Lakehead UNIVERSITY

Project 2016-24: Honours Bachelors in Computer Science (HBSc) – University Transfer Option

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Prepared for the Ontario Council for Articulation and Transfer

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Acknowledgements

This project represents the efforts and participation of many educators and researchers and administrators involved in the education of Computer Programmers and Computer Science professionals in Ontario.

We would like to document and acknowledge all those who played a key role in producing the pathways and/or envisioning future pathways that are outlined in this Final Report and look forward continued communication and educational alignment in the high speed, ever evolving field of technology.

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Project Purpose and Goals

The primary purpose of this project was to develop efficient and functional credit transfer agreements into the Lakehead University Honours Bachelor of Computer Science (HBSc) from Ontario colleges offering diplomas that aligned with the HBSc curriculum, research focus and vocational opportunities.

Sparked by consistent curriculum updates necessary to match the fast-paced evolution of information technology related post secondary education, the Faculty of the Computer Science department at Lakehead University recognized the opportunity and need to develop credit transfer pathways and relationships with colleges who offer vocational education credentials in cutting edge IT professions. This perceived need was reinforced through:

- Communications with various Ontario college contacts seeking increased transfer mobility for their graduates
- Recognizing consistent overlaps (and policy based barriers to transferring credit) in college and university content through the process of assessing individual college transfer students on a case-by-case, course-by-course basis.

Through the course of this project the goals and purposes were refined and adapted via shared communication with the partnering institutions. Key points derived from these communications include:

- There is a large demand for Information Technology trained professionals with diplomas matching the industry needs and predicted growth in each geographic college catchment area.
    - Note: Some participating Ontario colleges reported a perfect or near perfect hire rate for all Computer Programming related diploma graduates immediately upon credential completion
- Depending on the industry (Health Informatics, Web Development, Mobile Development, Database Administration) graduates from diploma, honours bachelor and masters programs may benefit from credit transfer agreements that aid mobility in all possible directions:
    - Diploma to Degree
    - Degree to Diploma
    - Post-Graduate Degree to Certificate/Diploma

Therefore the project purpose and goals evolved to include identifying multiple venues for credit transfer and increased mobility between the Lakehead University undergraduate and graduate level degree offerings in Computer Science and related Information Technology diploma programs in Ontario.

The results of this project include the development/identification of:

- Three diploma to degree block transfer agreements into the HBSc of Computer Science with three Ontario Colleges
- Potential for the piloting a multi-lateral block transfer agreement for all diploma graduates of the two year Computer Programmer Diploma in Ontario pending the success of future block transfer students sent from the program specific pathways developed in this project
- An acceptance agreement between Honours Bachelor degrees offered by an Ontario college and the Masters of Computer Science program at Lakehead University
- An accelerated diploma/certificate for both HBSc and Masters level students seeking entry into a specific/specialized Information Technology (IT) industry

Pathway Development

Methodology, Analysis and Timelines

April 2016	**Institutional Partnerships**: To initiate this project, faculty from Lakehead University contacted Program Coordinators and Deans from a variety of related Ontario college diploma programs to confirm their participation and identify diplomas that would be best served by the pathway development process. Factors influencing this process included: • Building on pre-existing relationships between IT faculty and administration between institutions • Geographic proximity of Ontario colleges to Lakehead University's Thunder Bay campus • The availability of similar Honours Bachelor level credentials offered by the participating college • Industry demand for a specific credential in the college's catchment area and variations in the desirability and necessity for credential upgrades to facilitate workforce entry. In addition to partner relationship building processes, the Department of Computer Science began the recruitment process for hiring a Project Manager (PM). After a lengthy competition process, there were limits in suitable candidates available during the Spring/Summer period for a limited term contract and so the hiring of a PM was delayed until Fall of 2016.
June 2016	**Georgian/Lakehead Meetings** Lakehead University faculty travelled to Barrie, Ontario and met with Georgian College Computer Programming Program Coordinator and faculty and through consultation and meetings established: • The credentials which would be best suited to examine for a block transfer agreement • The types of curricula which overlap between the identified credentials • The future of their respective IT programs in the context of annual technology advancements that can require a nimble curriculum development strategy in relation to other types of science credentials

