Exploring the “Why” of Micro-Credentials and Digital Badges: Engineering Students’ Motivations for and Perceived Utility of Learning Outside of Class

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***Abstract*— Educational institutions are working to implement micro-credentials and digital badges to address gaps in formal education and meet workforce demands. Calls from the National Academy of Engineering (NAE) and disciplinary societies like the American Society of Mechanical Engineering (ASME) encouraging institutions to align with workforce needs more closely, despite already tight engineering curriculums, require institutions to explore innovative approaches such as micro-credentials. Micro-credentials are typically represented by digital badges which students can display on personal web portfolios and through networking sites like LinkedIn. As more higher education institutions begin to implement micro-credentials and award digital badges, the student perspective and motivation in this realm warrants exploration.**

The purpose of this study was to investigate both (1) engineering students’ motivation for participation in micro-credential offerings and (2) the value they attribute to the digital badge token itself. Study participants included engineering students who completed at least one of a variety of micro-credentials offered by various departments within a College of Engineering at a large northeastern public university. Micro-credentials were offered as both synchronous and asynchronous opportunities. ~~They required~~ Micro-credential offerings included formal assessment of knowledge and skills for successful completion and the subsequent award of the corresponding digital badge. A survey comprising both the validated Situational Motivation Scale (SIMS) and questions investigating the perception of the digital badge itself were sent to participants immediately upon completion of the micro-credentialing experience.

This study finds participants to be both intrinsically and extrinsically motivated to take part in micro-credentialing experiences, attributing some professional values to the digital badge itself. The findings lay necessary groundwork for future research in this evolving domain and also suggest where institutions can better communicate to stakeholders, including students, the value of these relatively new approaches.

Keywords—micro-credential, digital badge, intrinsic motivation, extrinsic motivation, situational motivation, digital token

I. Introduction

In recent years, within K-12, higher education, and corporate environments, micro-credentials and digital badges have increased in their recognition and adoption [1], [2], [3]. In brief, a micro-credential represented by a digital badge is something a student or employee earns for participation in a learning activity, completion of a series of learning activities, and/or demonstration of a specified set of skills and competencies. Micro-credentials are typically positioned in contrast to more formal, larger credentials such as an undergraduate degree. Just as an undergraduate degree is represented by a transcript and diploma, an earned micro-credential is visually represented by a digital badge. In its simplest form, the digital badge is a clickable image that contains details, or metadata, about what it represents [4]. See Figure 1 for an example of the type of metadata included on the badge. The digital badge image itself usually contains the name of the award or credential and the organization awarding the micro-credential. The metadata provides more extensive and meaningful information about the earner's experience and accomplishments, including what they did to receive the badge, any artifacts related to the badge, and any required assessments such as a web portfolio displaying project work [5]. Because the types of experiences for which digital badges are awarded can vary greatly—from attending an hour-long workshop to a semester-long project meeting rigorous standards—this descriptive metadata is very important [5].

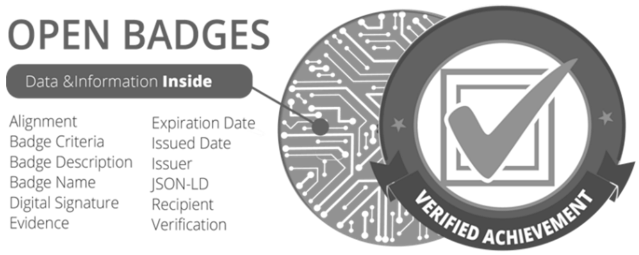

Fig. 1. Open Badges image from https://openbadges.org/ created by IMS Global Learning Consortium. Image licensed under Creative Commons Attribution 4.0 International License

Within a higher education context, the potential of micro-credentialing, recognized by digital credentials, has been theorized and promoted for over a decade [6]. Digital badges have been posited as credentialing students' academic performance or achievements that otherwise might not be captured in a formal degree. Those in favor of this form of alternative credentialing point to the inherent limitations and lack of transparency and meaningful information contained on a student's transcript [7]. A transcript typically lists courses taken, often abbreviated to the point of becoming meaningless to the public, a letter grade, and the semester during which the course was taken. This provides very little helpful detail for hiring managers and other stakeholders as to what the student *actually did*, *learned*, and *can do* [6]. Much of the academic-industry pipeline relies on a trust relationship between the schools awarding the transcripts and degrees and the organizations hiring the students. This trust is based, in no small part, on students' possession of said transcripts and degrees. Significantly, the transcript that the student essentially created by paying tuition, taking classes, and completing assigned work does not actually belong to the student. A student typically must purchase *their own* transcript from the awarding institution to have a certified copy. In contrast, digital badges are *owned* by the learner, and they have flexibility with what they choose to do with them. For example, an individual can earn badges from different entities—schools, professional societies, and companies—and collect and display them together, all at their discretion.

