from course instructors. We decided to create a customized survey using Qualtrics, an institutionally supported survey software. The survey went through several iterations based on feedback from the lead Associate Dean Academic, other members of the Educational Development team, and from six instructors who piloted the survey and provided feedback on question clarity, language, and usability. We revised the survey based on the feedback and tested the survey extensively to remove any “bugs” before it launched.

Pre-Launch Communication

The Associate Dean Academic communicated the value of the project to chairs, faculty, instructors, and fellow Associate Deans to gain support for the project. A kickoff meeting was held for all curriculum committee chairs to discuss the aims of the project in greater depth and address any concerns. The curriculum committee chairs were instrumental in identifying the instructors who could complete the mapping survey for each course and communicating the value of the project at department meetings. A dedicated project website linked from the Associate Dean Academic’s site was developed and included project information, an introductory video about the project, the goals of the project, the survey link, and a list of drop-in mapping sessions.

Phase 2: Data Collection

To launch the project, an email from the Associate Dean Academic was sent directly to all instructors who were being asked to complete a survey. This email provided instructors with an overview of the project and its goals, directed instructors to the mapping project website, linked to the kickoff video, provided the survey link, and indicated the intended data collection dates for that semester. Information regarding drop-in sessions, held in a computer lab with members of the curriculum mapping project team present, was also provided.

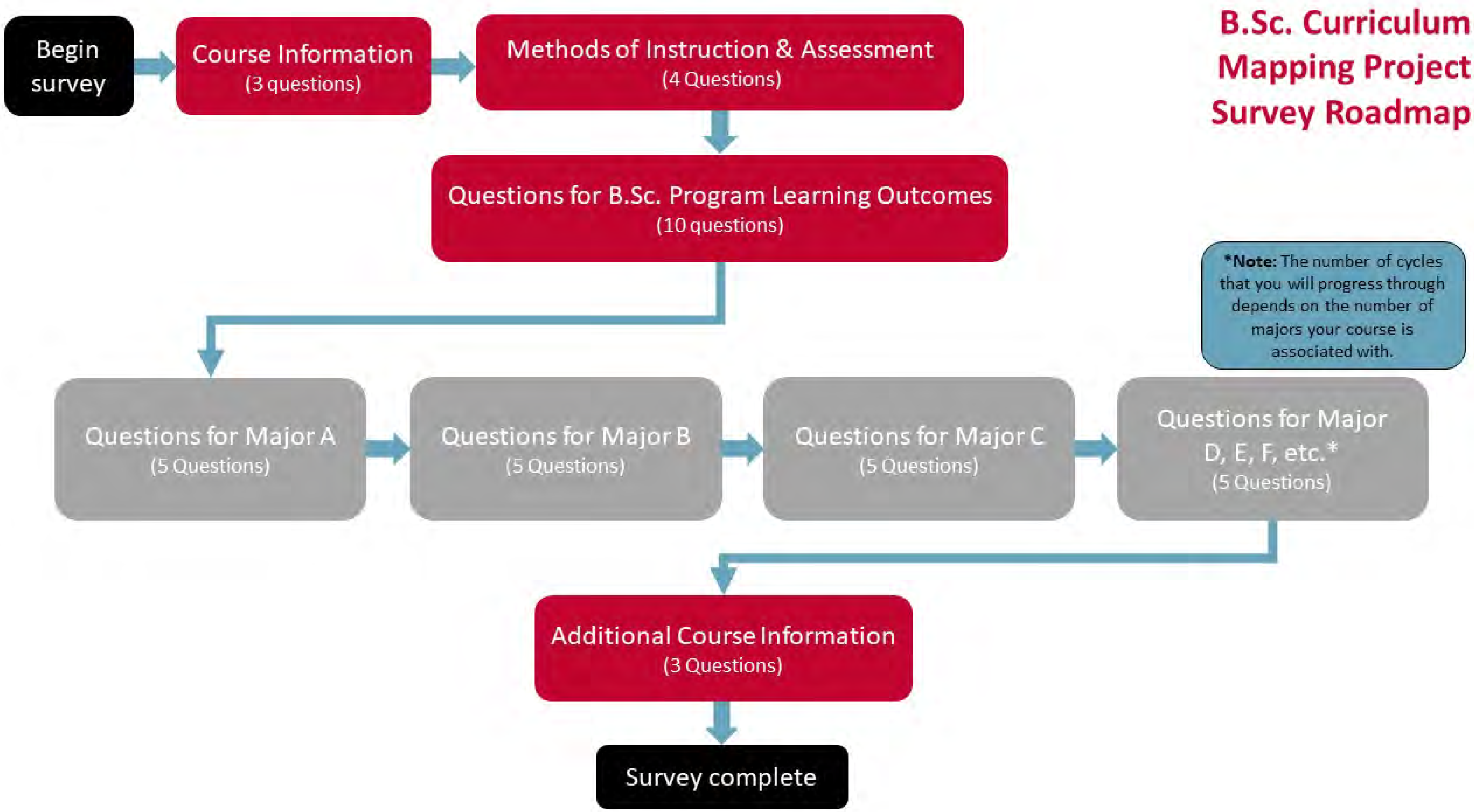
The Curriculum Mapping Survey

Each faculty member or instructor teaching a required or restricted elective course for any of the B.Sc. majors was asked to complete a separate survey for each course that they taught (see Appendix C for the mapping survey). Instructors could access the survey using the link provided in the launch email or via the curriculum mapping website. Survey instructions suggested that it would be beneficial to gather course materials including course outlines and lesson plans before beginning the survey. The instructions also included an explanation of the flow of the survey and a schematic depicting the sections included (see Figure 1).