July/August 2016	**Database Development** Building on identified credentials and partner institutions, two undergraduate research assistants established a database of courses and course descriptions from all potential sending institutions (Confederation College, Georgian College, Sheridan College, Seneca College and Humber College) as well as the specific course requirements and policies for both the HBSc in Computer Science - Science Focus and Business Focus degree options offered at Lakehead University.
September/October 2016	**Gap Analysis Database Refinement** A Project Manager was hired in September of 2016 and a series of processes were initiated: 1. The database of course descriptions was updated to include learning outcomes from all potential sending institutions. 2. The learning outcomes, course descriptions and content of all potential sending institution credentials were compared to the Published Program Standards provided by the Ministry of Advanced Education and Skills Development (formerly the MTCU) to assess for similarities across multiple credentials 3. Based on the wide degree of variation in content between Ontario IT diplomas identified during the examination of Published Program Standards, the Project Team elected to focus pathway development efforts on geographically proximal partners in the short term (Confederation College and Georgian College) to best serve local industry and students seeking credentials in the areas adjacent to Lakehead University campuses. 4. A part time research assistant was hired to convert the database of course content and learning outcomes into an online database and learning outcome comparison tool which would assist faculty and administration in comparing overlaps and gaps between credentials. 5. The Dean and faculty members of Confederation College attended a meeting at Lakehead University to discuss the needs of IT industry in Thunder Bay and indicated that the HBSc of Computer Science - Business Focus degree option would likely be the most beneficial credential for potential transfer students.
November 2016	**Learning Outcome Development and Specializations** To facilitate an assessment of college and university based learning outcomes, the Department of Computer Science at Lakehead University embraced the idea of developing detailed, specific and comprehensive course level learning outcomes to facilitate a transparent credit transfer process.

	After the extensive review of Learning Outcomes (LOs) across IT programs, faculty recognized that LOs can often be vague and allow for a wide variety of course content delivery without identifying what is specifically taught. As a result of this insight, the HBSc Computer Science faculty requested the provision of a Learning Outcome Workshop to facilitate the writing of course level learning outcomes that: • Contained an action verb that was directly associated with and easily identified as relating to the appropriate level of Bloom's Taxonomy of Learning • Contained enough content and details on the skills, software languages and technical content covered in the course to ensure that when it was reviewed by a college faculty, they could easily match the outcomes, skills and content to their course content and outcomes • Were laddered in sequence throughout all courses in the four year degree structure to match the overall program learning outcomes aligned with Undergraduate Degree Level Expectations (UDLE) o In this process the IRP acronym was helpful to identify where skills and competencies were **I**nitiated, **R**einforced and at what point **P**roficiency has been attained Based on the efforts of the HBSc Computer Science faculty and their work on learning outcome development, detailed learning outcomes were established for courses, particularly those being assessed for credit transfer. In addition, the revised learning outcomes contributed to a new degree specialization (Health Informatics) which has been identified as a necessary credential for the IT industry in Ontario by two of the partnering colleges in this project. Finally a tele-conference between the Georgian College Computer Programmer Program Coordinator, the Lakehead University ONCAT project team and the Lakehead/Georgian Partnership Lead took place to re-align our respective institutions in light of potential program changes taking place in the 2017/18 and 2018/19 curricula.
December 2016/January 2017	**Learning Outcome Gap Analysis** With an established list of learning outcomes, Lakehead University faculty identified areas of content overlap between the programs being assessed and constructed a preliminary list of overlapping college and university courses with learning outcomes attached. A list of courses containing overlapping

	content was sent to the participating colleges to review and adjust as necessary. Despite efforts to complete the online learning outcome gap analysis tool before 2017, the software was not yet functional and therefore the project team elected to create an online gap analysis survey using Google Forms. This process included: • Uploading all overlapping courses between the two institutions with learning outcomes to the online survey and arranging matching courses in sequence for analysis. • Allowing for review and collaboration by faculty of each institution. Upon initial review, one college program coordinator identified college courses that overlapped with university courses but were not included in the online survey. The process of collaborating and refining the online survey between institutions was a positive and productive one. In future online surveys that involve course comparisons, all institutional partners should be included as collaborators on any learning outcome and course-matching database as the process leads to enlightening discussions towards pathway development. • The finalized survey for each institution pair (Georgian/Lakehead and Confederation/Lakehead) was sent to all faculty in each respective department to assess the course matches and learning outcomes by: o Reviewing the course level learning outcomes and indicating a percentage of content/skills overlap per course o Identifying if they recommended each course be given as a transfer credit (Yes or No) o Providing comments on the quality of the learning outcome match and also any questions regarding the skill sets/competencies and learning outcomes that were not evident in the survey. While the survey was being conducted, the Project Manager reviewed degree policies and pre-requisite course requirements to ensure that future drafts of transfer pathways resulting from the survey would not include credits which run in to unnecessary stumbling blocks in future approval processes or for future block transfer students applying for graduation.
February 2017	**Transfer Pathway Development** The results of the online survey were analyzed and synthesized into presentations and first draft block transfer pathways.