Within engineering specifically, micro-credentialing and digital badges are one possible response to calls by leadership bodies for educators to be more responsive to contemporary contexts. NAE has suggested that engineering institutions should "consider organizational structures that will allow continuous programmatic adaptation to satisfy the professional needs of the engineering workforce that are changing at an increasing rate." [8] ASME has argued for greater emphasis on students' exposure to practicing engineers, the enhanced development of professional and communication skills, and improved competencies related to diversity and inclusion [9] Given the sometimes slower pace of formal curricular change within higher education, micro-credentials and digital badges are one means by which engineering educators can be more agile in their offerings. Digital badges have been implemented to recognize student skills in such areas as business and professional skills [10] project management [11], and information literacy [12] These types of offerings meet the spirit of calls such as those put forth by NAE and ASME.

Questions pertaining to the motivational elements of micro-credentialing and digital badging remain unanswered. In a broad sense, one might consider the student perspective: Why should I do this? Does it matter? Am I interested in this topic? Is it important? Will employers care about digital badges? Because digital badges are often awarded following participation in something like a workshop, it can be unclear as to whether students were motivated by an interest in learning about the topic and/or because of the value they place on the digital badge itself as a shareable token. This study begins to explore these questions related to students' motivation for participating in micro-credentialling experiences as well as the value they attribute to the digital badge in and of itself.

II. Literature Review

Much of the research pertaining to motivation and digital badging has been through the lens of gamification theory. Gamification theory sheds light on the engagement and motivation behind a gamified learning process and provides insights into both intrinsic and extrinsic motivation. [13]Application of gamification in higher education often appears as digital badges embedded into curricular structures. Digital badges have been found to be effective at increasing motivation when implemented in gamified online physics courses [13]. It has also been suggested that when digital credentials are aligned with skill needs it will potentially provide motivation from an intrinsic perspective with the actual digital badge acting as an extrinsic motivator, providing an added benefit particularly with students who may need support in motivating themselves to learn [1]. In contrast, an undergraduate composition course analyzed the intrinsic and extrinsic motivation of badge implementation finding that the presence of badges in the course did not increase motivation [14]. In terms of digital badges and motivation, it can be difficult to truly separate motivational factors when the badges themselves are integrated into a formal curriculum and are therefore obligatory. Student participation in co-curricular digital badge offerings, where there is more of an element of choice and self-determination on the part of the learners, may provide additional insight into the complexity of student motivation, micro-credentials, and digital badges.

There is less evidence of empirical studies that explore intrinsic and extrinsic motivation associated with digital badges offered as co-curricular. Here it is important to understand motivation from a situational, or state, perspective since it likely involves elements of both intrinsic and extrinsic motivation at a point in time [15]. Situational motivation intersects with self-determination theory, considering the degree to which a person feels they are doing something of their own choosing versus doing something because it is required or expected of them [15]. Within such a framework, there are four motivational factors along the continuum from high to low self-determination: intrinsic motivation, identified regulation, external regulation, and amotivation. Intrinsic motivation refers to behaviors that are performed for their own sake because of their inherent value. This is something the individual would engage in regardless of the presence or absence of external factors. In terms of extrinsic motivation, both identified regulation and external regulation reflect extrinsic motivational states because they relate to activities in which the behavior is viewed as a "means to an end." Internal regulation, however, is also valued and is an activity that has been chosen and is therefore higher on the self-determination continuum. External regulation, in contrast, relates to "behavior [that] is regulated by rewards or in order to avoid negative consequences.". Finally, amotivation is neither intrinsic or extrinsic motivation but rather refers to a state of "learned helplessness," where a person has neither a sense meaningfulness nor anticipated value [15]. In this state, they may be doing something but without a clear sense as to the benefits. See fig. 2 for a graphical overview of these four motivational states. The Situational Motivation Scale (SIMS), a validated instrument, measures these four motivational factors [15].