The curriculum mapping survey was designed to be as streamlined and user-friendly as possible. We used Qualtrics's survey design features to "carry forward" instructors' responses from different parts of the survey, so that the instructor never had to provide the same information twice. For example, instructors indicated which instructional methods they used in the course and which PLOs they taught in the course. The survey then carried forward the selected instructional methods and selected PLOs into a matrix where instructors indicated *how* they taught each PLO by clicking on the corresponding cells to associate the selected instructional strategies used to teach each of the selected PLOs (see Appendix C p. 3, question 11). The same logic was used to gather information about the course's assessment methods. After completing the questions related to the teaching and assessment of PLOs, instructors then cycled through the same questions for the MLOs for any major to which their course mapped. We made use of Qualtrics's survey design features to create unique survey paths for each course. Therefore, instructors were not required to know (or look up) the majors to which their course mapped. Instead, the survey led instructors through the process of mapping all relevant majors and no irrelevant majors.

The base curriculum mapping survey consisted of 22 questions and took an average of 15 to 20 minutes for instructors to complete. The number of questions changed depending on the number of majors associated with the course. Courses required for several majors resulted in a longer mapping survey. Our aim in using the sophisticated survey design tools was to reduce cognitive load for instructors by streamlining the response options that they needed to read for each question. The survey design also allowed us to manage the logistics of mapping a single course to multiple majors. Other curriculum mapping projects suggest using fillable spreadsheets or other less customized methods to collect information about the teaching and assessment of learning outcomes. These methods, while simpler to set up, could lead to instructors spending more time providing information, confusion about what information to provide, and ultimately lower response rates from instructors.

Figure 1
Curriculum Mapping Survey Schematic



Tracking Response Rates and Encouraging Curriculum Mapping Completion

During data collection, the project team used a shared tracking sheet to identify courses for which data were collected. Reminder emails were sent to instructors with uncompleted surveys two weeks prior to the semester deadline with a final reminder sent two days prior to intended deadline. At the deadline, a list of courses without data was sent to department chairs to encourage their instructors to complete the survey. Instructors who did not complete the survey in the Fall semester were contacted again in the Winter semester to encourage them to complete it. Using these strategies, data were collected for 93% (N = 417) of the courses in the project, with the majority of majors having at least a 90% response rate.

Phase 3: Data Analysis and Dissemination

Data analysis occurred over the summer semester immediately following data collection. Data were downloaded from the Qualtrics survey as an Excel file. A master file housed data for all courses mapped to the overall B.Sc. PLOs. Because many courses contribute to multiple majors, components of the data collected for an individual course were split over the variety of majors relevant to that course. Separate files were therefore created to store and analyze data for each major, with survey data for only the required and restricted electives for major's courses mapped to the PLOs and MLOs. The collected data was used to create curriculum maps and other visualizations of the teaching and assessment of the PLOs and MLOs to provide information to program faculty in each of the majors about the sequencing and structure of the curriculum (see Figures 2, 3, and 4 for sample visualizations produced). An undergraduate work-study student joined the project team to support the development of curriculum maps, visualizations, a two-page summary report, and workbooks to be distributed to faculty members. Customized reports and workbooks were created using data for each major. During the data analysis phase, members of the Educational Development team stored all data on secure servers. At the end of the data analysis period, faculty members representing each major received a Curriculum Mapping Workbook, a two-page Curriculum Mapping Summary Report, and a clean version of the raw data. Each product is described in more detail below.

Curriculum Mapping Products Created

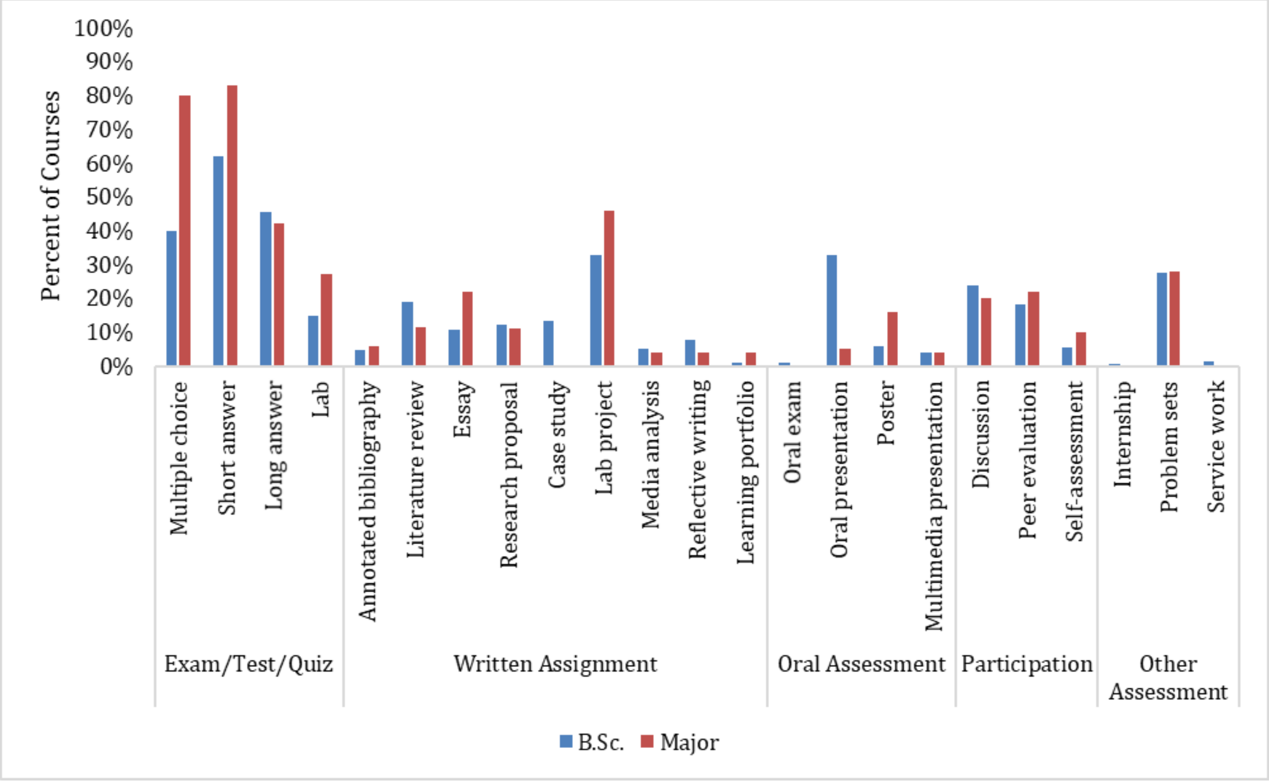
Major-Specific Curriculum Mapping Workbook