	Georgian College Associate Dean of Design, Computer Programmer Program Coordinator and faculty travelled to Lakehead University on February 27/28 to engage in an extensive review of the learning outcome gap analysis survey results and also a collaborative course mapping exercise. The outcomes of this meeting include: • Agreement on a draft block credit transfer degree curriculum from the Computer Programmer Analyst Diploma at Georgian College to the HBSc Computer Science undergraduate degree offerings at Lakehead University • Agreement on Bridge curricula and also potential courses which would act as exemptions. • Identification of curricula for an accelerated diploma or certificate offered by Georgian College for HBSc direct entry graduates and domestic/international Masters students seeking employment in Southern Ontario. • Continued communication and shared course refinement between respective programs to embrace the evolution of IT in Ontario's post-secondary sector. Communication between Sheridan College and Lakehead University, while ongoing through January and February resulted in the identification of a pathway from the Sheridan College HB in Computer Science to the Masters in Computer Science at Lakehead University. This pathway will require further negotiation with respective departments and administration at both institutions. A Gap Analysis survey and draft block transfer pathway was formulated specific to the Sheridan College Computer Programmer diploma and may be conducted or refined once Sheridan has completed program changes for the 2017/18 academic year. Significant progress was made on the online gap analysis tool with the intention of piloting it for the Sheridan College pathway. It has value as a database tool allowing post-secondary institutions to track changes in learning outcomes and courses live and in real time. Screen shots of the User Interface are included as Appendix C and a trial of the pilot This online gap analysis and learning outcome database tool is likely to be tested in future pathway development projects at Lakehead University. If functional, it may become available for multiple institutions.

March 2017	**Finalizing Transfer Credit and Approvals** Over the course of March the following steps have been initiated: • Confederation College Dean and Associate Dean of Aviation, Technology and Trades, Computer Programmer Diploma Program Coordinator and faculty members will be visiting the Lakehead University campus on March 21st to review the online survey results and first draft of a block transfer curriculum. • Departments involved in the delivery of courses assessed for block transfer credit are being consulted to finalize decisions for non-computer science courses included (Math and Business) • Faculty of Graduate Studies Office contacted regarding direct pathway from HBSc at Sheridan College to Masters in Computer Science at Lakehead University • Georgian to consider developing accelerated diploma/certificate for Lakehead University HBSc and MSc Computer Science graduates

Bridge Curriculum

Throughout the gap analysis process, all participants in the online survey and in-person consultation process have identified two key gap areas between the HBSc in Computer Science and IT related diplomas:

- Within a Science focus degree program, students learn the theory and foundations of computing with an emphasis on computational science and algorithm building. Therefore, different programming languages are sometimes more useful in teaching the 'science' of computing than programming languages used by Ontario colleges, whose focus is primarily to teach programming languages which are best suited for industry. In this project, the ability to perform advanced programming in the C/C++ language emerged as a skill which will need to be bridged for block transfer students

- The ability to manage Data Structures within the C/C++ programming language emerged as a secondary gap area in that the degree level science of computing often requires deep understanding to be applied in the construction and manipulation of various data structures (e.g. link list, stack, queue, tree, graphs and dictionaries) whereas the level of data structures taught at the college level provides a more practical exposure to some of these structures which serve as complimentary knowledge required for object oriented programming in Java.

Founded on the results of the gap analysis, the Lakehead University faculty responsible for teaching courses in C/C++ programming as well as Data Structures see value in offering a half course equivalent in the Spring/Summer semester which focuses primarily on building the skills and competencies necessary to access upper year level courses in the HBSc through the block transfer pathway. Of note, Georgian College Computer Programmer faculty are also in the process of developing courses that cover the gap content areas. Both departments have agreed in principle that transfer students may be exempted from this bridge course if their college program includes the proposed college level "Data Structures in C++" course. (Note: course title is a draft and may change after the publication of this report.)