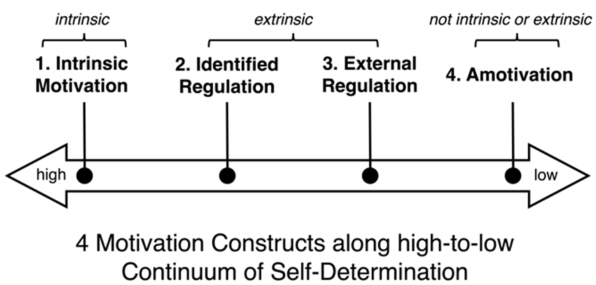

Fig. 2. Image created based on Guay et al., 2000

In the context of engineering education, motivation can also have gendered elements. A recent study implemented SIMS to measure state motivation across three types of engineering courses: traditional (lecture-lab), mixed, and non-traditional (project and/or discussion-based) [16]. The study found that in traditional engineering courses female students experienced significantly less autonomy (lower intrinsic motivation and higher external regulation) than their male counterparts. However, in the project- and discussion-based courses, the intrinsic motivation of females and males was statistically equal, and females also experienced less external regulation than their male counterparts in these non-traditional settings [16].

With the lens of situational motivation, we can better understand a participant's choice to participate in the activity. Therefore, in this study, we look at both the state motivation and perceived digital badge utility of engineering students participating in co-curricular micro-credential workshops and earning digital badges.

The research questions guiding this study are:

- RQ1: What are participants' perceptions of the utility of the digital badge they earned? Are there differences in perception based on gender?
- RQ2: What are their motivations to participate in the full digital badge experience, including the micro-credentialing workshop? Are there differences in motivation based on gender?
- RQ3: Are there significant relationships between motivation states and the perceived utility of the digital badges?

III. Mehtods

A. Study setting

A large Northeastern R1 University developed and offered various micro-credentials during Spring 2022 for students across engineering majors. The micro-credentials were offered in slightly different formats. The Mechanical Engineering Department offered two synchronous micro-credential opportunities. The first focused on Career Management for engineers and the second focused on Legal and Regulatory issues within engineering. These micro-credentialing workshops were each offered only once, and students were awarded a digital badge after both (a) participating in a three to four-hour interactive workshop and (b) completing an assessment demonstrating specified competencies. The Engineering Leadership Development Program offered a series of four micro-credential learning opportunities related to ethics and equity. This four-part micro-credential series was offered live and was also recorded to allow for asynchronous participation. After attending live or watching the recorded workshops, participants completed a knowledge quiz to earn the digital badge for each of the four offerings. If students completed all four micro-credentials, they were awarded a meta-badge. A meta-badge is a culminating digital badge that reflects the completion of multiple pre-requisite badges. Fig. 2 outlines the different opportunities for students.

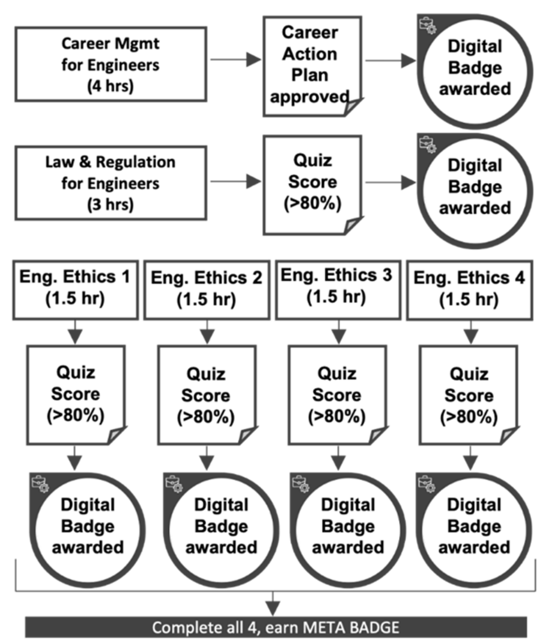

Fig. 3. Micro-credentialing workshops and digital badges within Engineering

B. Data collection and analysis

Institutional Review Board approval (STUDY00018316) was secured for this study. A total of 61 students who participated in one of the SP22 micro-credentials consented to be a part of the study and completed the survey instrument during or immediately following their experience. Participants were undergraduate students (70%), graduate students (27%) and others (3%). Of the participants, 66% identified as male and 34% identified as female. Engineering disciplines represented in the study included mechanical engineering (48%), computer science (15%), biomedical engineering (10%), electrical engineering (10%) and other engineering majors (17%). Racial/ethnic group representation included 60% European American/White, 30% Asian American/Pacific Islander, 5% African American/Black, and 5% others.

