

Exploring the Integration of Micro-Credentials in a Typical Canadian Construction Management Degree Program

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This paper reports on the first part of a study aimed at integrating micro-credentials in a construction management program. Course instructors teaching in George Brown College's Honors B.Tech. Construction Management (CM) program generated potential micro-credentials for the program's courses which were analyzed in relation to the program's learning outcomes. A majority of the proposed micro-credentials are competency-based micro-credentials, requiring direct authentic assessment of evidence demonstrating learning outcomes of skill. This, according to the literature reviewed, will lead to mastery of specific skills by earners of micro-credentials. The proposed micro-credentials authenticate eight CM competencies. Feedback obtained indicates that the CM competencies of interpreting and using construction information, as well as applying CM technologies for scheduling and estimating have a higher relative importance of authentication by micro-credentials. Potential strengths of integrating micro-credentials in a CM program include verifying that a learner has acquired skills in specific areas of CM that differentiate them both academically and professionally, while a significant challenge is assessments associated with micro-credentials may be cumbersome to administer, which may necessitate changes to faculty workload. General feedback indicates preference for a CM degree embedded with micro-credentials from an average ranking program as opposed to one without micro-credentials from a high ranking program.

Key Words: B.Tech, Canadian, Construction Management, Degree, Micro-Credentials

Introduction

The world is currently in the fourth industrial revolution or industry 4.0 (i4.0) (Rüßmann *et al*., 2015) which is characterized by both technological and process innovations. While these innovations are impacting our daily lives, higher education seems to be slow in adopting these new innovations and technologies. Chao (2017) argues that in spite of various efforts on student-centered learning, including the use of information and communication technology (ICT) in education, higher education is barely keeping up with the needs of industry and contemporary social life in i4.0. In this regard, the World Economic Forum (2016) argues that higher education needs to place more emphasis on skills acquisition. The World Economic Forum (2016) also urges that in addition to providing certifications for students upon completion of their studies, the higher education community must adopt technologies and innovations, and adapt their delivery models to better address the issue of students who face disruptions in the completion of their programs. This challenge, according to the World Economic Forum (2016), may be addressed by creating micro-certificates or micro-credentials that recognize the level of knowledge or skills acquired by the sum of a person's education until the moment of interruption. Based on this, micro-credentials represent a way of acknowledging achievements or skill acquisition at a more granular level than a formal college degree.

While the extent to which new technologies and innovative processes will disrupt the delivery of Construction Management (CM) degree programs is unclear, it is apparent that Canadian colleges and universities, more pointedly, the Canadian Colleges of Applied Arts and Technology (CAAT) that offer such applied programs, will need to consider various innovative approaches to better meet the needs of students and industry. Micro-credentialing in the form of verified digital badging could be the solution needed to successfully chronicle CM students' skills development and allow employers to understand and trust their technical and soft skills

achievements. In this regard, the goal of this study is to explore the integration of micro-credentials in a typical Canadian Construction Management Bachelor's degree program, which to-date, has never been done in any structured fashion. This study represents an initial step in the application of an innovative approach to provide CM students with a learning framework that meets their evolving needs, as well as provides benefits to employers. The specific objectives of this study, therefore, are: 1) propose micro-credentials for a Canadian Bachelor of Technology (B.Tech.) CM program; 2) analyze the proposed micro-credentials to determine their relationship with program learning outcomes and competency development; and 3) highlight feedback concerning the usefulness of integrating micro-credentials in existing CM degree programs.

It is expected that the findings of this study will be useful to both CM academics and higher education administrators as it will highlight how micro-credentials can be integrated in existing CM degree program.

Literature Review

Styles (1999) defines credentialing as a process used to verify that an individual has met defined standards established by a group charged with creating and implementing these standards. In terms of micro-credentialing, Davies et al. (2015) argue that miniaturizing the process of credentialing was motivated by the need to recognize learning on a smaller scale and offer multiple pathways that enable formal and informal learning approaches. Based on this, micro-credentialing is a non-traditional learning pathway where students gain skill-sets in a specific technical area and receive a credential within a matter of days, unlike multi-year programs that require both lengthy time and financial commitments (DEVOPSdigest 2017). Florentine (2017) adds that micro-credentialing is the process of earning a mini-certificate in a specific, highly focused topic area, which is then used to demonstrate mastery of that specific topic or skillset. Mastery refers to having both comprehensive knowledge of a topic as well as superiority in a skill or competency (IMS Global Learning Consortium, 2018).

