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Executive Summary

Health informatics (HI) is a relatively new profession, and academic programs are likewise new, especially compared to other healthcare professions such as nursing and medicine. Recent studies such as the 2009 Health Informatics and Health Information Management Human Resources Report (facilitated by COACH and other partners) highlighted the need for more Canadian HI professionals. HI professionals are expected to work in a number of roles ranging from IT to project management to organizational and behavioral management to clinical informatics. This has culminated in the need for a wide range of expertise in this field and, as a result, there are different interpretations of the HI domain and its need. Such wider expectations have serious implications on what needs to be taught to future HI professionals.

The Curriculum Discussion Working Group (CDWG) was formed following an Academic Forum held at the eHealth 2010 Conference. The main objectives of the working group were to bring together a collaborative community of academic institutions offering academic and educational HI programming to exchange information, perform a ‘current state’ assessment of HI curricula in Canada, and inform evidence-based HI professional development.

To these ends, research questions for Health Informatics Education in Canada include: “What is the scope of program elements across programs in Canada?”, “To what extent do HI curricula in Canada differ across programs and institutions?”, and “What, if any, are the potential influences on HI professional development and identity”.

Because this was the first time a Canadian HI curriculum report had been attempted, the CDWG limited the scope to include existing or planned Canadian programs entitled “health informatics” or “eHealth”. In total, the curricula from 15 Canadian HI programs (grouped into four broad categories) were analyzed.

This report documents the identification of the diversity of the programs being offered across Canada and recognizes that many programs were developed to meet an industry need. There are also multiple points of entry into HI education to meet students’ goals and development of their HI professional identity.

KEY MESSAGES

Program Theory and Rationale

Almost all programs stressed the need for and provision of individualized assessment of learning needs, course selection, and tailoring of content and experience for each student. Programs valued “real life” experience and experiential learning as shown by a broad range of courses and instructors from many disciplines and interests, internships, research opportunities, integration with organizations (e.g., Infoway) and faculty consultation services. The most important focus reported across the programs was interdisciplinary and collaborative learning with many programs focusing on integration of two or more aspects of health, health informatics, business, management, computing, and technology.

HI Knowledge Domains and Course Learning Elements

There is compelling evidence to suggest that across the spectrum of Canadian HI post-secondary education there are indeed core knowledge domains and topics that are offered by all programs.

Program Demographics

Canada now boasts a robust number and variety of HI post-secondary programs at all levels from diploma to PhD. Although most of the programs are concentrated in BC and southwestern Ontario, there
are several programs in other locations as well as a growing number of programs offering online education. The variety of educational attributes across all offerings speaks to the diverse demographics of the students that may be transitioning into HI from different fields, or embarking on a career in HI post schooling. A prominent theme in the programs is the emphasis on co-op or internship experience that enables students to gain relevant work experience in the Canadian context.

HI Knowledge Domains and Course Learning Elements

While all HI programs offer “core” knowledge domain and topical content, there are distinct differences among the degree levels and program types. Graduate programs are more likely to concern themselves with health systems topics than the diploma, certificate or undergraduate programs. Conversely, diploma programs are more likely to focus on ICT, and less likely to focus on HI processes than any other program. Certificate and undergraduate programs tend to have very similar knowledge domain distributions but are quite different in both their length and in their pedagogical approach.

As each program type was examined in more detail, it became clear that while there were few differences with respect to knowledge domain scope, there were distinct differences with respect to content focus (e.g., ICT versus health systems) and pedagogical style. These differences could be explained when we viewed the curricula through the lens of the COACH HIP Career Matrix and the expected professional competency levels for each program type’s graduates.

Exit Learning Competencies

There is significant breadth and depth of curricular elements available across Canadian HI programs. Competencies at both the cognitive process and knowledge component dimensions appear to be appropriate to the education level (diploma, certificate, undergraduate, graduate), and consistent with provincial/Canadian credentialing frameworks.

Program Impact

In terms of program impact, ties to the HI field are very important and are reflected in the way that programs report the impact to graduates and employers. While it appears that much information about the impact of programs on the field of health informatics is available, the information that schools collect and make publicly available is neither consistent, nor standard.

Given the number of established HI educational programs, there is significant evidence to suggest that HI professionals can be trained and leaders developed versus the notion that they “accidentally” get into the field.

POTENTIAL INFLUENCES ON HI PROFESSIONAL DEVELOPMENT AND IDENTITY

The academic HI discipline has evolved from grassroots, and continues to evolve as opposed to stemming from other professions. HI academic programs were developed to meet both academic and industry market needs, with implicit (as opposed to explicit) theory. Similarly to what has occurred in the information technology industry, an implicit HI theory, emerging through need, will evolve through the growth and development of the discipline. As the academic HI discipline continues to advance, there will be more opportunities for further, more explicit, conceptual HI theory development. Health informatics practice will likely continually inform the development of the discipline, and the discipline will in turn, continue to develop HI professionals to apply the body of knowledge and skills that lead to the development of their HI professional identity.

Given the current governmental imperatives surrounding the sustainment of publicly funded health care, and the national eHealth agenda, the health informatics discipline and profession will be subject to the forces and changes that are likely to ensue in this political landscape. Therefore, academic programs have to respond by engaging and collaborating with industry, academic and political partners to develop health informatics education and programming,
and provide feedback mechanisms with all stakeholders including alumni, to appropriately respond to external forces that influence HI professional development and identity.

**NEXT STEPS**

There are opportunities for schools to better articulate their respective curriculum elements including knowledge domains, exit competencies (program outcomes), and their specific program attributes and impacts using agreed-upon structure (methodology) in order to make future comparisons more practical and useful. This would allow for greater clarity about what differentiates both levels (diploma, certificate, undergraduate, and graduate) and programs. Furthermore, an agreed-upon framework would facilitate better comparison with industry competencies such as those published by COACH (*HIP Core Competencies Version 3.0*, 2012).

While HI exit learning competencies in most programs are formulated for the ‘entry to practice’ level, some schools may wish to proceed with formal mapping of their curriculum against the COACH Core Competencies in order to determine the degree to which *entry to practice* competencies, as determined by academia (while influenced by industry through advisory structures in an ongoing way), are adequately aligned with COACH’s *professional core* competencies, as these undergo revisions every few years.

Given the evolving nature of HI, schools may also wish to review COACH’s Health Informatics Professional Role Profiles, in order to help guide their most important stakeholder: students, regardless of program level (diploma, certificate, undergraduate, graduate), to plan their educational and career pathway. Students and faculty alike must clearly understand the array of current and emerging opportunities and be intimately familiar with the qualifications that are required of these positions, to meet industry needs.

It is also hoped that the information contained in this report can support Canadian HI programs to relate their own strategies for measuring and determining impact, to strategies used by other programs, which can lead to sharing of lessons learned. The ongoing sharing of information can result in synergistic collaborative opportunities between academia and its broad industry network, and in a description of the Canadian HI program landscape of deeper breadth and depth.

Lastly, this report has attempted to link curricular elements such as knowledge domains, competencies, and pedagogy to COACH’s HIP Career Matrix. It is therefore suggested that these theoretical assumptions be tested using more rigorous research methodologies. Such a project, should it come to fruition, should be a collaborative endeavour between COACH and academia.
Health informatics (HI) is still in the early days of establishing itself as a profession and health informatics post-secondary educational programs are relatively newly established. COACH: Canada’s Health Informatics Association was founded in 1975; however, it was not until 1981 that the first Canadian health informatics program (at the University of Victoria) was created. During the 1980s and 1990s, professionals entering the HI field primarily did so by “accident” and HI professionals were primarily created from experience, rather than education.

Several additional programs were established over the years, but it was not until the mid to late 2000s that the number of HI programs grew significantly. Programs are created from demand, and several factors contributed to this growth including:

- The infusion of large amounts of funding into the industry ($2.1 billion in investments from Canada Health Infoway alone)
- The launch of many eHealth projects
- Additional expectations from employers that they were hiring and retaining competent staff.

In 2009, COACH, along with several other partners including Canada Health Infoway, Canadian Institute for Health Information (CIHI), Information and Communications Technology Council (ICTC), Information Technology Association of Canada (ITAC) Health and Canadian Health Information Management Association (CHIMA), released the Health Informatics & Health Information Management Human Resources Report (COACH 2009). The first comprehensive national “census” of the health informatics and health information management workforces, the report indicated that there were not only great numbers of vacancies and skills shortages, but that the HI workforce would need to grow significantly (as well as broaden their skills) by 2014. The report forecasts that in cases of low, moderate, and high demand scenarios, the proportion of HI professionals who will require formal training to broaden their skills may increase to 39%, 59%, and 78% respectively by 2014.

These HI professionals are expected to work in a number of roles ranging from IT to project management to organizational and behavioral management to clinical informatics. This has culminated in the need for a wide range of expertise in this field and, as a result, there are different interpretations of the HI domain and its need. Such wider expectations have serious implications on what needs to be taught to future HI professionals.

Canada now boasts a robust number and variety of HI post-secondary programs at all levels from diploma to PhD. However, until now there has not been a national analysis of all the programs and their curricula.

The 2009 HI & HIM Human Resources Report indicated that by 2014:

- 6,320 - 12,330 professionals would be needed
- 13,690 - 32,170 professionals would require broader skills
Background

COACH established a Health Informatics Professionalism (HIP™) program in 2006. The purpose of the program was to support the development of HI as a profession, through focused work in three main areas (Careers, Capacity and Credential). In order to strengthen ties with the academic community creating future HI professionals, COACH established a HIP@school Task Force.

