Curriculum Mapping Across the Disciplines: Differences, Approaches, and Strategies

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Curriculum mapping can be used to document, align, visualize, and assess curricular data, such as learning outcomes, assessment materials, instructional techniques, and student pre- and post-testing scores. A cross-disciplinary Curriculum Mapping Initiative currently underway at the University of Toronto Mississauga aims to: (1) develop guidelines for the curriculum mapping process; (2) develop cross-disciplinary curriculum mapping templates and samples to guide departments through the curriculum mapping process; (3) communicate narratives for how to use curriculum mapping to inform curricular change; (4) develop visualization strategies for curricular data; (5) initiate a plan for dissemination and sustainability; and (6) initiate a plan for informing students about how to use curricular maps in their academic experiences. Through this curriculum mapping initiative, we have discovered that discipline-specific differences exist in approaches to curriculum mapping. The purpose of this paper is to communicate these cross-disciplinary similarities and differences in purpose, process, and utilization of curriculum mapping strategies. We found that different departments had some common ground in the curriculum mapping process, but also key differences. The differences could be categorized according to: purpose for initiating the curriculum mapping process; approach to curriculum mapping; dissemination of completed maps; dealing with pedagogical jargon; and faculty buy-in.

Curriculum mapping is an active process for aligning student learning outcomes and curriculum activities (Kopera-Frye, Mahaffy, & Svare, 2008). Much has been written in the literature regarding the curriculum mapping process, especially in the medical and engineering disciplines (French, Shah, Rankin, Bagiati, & Breslow, 2012; Komenda et al., 2015). Curriculum mapping is often undertaken to assist with accreditation procedures (DeLuca & Bellara, 2013; Kelley, McAuley, Wallace, & Frank, 2008; Perlin, 2011), or for formalized curricular review and improvement (Veltri, Webb, Matveev, & Zapatero, 2011). Curriculum mapping can be used to map learning outcomes throughout a single course or across programs, to map course progression, to track both the teaching and assessment of student learning outcomes, or as part of the curricular alignment process (Lam & Tsui, 2013). Curriculum mapping can also be used to identify gaps (Lam & Tsui, 2013), and can lead to increased transparency (Harden, 2001).

The Curriculum Mapping Initiative at the University of Toronto Mississauga

A cross-disciplinary curriculum mapping initiative at the University of Toronto Mississauga is focused on: (1) developing guidelines for the curriculum mapping process; (2) developing cross-disciplinary curriculum mapping templates and samples that can guide other departments through the curriculum mapping process; (3) communicating strategies for how to use curriculum mapping to inform curricular change; (4) developing curricular visualizations; (5) initiating a plan for dissemination and sustainability, with a focus on continuing the curriculum mapping process at the University of Toronto Mississauga, and (6) initiating a plan for informing students about curricular maps, and how they can use the maps throughout their academic experiences. Participating departments (initially Biology, Geography, Sociology, Historical Studies, Language Studies, and Institute of Communication, Culture, Information and Technology) were specifically chosen to represent a cross-disciplinary diversity, as well as a wide range in terms of how much progress had already been made in the curriculum mapping process at the developmental level.

Curriculum Mapping in the Literature

In order to see what different disciplines had previously reported regarding curriculum mapping, we did a thorough literature review. Prior to initiating our literature search, the search strategy and search string were approved by an independent liaison librarian. The search string "curriculum map*" was searched in September 2016 in the following databases: ProQuest Education Journals (limit to scholarly journals), Scopus, ERIC, CBCA Education, PsycINFO, and Web of Science. Removal of duplicates resulted in 597 unique results.