Micro-credentials can take various forms which include: digital badges, e-portfolios, verified certificates, or other tools that provide earners with a way of signaling competencies and skills through a growing system emphasizing evidence-rich credentials (Friedman 2016). Knapp & Associates International, Inc. (2014) describes the purpose of micro-credentials as being used to recognize completion of formal or informal learning and/or representing completion of an assessment.

Willis et al. (2016), in reviewing micro-credentials and educational technology, identified a series of ethical issues related to shifting power, archiving the future, and building trust that need to be addressed in order for micro-credentials to be successful. Knapp & Associates International, Inc. (2014) identified six challenges associated with micro-credentialing, including devaluing and cannibalizing current certifications offered and undermining the value of certification for the whole certification industry. In contrast, Netzer (2016) argues that micro-credentials will benefit millennials who want to instantly port their credentials to show employers their certifications and competency skills earned during their college journey. Kirver & Riksen (2016) posit that when micro-credentials are supported by digital badges, education institutions can present the education they offer in smaller units, primarily to their own students, to students enrolled at other institutions, and as contract education to other groups; all of which benefits the various stakeholders involved the certification process.

A common type of micro-credentialing is the use of digital badges. A digital badge is similar to a physical badge in that it communicates to the public that the holder of the badge has a specific competency or ability. According to Portfolium (2018) there are two types of badges, i.e. achievement badges and competency badges. Achievement badges are issued upon the completion of one or more transactions, "scored" on pass/fail, while competency badges represent direct qualitative measures of competencies and are issued as a result of some performance assessment (Portfolium, 2018). In addition, competency badge issuance is triggered when some machine or human evaluator completes a direct authentic-assessment of evidence or artifacts that demonstrate learning outcomes of skill (Portfolium, 2018). The issuance criteria, according to Portfolium (2018), is directly linked to an underlying rubric authored by the badge's issuer, used by an evaluator to score competency evidence. In addition, the issuer may determine a score threshold at which a badge is to be awarded, and can make that threshold transparent to the public (Portfolium, 2018).

So, why are micro-credentials, most notably badges, worthy of serious consideration in CM-related higher education now? Simply, as Irvine (2018) argues, they provide clear, digestible information about what the learner knows and has done (and therefore should be able to continue to do) in language and classifications that are portable and easy to consume and trust.

It is apparent that micro-credentialing has not yet been completely integrated in a CM bachelor's degree program. In addition, it is not clear as to which CM program learning outcomes and skills will be impacted through integration of micro-credentials, as well as industry's perceptions with respect to the usefulness of this type of degree delivery framework. It is, however, apparent that micro-credentials in the form of competency digital badges will be useful to CM students as it will allow them to better demonstrate their mastery of specific CM skills and competencies to prospective employers by easily porting and sharing these verified credentials. This research study will therefore focus on exploring the integration of micro-credentials in an existing Canadian CM bachelor's degree program and will highlight how the integration of micro-credentials will address the program's learning outcomes in terms of knowledge and competency attainment.

Method

The research study's method consisted of three parts based on its objectives and shown in the figure below.