At the 2010 eHealth conference, the COACH HIP@school Task Force hosted an Academic Forum to discuss curricular issues in health informatics programs across Canada. This forum was well attended by representatives from almost all the Canadian HI programs. At the forum, it was agreed that an overall picture of the Canadian HI post-secondary education would provide useful information for current and future health informatics programs, thus the HIP@School Task Force invited the program representatives to join a subgroup called the Curriculum Discussion Working Group (CDWG).

Program directors or their delegates from post-secondary programs who self-identified as meeting the following criteria were invited to join the Curriculum Discussion Working Group:

- Canadian-based institution
- Program entitled “health informatics” or “eHealth”
- Existing or planned program

It was discussed whether the working group should include representatives from related programs (e.g. Health Information Management), but it was determined that in order to manage the scope of the work membership of the group would be restricted to HI educational programs only.

The individuals who joined the CDWG developed a Terms of Reference (Appendix A) and agreed to accomplish several deliverables, including this report. In December 2011, an interim report was produced and shared with the members of the working group and the HIP@school Task Force. The interim report, and this final report, were prepared entirely by volunteers from the committee and COACH staff and represent a significant effort from those individuals.
Objectives

The main objectives of the Curriculum Discussion Working Group were to bring together a collaborative community of academic institutions offering academic and educational HI programming to exchange information, perform a 'current state' assessment of HI curricula in Canada, and inform evidence-based HI professional development.

To these ends, research questions include: "What is the scope of program elements across programs in Canada?"; "To what extent do HI curricula in Canada differ across programs and institutions?", and "What, if any, are the potential influences on HI professional development and identity?”. This report further describes the current academic programming across:

- Program rationale and theory;
- Program attributes and demographics;
- Knowledge domains;
- Exit competencies; and
- Program impact.

The report provides an analysis on each section, followed by an overall discussion and recommended next steps. Appendices provide further details on the various sections.
Methodologies

The primary focus of this report is the description and interpretation of the current state within and across HI academic settings with respect to curriculum. Comparative research methodology was used for this study. Participating member programs were deconstructed and compared to discover the convergence or divergence exhibited by their curricula. For making comparisons, the Framework approach (Pope et al., 2000) was used for data organization and analysis across five stages:

1. Familiarization
2. Identifying a thematic framework
3. Indexing
4. Charting
5. Mapping and Interpretation.

Data were collected from institutions pertaining to the above-mentioned stages of investigation and stored into a master database that evolved through different iterations. Once the data collection stage was complete, analysis of the raw data was undertaken by various methods (described accordingly in each section) to generate the findings of this report.

SAMPLING

Programs who agreed to take part in the project were invited in a volunteer sampling model. As the work of the committee progressed, additional program representatives were asked to join (snowball sampling) based on the need to ensure participation from the maximum amount of self-identified HI programs possible. In some cases participating schools had more than one HI program - institutions that offer more than one program provided curricular information about at least one of their programs to ensure appropriate representation across program types. For example, the University of Victoria only provided information about their undergraduate program, as this level was poorly represented in earlier sampling efforts.

It is worth noting that while efforts to gather institutional/programmatic information in all areas of investigation yielded a substantial amount of data that were subsequently analyzed, the interpretation presented in this report is limited to information that institutions shared with the committee, and/or to information that was publicly available on institutions’ websites at the time of data collection. It is also important to note that several institutions who participated in the project did not yet have a formal HI program, thus did not provide data. Table 1 outlines the data collected from the participating programs.

In order to facilitate analysis, programs were grouped into four broad categories. Wherever possible, the categories were colour-coded to provide a visual cue for the reader:

- Diploma
- Certificate
- Undergraduate
- Graduate
### Table 1: Data availability by school pertaining to each domain of analysis

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<th>School/Program</th>
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* In 2010, BCIT phased out its HI Certificate and has since integrated the curriculum into its Health Care Quality Management Advanced Certificate and Health Leadership Advanced Certificate. The HI components for clinical professionals were integrated into the Bachelor of Science in Nursing. The data reported by BCIT represent the HI curriculum in the Certificate up until 2010 and HI curriculum that has been integrated into the Advanced Certificates since that time.
Analysis

The analysis section of the report is structured into five parts:

1. Program rationale and theory
2. Program demographics and attributes, including a summary of general pedagogy employed across programs.
3. Knowledge domains, outlined in two sections describing observations on: a) all participant programs and b) by program type.
4. Exit graduate competencies (program outcomes)
5. Program impact

PART 1: PROGRAM RATIONALE AND THEORY

In this report, program rationale is defined as any stated reason for starting the program, acknowledging the needs of society or organizations. Program theory is defined as any statement elucidating the underpinning theoretical framework for how the program was developed or is being taught, such as interdisciplinary teaching, developing self-directed learners etc.

Preparation

Data were extracted from the reports submitted by the participating institutions and then classified into program rationale and theory for all schools. In addition, all of the other sections (e.g. demographics, knowledge domains, and exit graduate competencies) of the reports submitted were scanned for references to why the program was started, its goals, and any other information related to program rationale. The data were categorized into logical themes and summarized in the following section. Please refer to Table 1 for the programs that contributed program theory data.

Findings

Program Rationale

Many of the programs have similar goals and reasons for starting a health informatics program although the individual implementations vary greatly. As an economic rationale, the programs, regardless of their level (diploma through to graduate) were almost universal in their goal of addressing societal (local, regional, national, and international) needs for more trained and versatile information professionals in healthcare. The rationale for expanding new knowledge was less common; themes of developing new theory around health informatics show up in several programs; however, the application of existing information, knowledge, and systems are more prevalent goals of HI program graduates. Similarly, more programs concentrated on broadly defined business and management skills and knowledge and the practical skills involved in healthcare and technology than on developing new knowledge through research and development. In that regard, the health informatics programs seemed to seek to train professionals for emerging HI careers.

Figure 1: Program rationale summary by program type
Approximately one third of the institutions have the agenda to meet the need for HI professionals or enhance careers as part of the rationale, whereas one third catered to bridging the gaps between healthcare, business and technology. Some of the programs offered advanced HI knowledge, however less than half of the programs included the rationale of improving healthcare, and few stated a focus on developing HI leaders as part of their program rationale.

Stated outcomes from the programs concentrated on healthcare and IT skills and knowledge, and often the program explicitly sought to develop HI professionals with existing health and information technology backgrounds by enriching the one of the pair that is weaker. The programs sought to train people to function in rapidly changing and complex domains and also to be bridges among health professionals, administrators, business people, and technology experts. The programs often stated a foundational or important goal of interdisciplinary education and experience. Other important goals were advancing knowledge and knowledge application through internships, research, and consultation within the programs. Details of program outcomes are discussed later in this report.

Program Theory
While program theory was not explicitly described, the majority of programs emphasized tailoring to learner needs. As mentioned earlier, the majority of the programs claimed that their programs are interdisciplinary in nature. Close to half of the programs reflect that they incorporate applied learning principles. Many of the programs offered individualized learning and at least one third offered active learning. Some programs have a built-in distance education component, others are offered fully online. Few programs highlight internship and lifelong learning goals as part of the program theory, however it should not be assumed that programs do not consider these aspects to be important.

It should also be noted that not all programs provided information on their rationale for being developed or their basic program theory. Some information related to both rationale and theory was pulled from other sections (e.g. demographics, knowledge domains and exit graduate competencies) of the master database. Please refer to the Limitations section for more information.

Figure 2: Common program theory themes by program type

PART 2: PROGRAM DEMOGRAPHICS AND ATTRIBUTES

Data Preparation
Discussion of this section was facilitated by the data collected from the participating schools. In the cases where there were gaps, data were manually extracted from information publicly available on the institutions’ websites, and incorporated into the database. The data were categorized into logical themes that are summarized in the following section. As discussed previously, at the time of analysis there were several programs that were being developed and were at too early a stage of development to be included in this report.

“Interdisciplinary” is the most common program theme across all program types
Findings

Demographics

Geographically, 73% of programs (at all levels) are located in southwestern Ontario, and there are currently no programs in either the Prairies or the Territories. There are, however, several institutions that offer their programs entirely online (i.e. the student does not need to live in the same province in which the education is delivered). It should also be noted that Université de Sherbrooke is the only school in Canada that offers a health informatics program in French.

Figure 3: Geographic distribution of Canadian HI programs.
There are three diploma, four certificate, four undergraduate, and five graduate degree programs (from the programs who submitted data). It is worthy to note that Sherbrooke’s certificate program is the only certificate at the Masters level, and hence requires students to possess an undergraduate degree prior to commencing the program. Several schools have multiple HI programs at the same level for example, Université de Sherbrooke has multiple certificate programs, while University of Victoria has an undergraduate, a masters and a PhD program. However, the majority of the institutions who contributed information chose to report on one HI program, at a specific level.

Programs range in size significantly – from the smallest (UOIT with 5 students) to the largest (University of Victoria with 150 students). Because of these relatively small enrolment numbers, programs can typically only offer a specific class once per year.

The length of the program varies by attained credential upon graduation (all numbers are on a full-time basis and include mandatory co-op/internship placements where applicable):

- Both diploma programs are three years in length
- Certificate programs are up to three semesters in length
- Undergraduate programs range between four and five years
- Graduate programs vary in length (Master degree programs range from 12-24 months and PhD programs can be as long as five years)

Several programs do not allow part-time studies, while other programs encourage it or are structured so that a student can maintain a full-time job while pursuing further education. One potential issue with part-time studies is that given most of the programs have very small class sizes, students can run into challenges with the availability of a particular class and it can take longer to complete their program.

Approximately half of the schools (at all levels) offer an internship/co-op/work placement program. These range in length from four to eight months and are mandatory in order to fulfill the requirements for graduation. This speaks to the programs’ emphasis on experiential learning to apply theoretical and skills/knowledge learned to real life scenarios, and fit with the “ties to the industry” that were mentioned so frequently in the program attributes section of the master database.