Figure 1

Percentage of Scholarly Publications devoted to curriculum mapping in higher education, sorted by discipline.[1]

[1] The search string "curriculum map*" was searched in ProQuest Education Journals (limit to scholarly journals), Scopus, ERIC, CBCA Education, PsycINFO, and Web of S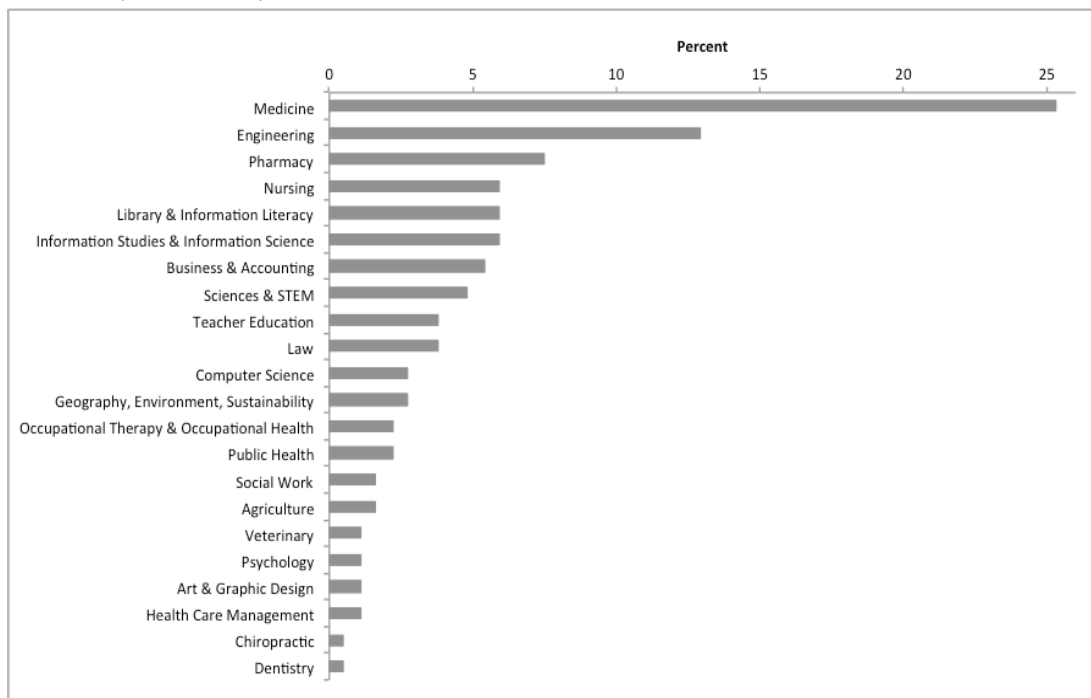cience. Removal of duplicates resulted in 597 unique results, and subsequent removal of articles not in the higher education context resulted in 185 discipline-specific references.

Table 1

Curriculum mapping in higher education: publications by discipline in the literature (*n* = 185).

Discipline	Total No.	%	Sample Reference(s)
Medicine	47	25.3	(Balzer et al., 2016; Cottrell, Linger, & Shumway, 2004; Ellaway, Albright, Smothers, Cameron, & Willett, 2014; Harden, 2001; May, 2012; Wardle et al., 2011; Willett, 2008; Wong & Roberts, 2007)
Engineering	24	12.9	(Ahmad, 2015; Cloutier, Hugo, & Sellens, 2012; French et al., 2012; Joenathan, Bunch, & Granieri, 2005; Liu, Chen, Yueh, & Sheen, 2014; Ranade et al., 2011; Saad, 2014)
Pharmacy	14	7.5	(Britton, Letassy, Medina, & Er, 2008; Keijsers et al., 2015; Kelley et al., 2008; Malone, Short, Naidu, White, & Kirkpatrick, 2015; Plaza, Draugalis, Slack, Skrepnek, & Sauer, 2007; Zelenitsky et al., 2014)
Nursing	11	5.9	(Landry et al., 2011; Miller & Neyer, 2016; Narayanasamy, Jurgens, Narayanasamy, & Guo, 2013)
Library & Information Literacy	11	5.9	(Archambault & Masunaga, 2015; Buchanan, Webb, Houk, & Tingelstad, 2015; Charles, 2015; Fournier, 2014)
Information Studies & Information Science	11	5.9	(Karsten & Roth, 2015; McGrath, 2010; Pratt, Keys, & Wirkus, 2014; Veltri et al., 2011)
Business & Accounting	10	5.4	(Wang & Ashcraft, 2012)
Sciences & STEM	9	4.8	(Johnson, Peters-Burton, & Moore, 2015; Regier, 2015; Reid & Wilkes, 2016)
Teacher Education	7	3.8	(Baecher, 2012; Rowley & Dunbar-Hall, 2012; Lam & Tsui, 2013)
Law	7	3.8	(Curtis & Moss, 2010)
Computer Science	5	2.7	(Gluga, 2010; Harris & Patten, 2015)
Geography, Environment, Sustainability	5	2.7	(Spronken-Smith et al., 2016)
Occupational Therapy & Occupational Health	4	2.2	(MacNeil & Hand, 2014; Hege, Nowak, Kolb, Fischer, & Radon, 2010; Merritt, Blake, McIntyre, & Packer, 2012)
Public Health	4	2.2	(Britten, Wallar, McEwen, & Papadopoulos, 2014; Figueroa, Birch, King, & Cottrell, 2015)
Social Work	3	1.6	(Mackie & Anderson, 2011; Watts & Hodgson, 2015; Williams & Bolland, 2011)
Agriculture	3	1.6	(Acuña, Kelder, Lane, Hannan, & Jones, 2013)
Veterinary	2	1.1	(Bell, Ellaway, & Rhind, 2009)
Psychology	2	1.1	(Stanny, 2015)
Art & Graphic Design	2	1.1	(Lamb, 2016)
Health Care Management	2	1.1	(Valerius & Hersh, 2008)
Chiropractic	1	0.5	(Gorrell, Beirman, & Vemulpad, 2015)
Dentistry	1	0.5	(Mazurat & Schönwetter, 2008)