Finally, the Project Team identified that, depending on the program, some of the college sending institutions may have diploma graduates who have not completed a Grade 12 'U' level calculus course which is required to register for the Math courses embedded in Lakehead University's HBSc Computer Science degree. As of the writing of this Final Report, the department of Computer Science at Lakehead University is willing to review and potentially accept pre-calculus equivalents offered by the partnering colleges. The Lakehead University Math Department see value in offering a summer "pre-calculus" bridging course for students who do not have this mandatory pre-requisite pending a ten student enrollment minimum.

Block Transfer Pathways

Before discussing the components of the current block transfer pathway drafts, it is necessary to review details regarding the credentials offered at Lakehead University that were included in the gap analysis and pathway development process:

Lakehead University Computer Science Degree Variations

The HBSc in Computer Science has two distinct options. Students, upon entry, must elect to take the Science Focus pathway or the Business Focus pathway and can also select a degree specialization area. Both degree foci and the following specializations were taken into consideration within the block transfer pathway development process as 'value added' for potential transfer students.

- The Science Focus contains mandatory electives in the Faculty of Science (excluding Engineering courses) that contribute to depth and breadth of knowledge in the field of Science.
- The Business focus contains a sequence of courses offered by the Faculty of Business Administration that are designed to allow Computer Science graduates to also be eligible for an Entrepreneurship Certificate upon graduation.
- A Specialization in Game Programming includes taking three half course equivalents related to components of game programming and an associated elective to demonstrate depth and breadth of knowledge. It is currently offered.
- A Specialization in Health Informatics includes taking three half course equivalents related to various aspects of health information management and database organization/analysis and an associated elective to demonstrate depth

and breadth of knowledge. It is currently undergoing approval processes with an intended start date of Fall 2017.

Drafts of transfer-mapped curriculum have been distributed to one of the participating colleges and has gone through extensive revisions based on both university and college faculty consultations. The process of refining and consulting on the final drafts of these pathways will continue beyond the final report for this project.

Entry requirements include having a completed diploma from the aforementioned programs with an overall minimum average (e.g. 70%). Based on the college curriculum offered by partner institutions and feedback from all stakeholders in the block transfer development process, diploma graduates from sending college institutions are very likely to be successful in the HBSc Computer Science with the agreed upon average.

A brief summary of pathway development for each unique pathway is addressed below and is representative of the most recent pathway drafts as of April 1st, 2017. A diagram of all diploma to degree pathways explored/developed during the course of this project are included as Appendix A and potential degree to diploma pathways are included as Appendix B.

Georgian College Computer Programmer Analyst Diploma (Three year program) to HBSc in Computer Science

Based on a strong foundation in mobile application development, object oriented programming, industry focused co-op and creative programming curriculum in multiple languages, Georgian College COPRA diploma graduates have a skill set well matched to fast paced growth and demand for IT professionals in Simcoe County.

The most recent draft of the block transfer agreement allows graduates of the three year COPRA diploma at Georgian College with an average of 70% or greater to receive 10 Full Course Equivalents of credit (equal to four semesters or two years of study) towards the HBSc of Computer Science.

In addition, pending final approval, block transfer pathway students may be able to structure their courses to meet the requirements for the Certificate in Entrepreneurship from the Faculty of Business Administration (only available to HBSc Computer Science – Business Focus students) and also for all available degree specializations.

Georgian College Computer Programmer Diploma (Two year program) to HBSc in Computer Science

In addition to the three year COPRA program, the two year Computer Programmer (CP) diploma was assessed for credit transfer. Through in person consultations and email communications, a list of transfer eligible courses that are available through the three year COPRA but not available in the two year CP diploma, was made available under the premise that both institutions would analyze and, if appropriate, modify their programs to facilitate a transfer agreement without compromising the academic integrity of the programs involved. This work is underway at both institutions.

Pending further modification, the most current iteration of the block transfer pathway between the 2 year CP diploma and the 4 year HBSc in Computer Science allows graduates with an average of 70% or greater to receive up to 8.0 Full Course

Equivalents of credit (equal to ~three semesters or one and a half years of study) towards the HBSc of Computer Science with a mandatory bridge to be completed prior to entering third year.

In addition, pending final approval, block transfer pathway students may be able to structure their courses to meet the requirements for the Certificate in Entrepreneurship from the Faculty of Business Administration (only available to HBSc Computer Science – Business Focus students) and also for all available degree specializations.