There are few programs (essentially the schools that offer diploma or undergraduate programs) that target high school students directly. The majority of programs, however, are targeting mature students (i.e. practicing professionals). Several types of practicing/mid-career professionals were identified:

- HI professionals looking to expand their knowledge and skills /gain a master’s degree
- Transitioning professionals from other careers (usually but not always people with IT and clinical backgrounds)
- Internationally educated health professionals

There are two varieties of masters programs – thesis-based and course-based. McMaster University for example, observes that “The majority of our students are course based rather than thesis based. This concentration on course students is based on our assumptions that more jobs need practitioners than academic (thesis based) students”. Only UOIT mentioned preparing students for doctoral studies – the other programs appear to be preparing students to
enter the workforce/advance their careers as opposed to pursuing more studies or an academic career.

Program Attributes:
Some programs emphasize the breadth of health informatics, such as healthcare system analysis, health information research, project management, and healthcare policy, whereas some emphasize the depth in one or more several domain areas such as health data standards, interoperability, or privacy and security. For example, the University of Toronto and McMaster University have a greater amount of management courses; focus areas include project, knowledge, and change management courses specific to health informatics and eHealth.

The diploma programs, such as Centennial College and Mohawk College, are much more technical in nature; although other programs (University of Victoria as an example) do require a minimum level of technical competence.

Mohawk College and University of Waterloo have applied HI research centres, and Algoma is in the process of developing one. Most programs belong to a specific faculty within a university or college, which varies from computer science to health sciences. The McMaster masters program is the only one that spans three faculties: business, health sciences, and engineering, without a formal faculty to house the program.

Many schools emphasize the strong ties they have with the HI industry. For example:

- UOIT: “Students work with leading edge researchers and learn about the latest approaches to health informatics.”
- McMaster University: “We also strongly encourage our students to write papers, produce posters, and make presentations at local and other conferences and research days to build their communication skills and networks.”

- Mohawk College: “Over 40 partners from the Health/ICT community participate in the projects at the research centre. The MARC-HI centre offers the infrastructure over the Internet as a learning tool. Two prototyping and development studios are available for collaboration with industry.”

Eleven of the schools are Academic Institutional Members of COACH, a program that allows institutions to add unlimited numbers of faculty and students as COACH members.

Pedagogy:
British Columbia Institute of Technology, George Brown College and Université de Sherbrooke are the only programs currently to offer an entirely online program (however there are more in development). George Brown College notes that: “Courses in this program are offered online, plus some Friday and Saturdays, allowing students to continue working during their studies”. Again, there is an emphasis here on practicing professionals.

Several other schools offer blended learning (combination of online and in person). Of these schools several are in the process of evaluating whether to move more towards online. UOIT allows its students to “be engaged either in-person or online for most of the program. For the first semester there is a requirement for attending two of the required courses. With all subsequent courses and research may be engaged in-person or online. The program is currently in a review stage and the attendance requirement for the first semester may be changed.”

Throughout the programs, there is a strong focus on group work, real-life examples and case studies. More information on pedagogy is contained in Part 3: HI Knowledge Domains and Course Learning Elements.
PART 3: HI KNOWLEDGE DOMAINS AND COURSE LEARNING ELEMENTS

Along with the course codes and titles of current course offerings, the 15 participating health informatics programs were asked to submit a list of the knowledge domains that were the focus of their courses. Additionally, if available, some programs provided course-level learning outcomes that corresponded to each course.

Following the framework analysis guidelines, text from course titles, knowledge domain foci and course-level learning outcomes were collected and processed to identify common themes in knowledge domains.

Data Preparation

All course titles were stripped of text or numerical data that was non-essential to the topic or knowledge domain described by the title (e.g., course numbers). Key focus descriptors in the title were maintained (e.g., a title beginning with COMP to denote a computer science course). Terms in the course title were parsed and stemmed to provide some degree of standardization. Where provided, course-level learning outcomes were parsed for key terms that further refined or described the course knowledge domain and learning elements. The key terms were then stemmed and standardized similar to the course titles. A total of 376 key terms was identified.

Qualitative Analysis

Prepared textual data from participating programs were grouped by program type: diploma (n=2), certificate (n=4), undergraduate (n=4) and graduate (n=5).

The prepared textual data were loaded into a word map process using a web-based word map application Wordle™ (Feinberg, 2011) and a word map for each program type was produced.

The Wordle word maps indicate the frequency a knowledge domain term appeared in the listed knowledge domains or topics, course titles or course learning outcomes provided by the programs. Where the domain term was used at least once, it is listed horizontally in the smallest font. Where a term is used more frequently it is presented in the word map in larger and denser fonts. Thus the Wordle word maps provide a broad measure of knowledge domain scope and saturation, as well as a visualization of the key themes among program type members. The word maps do not provide any measure of concordance among the terms.

To assist with case mix comparisons, each of the 376 domain terms was further categorized using the hierarchy of key themes derived from the word maps.

Findings

Four broad health informatics curriculum knowledge domains were identified from the word maps: Health Systems (n=52), Health Informatics Processes (n=141), Information and Communication Technologies (n=109), and Research (n=29). A fifth dimension was identified that related to Pedagogical Approaches (n=45) within the curricula.

<table>
<thead>
<tr>
<th>Knowledge Domains</th>
<th>Diploma</th>
<th>Certificate</th>
<th>Undergraduate</th>
<th>Graduate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Systems</td>
<td>2%</td>
<td>3%</td>
<td>3%</td>
<td>6%</td>
<td>14%</td>
</tr>
<tr>
<td>HI Processes</td>
<td>7%</td>
<td>9%</td>
<td>10%</td>
<td>12%</td>
<td>38%</td>
</tr>
<tr>
<td>ICT</td>
<td>13%</td>
<td>4%</td>
<td>6%</td>
<td>7%</td>
<td>29%</td>
</tr>
<tr>
<td>Research</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
<td>4%</td>
<td>8%</td>
</tr>
<tr>
<td>Pedagogy</td>
<td>3%</td>
<td>2%</td>
<td>2%</td>
<td>5%</td>
<td>12%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>25%</td>
<td>19%</td>
<td>23%</td>
<td>34%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The largest and boldest words in a word map represent the terms that occurred the most frequently in the listed knowledge domains or topics, course titles or course learning outcomes provided by the programs.
Each broad curricular knowledge domain was further parsed into a number of topic areas.

**All Participating Programs’ Knowledge Domains**

- **Health systems:**
  - Canadian healthcare system generally
  - Biomedical and clinical systems
  - Public and consumer health and patient processes and clinical journeys

- **Information and Communication Technology (ICT):**
  - Computer applications and software engineering
  - Information system development, architecture and technology
  - Information systems: health or clinical information systems and databases
  - Information and data security and standards

- **Health informatics processes:**
  - eHealth, telehealth, mobile health
  - Systems analysis and systems integration
  - Change management
  - Project management
  - Human factors and human-computer interface
  - Organizational systems, leadership, and knowledge management
  - Confidentiality and privacy

- **Research**
  - Research methods and processes
  - Statistical or data analysis
  - Thesis development

Figure 5: Word map of knowledge domain keywords for all HI programs

The scope of health informatics knowledge domains is extensive and diverse and represents basic foundational knowledge elements generally associated with HI education. In Figure 5, the saturation of these elements is more pronounced and balanced among health and/or clinical systems, basic health informatics processes (systems analysis, organizational management, change management, project management etc.) and computer or information and communication technologies. Less saturation is observed in more peripheral elements such as unique topics in health and ICT as well as research, and pedagogy, etc. which indicate wider variation in curriculum and pedagogical approach across the program types.

Thematic categorization of the keyword elements from the Word map show the broad range of **core** HI knowledge domains reported across all educational programs:
**Figure 6: Knowledge domains, topics and learning elements for all programs**

- **Health Systems**
  - Patient/consumer perspective
  - Canadian healthcare system in general
  - Biomedical & clinical processes
  - Management and organizational systems
  - Human factors and human computer interface
  - Health information management

- **HI Processes**
  - HI systems, applications and tools (eHealth, EHR, mHealth, etc.)
  - Systems analysis and integration
  - Project management
  - Privacy and confidentiality
  - Knowledge management
  - Decision support
  - Change management

- **ICT**
  - Standards
  - Information systems
  - Development & architecture
  - Data and security
  - Computer programming and software engineering

- **Research**
  - Methods & processes
  - Epidemiology, statistics & analysis

- **% of all terms identified (N=331)**

*Legend: Diploma - Blue, Certificate - Red, Undergraduate - Green, Graduate - Purple*
Interestingly, while the certificate and undergraduate programs are very similar with respect to the proportional distribution of broad knowledge domains, there are demonstrable differences between their pedagogical approaches. The certificate programs are very focused on specific experiential learning, whereas the undergraduate programs are much more traditional in their approach. The diploma programs were the least variable and the graduate programs were the most variable in their teaching methods and styles.

**Knowledge Domains and Pedagogy by Program Type**

While the scope of key knowledge domains for each program type may be similar, the saturation and focus of key knowledge domain themes differ noticeably.