To address RQ1, the authors created a questionnaire to determine the perceived utility of the digital badge itself as a token associated with the micro-credential offering. Respondents were told that the "digital badge is a clickable image you can share on LinkedIn and other social media, highlight on a resume, and discuss in interviews, among other things." They were then asked to rate their level of agreement with the following statements along a six-point Likert scale from "strongly disagree" (1) to "strongly agree" (6).

- Q1. I believe this digital badge is a valuable tool to help promote myself professionally.
- Q2. I believe this digital badge is a valuable way to demonstrate my skills.
- Q3. I plan to display this digital badge on my social media.
- Q4. I don't think this digital badge will make any difference for my career.
- Q5. I think it's fun to earn digital badges.
- Q6. I don't think employers really care about digital badges.

For RQ2, the validated Situational Motivation Scale (SIMS) was used to measure state motivation at any given point in time and was administered immediately following the completion of the presentation portion of the micro-credential [15]. SIMS is comprised of 16 items of which four assess intrinsic motivation, four assess identified regulation, four assess external regulation, and four assess amotivation. SIMS asks students to rate their agreement with 16 statements related to activity engagement: "For each statement below regarding your reason for engaging in this micro-credentialing/digital badge experience, select the value that best applies." along a 7-point Likert scale from "corresponds not at all" (1) to "corresponds exactly" (7).

Data were analyzed using descriptive and inferential statistics including independent t-tests and simple bivariate correlations ($0.05 < p$) to determine significant relationships and differences among variables. The standard deviation reported is the average distance between the actual data and the mean values. In addition, Cohen's d values are reported and interpreted as: (small effect size) < .20, (medium effect size) .20 < d > .8, and (large effect size) > .8 [17].

IV. RESULTS

RQ1: What are participants' perceptions of the utility of the digital badge they earned? Are there differences in perception based on gender?

Means and standard deviations are reported in Table I across the questions related to the perceived utility of the digital badge. For each item participants were asked to rate the degree to which they agreed with the statement on a 6-point scale, from 1, *strongly disagree*, to 6, *strongly agree*.

TABLE I. MEANS AND STANDARD DEVIATIONS FOR 6 QUESTIONS ON PERCEIVED UTILITY

n=61		
	Mean	**SD**
Q1. I believe this digital badge is a valuable tool to help promote myself professionally.	4.77	1.09
Q2. I believe this digital badge is a valuable way to demonstrate my skills.	4.43	1.18
Q3. I plan to display this digital badge on my social media.	4.38	1.33
Q4. I don't think this digital badge will make any difference for my career.	3.05	1.12
Q5. I think it's fun to earn digital badges.	4.07	1.32
Q6. I don't think employers really care about digital badges.	3.46	1.16

Differences in perceptions of utility based on gender were also calculated. Independent t-tests (table II) evaluated gender differences in perceived utility based on the six questions. Details are presented in table II, presenting the means, standard deviations, mean differences (female-male), t-values with degree of freedom, and Cohen's d showing the practical significance.

TABLE II. PERCEIVED UTILITY OF DIGITAL BADGES BY GENDER.

	Female (n=20)		Male (n=40)				
	Mean	**SD**	**Mean**	**SD**	**MeanDiff.**	***t* (df)**	**Cohen's *d***
Q1	5.19	0.93	4.55	1.11	0.64	2.39* (47)	0.61
Q2	5.05	0.92	4.10	1.17	0.95	3.47*** (50)	0.86
Q3	4.86	0.91	4.13	1.45	0.73	2.41* (57)	0.56
Q4	2.57	1.12	3.30	1.04	-0.73	-2.47** (38)	-0.68
Q5	4.52	0.87	3.83	1.45	0.69	2.35* (58)	0.54
Q6	3.24	1.00	3.58	1.24	-0.34	-1.15 (49)	-0.29

a. Note. *p ≤ 0.05, **p ≤ 0.01, and ***p ≤ 0.001. Cohen's d values were interpreted as: (small effect size) < .20, (medium effect size) .20 < d > .8, and (large effect size) > .8. [17]

While the mean values of question 1, 2, 3, and 5 are significantly higher in females than males, the means of question 6 were not significantly different between females and males, *t* (58) = -1.15, p = .26. Q 4 is a negatively stated question that males are significantly higher than females. Particularly, the mean differences for question 2 (*I believe this digital badge is a valuable way to demonstrate my skills)* was largely significantly different and had a Cohen's *d* value of .867 indicating a large effect size. In contrast, the effect sizes of the other items (Q1, Q3, Q4, and Q5) were moderate with Cohen's *d* between .545 and .681 respectively [17].