We manually reviewed all articles and set a restriction to articles dealing with the higher education context, resulting in 185 discipline-specific references for curriculum mapping in higher education. We then categorized these references by discipline, as seen in Figure 1 and Table 1. Medicine and engineering were the dominant disciplines with 25.3% and 12.9% of references respectively. The top six disciplines, based on published references from our literature search, were: Medicine, Engineering, Pharmacy, Nursing, Library & Information Literacy, and Information Studies & Information Science.

The search results showed more publications dealing with professional schools and the sciences, and fewer publications dealing with humanities. Several subjects and disciplines were not found in the literature search, such as language studies and history.

We recognize that this literature search represents only a snapshot, and subsequent web searches showed active curriculum maps in subjects and disciplines not listed in Table 1. We also recognize that much curriculum mapping work is not published in the scholarly literature.

Similarities and Differences in Curriculum Mapping: Approaches between Disciplines

The departments from the University of Toronto Mississauga that are involved in the curriculum mapping initiative represent disciplines from Science, Social Science, and Humanities, as well as interdisciplinary programs. The departments that provided input to this article include Biology, Geography, Language Studies, and the Institute of Communication, Culture, Information and Technology (ICCIT). Throughout this curriculum mapping initiative, we noticed some discipline-specific similarities and differences in the approaches to curriculum mapping. We noted that the similarities and differences could be classified according to several different themes: (1) the purpose and motivation for engaging in curriculum mapping; (2) the process of curriculum mapping; (3) the

implementation and use of the curriculum maps; (4) terminology & jargon; (5) faculty buy-in and support; and (6) curriculum map visualization and dissemination. We have summarized our key findings in Table 2.

Purpose and Motivation for Engaging in Curriculum Mapping

As the University of Toronto Mississauga recently adopted the Undergraduate Degree Level Expectations (UDLEs) as established by the Ontario Council of Academic Vice-Presidents, departments have been encouraged to describe how they meet these learning expectations, encouraging some departments to initiate curriculum mapping projects. All departments described here have shown an interest in clearly conveying this curricular information and an interest in identifying gaps. It also became clear that different disciplines sometimes had different motivations for participating in the curriculum mapping process. For example, the Department of Geography's initial motivation was to respond to the requirements of a national-level program accreditation process. Subsequently, motivation included a need to analyze course progression to identify competency gaps, and also to link outcomes with assessment.