### Table 3: Broad HI knowledge domains as a proportion of program curricula by program type

<table>
<thead>
<tr>
<th>Knowledge Domains</th>
<th>Diploma</th>
<th>Certificate</th>
<th>Under Grad</th>
<th>Graduate</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Systems</td>
<td>10%</td>
<td>16%</td>
<td>14%</td>
<td>21%</td>
<td>16%</td>
</tr>
<tr>
<td>HI Processes</td>
<td>30%</td>
<td>52%</td>
<td>49%</td>
<td>42%</td>
<td>43%</td>
</tr>
<tr>
<td>ICT</td>
<td>57%</td>
<td>25%</td>
<td>27%</td>
<td>23%</td>
<td>33%</td>
</tr>
<tr>
<td>Research</td>
<td>4%</td>
<td>8%</td>
<td>9%</td>
<td>13%</td>
<td>9%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Of the four broad knowledge domains as proportion of a program type's curricula (Table 3), graduate programs are more likely to concern themselves with health systems topics than the diploma, certificate or undergraduate programs. Conversely, the diploma programs are more likely to focus on ICT, and less likely to focus on HI processes than any other program.
Knowledge domains for diploma programs

Figure 8: Word map of knowledge domain keywords for diploma programs

Diploma HI programs (n=2) have a primary focus on information and communication technology (ICT) with an emphasis on computer science and programming, and how they specifically function in healthcare environments. Health informatics processes are rather limited to the use of ICT applications in health organizations and how that is impacted by health organizational behaviour. Pedagogical techniques and approaches are primarily experiential and include courses that bolster basic academic/scholastic and basic organizational, job and employment skills.

Diploma program HI knowledge domains reported by Centennial and Mohawk Colleges include:

- **Health Systems**
  - Knowledge of basic clinical and medical processes
  - Canadian healthcare system generally

- **Information and Communication Technology**
  - Structure of healthcare information systems, data security and privacy in healthcare systems
  - Computer sciences: design, develop, modify, and test software for healthcare applications to analyze and model data, develop healthcare database
  - Software engineering and object-oriented software design methodologies, user-oriented interface design
  - Focus on technologies such as C#, Java, JEE, Oracle, MS-SQL Server, Unix/Linux, Microsoft’s .NET, HTML/XML, Rational/Websphere, data warehousing and data mining

- **Health Informatics Processes**
  - Basic organizational skills: career development, communication, group dynamics and conflict management; employment skills, business communications, management and organizational behavior, procurement, quality improvement, reengineering and solving problems
  - Use of tools, algorithms and health informatics methods for hospitals, schools, healthcare agencies and public health departments (e.g., telehealth and mobile health)
  - Health information management

- **Pedagogical Processes**
  - Experiential learning: practica and co-ops
  - Basic English and mathematics
Figure 9: HI knowledge domains and pedagogy for diploma programs
Knowledge Domains for Certificate Programs

The word map shows that within certificate programs (n=4), there is a more intense focus (or more saturation) along a broader spectrum with respect to \textit{health informatics processes}, particularly with respect to eHealth and clinical and general healthcare applications. The secondary focus of ICT concentrates less on computer programming and more on how technology adapts to, integrates with, and is managed within whole health organizational systems (e.g., standards). While basic critical thinking and research skills are introduced, in certificate programs there remains a strong emphasis on experiential learning and "hands on" training as well as basic management and professional training.

1 There are significant differences among the "Certificate Programs". Université de Sherbrooke offers a post-degree certificate program that includes graduate level courses. However, BCIT, George Brown and Ryerson offer post-diploma programs where courses are considered to be at a Community College level. We include these programs in one group as they are neither completely degree nor diploma programs.

Certificate program HI knowledge domains reported by BCIT, George Brown College, Ryerson University and Université de Sherbrooke include:

- **Health Systems**
  - Canadian healthcare system
  - Evidence based medicine and clinical practice
- **Information and Communication Technologies**
  - Health information systems and health information management
  - Terminologies and standards
  - Electronic health record
  - Distributed systems, interoperability and HL7
- **Health Informatics Processes**
  - eHealth
  - Project management
  - Systems analysis and systems implementation
  - Human factors and human computer interface
  - Nursing informatics
  - Professional or management skills, ethics, and leadership
- **Research**
  - Basic quantitative and qualitative research and evaluation methods
  - Data analysis
- **Pedagogical Processes**
  - Case studies, co-ops, internships, practicum or field placements, simulations
  - On-line and/or distance learning
Figure 11: HI knowledge domains and pedagogy for certificate programs
Knowledge Domains for Undergraduate Programs

In the word map for undergraduate HI programs (n=4) the term "health informatics" is most prominent, suggesting an emphasis on richer **health informatics processes** that consider health information management in detail and encompass the clinical, biomedical and healthcare environments more deeply. While there is some inclusion of computer application programming and development (depending on the program), there is a greater emphasis on information systems analysis, design and development. There is a much broader scope of knowledge domain terms that include management of clinical, technological and organizational systems as well as basic or applied research. Pedagogical approaches include a focus on both basic and advanced critical thinking academic skills, research methodology, as well as experiential projects, field and case studies.

Undergraduate program HI knowledge domains reported by University of Victoria, University of Western Ontario, Conestoga College and York University include:

- **Health Systems**
  - Canadian healthcare systems
  - Clinical, biomedical, public and population health systems
- **Information and Communication Technologies**
  - Information and communication systems design, development and analysis
  - Database applications and management
- **Health Informatics Processes**
  - Health information management: data archiving, retrieval, programming, report generation, and interfacing such systems with the hospitals, community health agencies and offices of health professionals.
  - Change management and human factors
  - Business and clinical systems analysis
  - Decision support
  - Project management
  - Knowledge management and problem solving
  - eHealth services education
  - Professional or management skills, ethics, and leadership
- **Research**
  - More advanced quantitative and qualitative research methods
  - Statistical analysis and epidemiology
  - Evaluation and quality improvement
- **Pedagogical Processes**
  - Research projects, case studies and field studies
Figure 13: HI Knowledge domains and pedagogy for undergraduate programs
Figure 14: Word map of knowledge domains for graduate programs

Of all programs studied for this report, graduate programs present the greatest number and most varied array of health informatics knowledge domains. The word map in Figure 14 shows a general focus on advanced topics in health, eHealth, research and systems that is embedded within a much broader, richer and more comprehensive set of knowledge domain terms included in health systems, health informatics processes, ICT, and research. Under health systems, graduate programs uniquely report or recognize the patient/consumer perspective in their curricula. The primary focus of advanced health informatics processes includes higher level and advanced critical assessment/analysis, design, development and management of innovation and solution architecture in health systems and organizations. Pedagogy in graduate programs includes much more diverse and advanced academic skills with a focus on development of the self-motivated professional leader as opposed to training.

Graduate program HI knowledge domains reported in McMaster University, University of Toronto, University of Waterloo, Dalhousie University and UOIT are:

- **Health Systems**
  - Patient/consumer perspective
  - Biomedical & clinical processes
  - Canadian healthcare system generally

- **HI Processes**
  - Systems analysis and integration
    - innovation in eHealth, assessment, system design and evaluation
  - Project management
  - Management and organizational systems
    - Business/management and entrepreneurship, quality, communication, ethics, health management, incident handling, leadership, legal issues, management issues in eHealth, organizational behaviour, performance measurement, personal management, professional behaviour, social responsibility, teamwork

- **Knowledge management**
  - Knowledge management systems, knowledge translation in eHealth

- **Human factors and human computer interface**

- **Health information management (advanced)**

- **Change management**

- **HI systems, applications and tools (eHealth, EHR, mHealth, etc.)**
  - eHealth applications, eHealth tools, electronic health records including personal health records, fundamentals of eHealth, health informatics, health information systems and technology
- **Information and Communication Technology (ICT)**
  - Standards
  - Management and organizational systems
  - Information systems
  - Data processing, health enterprise architectures and systems, information and human systems management, information systems, services and system design, information technology, health information
  - Development & architecture
    - Information communication technology theory, systems and applications
  - Information management
  - Data, security and standards
    - Health security, auditing and fraud-analysis, information communication technology in healthcare, secure software systems
  - Computer programming and software engineering
    - Artificial intelligence, computer science & technology, computing information technology, modern software technology for eHealth, pervasive and mobile computing, service computing, software quality management

- **Research**
  - Methods & processes
  - Epidemiology, statistics & analysis

- **Pedagogical Processes**
  - Thesis
  - Seminars
  - Professional Development
  - Problem Based Learning
  - Electives
  - Co-op, Internship, Practicum, Field Placement
  - Colloquia
  - Advanced Learning
Figure 15: HI knowledge domains and pedagogy for graduate programs
PART 4: EXIT GRADUATE COMPETENCIES

As part of the CDWG mandate to describe Canadian health informatics (HI) programs, this section of the report presents analyzed data for one specific area for the participating programs; exit graduate competencies (program outcomes). The findings presented are limited to the exit graduate competency information provided by the participating programs; however, not all of the programs contributed data in the exit graduate competency section of the master database e.g., BCIT, McMaster University, University of Western Ontario, and York University.

Qualitative Analysis Framework and Process

The selected methodology for analyzing the HI exit graduate competencies across schools and program types is rooted in Anderson and Krathwohl’s (2001) revision of the original Bloom’s taxonomy (Bloom & Krathwohl, 1956) who proposed a more practical two dimensional framework of the cognitive domain as the intersection of the Cognitive Process Dimension and the Knowledge Dimension (see Appendix C); the Taxonomy Table (Anderson & Krathwohl, 2001). More specifically, the taxonomy in this revised adaptation, now ‘intersects and acts upon different types and levels of knowledge -- factual, conceptual, procedural and metacognitive’ (Wilson, 2005, para 5). This taxonomy has been useful as a framework for both generating and classifying educational objectives and standards (Krathwohl, 2002), and for organizing learning activities resulting from those objectives into ‘both lower order and higher order thinking skills as well as a mix of concrete and abstract knowledge’ (Iowa State University, 1995-2011). Krathwohl (2002) offers a clear explanation of what components are included in objective statements:

Objectives that describe intended learning outcomes as the result of instruction are usually framed in terms of (a) some subject matter content and (b) a description of what is to be done with or to that content. Thus, statements of objectives typically consist of a noun or noun phrase—the subject matter content—and a verb or verb phrase—the cognitive process(es) (p. 213).