Confederation College Computer Programmer Diploma (Two year program) to HBSc in Computer Science

The Confederation College Computer Programmer Diploma provides a much-needed educational credential for meeting the high demand for IT professionals in North Western Ontario with curriculum strengths including Object Oriented Design, Software Engineering and also Database Management.

The current draft of the block transfer pathway between the 2 year CP diploma and the 4 year HBSc in Computer Science allows graduates with an average of 70% or greater to receive up to 8 Full Course Equivalents of credit (equal to three semesters or one and one-half years of study) towards the HBSc of Computer Science. Once again, there is a mandatory bridge requirement that must be completed prior to entering third year.

In addition, pending final approval, block transfer pathway students may be able to structure their courses to meet the requirements for the Certificate in Entrepreneurship from the Faculty of Business Administration (only available to HBSc Computer Science – Business Focus students) and also for all available degree specializations.

Lakehead University HBSc and MSc in Computer Science to Vocational/Industry Based Credential at Georgian College

Through in person consultation both project teams identified that a core group of students graduating from a degree level credential at Lakehead University, particularly those who have a highly theoretical specialization or research area, may benefit from an additional college level credential to gear their computer programming skills towards entering the workforce.

With a large cohort of international students, our project team also identified that mobility pathways should be available for students to move to popular urban centers and assist them in entering the workforce, particularly in Southern Ontario.

Georgian College faculty and administration agreed, at the time of this report, to review the content gap analysis and reverse engineer it to find gaps that might lead to a selection of Georgian College courses and educational experiences to meet this need.

Currently, the following areas of vocation focused expertise are being explored:

Advanced Object Oriented Courses (UML) - Unified Processes/CRUD Matrix/Requirement Application Advanced Data Network Design - Practical routing/assigning/troubleshooting/IGP protocols - Windows Server Administration and the Administration of Linux systems

Sheridan College HBSc in Computer Science to MSc in Computer Science

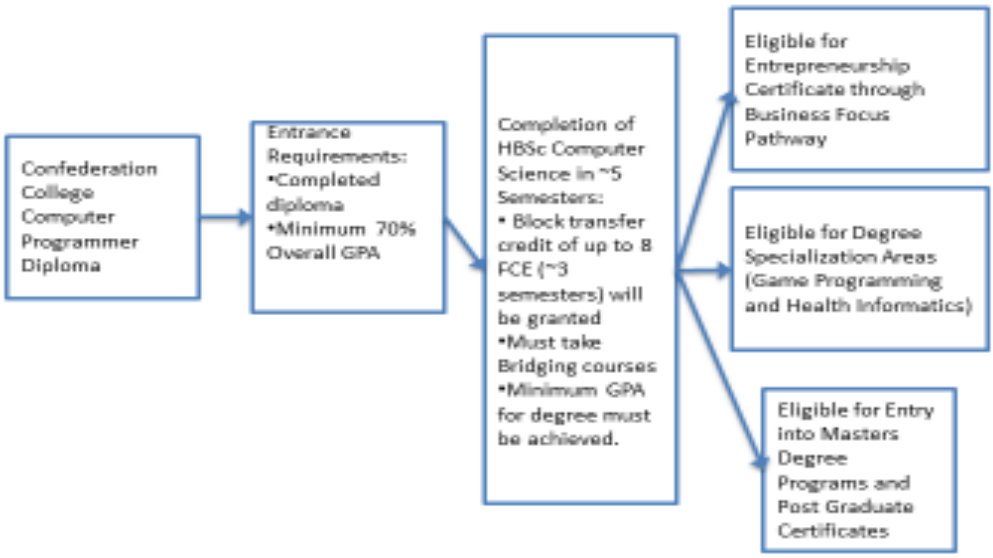
Through a series of email communications with Sheridan College the project team identified a potential direct pathway into the MSc Computer Science for HBSc in Computer Science graduates from Sheridan College. This mobility option will provide students with increased assurance of acceptance, a streamlined application process and an increased opportunity to access funding for their graduate studies. As of the writing of this report, the project team has reached out to Sheridan associates for a review of agreement terms.