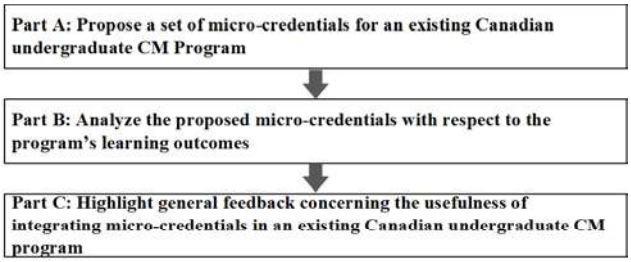

Figure 1: General overview and sequence of the research study's method

Part A was done by reviewing the curriculum of George Brown College's (GBC) Honors (B.Tech.) CM program and consulting with course instructors to determine suitable micro-credentials for each course. The curriculum from GBC's Honors B.Tech. CM program was selected and utilized based on the authors' familiarity with it, as well as the program being accredited by the Chartered Institute of Building (CIOB), having reciprocity with the American Council for Construction Education (ACCE). Based on this, GBC's Honors B.Tech. CM program has many similarities with comparable programs offered in both the US and UK. Part B of the study was done by analyzing each proposed micro-credential in the context of its parent course to determine which program-level outcomes were addressed. A mapping was done to highlight program-level outcomes achievement along with specific competencies that were authenticated by the proposed micro-credentials. Finally, Part C of the study was done by administering a survey to experienced course instructors and industry practitioners to gather their feedback on the effectiveness of the micro-credentialing approach in the delivery of CM education. The survey instrument consisted of 6 questions which addressed risk, competitiveness and usefulness of various types of micro-credentials. The survey instrument also gathered feedback the importance of authenticating various CM competencies by micro-credentials and the strengths and challenges associated with micro-credentials. A total of 25 participants were surveyed for this study, of which 15 responded (response rate = 60%). Of the 15 respondents, three were human resource professionals working in the construction industry, three were course instructors, and nine were industry practitioners.

Results and Discussion

Part A: Proposed Micro-Credentials

Course instructors were invited to propose micro-credentials which were then checked for relevance and distilled to remove repetition. This was done by adhering to the following two guidelines:

1. Each micro-credential had to be unique and encountered once by learners as they transitioned through the degree program, except for learners that were required to repeat a course that contained a micro-credential. This helps to ensure the relevance and value of each proposed micro-credential, both as a learning tool as well as an authenticated achievement that earners could use to highlight various competencies to prospective employers.
2. Most micro-credentials were required to be competency-based, i.e. their award was required to be based on direct authentic assessment of evidence that demonstrate learning outcomes of competency. This was required to ensure that most of the proposed micro-credentials are not automatically earned by all students, but only by those who have demonstrated a mastery of a specific competency. In this way, the proposed micro-credentials are relevant and accurate indicators of competency that prospective employers can rely on when judging a student's or graduate's skills and abilities.

GBC's Honors B.Tech. CM program consists of 54 courses. A total of 29 micro-credentials were generated from 22 courses, of which 18 of the micro-credentials are identified as competency-based and 10 are identified as achievement or completion-based. Table 1 highlights the micro-credentials generated for 22 of the program's courses. Five of the 10 completion-based micro-credentials are associated with the Semester 2 course: *Construction Health and Safety*. The reason for this is it is mandated that these certificates are awarded to students upon successful completion of this course in order for them to work on or visit construction sites in the Province of Ontario. Year 1 of the program has the greatest number of micro-credentials, while Year 4 has the least. One implication of this is that most of the program's micro-credentials will be awarded before students embark on the co-op work term at the ending of Year 3.

Table 1: Micro-credentials generated for the program's courses

Semester No.	*Course Title*	Micro-Credential No. & Name	Type
		Year 1	
Semester 1	*Residential Construction Technology*	**S1-A**: Blueprint Reading for Housing Construction	Completion
	Construction Materials Testing & Analysis	**S1-B**: Implementation of 28 Day Concrete Compression Test	Competency
		S1-C: Implementation of Atterberg Limits Test	Competency
Semester 2	*Introduction to Building Information Modeling*	**S2-A**: Use of Revit for Drafting	Completion
	Building Codes and Regulations 1	**S2-B**: Interpretation of Part 9 of the Ontario Building Code	Completion
	Construction Health and Safety	**S2-C**: Fall Protection Certificate	Completion
		S2-D: WHMIS Certificate	Completion
		S2-E: Working in Confined Space Certificate	Completion
		S2-F: Rigging Certificate	Completion
		S2-G: Traffic Control Certificate	Completion
		Year 2	
Semester 3	*Construction Estimating 1 – Quantity Surveyin*	**S3-A**: Estimating Using MS Excel	Competency
Semester 4	*Construction Estimating 2 – Pricing*	**S4-A**: Estimating Using Planswift	Competency
	Commercial Construction Technology	**S4-B**: Blueprint Reading for Commercial Construction	Completion
	Building Codes and Regulations 2	**S4-C**: Interpretation of Part 3 of the Ontario Building Code	Completion
	Construction Project Management 1 - Planning	**S4-D**: Scheduling with MS Project	Competency
		S4-E: Scheduling with Primavera	Competency
		Year 3	
Semester 5	*Highrise Construction Technology*	**S5-A:** Blueprint Reading for Highrise Construction	Completion
	Construction Estimating 3 – Bidding	**S5-B:** Estimating using Bluebeam	Competency
	Construction Quality Management	**S5-C:** Development of Construction Quality Control Plans	Competency
Semester 6	*Construction Safety Management Practices*	**S6-A:** Developing Construction Safety Plans	Competency
	Construction Estimating 4 – Cost Control	**S6-B:** Preparation of Earned Value Analysis	Competency
	Construction Project Accounting	**S6-C:** Construction Project Accounting using Quickbooks	Competency
	Heavy Construction Management Practices 2	**S6-D:** Document & Submissions Management using Procore	Competency
		Year 4	
Semester 7	*Construction Business Management*	**S7-A:** Financial Management of a Construction Company	Competency
	Economics of Project Development	**S7-B:** Preparation of Project Pro-Forma Analysis	Competency
	Preconstruction Cost Planning	**S7-C:** Preparation of Elemental Cost Analysis	Competency
	Building Information Modeling - Management	**S7-D:** Clash Detection using Navisworks	Competency
Semester 8	*Project Financial Monitoring*	**S8-A:** Preparation of Project Monitoring Reports	Competency