One of the goals of the project was to provide curriculum mapping data that was relevant and useful to faculty. Therefore, we developed a workbook that encouraged faculty members to engage with the data. The purpose of the workbook was not to provide an outside evaluation of the results of the curriculum mapping, but to organize the data in a way that would help faculty take action to improve curriculum. Each workbook contained instructions for interpreting the curriculum mapping data, the curriculum maps, and additional visualizations representing the instructional and assessment methods used in the major. Reflection questions were interspersed throughout the report with space for faculty members to record their thoughts. The mapping workbook also included an action item worksheet for faculty to record potential program changes, prioritize recommendations, establish timelines, and connect with the campus resources including the Educational Development team for support in enacting any change. The curriculum mapping workbooks for each major were 45 to 50 pages long. Further description of each of these sections follows.

Information About Methods of Instruction and Assessment. The mapping workbook included information about the proportion of required courses in the major that used each instructional and assessment method compared to the use of these methods across all B.Sc. courses. This presentation allowed faculty to easily see differences in the teaching and assessment in their major compared to science courses overall, allowing for the identification of unique strengths of the program (e.g., more opportunities for lab activities) or areas in need of improvement (see Figure 2 for a sample). Note that all figures that depict data in this paper use sample data for illustrative purposes, and do not represent data from an actual course or major. Use of instructional and assessment techniques was also displayed by program year to allow for comparisons through each year of an undergraduate degree program. Questions for reflection in this section of the workbook included: Is the distribution of instructional (assessment) techniques appropriate for the program? If the distribution of instructional (assessment) techniques is not appropriate, what techniques appear to be over- or under-utilized?

Figure 2

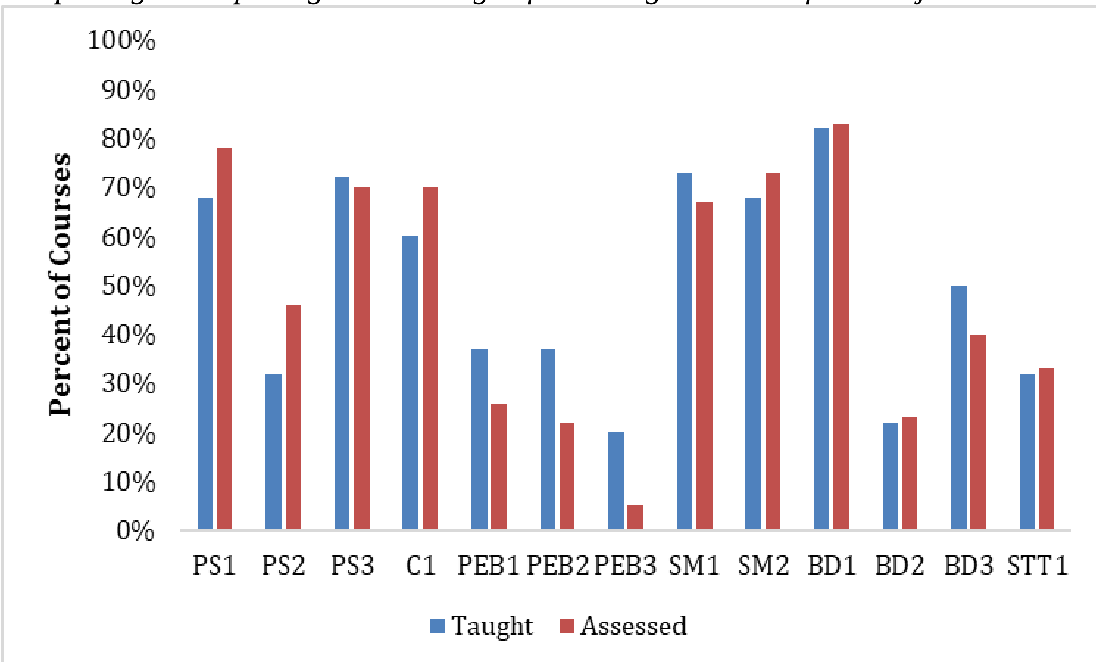
Sample Assessment Methods Visualization



Coverage of Learning Outcomes. Next, the mapping workbook contained a list of the 13 PLOs and the MLOs for the specific major. Then, a bar chart displayed the percentage of required courses in the major that teach or assess each of the MLOs and PLOs (see Figure 3 for an example). This graph was used as a snapshot of the overall coverage of each learning outcome before presenting more detail about this coverage in the curriculum maps. One question for reflection was included in this section: Do any of the outcomes stand out in terms of the coverage (teaching or assessment) of the outcome? If so, which outcome(s) require further investigation?

Figure 3

Sample Figure Depicting the Coverage of Learning Outcomes for a Major



Curriculum Maps. The next set of items in the workbook was the curriculum maps for each PLO and MLO. One curriculum map was created for each outcome, displaying the coverage of the outcome by each course[2] in the major. These curriculum maps showed the coverage of each LO and the progression of the depth of knowledge from 1st to 4th year. The curriculum map consisted of a two-dimensional matrix with each row of the map representing one course. The courses were listed in the first column in the order that appears in the academic calendar (i.e., with 1st year courses in the top rows proceeding through the end of the degree program in the bottom rows). Columns indicating whether the specific learning outcome was taught and assessed, the depth of assessment, and the method of instruction and assessment followed. Cells in the matrix contained information pertaining to the course in the associated row and the particular outcome for the map. Figure 4 displays a sample curriculum map with course codes removed.