Using the *noun* to provide the basis for the Knowledge dimension and the *verb* to form the basis for the Cognitive process dimension allows for easy classification of objective (competency) statements into the taxonomy table (Krathwohl, 2002). Krathwohl contended that once completed, the taxonomy table offers educators the opportunity to examine the relative emphasis of educational objectives, curriculum alignment, and gaps in curricular content (2002, p. 218).

In addition, *Bloom’s Digital Taxonomy* (adapted from Bloom’s original taxonomy) concept map was also used during the first phase of analysis, in instances where verbs in the statements depicted behaviours and actions consistent with technological advances e.g., ‘new technologies and the processes and actions associated with them’ (Churches, 2009, p. 3) to classify them into the taxonomy (see Appendix C). This adaptation was also useful as it presents lower to higher order thinking skills and actions across the communication-to-collaboration spectrum along the cognitive process dimension which is an important spectrum in HI curricula.

Data Preparation

The first phase in analyzing the data submitted in this category was to classify exit graduate competencies by **program** into the taxonomy table. In the first instance, competency statements were read and first classified into the cognitive process dimension cell using the verb – the action involved in the intended cognitive aspect - of the statement. Subsequently, the object – the knowledge the student is expected to have acquired and/or constructed (Iowa State University, 1995-2011) - in the statement was re-read, interpreted and placed into the corresponding knowledge dimension cell. The second instance in this phase involved a re-interpretation of all of the competency statements as a whole, to ensure appropriate placement across both dimensions on the taxonomy table.

The second phase of analysis was to organize the taxonomy tables by **program type** which included: diploma, certificate, undergraduate, and graduate levels of programs. Although the various programs are not exactly similar in terms of duration, the use of color codes
and superimposition of the program name across cognitive process and knowledge dimensions facilitated a visual illustration of patterns of competencies across program type by levels. The third phase involved combining diploma level and certificate competencies in one grouping and undergraduate and master’s level competencies in another grouping, in an effort to illustrate (and differentiate) the main areas of foci for each grouping.

**Findings**

As illustrated in table 4a, it appears that the bulk of diploma (n=2) and certificate (n=3) programs’ exit competencies are concentrated across the higher-order thinking cognitive process dimension, but almost evenly distributed across the knowledge dimension. This pattern also reveals that as might be expected for this grouping, the factual knowledge dimension is an important component, but the create cognitive process dimension is not much of a focus at this level. The low emphasis on the create component of the cognitive dimension in this grouping is appropriate as the focus in certificate and diploma level programs, while needing to meet all specific vocational learning outcomes as defined by provincial program standards, does not include, at least for Ontario programs (Ministry of Training, Colleges and Universities Colleges of Applied Arts and Technology [MTCU], Policy Framework, 2005), an expectation for competencies around ‘generating new products’.
Table 4a: Taxonomy table for exit graduate competencies (outcomes): analysis by diploma and certificate program levels combined


<table>
<thead>
<tr>
<th>The Knowledge Dimension</th>
<th>The Cognitive Process Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factual Knowledge</strong></td>
<td>Remember</td>
</tr>
<tr>
<td>Document health information systems based on specifications and software engineering methodologies</td>
<td></td>
</tr>
<tr>
<td>Provide efficient and effective technical support to clients in a manner that promotes safe computing practices, reduces the risk of the issue recurring, and encourages effective working relationships</td>
<td></td>
</tr>
<tr>
<td>Knowledge about the core areas of healthcare informatics domain*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Conceptual Knowledge</strong></th>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define the specifications of a health information system based on user requirements</td>
<td></td>
<td></td>
<td>Apply knowledge of security issues to the implementation of information technology solutions</td>
<td>Analyze the specifications of a health information system based on user requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Work with the different aspects of data entry, processing, storage, treatment, release, new technologies and their applications in the healthcare field</td>
<td>Integrate relevant standards and professional, ethical and legislative requirements with the appropriate health information system technologies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Assess new information technology and advances in communication, as they relate to the specifics of the healthcare system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Knowledge Dimension</td>
<td>Remember</td>
<td>Understand</td>
<td>Apply</td>
<td>Analyze</td>
<td>Evaluate</td>
<td>Create</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------</td>
<td>------------</td>
<td>-------</td>
<td>---------</td>
<td>----------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>Procedural Knowledge</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implement health information systems based on specifications and software engineering methodologies</td>
<td></td>
<td></td>
<td></td>
<td>information technology problems through the application of systematic approaches, diagnostic tools, and customization of software</td>
<td>Design, test, document, and deploy programs based on given specifications</td>
<td>Design health information systems based on specifications and software engineering methodologies</td>
</tr>
<tr>
<td>Apply knowledge of security and privacy issues in the analysis, design, and implementation of integrated solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Evaluate the effectiveness of HIST within health related settings</td>
<td></td>
</tr>
<tr>
<td>Install, configure, troubleshoot, monitor, maintain, upgrade, and optimize computer systems and networks</td>
<td></td>
<td></td>
<td></td>
<td>Develop integrated software solutions, using relevant methodologies, policies, and standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribute to the successful completion of the project applying the project management principles in use</td>
<td></td>
<td></td>
<td></td>
<td>Analyze, design, and implement integrated solutions using knowledge of security issues to ensure customer requirements are met</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge on practical application of tools, techniques and frameworks essential for a health informatics career*</td>
<td></td>
<td></td>
<td></td>
<td>Apply the newly learnt skills in their respective fields</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Metacognitive knowledge</strong></td>
<td>Articulate, defend, and conform to workplace expectations found in information technology (IT) environments</td>
<td></td>
<td></td>
<td>Pursue their individual career paths in the healthcare or IT field</td>
<td>Test health information systems based on specifications and software engineering methodologies</td>
<td></td>
</tr>
<tr>
<td>Understand the ethical issues pertaining to the computerization of the healthcare system and become an agent of change in their workplace</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Outcomes statement was not originally formulated according to Bloom’s taxonomy
For undergraduate (n=3) and graduate (n=3) degree programs’ exit competencies, the concentration across both cognitive process and knowledge dimensions is focused on higher-order skills. In contrast to the diploma-certificate grouping, the create component of the cognitive dimension is emphasized as are the procedural and metacognitive component of the knowledge dimension, while the factual knowledge component is not much of a focus. The fact that the metacognitive knowledge component is significant is not surprising given that at the undergraduate but more significantly at the graduate level, according to the Council of Ministers of Education, Canada’s Canadian Degree Qualifications Framework (CMEC, 2007), awareness of limits of knowledge and professional capacity/autonomy are degree-level expectations of graduates specified in standard statements at each degree level. Metacognitive knowledge, according to Pintrich (2002), includes ‘knowledge of general strategies that might be used for different tasks, knowledge of the conditions under which these strategies might be used, knowledge of the extent to which the strategies are effective, and knowledge of self’ (p. 219).

Table 4b: Taxonomy table for exit graduate competencies [outcomes]: analysis by undergraduate and graduate program levels combined

Undergraduate (n= 3) & Graduate [Masters] (n= 3) Level Competencies Combined

<table>
<thead>
<tr>
<th>The Knowledge Dimension</th>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual Knowledge</td>
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<tr>
<td></td>
<td>Educate health care professionals in a use of health care information systems, including wireless methods to support patient care</td>
<td>Communicate effectively with members of a health care team</td>
<td>Apply the principles and skills of business administration and leadership</td>
<td>Apply psychosocial, economic and environmental concepts and values</td>
<td>Adhere to professional, ethical and legal codes and standards</td>
<td>Use communication styles and method effective for the situation and audience</td>
</tr>
<tr>
<td>The Knowledge Dimension</td>
<td>Remember</td>
<td>Understand</td>
<td>Apply</td>
<td>Analyze</td>
<td>Evaluate</td>
<td>Create</td>
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<tr>
<td><strong>Conceptual Knowledge</strong></td>
<td><strong>Understand</strong></td>
<td>Understand the following health science concepts and their importance for developing health care information systems: health and medical terminology, anatomy and physiology, pathology, diagnosis, prevention and treatment of diseases</td>
<td>Manage patient care and administrative information systems that include data archiving, retrieval, programming, report generation, and interfacing such systems with the hospitals, community health agencies and offices of health professionals</td>
<td>Integrate the knowledge of the health care delivery system into functionality of health information systems</td>
<td>Conduct research with health professionals using theory and practice of health informatics</td>
<td>Contribute to evidence based practice in health informatics</td>
</tr>
<tr>
<td><strong>Procedural Knowledge</strong></td>
<td><strong>Understand</strong></td>
<td>Recognize the need for information gathering and/or identifies and clarifies the questions that need to be answered</td>
<td>Ensure the ongoing efficient operation and evolution of core computer functions and networks in a variety of health care settings</td>
<td>Apply problem-solving skills to priorities for health informatics in order to ensure high quality and safety of patient care</td>
<td>Implement health information systems</td>
<td>Develop health care information systems that support health-care administration, management, policy, training, clinical management and clinical research</td>
</tr>
<tr>
<td></td>
<td><strong>Apply</strong></td>
<td>Practice health informatics knowledge and skills through co-op work terms in health care agencies</td>
<td>Manage the process and implementation of projects and tasks in a timely and directed manner</td>
<td>Analyze, diagnose, and resolve technical issues associated with information systems in health care organizations</td>
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</tr>
<tr>
<td></td>
<td><strong>Analyze</strong></td>
<td>Implement health information systems</td>
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<tr>
<td></td>
<td><strong>Evaluate</strong></td>
<td>Integrate theoretical foundations of Health Informatics component domains and technologies</td>
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</tbody>
</table>
**PART 5: PROGRAM IMPACT**

Academic programs seek to understand and communicate the way that they impact their students and the field in which they practice. This section of the report describes how the HI programs relate to these areas of impact: application and registration patterns; graduate satisfaction; employer/market feedback; student success recommendations; retention/attrition; and alumni feedback.