Part B: Analysis of Relationship between Proposed Micro-Credentials and Program Learning Outcomes

GBC's Honors B.Tech. CM program has 12 program outcomes that are established by the Province of Ontario's Ministry of Training, Colleges and Universities. It is observed that four micro-credentials are mapped to Program Outcome 1*: Using relevant media to communicate all manner of information related to a construction project.* These are micro-credentials S1-A, S1-D, S4-B, and S5-A, which authenticate blueprint reading skills and skills in delivering professional presentations. Eight micro-credentials are mapped to Program Outcome 3: *Manage projects in a compliant, safe, ethical and green manner*. These are micro-credentials S2-B, S2-C, S2-D, S2-E, S2-F, S2-G, S4C, and S6-A. These are all completion-based micro-credentials that are automatically awarded upon the completion of their parent courses, except for micro-credential S6-A: Developing Construction Safety Plans, which is a competency-type micro-credential. Six micro-credentials are mapped to Program Outcome 4: *Apply management tools and concepts in the execution of construction projects*. These are micro-credentials S3-A, S4-A, S4-D, S4-E, S5-B, S6-D, and S7-D. Two micro-credentials are mapped to Program Outcome 8: *Model and analyze technical problems by employing sound engineering and building science principles*. These are micro-credentials S1-B and S2-C. Two micro-credentials are mapped to Program Outcome 9: *Assess and apply business, accounting and financial principles.* These are micro-credentials S6-C and S7-A. Finally, four micro-credentials are mapped to Program Outcome 12: *Create technical documents such as tenders, RFPs, records, etc.* These are micro-credentials S5-C, S6-B, S7-B, and S8-A.

No micro-credentials are mapped to the following program outcomes: Program Outcome 2: *Analyze past performance of projects to predict and improve future projects;* Program Outcome 5: *Recognize and value diversity of opinion, process and approach;* Program Outcome 6: *Incorporate effective leadership strategies to form multidisciplinary and multicultural teams and work groups;* Program Outcome 7: *Use the theories and practice of organizational behavior and human resources to manage and develop people;* Program Outcome 10: *Assess and apply logistical concepts and practices in the management of time, cost and quality performance;* and Program Outcome 11: *Evaluate risk potential and environmental impact of projects and mitigate accordingly.*

Table 2 lists specific CM competencies that will be authenticated by the proposed micro-credentials. Eight specific CM competencies will be authenticated by the proposed micro-credentials, including authenticating students' abilities with respect to: *applying CM technologies for estimating, applying CM technologies for scheduling, applying CM technologies for BIM, implementing material tests, satisfying health & safety requirements, interpreting and using construction information, managing construction finances*, and *creating construction documents*.