[2] Due to the level of detail collected, we only included *required courses* for each major in these maps. Information about restricted electives was included in the overall maps described below.

Figure 4

Sample Curriculum Map for "Problem Solving and Critical Thinking Outcome 1"

	Problem Solving & Critical Thinking				
Course Information	**PS1: Critically evaluate ideas and arguments by gathering and integrating relevant information, assessing its credibility, and synthesizing evidence to formulate a position.**				
Course Code	**Taught**	**Assess**	**Depth**	**Method of Instruction**	**Method of Assessment**
1st year course		A	I		MC exam, SA exam, Poster, Peer evaluation, Problem sets
1st year course	T	A	I	Other instruction	Essay, Poster
1st year course					
1st year course	T	A	M	Lecture, Discussion, IBL	MC exam, SA exam, LA exam
1st year course					
1st year course		A	I		MC exam, Lab project, Poster
1st year course	T	A	I	Lecture, Discussion, Lab activities, Readings, Simulations	Poster
1st year course					
1st year course	T	A	I	Lecture	MC Exam, SA exam
2nd year course	T	A	I	Lecture, Discussion, Multimedia, Readings	Case study
2nd year course	T	A	R	Lecture, Lab activities, iClicker	MC exam, SA exam
2nd year course	T	A	M	Lecture, Discussion, Lab activities, IBL, Readings, Research projects, Self-assessment, Debate	SA exam, LA exam, Lab exam, Lab project
2nd year course	T	A	R	Lecture, Discussion	MC exam, SA exam, Discussion
2nd year course	T	A	I	Lecture, IBL	MC exam, SA exam
3rd year course	T	A	M	Lecture, multimedia, Other instruction	MC exam
3rd year course	T	A	M	Case studies, IBL, Multimedia, Readings	MC exam, Case study, Multimedia, Problem sets
3rd year course	T	A	R	Lecture, iClicker	MC exam, SA exam
3rd year course	T	A	R	IBL, Multimedia, Other instruction	MC exam, SA exam, LA exam
3rd year course	T	A	R	Lecture, Other instruction	MC exam, SA exam
4th year course	T	A	R	Lecture, Discussions, IBL, Readings, Research projects	MC exam, LA exam, Lit review
	T	A	M	Lecture, Discussions, Other instruction	Media analysis, Presentation
4th year course	No data available				
4th year course	T	A	M	Lecture	MC exam, SA exam
4th year course	T	A	R	Lecture	MC exam, SA exam
4th year course	T	A	M	Lecture, Lab activities, Case studies, Guest lectures, Research projects	LA exam, Lit review, Presentation, Discussion
4th year course	T	A	M	Discussions, Guest lectures, Collaboration, Debate	Case study, Presentation, Poster

T	Outcome is taught in the course
I	Outcome is assessed at an Introductory level
R	Outcome is assessed at an Reinforced level
M	Outcome is assessed at a Mastery level

The questions for reflection included in this section of the workbook were: In the teaching of these learning outcomes which outcomes, if any, are covered too much? Which outcomes, if any, are covered too little? Does the sequencing of courses allow all students to progress through the outcomes to the level of mastery? and Do the methods of instruction (assessment) seem appropriate for teaching the learning outcomes?

Overview Curriculum Map. Following the program and major-specific curriculum maps, we included a simple overall curriculum map intended to provide a snapshot of the coverage of learning outcomes across the major. This map was arranged with each row representing a course, with required courses at the top (by year) and restricted elective courses displayed below. Restricted electives were grouped in the lists as they would appear in the course calendar (e.g., certain restricted electives formed areas of concentration within a major). This grouping and labelling allowed for comparisons across theoretically equivalent courses and various areas of concentration. The map included information about whether each outcome was taught and assessed and the depth of assessment. The methods of instruction and assessment were not included in the overall map. See Figure 5 for a simplified sample overview curriculum map with course names removed.

Content Mapping. Faculty also received content maps displaying the coverage and sequencing of specific scientific content within the program. The content maps were organized sequentially by course, with the responses to the content mapping questions provided verbatim. Figure 6 displays a sample content map.

Coverage of High Impact Practices. High impact practices refer to pedagogical techniques that have been shown to increase undergraduate engagement and retention (Kuh, 2008). These practices include 1^{st} year seminars, undergraduate research opportunities and capstone courses or projects. The Curriculum Mapping Report included a table displaying the percentage of required courses within the major that use each of the ten high impact practices, according to instructor responses on the curriculum mapping survey. The table also lists the specific courses that use each high impact practice. The questions for reflection in this section included: Is the progression and distribution of high impact practices appropriate for the program? and What high impact practices would add the most value to the program, and where could they be incorporated?

Major-Specific Summary Report. All instructors who completed a survey or were teaching in any course related to the B.Sc. program received a thank you email from the project team and were directed to the project website where two-page summary reports for each major were posted. The summary reports included similar information as the longer reports, including the overall curriculum map, but did not include the curriculum maps for each outcome. Instructors were encouraged to review the report and follow-up with any questions to the appropriate curriculum committee or members of the project team. This communication also outlined the next steps of the project including curriculum mapping data review sessions being offered for each of the majors included in the mapping project.