**Data Preparation**

To illustrate the areas of impact, the Program Impact section of the database was reviewed; the information was parsed into individual concepts, grouped, and then coded. The process was then iterated until the information converged into meaningful themes. When analyzing the information provided by the schools, several themes emerged. Two themes focused on stakeholder groups: 1) students and 2) graduates and employers. The third program impact theme related to the formal ways in which the program measures impact. The fourth theme was notable areas - ways in which the program has distinguished itself externally.

Table 5 illustrates the frequency of the identified area of Program Impact identified as submitted in the master database.
Findings

Students

In the student theme, the most frequently identified measure to determine program impact were application, admissions, enrolment and registration rates (these are indicators of volume of activity, expressed as students enrolled in the program, or course registrations if flexible models of program delivery are used), and student retention. In addition, several other measures were used, including time-to-graduation and graduation rate, student satisfaction and co-op/internship placements (Conestoga, McMaster). Some institutions cite annual admissions/intake with established targets (e.g., George Brown, which routinely meets its targets) while others cite total students in its program (Centennial). Among programs that are relatively new (Centennial, George Brown, Mohawk), graduation rates are de-emphasized due for the need for a larger sample size of graduates prior to reporting program completion and post-completion statistics.

Graduates and Employers

This theme describes students’ success in obtaining employment in their field, and the employer’s success in hiring a graduate. The most frequent indicator mentioned in this theme is the employment rate, which can be interpreted as the proportion of graduates who intended to enter the workforce and successfully secured employment in the HI field within a certain time after graduation. Employment rates quoted range of 56% to 100%, although there are differences in how ‘employment’ is defined. For example, George Brown distinguishes between graduates who are ‘working’, ‘working in a related field’, and ‘working part-time in related field’. George Brown also compares HI graduate salaries to the average salary of its institution’s graduates, and indicates that the HI graduates salaries are significantly higher. Also frequently mentioned was graduate satisfaction, and a description of the various positions graduates attained after graduation. Several programs have been established in recent years and these identified in a prospective manner, the typical position titles and roles students could obtain after graduation, based on the HI professional competency profile that was referenced by the HI program (e.g., COACH HI Professional Core Competencies, [2009, March], and the Pointing the Way: Competencies and Curricula in Health Informatics of Covvey, Zitner, and Bernstein, 2001). Programs that have many years of experience tended to cite specific positions that their graduates have obtained. The least frequent measure was employment salaries. Perhaps this information was more difficult to obtain compared to the other measures.

Example: Employment Positions Obtained Upon Graduation - Prospective (Ryerson University)

Most of the students who have registered/completed the courses are already employed either in a healthcare setting or in an IT related organization, this certificate provides an
academic credential for the successful students in the field of health informatics and can pursue new and better positions within their organizational domain, such as,
- Information Systems Manager
- Health Information Manager
- Quality Improvement Coordinator
- Clinical/Systems/Information Analyst
- Project Manager or Sales Executive in an IT company
- Systems Administrator
- Health Consultant
- Clinical Applications Coordinator/Data Manager
- Clinical Project Manager, Senior Project Manager
- Clinical Researcher/Research Associate
- Clinical Vocabulary Manager
- Enterprise Applications Specialist
- Health Systems Specialist
- Health Information Services Department Technician
- Information Privacy Coordinator
- Integration Architect (Implementation)
- Records and Information Coordinator

Example: Employment Positions Obtained
(University of Toronto)

100% of the alumni are currently employed in career Health Informatics positions with leadership roles and functions in health/clinical/medical information applications and/or systems analysis, design, development, implementation, management, education and evaluation

- Teaching Hospitals
- Community Hospitals
- LHINs and/or Health Authorities
- Community and Public health care organizations
- Government Ministries, Departments and eHealth Agencies
- Research Institutions
- Health or Disease Advocacy Organizations
- Vendors and/or Application Developers
- Consulting Firms

Example: Employment Positions and Progression of Alumni
(University of Victoria)

Our Alumni may be found in positions throughout Canada as well as internationally. They work for private consulting firms, vendors, Federal government agencies, Provincial ministries Health Authorities and hospitals. They occupy virtually all levels of the workforce in the field of HI, from Junior Business Analyst to Chief Information Officer. Some students go on to a Ph.D. degree and find faculty/research positions at academic institutions.

Formal Impact Measurement
This theme reflects the systematic and formal methods of collecting information through a multi-disciplinary, multi-stakeholder, or through general surveys or interviews. The most frequent method of gaining comprehensive information about the program impact is through the Program Advisory Committee/Program Advisory Board (e.g., Conestoga, McMaster University, George Brown College). Typically, these are made up of group of individuals that represent a cross-section of the external community, representing the views of employers in different sub-sectors of the HI community, other educators, and alumni. Another source of information, but less frequently mentioned is a formal program review, which may occur on
a periodic basis, continuously, or as needed inform a key (strategic) decision, and it involves systematic data collection and analysis from specific required sources. The use of formal program review is cited by Université de Sherbrooke, Conestoga, and BCIT. Least frequent sources of information mentioned are the faculty members themselves and industry surveys. Perhaps the ongoing interaction of faculty and the program makes formal data collection from faculty unnecessary.

Notable Areas
Several other indicators of program impact were also reported, although these were less frequent. These include awards and scholarships obtained by students in the program, published papers, conference abstracts, and presentations, and alumni testimonials that provided a compelling picture of the successes achieved by students upon graduation and by faculty.
Discussion

This report examined health informatics programs in fifteen different institutions across Canada in order to answer the following questions:

1) WHAT IS THE SCOPE OF PROGRAM ELEMENTS ACROSS PROGRAMS IN CANADA?

Program theory and/or rationale was not described explicitly although almost all programs stressed the need for and provision of individualized assessment of learning needs, course selection, and tailoring of content and experience for each student. Programs valued “real life” experience and experiential learning as shown by a broad range of courses and instructors from many disciplines and interests, internships, research opportunities, integration with organizations (e.g., Infoway) and faculty consultation services. The most important focus reported across the programs was interdisciplinary and collaborative learning with many programs focusing on integration of two or more aspects of health, health informatics, business, management, computing, and technology.

Canada has developed a number of post-secondary health informatics and eHealth programs since the first program was established in 1981. With increased eHealth investments from all levels of government, many of the programs have been established in the past five years. In terms of demographics, programs span across all levels of post-secondary education as certificate, diploma, undergraduate, graduate, and PhD programs. Although most of the programs are concentrated in BC and southwestern Ontario, there are several programs in other locations as well as a growing number of programs offering online education. The variety of educational attributes across all offerings speaks to the diverse demographics of the students that may be transitioning into HI from different fields, or embarking on a career in HI post schooling. A prominent theme in the programs is the emphasis on co-op or internship experience that enables students to gain relevant work experience in the Canadian context.

There is compelling evidence to suggest that across the spectrum of Canadian HI post-secondary education there are indeed core knowledge domains and topics that are offered by all programs. These include:

**Health Systems**
- Biomedical & clinical processes
- Canadian healthcare system in general

**Information and Communication Technology**
- Computer programming and software engineering
- Data, security and standards
- Development & architecture
- Information systems
- Management and organizational systems
- Standards

**HI Processes**
- Change management
- Decision support
- Health information management
- HI Systems, applications and tools (eHealth, EHR, mHealth, etc.)
- Human factors & human computer interface
- Knowledge management
- Management and organizational systems
- Privacy and confidentiality
- Project management
- Systems analysis and integration
2) TO WHAT EXTENT DO HI CURRICULA IN CANADA DIFFER ACROSS PROGRAMS AND INSTITUTIONS?

While it is acknowledged that there are common skills and knowledge required going into the industry, those of the graduates of Canadian programs discussed in this report vary depending on where students are with respect to the education spectrum as well as their academic and professional goals (e.g. technician through doctoral research). Given the number of established HI educational programs, there is significant evidence to suggest that HI professionals can be trained and leaders developed versus the notion that they “accidentally” get into the field.

It is clear that there is significant divergence with respect to program attributes and curricular elements. However on the whole, because many of the programs were developed to meet industry needs, as opposed to a theoretical rationale, HI programs are generally not clearly articulated and/or transparent to the HI community and the education consumer. Many schools attempt to make available information about how they impact their students and the industry in which they practice, while newer programs do not yet have as much data to report. For example, in analyzing the information provided on program impacts, it was also evident that either the schools did not see “notable areas” - awards, scholarships, conference presentations etc. - as being germane to this report or they do not collect this type of information. Reporting program demographics, curriculum elements (including course descriptions and learning objectives), exit competencies or program outcomes, and program impacts in a consistent and/or standardized fashion would allow Schools to further differentiate themselves, especially where they are interested in promoting that they meet a specific niche in the market.

While all HI programs offer “core” knowledge domain and topical content, there are distinct differences among the degree levels and program types. Graduate programs are more likely to concern themselves with health systems topics than the diploma, certificate or undergraduate programs. Conversely, diploma programs are more likely to focus on ICT, and less likely to focus on HI processes than any other program. Certificate and undergraduate programs tend to have very similar knowledge domain distributions but are quite different in their pedagogical approach.

As each program type was examined in more detail, it became clear that while there were few differences with respect to knowledge domain scope, there were distinct differences with respect to content focus (e.g., ICT versus health systems) and pedagogical style. These differences could be explained when we viewed the curricula through the lens of the COACH HIP Career Matrix (2009b) and the expected professional competency levels for each program type’s graduates.