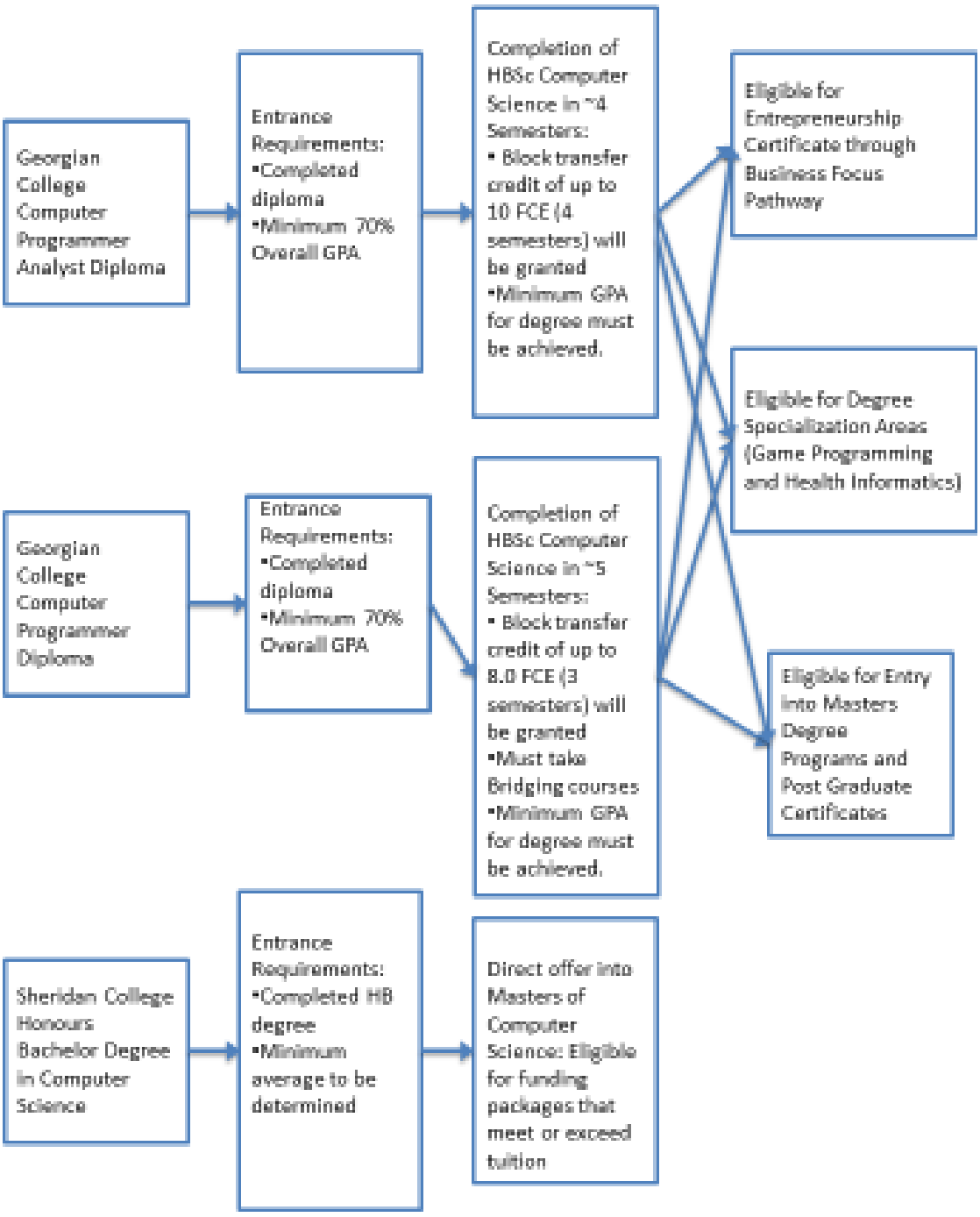
In addition, the project team has developed a diploma to undergraduate degree gap analysis survey specific to Sheridan's two year Computer Programmer diploma program. Based on upcoming changes in the Ministry of Advanced Education and Skills Development criteria for Computer Programming diplomas, Sheridan College will not engage in the gap analysis project by the time this final report is complete however the relationship will continue beyond the granting period and has the potential to lead to the establishment of an diploma to degree block transfer pathway.