Figure 5

Sample Overview Curriculum Map Including Required Courses and Restricted Electives

		Problem Solving and Critical Thinking						Commun-ication	
Course Code		PS1		PS2		PS3		C1	
		T	A	T	A	T	A	T	A
Required Courses									
1st year			I	T	I	T	I		
1st year		T	I	T	I			T	I
1st year						T	I	T	I
2nd year				T	R	T	M	T	R
2nd year		T	I	T	I	T	I	T	I
3rd year				T	R				
3rd year						T	I	T	R
4th year		T	M	T	I	T	M	T	I
Restricted Electives									
or	1st year		I		I	T	I		
	1st year	T	I					T	
or	3rd year		R			T	M		I
	4th year		R		R	T			
or	4th year	T	I		I			T	R
	4th year		R		R	T	R		
or	4th year						R		
	4th year	T	M	T	M				

T	Outcome is taught in the course
I	Outcome is assessed at an Introductory level
R	Outcome is assessed at an Reinforced level
M	Outcome is assessed at a Mastery level

Note: This simplified overview curriculum map displays information about the teaching and assessment of Problem Solving and Critical Thinking and Communication outcomes.

Figure 6
Sample Content Map

	Breadth & Depth of Understanding 2: Demonstrate knowledge of the ethical, economic, commercial and social implications of scientific discovery and technological innovation.
	What required B.Sc. courses teach ethical, commercial, or social issues(s)?
Course Code	**Ethical, commercial, or social issues**
1st year course	Impact of technology on human health
1st year course	Intellectual property, privacy and security of personal information
2nd year course	Risk analysis associated with natural diasters, urban planning, hazard/disaster mitigation, politics
2nd year course	✓
2nd year course	✓
2nd year course	GM technology and environmental impact of agriculture
2nd year course	Ocean biodiversity and fisheries management, Terrestrial biodiversity and agricultural practices
2nd year course	Applications of science within the food industry; social responsibility of the food industry
3rd year course	Understanding recurrence intervals and probality of risks, communicating natural sciences to non-experts
3rd year course	Climate change
3rd year course	Biotechnology, GMOs, transgenic plants and animals, gene therapy
4th year course	Use and misuse of antibiotics, global public health - the need for developed countries and multinational pharmaceutical companies to assist with health infrastructure, vaccine and antimicrobial delivery, monitoring and reporting of antibiotic resistance and disease outbreaks, in developing countries where infectious disease is still the #1 killer, and new and emerging diseases generally originate
4th year course	Commercial issues: on tests, students are often asked to select between several synthesis or characterization methods. To achieve full marks, commercial (cost) issues must be considered.
4th year course	✓
4th year course	✓
4th year course	Use of animals in lab, conservation and social implications for parasitisation

Note: ✓ indicates that the outcome is covered but no additional information was supplied

Clean Version of Raw Data. In addition to receiving the Curriculum Mapping Workbook and the two-page summary report, each program chair and curriculum committee chair received a clean version of the curriculum mapping survey data for the courses and outcomes associated with their major. The Excel file included information about all required and restricted elective courses for the particular major including survey responses for instructional and assessment methods, high impact practices, and the B.Sc. PLOs and the MLOs for that major. The Excel file did not include the formatted curriculum maps or the other visualizations (e.g., graphs of the percentage of courses covering each outcome). The purpose of the raw data file was to allow faculty to conduct additional analyses if desired. Faculty also received an orientation guide to assist them with interpreting the Excel file data. The orientation guide contained a list of data included in the dataset, a description of the layout of the dataset with screenshots, and a legend for coded variables (e.g., in the Level of Assessment Column, 1 = Introduce, 2 = Reinforce, 3 = Master).

Phase 4: Departmental Action

To support faculty in using the curriculum mapping data to inform program improvements, we offered several half-day curriculum mapping retreats during the Fall semester immediately following the distribution of the mapping workbooks. The purpose of the retreats was to allow faculty members time to work through the curriculum mapping report for their major and reflect upon the results in the context of their major. The retreats were jointly hosted by the Office of the Associate Dean Academic and the Educational Development team. Each major was asked to send three to five faculty, staff, or instructors (typically including the Chair and members of the curriculum committee) to represent the major at the retreats. Each retreat hosted representatives from approximately four majors. An Educational Developer was paired with the representatives from each major to support their discussions, record notes, and help to guide them through the process of reflecting on their curriculum mapping data.

During the retreat, the curriculum mapping project team explained the project goals and provided a brief orientation to the curriculum mapping workbook. Next, the representatives from each major reviewed and discussed the data about instructional and assessment methods and high impact practices contained in the workbook. The project team then instructed the representatives to list three strengths, three areas of improvement, and three areas for further investigation based on these data. After this review and reflection process, each team of representatives prioritized next steps or recommendations to bring back to their respective curriculum committees.

The project team then gave a short presentation describing how to interpret a curriculum map and each team of representatives was instructed to review the overall curriculum map for their major and choose three outcomes to investigate in more detail. Teams for majors tended to select outcomes that lacked adequate coverage, or that were particularly important to the major. Next, teams of representatives spent 20 minutes per outcome examining the in-depth curriculum map, discussing the progression of teaching and instruction, identifying any gaps or redundancies, and listing next steps or recommendations. The team was encouraged to use a recommendation worksheet to record and prioritize recommendations and assign action items and timelines. Recommendations generated at the retreat included developing a fourth-year capstone course to teach and assess an outcome and integrating more opportunities for feedback on written work in 1^{st} and 2^{nd} year courses. Each team of representatives was asked to share with the larger group their main recommendations and a plan for how they would communicate this information with the other faculty from their major. Teams were encouraged to set a date with their assigned Educational Developer to follow up on their progress and keep the proposed curricular revisions on track.

Evidence of Mapping Effectiveness

In the four years since the completion of the curriculum mapping project, and the initial retreats, the curriculum mapping project team has seen evidence that the curriculum mapping data was used extensively to inform program review and improvement. The project team draw on the mapping data extensively in our work with the 24-relevant majors. For example, the lead Associate Dean and Curriculum Manager led a College-wide retreat for all Biological Science majors. The retreat, which drew 26 faculty and staff, representing 14 majors, increased awareness of the mapping data and provided another opportunity for faculty and staff to engage with the information to make curricular decisions based on evidence. After the College-wide retreat, several majors began working with Educational Developers to address recommendations directly stemming from the curriculum mapping results.