For the Department of Biology, for which there is no national-level accreditation, the motivation for initiating the curriculum mapping process was driven by the desire of the faculty to track the development of student science process skills and other transferable skills. Biology also wanted to initiate discussion of threshold concepts: core, foundational, and gateway concepts that need to be understood to allow and support further learning in the discipline, akin to a portal (Meyer & Land, 2005), and can open up novel ways of approaching a subject or thinking about a problem. Biology was also particularly interested in aligning learning outcomes with assessment to gain an understanding of the development of transferable skills and collecting data that would enable evidence-based decision making during curriculum committee meetings.

Table 2

Highlights of common ground as well as differences found between departments that participated in the curriculum mapping process.

Category	Common Ground	Differences
Purpose and motivation for engaging in curriculum mapping	• to analyze course progression • to identify competency gaps • to link outcomes with assessment • to track the development of transferable skills • to examine how courses fit together to create a coherent curriculum • to align learning outcome progression with Undergraduate Degree Learning Expectations	Geography/Environment: to respond to national accreditation process Biology: facilitate increased use of backwards design; foster a reflective learning community Language Studies: align learning outcomes with the Common European Framework of Reference for Languages
Curriculum Mapping Process	• use faculty interviews in addition to course syllabi • track if learning outcomes are taught vs assessed, and at which level (introduced, reinforced, advanced)	Biology: start with a faculty survey to create a "data wishlist"; established a Biology Skill Set and a set of knowledge frameworks that would be mapped in addition to the departmental learning outcomes Language Studies: looked at assessments in addition to course syllabi
Implementation / Use of the Curriculum Map	• help faculty see how their courses fit within the large program scheme • use the map for future course planning	Biology: use the map to guide evidence-based decision making during curriculum committee meetings; guide the use of backwards design in course design and renewal ICCIT: use the map to guide faculty hire decisions Language Studies: use the map to re-write all courses' syllabi to align learning outcomes
Terminology / Jargon	• pedagogical jargon tends to be a barrier across disciplines	Biology: developed a pedagogical dictionary that contained biology-specific examples.
Faculty Buy-In and Support	• increase faculty buy-in by showcasing curriculum maps used by other departments	Biology: surveyed all faculty at the initiation of the curriculum mapping process ICCIT: high number of sessionals made faculty buy-in challenging
Curriculum Map Visualization and Dissemination	• most departments use excel to organize their curricular data	

Additionally, several faculty members wanted to use the curriculum mapping process to foster a reflective learning community and initiate a dialogue between faculty of different courses, and faculty with a research vs teaching focus. This has been previously reported in the literature in teacher education (Bartoo, 2005).

Much like Biology, ICCIT needed to examine how the variety of courses fit together to create a coherent curriculum. The challenge with an interdisciplinary unit is to make the overall curriculum seem logical and coherent, thus it was important to see how the courses are connected. This had implications for the range of assessment tools and strategies used across four different programs and the integration of faculty research. The curriculum mapping exercise partly informed the direction for posting for new hires and helped to guide students trying to navigate their way through the multitude of course options and create a cohesive course of study. As with Biology, ICCIT wanted to focus on transferable skills development, link the curriculum map learning outcomes with assessment, align learning outcomes throughout the program, and identify gaps, inconsistencies, and areas for improvement.

In Language Studies, a core set of learning outcomes for both French for francophone courses and French as a second language courses were developed in order to ensure coherent progression between levels and more cohesively scaffolded assessment methods. Based on the Common European Framework of Reference for Languages (Council of Europe, 2002), Canadian Language Benchmarks (The Centre for Canadian Language Benchmarks, 2006), as well as the UDLEs (University of Toronto Mississauga, 2016), a steering committee identified and described more program-specific areas of competencies and "can do" statements for each level of the series - e.g., at the end of this course, *you can* "interact with other French speakers on topics related to your daily routines". This work aimed to harmonize FSL series learning outcomes, level of language skills and competencies, and assessment methods. While many reasons are similar to those mentioned in Biology and ICCIT, Language Studies had several additional reasons for engaging in the

curriculum mapping process: (1) We wanted to make sure that our FSL series courses achieve similar level of competencies that other Canadian and International frameworks propose; (2) We wanted to guarantee that our students be able to compete in a real world; (3) We wanted to make sure repetitions, inherent to and necessary for language acquisition, are integrated in a cohesively progressive manner so that students do not just repeat the same materials from one level to the next one; (4) We wanted to evaluate logical progression in assessments that correspond accurately with materials taught in classes; (5) We wanted to collectively adopt more communicative and action-based pedagogical approaches; (6) We wanted to propose common grade distribution in all courses; and (7) We wanted to identify areas of improvement.