For the participating diploma programs, key knowledge domain themes tend to complement the developing emerging professional (COACH, 2009b). HI diploma programs focus on training in the design and use of concrete and technological tools to facilitate the integration of computer and information technology with healthcare systems. Curricula in these programs emphasize the design, development and implementation of rules-based tools and applications within the general scope of the healthcare context but with novice understanding of its complexity.
Certificate programs (post-diploma or post-degree) focus on the development of the emerging professional (COACH, 2009b), with additional degree level training on the use of HI fundamental functions and processes for the integration of Canadian healthcare and ICT systems. The increased breadth of knowledge domain scope indicates a holistic focus on the healthcare system where technology, clinical and generic management systems are considered in terms of patterns and principles (e.g., “standards”).

The focus of undergraduate programs is to develop a well-rounded competent health informatics professional (COACH, 2009b), who is trained to function competently across multiple knowledge domains: clinical, technological, organizational and academic or political. Compared to diploma and certificate programs, undergraduate health informatics education presents an expanded scope of HI knowledge domains at both the applied and theoretical or academic levels. Use of the term “health informatics” first appears at this level suggesting an emphasis on richer HI processes that encompass the clinical, biomedical and healthcare environments more deeply. This would seem to indicate that undergraduate programs are building competencies in HI knowledge translation as well as proficiencies in HI knowledge creation that facilitates accountable and active decision-making by the health informatics professional.

All graduate programs seek to develop the health informatics professional expert (COACH, 2009b), who is capable of creating new knowledge at a highly theoretical and advanced academic level. Graduate programs use the most eclectic array of pedagogical techniques and methods that expose students to both significant depth and breadth and most comprehensive mix of knowledge domains and topics. The graduate Health informatics expert competently (and ultimately expertly) applies that knowledge to facilitate and drive change across a complex, multi-dimensional patient-centred health care system including clinical, technological, organizational and political systems.

While there are distinct differences with respect to knowledge domain content focus; there is apparent overlap between certificate-diploma and undergraduate-graduate programs’ exit learning competencies. When examined through the lens of an ‘educational pathway’ perspective, that is, through “the series of educational processes, [students] undergo in their formal training” (Doray, Picard, Trottier & Groleau, 2009, p. 1), it appears that the exit competencies, categorized along cognitive process and knowledge dimensions, may or may not adequately specify clear junctures “that mark transitions – the passage from one type of education to another, one level to another or (within the same level), one program to another” (p.1). As such, an inference that health informatics students in general follow a linear educational pathway within levels in each grouping, or between groupings should be avoided.

According to Doray et al. (2009b), many students in fact set course on much more atypical pathways and “take more complex routes, punctuated by interruptions in studies or even return to lower levels of education” (as cited in Doray et al., 2009b, p. 1), “for example, enrolling in a college program after university” (Doray et al., 2009a, p. 1) which is probably true of many of the students attending programs featured in this report. As Doray and colleagues contend, an individual’s progression through higher educational pathways may have less to do with a progressive succession of steps or situations (2009b, p. 4), rather it may take on a non-linear and more flexible form (Doray et al., 2009b). To this point, it is clear, through an examination of program attribute data, that some HI programs target candidates that come directly from high schools or are new graduates, or Canadian and/or internationally educated professionals possessing a variety of health and/or information technology (IT) backgrounds, many of which are seeking a second career in eHealth.

The convergence of knowledge domains and exit competencies potentially allows for collaboration or course credit sharing in both core content and elective courses. An extension of the core content concept might be the potential for building a strong alignment and
Discussion

Cohesion among schools to allow students to both develop and march along their own pathway of interest in the fields of health information, health informatics, health information management, and the other related disciplines. Potentially, frameworks such as the one developed by Western Canadian Deans’ Agreement (Western Canadian Deans of Graduate Studies, http://wcdgs.ca/), whose purpose is “the reciprocal enrichment of graduate programs throughout western Canada [through] an automatic tuition fee waiver for visiting students” (para 1, 2), might open doors to such collaboration and allow for cross-institutional study.

This and other types of collaborative efforts also open the door for all schools to take advantage of existing knowledge and courses, evaluate current (or future) programs that will determine as well as address “gaps” in the HI education market and build or rebuild programs to take advantage of the knowledge of what is out there as well as the experiences of what has worked (or not worked). It can also result in a more sustainable mix of programs that services the needs of HI students and employers at the local, regional, provincial and national level.

Limitations

Given time limitations, lack of a theoretical foundation that would support a valid quantitative survey of HI education in Canada, as well as the practical needs of a heterogeneous sample of HI academic programs, it was felt that an interpretive qualitative research methodology using a framework approach would be more appropriate. This approach, being both systematic and developmental, allows the intended audience to be clear about the stages by which the results and conclusions were obtained. While remaining inductive, this methodology allowed for the inclusion of a priori as well as emergent concepts (Lacey & Luff, 2007). This process, albeit fraught with design limitations, was vital to answering the research questions addressed in this report.

Through this qualitative comparative review based on the Framework approach (Pope et al., 2000), a variety of HI program data sources, processes and measures were analyzed. Insights have been gained about the breadth and depth of available information in HI programs and many examples were provided in terms of how the information is used to describe rationales/theoretical underpinnings, attributes, curricular elements, outcomes and impacts of programs across the Canadian landscape.

However, readers are reminded that these insights (or theories) cannot be generalized to specific programs without further rigorous deductive study. The sample of participating schools and academic institutions was not representative; HI programs in development or otherwise over-represented (e.g., graduate programs at the University of Victoria) were not included – but may well impact the HI landscape significantly. Additionally, information collected from participants was not complete. For example, with respect to the availability of application and registration information, one might conclude from this report that only some institutions monitor their application and registration figures where in reality, most institutions do. The difference is due to incomplete information.

Finally, collected information was not standardized. There is no current or validated taxonomy of HI terms or vocabulary and not all programs described their attributes, curriculum elements, and outcomes using a consistent format or framework. Knowledge domain and topic categories were derived through grounded theory techniques from course codes, titles or generic terms that might have been offered (e.g. “two courses on IT”). Program outcomes were not reported using a standardized framework of classification (e.g. Bloom’s taxonomy) which resulted in a fair degree of latitude in interpreting and classifying the competency statements in the taxonomy table. Therefore this study should be interpreted with caution and readers (e.g., prospective students, program leaders, and the broader HI community) should consult with the program website and the program itself as needed.
Implications

The last research question addressed in this report is best answered through an examination of potential implications:

3) WHAT, IF ANY, ARE THE POTENTIAL INFLUENCES ON HI PROFESSIONAL DEVELOPMENT AND IDENTITY?

This report documents the identification of the diversity of the programs being offered across Canada and recognizes that many programs were developed to meet an industry need. There are also multiple points of entry into HI education to meet students’ goals and development of their HI professional identity.

The academic HI discipline has evolved from grassroots, and continues to evolve as opposed to stemming from other professions. HI academic programs were developed to meet both academic and industry market needs, with implicit (as opposed to explicit) theory. Similarly to what has occurred in the information technology industry, an implicit HI theory, emerging through need, will evolve through the growth and development of the discipline. As the academic HI discipline continues to advance, there will be more opportunities for further, more explicit, conceptual HI theory development. Through a cyclical inductive-deductive process, Health Informatics practice will likely continually inform the development of the discipline, and the discipline will in turn, continue to develop HI professionals to apply the body of knowledge and skills that lead to the development of their HI professional identity.

Given the current governmental imperatives surrounding the sustainment of publicly funded health care, and the national eHealth agenda, the health informatics discipline and profession will be subject to the forces and changes that are likely to ensue in this political landscape. Therefore, academic programs have to respond by engaging and collaborating with industry, academic and political partners to develop health informatics education and programming, and provide feedback mechanisms with all stakeholders including alumni, to appropriately respond to external forces that influence HI professional development and identity.
NEXT STEPS

There are opportunities for schools to better articulate their respective curriculum elements including knowledge domains, exit competencies (program outcomes), and their specific program attributes and impacts using agreed-upon structure (methodology) in order to make future comparisons more practical and useful. This would allow for greater clarity about what differentiates both levels (diploma, certificate, undergraduate, and graduate) and programs. Furthermore, an agreed-upon framework would facilitate better comparison with industry competencies such as those published by COACH (HIP Core Competencies Version 3.0, 2012).

While HI exit learning competencies in most programs are formulated for the 'entry to practice' level, some schools may wish to proceed with formal mapping of their curriculum against the COACH Core Competencies in order to determine the degree to which entry to practice competencies, as determined by academia (while influenced by industry through advisory structures in an ongoing way), are adequately aligned with COACH’s professional core competencies, as these undergo revisions every few years.

Given the evolving nature of HI, schools may also wish to review COACH’s Health Informatics Professional Role Profiles (2009), which were under revision at the time of this report, in order to help guide their most important stakeholder; students, regardless of program level (diploma, certificate, undergraduate, graduate), to plan their educational and career pathway. Students and faculty alike must clearly understand the array of current and emerging opportunities and be intimately familiar with the qualifications that are required of these positions, to meet industry needs.

It is also hoped that the information contained in this report can support Canadian HI programs to relate their own strategies for measuring and determining impact, to strategies used by other programs, which can lead to sharing of lessons learned. The ongoing sharing of information can result in synergistic collaborative opportunities between academia and its broad industry network, and in a description of the Canadian HI program landscape of deeper breadth and depth.

Lastly, this report has attempted to link curricular elements such as knowledge domains, competencies, and pedagogy to COACH’s HIP Career Matrix (2009b). It is therefore suggested that these theoretical assumptions be tested using more rigorous research methodologies. Such a project, should it come to fruition, should be a collaborative endeavour between COACH and academia.
**Glossary**

**COACH: Canada’s Health Informatics Association:** COACH is the national, Canadian professional association for health informatics. COACH represents a diverse community of accomplished, influential professionals who work passionately to make a difference in health informatics.