A specific curriculum improvement initiative that arose directly from the curriculum mapping results relates to the coverage of the Professional and Ethical Behaviour PLO. Faculty and staff observed a gap in teaching and formal assessment of this PLO compared to what was intended. The information from the curriculum mapping data, as well as information gathered from alumni and current students, led to the creation of a professional planning and development strategy, which includes professional conduct and integrity modules for 1st year students. The curriculum mapping data continue to be used to inform curricular improvements across the University, demonstrating the usefulness of this method of large-scale curriculum mapping.

Summary and Recommendations

According to Hubball and Gold (2007), the scholarship of curriculum practice involves public sharing of ongoing learning about curricula. The intention with this paper is to add to the growing literature on how to engage in curriculum mapping processes, by describing how we mapped over 400 courses and 24 majors associated with the B.Sc. degree. Key aspects of our mapping initiative included the use of a customized Qualtrics survey to collect mapping data, the creation of curriculum mapping workbooks for each major, and facilitated retreats designed to help faculty use the results to reflect upon the curriculum. By sharing our challenges and successes, we hope to encourage other faculty, program administrators, and educational developers to critically engage with our process and adapt it for their own contexts.

Our sustained, coordinated effort to map the B.Sc. majors at once saved faculty and staff from duplicating efforts to map their courses several times. The mapping project also focused attention on the curriculum across three Colleges at the institution. The mapping project 'made the curriculum visible' (Wijngaards-de Meij & Merx, 2018) and encouraged instructors to reflect on their courses and the curriculum to identify strengths and areas in need of improvement. The mapping retreats and subsequent curriculum review and redevelopment work that arose out of the mapping initiative drew in faculty and instructors who would not typically be closely involved in reviewing the curriculum. By sharing a summary of the mapping results with all instructors who taught a B.Sc. course, we helped instructors see how their course fits into the curriculum. We also worked to encourage reflection on the curriculum mapping results by creating a workbook with questions for reflection and hosting retreats to guide instructors through the reflection process. A key assumption of a learner-centred curriculum design is that faculty and administrators will actively contribute to curriculum review and improvement (Hubball & Gold, 2007). Our efforts to include all instructors in the mapping process (from data collection, dissemination of results, and planning of curricular improvements) ensured that mapping would not become a box to check by a small group of volunteers or recruits. Because we shared information about the mapping process on our website, we also received several requests from other departments at our institution and at other universities for advice and recommendations about the mapping process. Therefore, similar to Uchiyama and Radin's (2009) findings, our project led to collaboration and conversations within and across departments.

When engaging in a large-scale mapping project, many standard curriculum mapping recommendations apply, including the need to gain faculty buy-in and create shared understanding of the terminology used in the mapping process. However, large-scale curriculum mapping projects also require other considerations in the planning, data collection, and analysis and dissemination phases so that the data can be used to inform curricular change. We were able to draw on many recommendations in the literature, but we also found that we needed to create a tailored process to suit our needs. For example, our customized survey was programmed so that instructors would map their course to all relevant majors. This method of collecting mapping data did not rely on instructors' knowledge of their course's role in several curricula and also served to inform instructors of the majors and LOs to which their course mapped.

The large-scale curriculum mapping project described here resulted in a rich data set representing the teaching and assessment of learning outcomes for 24 majors. It is important to note, however, that curriculum maps generated by faculty and instructors represent one view of the curriculum and should be used in combination with other information about student learning. Gathering information about the curriculum from the students' perspective captures the received or learned curriculum (Kopera-Frye et al., 2008), and can provide valuable insight about discrepancies in how students experience the curriculum compared to faculty (see for example, Labouta et al., 2019). Collecting student artifacts would help answer questions about whether students are able to demonstrate the learning outcomes, another important question that our project did not address (Hubball & Gold, 2007). Our next steps include engaging with students to gain their perspective on curriculum mapping data and extending our mapping efforts to other degrees.

Based on our experience in mapping the B.Sc. majors, we recommend undertaking large-scale curriculum mapping projects. Although these types of projects require a sustained effort from an interdisciplinary team, they also provide the opportunity to gather valuable data to inform evidence-based curricular improvements. Careful planning of the mapping process, from the design of the data collection instrument, to helping faculty reflect and act on the results, is required to ensure that the effort leads to evidence-informed curricular improvements. Each program, major, degree, or diploma is different, and program administrators will need to think carefully about the best process to engage in curriculum mapping. We hope that the process described in this paper will provide a blueprint for mapping multiple related programs simultaneously.

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Appendix A
Bachelor of Science Program Learning Outcomes

Type of Outcome	Learning Outcome Category	Learning Outcome
General Skills	Problem Solving & Critical Thinking (PS)	Critically evaluate ideas and arguments by gathering and integrating relevant information, assessing its credibility, and synthesizing evidence to formulate a position.
		Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise.
		Accurately interpret and use numerical information to evaluate and formulate a position.
	Communication (C)	Accurately and effectively communicate ideas, arguments and analyses, to a range of audiences, in graphic, oral and written form.
	Professional & Ethical Behaviour (PEB)	Demonstrate personal and professional integrity by respectfully considering diverse points of view and the intellectual contribution of others, and by demonstrating a commitment to honesty and equit y, and awareness of sustainability, in scientific practice and society at large.
		Collaborate effectively as part of a team by demonstrating mutual respect, leadership, and an ability to set goals and manage tasks and timelines.
		Plan for professional growth and personal development within and beyond the undergraduate program.
Degree-Related Knowledge and Skills	Scientific Method (SM)	Apply scientific methods and processes by formulating questions, designing investigations and synthesizing data to draw conclusions and make scientifically-based decisions.
		Generate and interpret scientific data using quantitative, qualitative and analytical methodologies and techniques.
	Breadth & Depth of Understanding in a Particular Scientific Discipline (BD)	Apply the core concepts of mathematics, physics, chemistry and biology to a chosen scientific discipline.
		Demonstrate knowledge of the ethical, economic, commercial and social implications of scientific discovery and technological innovation.
		Interpret current scientific concepts and gaps in knowledge (and methods) in light of the historical development of a chosen discipline.
	Scientific Technology & Techniques (STT)	Apply contemporary research methods, skills and techniques to conduct independent inquiry in a chosen scientific discipline.