Table 2: Specific CM competencies and Micro-Credentials that lead to their Authentication

Competencies	Associated Micro-Credentials
Applying CM Technologies for Estimating	*S3-A: Estimating using MS Excel, S4-A: Estimating using Planswift, S5-B: Estimating using Bluebeam*
Applying CM Technologies for Scheduling	*S4-D: Scheduling with MS Project, S4-E: Scheduling with Primavera*
Applying CM Technologies for BIM	*S7-D: Clash Detection with Navisworks*
Implementing Material Tests	*S1-B: Implementation of 28-day Concrete Compression Test, S1-C: Implementation of Atterberg Limits Test*
Satisfying Health & Safety Requirements	*S2-C: Fall protection certificate, S2-D: WHMIS certificate, S2-E: Working in Confined Space Certificate, S2-F: Rigging Certificate, S2-G: Traffic Control Certificate, S6-A: Developing Construction Safety Plans*
Interpreting and Using Construction Information	*S1-A: Blueprint Reading for Housing Construction , S1-D: Delivering Professional Presentations, S4-B: Blueprint Reading for Commercial Construction, S5-A: Blueprint Reading for Highrise Construction, S2-B: Interpretation of Part 9 of the Ontario Building Code, S4-C: Interpretation of Part 3 of the Ontario Building Code Certificate*
Managing Construction Finances	*S6-C: Construction Project Accounting using Quickbooks, S7-A: Financial Management of a Construction Company*
Creating Construction Documents	*S5-C: Development of Construction Quality Control Plans, S6-B: Preparation of Earned Value Analysis, S7-B: Preparation of Project Pro-Forma Analysis, S8-A: Preparation of Project Monitoring Reports*

Part C: Usefulness of Integrating Micro-Credentials in Existing CM Programs

Based on the responses obtained from the survey with respect to the usefulness of integrating micro-credentials in existing CM programs, the findings indicate that a majority of respondents (72%) are of the opinion that allowing CM students to earn micro-credentials will reduce risk and uncertainty in the hiring process. A majority of the respondents (90%) are of the opinion that completion of micro-credentials will improve a student's competitiveness for both co-op positions and permanent jobs. In addition, a majority of respondents (90%) are of the opinion that competency-based micro-credentials will be more useful in terms of improving a CM student's applied skills and abilities.

Interview results also indicate that a majority of the respondents (72%) are of the opinion that a student who has completed his/her CM degree from an average ranking CM program that allows students to earn micro-credentials will be more competitive in the job market than a student who has completed his/her CM degree from a higher ranking program that does not allow students to earn micro-credentials.

Figure 2 highlights feedback with respect to the relative importance of authenticating various CM competencies through the use of micro-credentials. According to the feedback obtained, the top four CM competencies that should be authenticated by micro-credentials are: interpreting & using construction information, satisfying H&S requirements, applying CM technologies for scheduling, and applying CM technologies for estimating. The competency of implementing materials testing was rated as the least important CM competency in terms of authentication by micro-credentials. The major implication of this finding is that in order to be effective, a majority of micro-credentials integrated in CM degrees should focus on authenticating students' competencies with respect to the application of CM technologies and the interpretation and use of construction information.

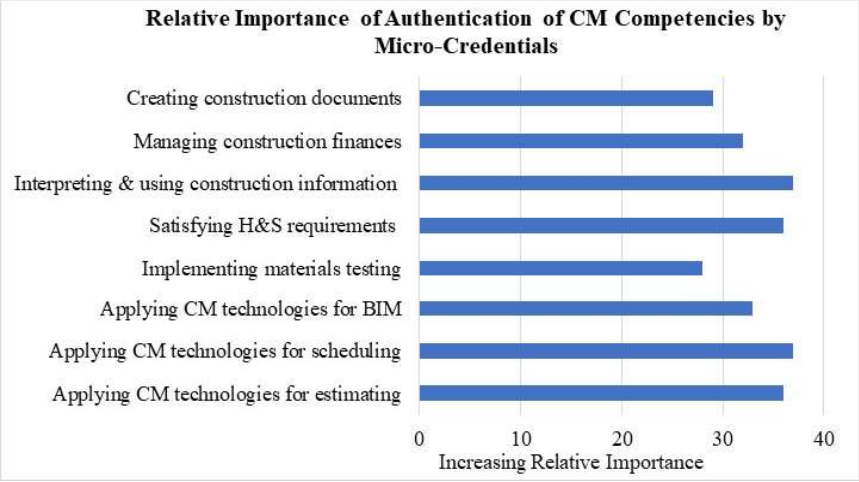

Figure 2: Relative importance of authentication of CM competencies by micro-credentials