Implementation Process and Timelines

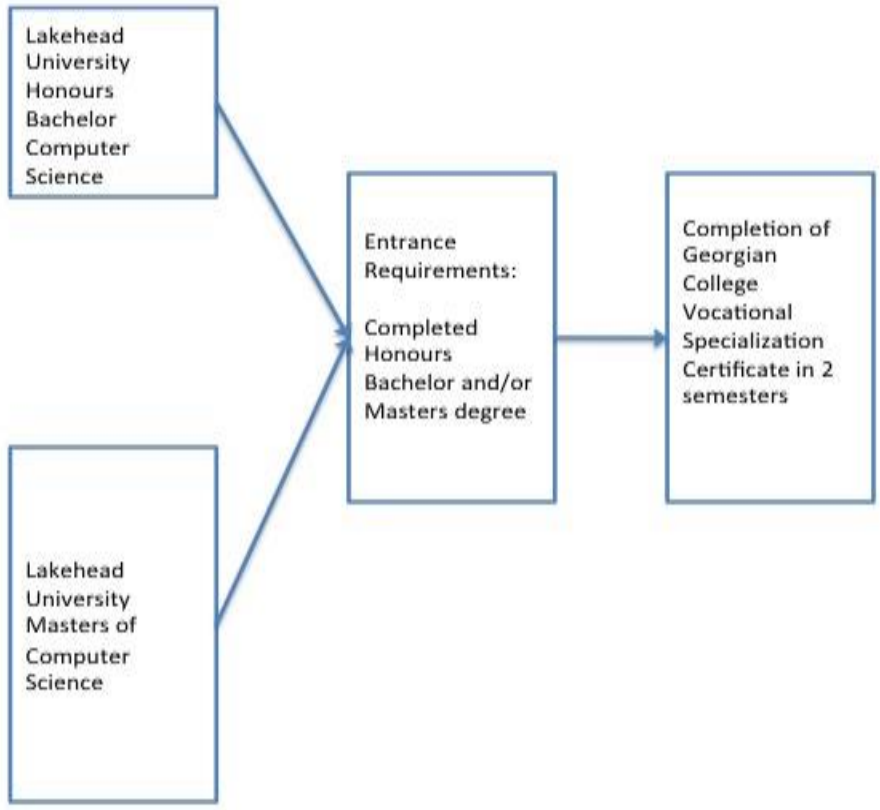
Transfer Pathway	Current Approval Level	Target Implementation Date
Georgian College COPRA diploma to Lakehead HBSc in Computer Science	College and University faculty have discussed first draft and requested revisions for consideration of Final Approval.	Fall 2018
Georgian College CP diploma to Lakehead HBSc in Computer Science	College and University faculty have discussed first draft and requested revisions for consideration of Final Approval	Fall 2018
Confederation College CP diploma to Lakehead HBSc in Computer Science	College Faculty to approve and request revisions on first draft of Transfer Pathway	Fall 2018
Sheridan College CP diploma to HBSc in Computer Science	College administration to move ahead with gap analysis process	Fall 2019 (pending college engagement)
Lakehead University HBSc and MSc to Georgian College Specialization Certificate	College faculty in the process of formulating curriculum	Fall 2018
Sheridan College HBSc in Computer Science to Lakehead University MSc in Computer Science	Informal approval gained from Graduate office at Lakehead University. Requires formal verbal agreement to proceed from College administration	Fall 2017

Appendix A - Diploma to HBSc and MSc Computer Science Degree Pathways




Georgian College Computer Programmer Analyst Diploma
Entrance Requirements:
•Completed diploma
•Minimum 70% Overall GPA
Completion of HBSc Computer Science in ~4 Semesters:
• Block transfer credit of up to 10 FCE (4 semesters) will be granted
•Minimum GPA for degree must be achieved.
Eligible for Entrepreneurship Certificate through Business Focus Pathway
Eligible for Degree Specialization Areas (Game Programming and Health Informatics)
Georgian College Computer Programmer Diploma
Entrance Requirements:
•Completed diploma
•Minimum 70% Overall GPA
Completion of HBSc Computer Science in ~5 Semesters:
• Block transfer credit of up to 8.0 FCE (3 semesters) will be granted
•Must take Bridging courses
•Minimum GPA for degree must be achieved.
Eligible for Entry into Masters Degree Programs and Post Graduate Certificates
Sheridan College Honours Bachelor Degree in Computer Science
Entrance Requirements:
•Completed HB degree
•Minimum average to be determined
Direct offer into Masters of Computer Science: Eligible for funding packages that meet or exceed tuition

Appendix B - HBSc and MSc Computer Science Degree to Certificate Pathway



Appendix C - Online Gap Analysis Tool Visual Examples