Appendix B
Undergraduate Degree Learning Outcomes

Learning Outcome	Sub-Outcomes	Description
Critical and Creative Thinking	Inquiry and Analysis; Problem Solving; Creativity; Depth and Breadth of Understanding	Critical and creative thinking is a concept in which one applies logical principles, after much inquiry and analysis, to solve problems in with a high degree of innovation, divergent thinking and risk taking. Those mastering this outcome show evidence of integrating knowledge and applying this knowledge across disciplinary boundaries. Depth and breadth of understanding of disciplines is essential to this outcome.
Literacy	Information Literacy; Quantitative Literacy; Technological Literacy; Visual Literacy	Literacy is the ability to extract information from a variety of resources, assess the quality and validity of the material, and use it to discover new knowledge. The comfort in using quantitative literacy also exists in this definition, as does using technology effectively and developing visual literacy.
Global Understanding	Global Understanding; Sense of Historical Development; Civic Knowledge and Engagement; Intercultural Competence	Global understanding encompasses the knowledge of cultural similarities and differences, the context (historical, geographical, political and environmental) from which these arise, and how they are manifest in modern society. Global understanding is exercised as civic engagement, intercultural competence and the ability to understand an academic discipline outside of the domestic context.
Communicating	Oral Communication; Written Communication; Reading Comprehension; Integrative Communication	Communicating is the ability to interact effectively with a variety of individuals and groups, and convey information successfully in a variety of formats including oral and written communication. Communicating also comprises attentiveness and listening, as well as reading comprehension. It includes the ability to communicate and synthesize information, arguments, and analyses accurately and reliably.
Professional and Ethical Behaviour	Teamwork; Ethical Reasoning; Leadership; Personal Organization and Time Management	Professional and ethical behaviour requires the ability to accomplish the tasks at hand with proficient skills in teamwork and leadership, while remembering ethical reasoning behind all decisions. The ability for organizational and time management skills is essential in bringing together all aspects of managing self and others. Academic integrity is central to mastery in this outcome.

Appendix C

BSc Curriculum Mapping Survey Questions

Note that all text in italics was not included in the curriculum mapping survey. Italicized text is included to clarify the survey design.

Course-Specific Questions

1. Please indicate the course for which you are completing this survey.
(Drop-down menu listing all required and elective BSc courses)

2. Please indicate who is filling out this survey by entering the name(s) of the respondent(s).
(Textbox)

3. Please select the option from the list below that best describes your role for this course:
(*Single select for each respondent listed in Question 2)*
   - Instructor/Lecturer
   - Course coordinator
   - Lab instructor
   - Other

4. What methods of **instruction** do you use in this course?
(Multi-select with text boxes for 'Other' responses)
   - ☐ Lecture
   - ☐ Discussions/exercises/activities (e.g., think-pair-share, classroom discussions, etc.)
   - ☐ Laboratory Activities
   - ☐ Case studies
   - ☐ Community engaged research
   - ☐ E-portfolios
   - ☐ Field observation or field trips
   - ☐ Guest lectures
   - ☐ iClicker questions/responses
   - ☐ Inquiry-based learning/problem-based learning (i.e., structured processes where students learn through identifying complex questions or solving problems)
   - ☐ International experience (e.g., first hand travel, online correspondence)
   - ☐ Internship/practicum/work opportunity
   - ☐ Multimedia presentations (e.g., video, film, YouTube)
   - ☐ Peer collaboration, peer feedback or peer review
   - ☐ Assigned readings
   - ☐ Reflective writing/journaling
   - ☐ Research projects (e.g., proposals, literature reviews, data collection, data analysis)
   - ☐ Self-assessment (i.e., student compares own progress toward intended learning goal)
   - ☐ Student debate
   - ☐ Simulations (e.g., computer simulations, role play, etc.)

- ☐ Workshop sessions (e.g., writing, peer-review, time management sessions)
- ☐ Other

5. What methods of **assessment** do you use in this course?

(Multi-select with text boxes for 'Other' responses)

- ☐ Exam, test or quiz - Multiple choice questions
- ☐ Exam, test or quiz – Closed-ended or short answer questions
- ☐ Exam, test or quiz – Open-ended or long answer questions
- ☐ Laboratory exam, test or quiz - involving a hands-on component
- ☐ Written assignment - Annotated bibliography
- ☐ Written assignment - Literature review
- ☐ Written assignment - Essay
- ☐ Written assignment - Research proposal
- ☐ Written assignment - Case study analysis
- ☐ Written assignment - Laboratory project/report
- ☐ Written assignment - Media analysis
- ☐ Written assignment - Reflective writing/journaling
- ☐ Learning Portfolio (e.g., ePortfolio, LinkedIn account)
- ☐ Oral exam
- ☐ Oral presentation (not including poster)
- ☐ Poster presentation
- ☐ Multimedia presentation (e.g. creating a video, podcast, etc.)
- ☐ Participation / Engagement - Discussion
- ☐ Participation / Engagement - Peer evaluation
- ☐ Participation / Engagement - Self-assessment
- ☐ Internship / practicum / work opportunity
- ☐ Problem sets / problem solving assignments
- ☐ Service work / community engagement
- ☐ Other

BSc Program Learning Outcomes Questions

The following questions explore how the core **BSc Program level learning outcomes** are covered within this course.