Curriculum Mapping Process

To initiate the curriculum mapping process, Biology surveyed faculty about what questions they had about the biology curriculum and how they would use the final curriculum map. As a faculty, Biology developed the "Biology Skill Set" that all students should be capable of upon graduation. This skill set as well as twelve departmental learning outcomes were mapped onto the curriculum of all courses. After discussing the results with faculty, questions were asked about knowledge content. Biology then developed six knowledge frameworks that were then mapped across all courses (Evolution, Genetics, Molecular Biology and Biotechnology, Animal Form and Function, Plant Form and Function, and Ecology). This resulted in three different curriculum maps that could be superimposed: a knowledge framework map, a skill set map, and a learning outcome map. Data for the maps was acquired through a review of course syllabi and interviews with course instructors. For each map element, instructors had to identify if it was taught and/or assessed, and at which level (introduced/reinforced/advanced) (as was done by Arafeh, 2016).

The ICCIT curriculum mapping project prompted a whole collection of activities. The first was to establish clear program outcomes and analyze

how those outcomes distinguished one program from another; for example, how the learning outcomes for a communication, culture, and media course define a separate set of skills from a professional writing and communication course. This exercise highlighted the skills that were essential for all programs and then points of distinction. The exercise also highlighted the various career paths that students could take through the different streams of courses - an important factor for this particular interdisciplinary institute. The next step was to develop templates that corresponded to the learning outcomes and gather information. An additional goal of the mapping process was to create a coloured visualization that would highlight overlaps, gaps, and inconsistencies.

For Language Studies, it was decided that a curriculum committee would be formed to work on curriculum harmonization during summer months. The committee researched frameworks that could be used as theoretical underpinnings (e.g., CEFRL, Canadian Language Benchmarks, UDLEs). Collectively, the committee discussed several language teaching approaches and determined the most suitable ones for the particular needs of University of Toronto Mississauga students. Afterward, it collected and studied course syllabi and sample assessments at all year levels. Learning outcomes were categorized by competencies and reformulated in greater detail, and each course's learning outcomes were linked to implement a logical progression from level to level. The committee also decided on a grade distribution based on four main criteria: oral comprehension, oral production, written comprehension, and written production.

Implementation/Use of the Curriculum map

For Biology, the map is currently used to guide evidence-based decision making during curriculum committee meetings. We also use the map to guide the use of backwards design in course design and renewal. We are exploring ways to communicate this data-rich map to students and to use in advising

sessions. We want to help students take responsibility for their own learning (Harden, 2001; Robley, Whittle, & Murdoch-Eaton, 2005).

The first phase of the ICCIT curriculum map helped faculty to better see how their courses fit within the larger program scheme, and as a group, the coloured visualization of the map was useful for future planning as the Institute was relatively new and had undergone early growing pains and transformations. The mapping exercise demonstrated the need for continuous review of how the four programs were evolving and aligning as new hires and new courses were added. The long-term goal was to be able to use the mapping data with students so they could gain a better sense of how the courses fit together to scaffold their learning and achieve the expected outcomes. The intention was for students to gain more autonomy over their own course choices, affecting how they experienced learning within their program.

For Language Studies, findings and recommendations of the curriculum committee were communicated at the program level. Learning outcome tables for the whole program were used to re-write all course syllabi, which clearly underlined learning outcomes and course expectations across all courses. New textbooks in a series were selected to provide guidelines to instructors, and an organization website page was created as a depository of tests and exams which were re-evaluated to match course content and assessment.