**Canada Health Infoway (Infoway):** Infoway is an independent not-for-profit organization funded by the federal government. Infoway jointly invests with every province and territory to accelerate the development and adoption of electronic health record projects in Canada.

**Canadian Institute for Health Information (CIHI):** The Canadian Institute for Health Information (CIHI), collects, analyzes and publishes data and information in a standardized way – A way that allows every jurisdiction to understand, compare and use the data and information effectively to make the decisions that lead to healthier Canadians.

**Canadian Health Information Management Association (CHIMA):** CHIMA is a not-for-profit professional association that represents more than 3,700 certified Health Information Management (HIM™) professionals from across Canada in addition to 1,300 affiliate, student and retired members.

**eHealth Conference:** Canada’s only national, annual conference dedicated to eHealth. Hosted by CIHI, COACH, and Canada Health Infoway, the conference is attended by HI professionals, clinicians, educators, students and more.

**Health Informatics (HI):** The intersection of clinical, IM/IT and management practices to achieve better health.

**HIP@School:** A COACH volunteer based committee that governs the Academic Institutional Membership (AIM) program and its associated products and services.

**Information and Communications Technology Council (ICTC):** ICTC is a not-for-profit sector council focusing on human resources planning to support the Canadian ICT industry and ICT workforce. ICTC tracks labour market trends for information and communications technology professionals, including estimates of future supply and demand trends.

**Information Technology Association of Canada (ITAC) Health:** ITAC-Health is an industry association representing more than 120 ICT companies in Canada that are actively engaged in supporting the application of information and communications technologies in the health sector. ITAC-Health is part of the Information and Technology Association of Canada.

**Program rationale:** Any stated reason for starting the program, acknowledging the needs of society or organizations.

**Program theory:** Any statement elucidating the underpinning theoretical framework for how the program was developed or is being taught, such as interdisciplinary teaching, developing self-directed learners.
References


## Background

COACH: Canada’s Health Informatics Organization has a strategic goal of enhancing the state of practice of health informatics as a profession. In addressing that goal COACH has convened a HIP (Health Informatics Professionalism) steering committee to oversee COACH’s activities in this domain.

A very important and fundamental aspect of the HIP initiative pertains to students and academic institutions, in light of the current and anticipated talent shortage in the industry. In order to advance HI as a profession, there is a need to attract, develop and/or retain various types of students including college, undergraduate, graduate, continuing education, etc. Engagement with the academic institutions that produce these graduates is essential to advance health informatics as a profession.

The HIP@school Task Force was originally convened in 2008 and has undergone several iterations. To date, the Task Force has accomplished several important tasks including launching the Academic Institutional Membership (AIM) program, Student Innovation Competition, and HIP Core Competencies Mapping Tool. Since the launch of the program (and associated products and services), COACH has developed a burgeoning relationship with many of the Canadian HI academic institutions.

At e-Health 2010 the HIP@School Task Force hosted an Academic Forum to discuss curricular issues in health informatics programs across Canada. This forum was well attended by representatives from almost all the health informatics programs in Canada. To continue the success of the Academic Forum discussion, the HIP@School Task Force invited the program representatives to join a subgroup called the Curriculum Discussion Working Group.

## Purpose

The purpose of the Curriculum Discussion Working Group will be to engage in thorough analysis that will describe the Canadian health informatics academic and educational landscape, and inform evidence-based development of a Health Informatics profession. The working group will build upon the groundwork laid by the HIP@School Task Force and other initiatives.
### Objectives and Duties

The working group objectives and duties can be summarized into three main areas of focus:

- **Encourage co-operation/collaboration within the community of academic institutions offering academic and educational HI programming**
  - Provide a place for information exchange among members
  - Build and maintain relationships with academic institutions

- **Assess ‘current state’ of HI curricula in Canada**
  - Observe and describe members’ current academic programming in terms of academic rationale or program theory, foci of curricular domains, pedagogy and learning outcomes or demonstrated competencies
  - Compare, contrast, and identify convergent and divergent HI curricular elements and learning outcomes among member HI programs.

- **Encourage awareness of HI curricula and inform evidence-based professional development**
  - Facilitate dialogue among participants about current HI curricula in Canada and its potential influence on HI professional development and definition.
  - Investigate current state/feasibility of articulation agreements between schools

### Deliverables

The Curriculum Discussion Working Group will issue an interim report to the HIP@School Task Force by June 30th, 2011 and a final report by November 30th, 2011 that will:

- **Describe for each HI academic program**
  - Rationale and/or program theory (e.g., research based, professional, or vocational, etc.)
  - HI knowledge domains and learning outcomes or competencies the program has chosen to focus upon
  - General curriculum elements and pedagogy that facilitate the achievement of the identified competencies

- **Describe convergent and divergent competency and curriculum elements across the programs and possibly compare with other jurisdictions as described in current literature**

- **Describe the potential influence of HI curricula on HI professional development**

- **Offer specific recommendations for further collaboration amongst educational institutions and between these institutions and COACH**

- **For existing academic programs, outline any lessons learned arising from evaluation of the program and/or from reflection on program development and implementation processes, and offer recommendations for improving or beginning HI programs**
### Composition and Appointment

- The Curriculum Discussion Working Group will elect co-chairs who will liaise on a regular basis with the chair of the HIP@school Task Force.
- The working group members will consist of program directors (or their appropriate delegates) from schools who have or are developing health informatics programs.
- At the discretion of the CDWG Co-Chairs, additional members may participate depending upon need and available expertise.
- Staff support to the Working Group shall be provided by the COACH Director, Programs and/or other COACH staff as required.
- The working group will seek input from HI students.

### Term of Office

The term of the Curriculum Discussion Working group will conclude with the completion of the final report, however it is expected the final report will contain recommendations for ongoing work and collaboration on this important topic.
The Cognitive Process Dimension

The structure of the Cognitive process dimension of the revised taxonomy (Krathwohl, 2002, p. 215) has six categories including:

1. **Remember** – ‘Receiving relevant knowledge from long-term memory’ which contains the following elements: Recognizing and recalling, listing, describing, retrieving, finding, identifying;
2. **Understand** – ‘Determining the meaning of instructional messages, including oral, written and graphic communications’ which contains the following elements: Interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining;
3. **Apply** – ‘Carrying out or using a procedure in a given situation’ which contains the following elements: Implementing, carrying out, using, executing;
4. **Analyze** – ‘Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose’ which contains the following elements: Organizing, deconstructing, attributing, interrogating, structuring, differentiating, organizing and attributing;
5. **Evaluate** – ‘Making judgments based on criteria and standards’ which contains the following elements: Checking, hypothesising, critiquing, experimenting, judging, testing, detecting, monitoring, and;
6. **Create** – ‘Putting elements together to form a novel, coherent whole or make an original product’ which contains the following elements: Designing, constructing, planning, producing, inventing, devising.

The Knowledge Dimension

The structure of the Knowledge dimension of the revised taxonomy (Krathwohl, 2002, p. 214) has four categories including:

1. **Factual Knowledge** – ‘The basic elements that students must know to be acquainted with a discipline or solve problems in it’, which contains the following elements: Knowledge of terminology and knowledge or specific details and elements;
2. **Conceptual Knowledge** – ‘The interrelationships among the basic elements within a larger structure that enable them to function together’ which contains the following elements: Knowledge of classifications and categories, knowledge of principles and generalizations, and knowledge of theories, models and structures;
3. **Procedural Knowledge** – ‘How to do something: methods of inquiry, and criteria for using skills, algorithms, techniques, and methods’ which contains the following elements: Knowledge of subject-specific skills and algorithms, knowledge of subject-specific techniques and methods, and knowledge of criteria for determining when to use appropriate procedures, and;
4. **Metacognitive Knowledge** – ‘Knowledge of cognition in general as well as awareness and knowledge of one’s own cognition’ which contains the following elements: Strategic knowledge, knowledge about cognitive tasks, including appropriate contextual and conditional knowledge, and self-knowledge.

Source: Anderson & Krathwohl, 2001
### Bloom’s Revised Digital Taxonomy Concept Map

#### KEY TERMS
- **Creating**
- **Evaluating**
- **Analyzing**
- **Applying**
- **Understanding**
- **Remembering**

#### HOTS
**Higher Order Thinking Skills**
- Designing, constructing, planning, producing, inventing, devising, making, programming, filming, animating, blogging, video blogging, mixing, re-mixing, wiki-ing, publishing, videocasting, podcasting, directing, broadcasting
- Checking, hypothesising, critiquing, experimenting, judging, testing, detecting, monitoring, blog commenting, reviewing, posting, moderating, collaborating, networking, refactoring, testing
- Comparing, organising, deconstructing, attributing, outlining, finding, structuring, integrating, mashing, linking, validating, reverse engineering, cracking, media clipping
- Implementing, carrying out, using, executing, running, loading, playing, operating, hacking, uploading, sharing, editing
- Interpreting, summarising, inferring, paraphrasing, classifying, comparing, explaining, exemplifying, advanced searches, Boolean searches, blog journaling, twittering, categorising, tagging, commenting, annotating, subscribing
- Recognising, listing, describing, identifying, retrieving, naming, locating, finding, bullet pointing, highlighting, bookmarking, favouriting/local bookmarking, searching, googling

#### LOTS
**Lower Order Thinking Skills**

#### COMMUNICATION SPECTRUM
- Collaborating
- Moderating
- Negotiating
- Debating
- Commenting
- Net meeting
- Skyping
- Video conferencing
- Reviewing
- Questioning
- Replying
- Posting & Blogging
- Networking
- Contributing
- Chatting
- eMailing
- Twittering/Microblogging
- Instant messaging
- Texting

Source: Churches, A. (2009). Used under a Creative Commons Attribution Share-Alike 2.5 License
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