6. Which of the following learning outcomes are **taught (**e.g., are presented, discussed, or involved in course activities) in this course? Check all that apply.

(Multi-select)

- ☐ PLO 1
- ☐ PLO 2
- ☐ PLO …
- ☐ PLO *N*

Content Mapping Questions
(Displayed only if respondents indicated that they teach 4 specific BSc PLOs in Q6)

7. What specific **qualitative or quantitative analytic method(s) or technique(s)** does this course cover?

(Textbox)

8. Please specify the **core scientific concept(s)** covered within each of these disciplines:
(*Multi-select and textbox to list specific scientific concepts*)

- ☐ Math
- ☐ Physics
- ☐ Chemistry
- ☐ Biology

9. What specific **ethical, commercial, or social issue(s)** does this course cover?

(Textbox)

10. What specific **research methods, skills, and techniques** does this course cover?

(Textbox)

11. Please specify **how** each learning outcome is **taught** in this course.

(Multi-select matrix table that carries forward the selected PLOs from Q6 and selected methods of instruction from Q4)

	Selected Method of Instruction 1	Selected Method of Instruction 2	Selected Method of Instruction 3	Selected Method of Instruction *N*
Selected PLO 1	☐	☐	☐	☐
Selected PLO 2	☐	☐	☐	☐
Selected PLO …	☐	☐	☐	☐
Selected PLO *N*	☐	☐	☐	☐

12. Which of the following learning outcomes are **assessed** (i.e., learning is evaluated with marks assigned towards the final grade) in this course?

(Multi-select)

- ☐ PLO 1
- ☐ PLO 2
- ☐ PLO …
- ☐ PLO *N*

13. Please specify **how** each learning outcome is **assessed** in this course (more than one option may be selected).

(Multi-select matrix table that carries forward the selected PLOs from Q12 and selected assessment methods from Q5)

	Selected Assessment Method 1	Selected Assessment Method 2	Selected Assessment Method 3	Selected Assessment Method *N*
Selected PLO 1	☐	☐	☐	☐
Selected PLO 2	☐	☐	☐	☐
Selected PLO …	☐	☐	☐	☐
Selected PLO *N*	☐	☐	☐	☐

14. Please indicate the depth of knowledge to which students are **assessed** for each of the learning outcomes.

(Matrix table that carries forward the selected PLOs from Q12; Single select per row)

	Introduce	Reinforce	Master
Selected PLO 1	o	o	o
Selected PLO 2	o	o	o
Selected PLO …	o	o	o
Selected PLO *N*	o	o	o

<u>Major X Learning Outcomes</u>

The following questions explore how the additional **<u>Major X Learning Outcomes</u>** are covered within this course.

15. Which of the following learning outcomes are **taught** in this course?

(Multi-select)

- ☐ MLO 1
- ☐ MLO 2
- ☐ MLO …
- ☐ MLO *N*

16. Please specify **how** each learning outcome is **taught** in this course.

(Multi-select matrix table that carries forward the selected MLOs from Q15 and selected methods of instruction from Q4)

	Selected Method of Instruction 1	Selected Method of Instruction 2	Selected Method of Instruction 3	Selected Method of Instruction *N*
Selected MLO 1	☐	☐	☐	☐
Selected MLO 2	☐	☐	☐	☐
Selected MLO …	☐	☐	☐	☐
Selected MLO *N*	☐	☐	☐	☐

17. Which of the following major learning outcomes are **assessed** in this course?
(Multi-select)
    - ☐ MLO 1
    - ☐ MLO 2
    - ☐ MLO …
    - ☐ MLO *N*

18. Please specify **how** each learning outcome is **assessed** in this course (more than one option may be selected).

(Multi-select matrix table that carries forward the selected MLOs from Q16 and selected methods of assessment from Q5)

	Selected Assessment Method 1	Selected Assessment Method 2	Selected Assessment Method 3	Selected Assessment Method *N*
Selected MLO 1	☐	☐	☐	☐
Selected MLO 2	☐	☐	☐	☐
Selected MLO …	☐	☐	☐	☐
Selected MLO *N*	☐	☐	☐	☐

19. Please indicate the depth of knowledge to which students are assessed for each of the learning outcomes.]
(Matrix table that carries forward the selected MLOs from Q17; Single select per row)

	Introduce	Reinforce	Master
Selected MLO 1	o	o	o
Selected MLO 2	o	o	o
Selected MLO …	o	o	o
Selected MLO *N*	o	o	o

<u>Major Y Learning Outcomes</u>

Following Q19, respondents completed Q15 to Q19 again for each major to which their course mapped, until the mapping process has been completed for all relevant majors for that course.

Additional Questions

20. The following is a list of high impact practices that have been shown to improve student retention and engagement. Please select any of the following that are integrated into this course.

(Multi-select)

- ☐ First-year seminars
- ☐ Common intellectual experiences (i.e., core courses for students from the same major/program)
- ☐ Learning communities (i.e., cohort-based experiences, or interdisciplinary/multi-course interactions)
- ☐ Writing-intensive courses
- ☐ Collaborative assignments and projects
- ☐ Undergraduate research opportunities
- ☐ Diversity-oriented learning or globally-focused learning (e.g., learners interact with diverse groups, are intentionally exposed to diverse perspectives, research/act on issues of global significance, participate in experiential learning in the community and/or study abroad)
- ☐ Service learning and community-based learning
- ☐ Internships/co-op/practicum placements
- ☐ Capstone courses/projects (i.e., learning experiences that allow students to integrate knowledge from courses throughout their program)

21. Please describe any innovative instructional and assessment strategies that you currently use in your course and would like to share as part of this curriculum mapping process.

(*Textbox)*

22. Please provide any further comments regarding this curriculum review process.

(Textbox)