Figure 3 highlights feedback with respect to potential strengths of integrating micro-credentials in CM degrees. The greatest potential strengths identified in this study are micro-credentials provide communication of a learner's knowledge, skills, achievements and competencies to construction employers, colleagues and peers; and verification that a learner has acquired skills in specific areas of CM that differentiate him/her both academically and professionally. This implies that micro-credentials may aid in a student's employment search as they will communicate aspects of a student's abilities and skills that are not clearly communicated by the student's transcript. This will help to reduce uncertainty and risk from an employer's perspective.

Figure 3: Potential strengths of integrating micro-credentials in CM degrees

Figure 4 highlights feedback with respect to the significance of three challenges that were identified in this study as being associated with integrating micro-credentials in CM degrees. Based on the responses obtained, the most significant challenge is that assessment of earned skills and abilities is cumbersome to administer and not always reliable. This means that in order for micro-credentials to be effectively integrated in CM degrees, adjustments may have to be made to instructor workloads. In addition, unique methods of assessment may have to be devised for specific micro-credentials in order for them to be authentic indicators of specific competencies. Micro-credentials leading to education dilution is the least significant challenge.

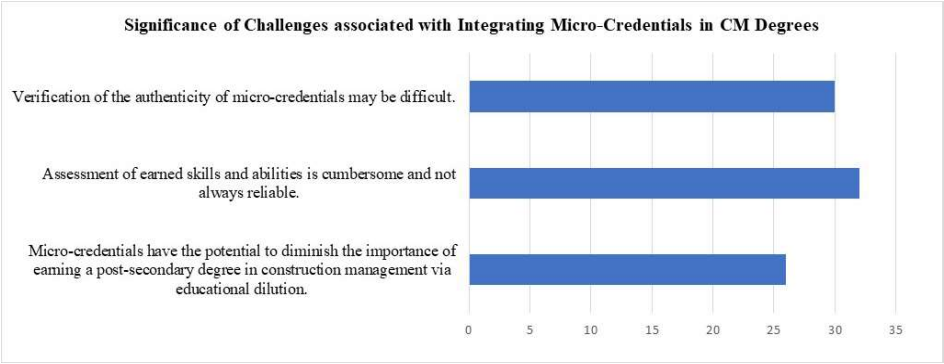

Figure 4: Challenges associated with integrating micro-credentials in CM degrees

Conclusion

Based on the study's findings, integrating micro-credentials in an existing CM degree program may have several implications. Firstly, industry's preference for competency micro-credentials may result in achievement or completion micro-credentials becoming irrelevant and less helpful to students and graduates in gaining employment. Secondly, since it may not be possible to authenticate every program outcome through the use of micro-credentials, traditional methods of assessment will have to remain as part of a program's delivery, in particular, as it concerns assessing students' soft skills. Thirdly, the higher relative importance of achievement of competencies related to the application of technologies in CM tasks may result in a proliferation of micro-credentials that assess this competency at the expense of micro-credentials that assess other competencies. Fourthly, instructors' opinions that issuing micro-credentials can become onerous indicates that issuing them may lead to operational inefficiencies and require adjustment to instructors' workloads. This may result in an increase in costs associated with delivering CM degree programs.

The major findings of this study appear to be in line with the views expressed by Markowitz (2018) who identified the "seven deadly sins of digital badging in education", which included operational inefficiencies and the need for the issuance of digital badges to be based on authentic evidence. It is the authors' opinion that the findings in this

study provide a justifiable basis on which to further investigate the integration of micro-credentials in existing CM degree programs. This should include designing various micro-credentials in the form of competency-based digital badges and begin offering them to students as they complete their course work. This will allow for an understanding of the technical issues involved in issuing micro-credentials as part of a CM program and an understanding of student opinions and preferences as they try to earn the micro-credentials, as well as industry response. In addition, the impact of integrating micro-credentials on a CM program's operational cost as well as the extent to which micro-credentials will enhance student learning and CM degree currency in the age of the skill-based economy should be investigated.

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