Terminology/Jargon

Pedagogical jargon appeared to be a barrier to multiple departments at various stages of the curriculum mapping process. In order to deal with this jargon roadblock, Biology developed a pedagogical dictionary that contained biology examples. It was also clear that across disciplines, differences exist in the definition of assessment and assessment levels/forms. All departments found that naming the different "levels" in terms of introductory, developing/reinforcing, and advanced/competency was very important, but also

challenging. Sometimes this appeared to be contextual in terms of program objectives, faculty expectations, and the assessment tools used.

Faculty Buy-In and Support

Diversity in disciplines is also represented in challenges, namely gaining faculty support and actual implementation at the course level. Geography was able to earn faculty buy-in by showcasing curriculum maps that were being used by other departments. Biology tried to increase faculty buy-in by surveying all faculty at the beginning and asking them what curricular questions they needed to be answered and then making sure to follow up with those answers after the mapping process. For Language Studies, due to existing frameworks and their adoption in many language programs and thanks to experts in education and second language acquisition in the department, a consensus on benefits and needs of curriculum mapping arrived without too much resistance. Complications would instead sometimes arise in the faculty's willingness to implement new learning outcomes and modify existing course curriculum. For ICCIT, faculty buy-in was an area that was most challenging due to the context (ICCIT includes joint programs and had a high number of sessionals during the initial mapping stage) and time. Collecting data from course syllabi was not enough. The second iteration of the ICCIT curriculum map will involve discussions with each instructor to gain more detailed information, and help them understand how they can use the collected data. Note that one other department had to drop out because of the lack of support from other faculty members.

Curriculum Map Visualization and Dissemination.

Biology explored numerous curriculum map visualization tools prior to collecting and disseminating any curricular data. Due to the complexity of the data set, and the desire to maintain the feasibility of updating the data set, Biology decided to use excel for all curricular data entry. Visualization of the curricular data consists of screen shots of colour coded Excel worksheets. We are currently developing approaches by which faculty and students will be able to interact directly with the curricular data and run their own queries of the dataset. ICCIT created a large colour coded map using an Excel file that was populated by information collected through a template distributed by email. The online collection of the data was efficient but lacked the kind of rich data that could be supplied through short face-to-face meetings. Language Studies entered their curricular data in table form similar to the CFERL's self-assessment grid for each level (Council of Europe, 2004), and detailed learning outcomes in an Excel worksheet. Having identified the need to visualize language learning progression in both spiral and scaffolded forms, the Department of Language Studies plans to extend its curriculum mapping process.

Benefits of Curriculum Mapping

All participating departments found that participating in the curriculum mapping process fostered a collaborative approach to discussing teaching and learning throughout the department, and it brought all faculty from both teaching stream and the research stream into the teaching and learning discussion. All departments identified that it helps with selection and planning of new courses, as well as the use of backwards design in course design and renewal. Similar to Biology and ICCIT, Language Studies found that curriculum mapping leads to establishing more coherent progression by bridging gaps between levels and courses. It also allows for repetitions of course content to be done in a more controlled fashion, and that assessment of students' competencies are aligned to each difficulty level. Also, graduating students can more accurately explain their competencies in professional contexts such as on a resume or during a job interview.

Cross-Disciplinary Collaboration for Curriculum Mapping

We want to conclude by emphasizing that many of the attributes we want our students to master are common across all of our disciplines, and are not discipline specific. For example, students in ICCIT will not need to learn to do t-tests like students in Biology, but we want all students to have a basic level of information literacy and graphical literacy, and a basic understanding of the processes involved in research and inquiry. This brings us back to the UDLEs and the need for cross-disciplinary collaboration to ensure that these learning expectations are met across programs and across the university. The current curriculum mapping initiative is still in its early stages, but we have identified that developing a learning community between interested individuals from different departments facilitates curriculum mapping for all involved and helps to develop a large pool of resources. Also, the importance of starting with a set of learning outcomes and promoting backwards design has stood out as applying across all disciplines. For other institutions wanting to engage in cross-disciplinary curriculum mapping projects, we recommend that a common language be established, and a common set of well-defined metrics be identified (such as taught/assessed; introductory/reinforced/advanced). Collaboration between departments also helps to develop more consistency in the process so that the data may be used more broadly by the institution in terms of meeting UDLEs and addressing graduate attributes required for the new work world both nationally and globally.

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