RQ2: What are their motivations to participate in the full digital badge experience, including the micro-credentialing workshop? Are there differences in motivation based on gender?

To address RQ2, the SIMS instrument, comprising 16 statements, was used to measure state motivation during or immediately following participation in the micro-credentialing workshop experience [15]. For each item, participants were asked to rate the degree to which they agreed with the statement on a 7-point scale, from 1, *corresponds not at all*, to 7, *corresponds exactly*. Table III. shows the mean values and the Cronbach's alpha (α) for each of the four SIMS factors (motivational states), and an example of the items that assess each of those factors.

TABLE III. MEAN, CRONBACH'S A, NUMBER OF ITEMS, AND SAMPLE ITEMS OF SIMS FACTORS FOR MOTIVATION STATE.

	Mean	α	No. of items	Example item (Stem Q: I do this activity because..)
Intrinsic motivation	4.40	.730	4	I think that this activity is interesting
Identified regulation	5.55	.809	4	I am doing it for my own good
External regulation	3.14	.880	4	I am supposed to do it
Amotivation	2.15	.863	4	I am not sure it is a good thing to pursue it

Table IV. presents bivariate correlations among four motivation factors and the means (M) and standard deviations (SD).The results indicated that identified regulation was negatively correlated with external regulation and amotivation, while having a positive correlation with intrinsic motivation.

TABLE IV. BIVARIATE CORRELATION AMONG FOUR FACTORS OF SITUATIONAL MOTIVATIONS

Variables	1	2	3	4	M	*SD*
Intrinsic motivation	-	-	-	-	4.40	1.08
Identified regulation	.478**	-	-	-	5.55	1.10
External regulation	-	-.461**	-	-	3.14	1.72
Amotivation	-	-.514**	-	-	2.15	1.24

b. ** Correlation is significant at the 0.01 level (2-tailed).

To evaluate gender differences, independent t-tests were conducted (table V.) for each of the four factors associated with state motivation. The mean value of intrinsic motivation was the only construct that was significantly different between genders, *t* (56) = 1.97, p = .05, with females (M = 4.73, SD = 0.75) attaining higher scores than males (M = 4.23, SD = 1.19). However, the effect size appeared to be relatively small with a Cohen's *d* value of .47.

TABLE V. PARTICIPANTS' MEANS AND STANDARD DEVIATIONS (*SD*) OF FOUR SITUATIONAL MOTIVATIONS BY GENDER

	Female (n=21)		Male (n=40)				
	Mean	**SD**	**Mean**	**SD**	**MeanDiff. (F minus M)**	**t (df)**	**Cohe n's d**
Intrinsic motivation	4.73	0.75	4.23	1.19	0.50	1.97* (56)	0.47
Identified regulation	5.78	0.76	5.44	1.23	0.34	1.30 (55)	0.31
External regulation	2.68	1.48	3.38	1.80	-0.70	-1.63 (48)	- 0.41
Amotivation	1.85	1.09	2.32	1.29	-0.48	-1.51 (47)	- 0.39

c. Note. *p ≤ 0.05, **p ≤ 0.01, and ***p ≤ 0.001. Cohen's d values were interpreted as: (*small effect size)* 0.20 ³ 0.50 (*medium effect size*) £ 0.80 (*large effect size)* (Cohen, 1988).

RQ3. Is there correlation between motivation and the perceived utility of the badges?

To address RQ3, multiple bivariate correlations were conducted between each of the six questions pertaining to the perceived value of the digital badges and the 4 situational motivation factors intercorrelated at p < 0.01 (2-tailed test). First, Q1 of the perceived utility of digital badges questions, was significantly correlated with Intrinsic Motivation and Identified Regulation at r = .324, and r =.324, respectively. There was no significant correlation between Q1 and External Regulation and a negative correlation with Amotivation. Q2 also positively correlated with Intrinsic Motivation and Identified Regulation and negatively correlated with Amotivation; however, the correlations are stronger for Q2 than Q1. Q3 had moderate positive correlations with Intrinsic Motivation and Identified Regulation. As for Q4, as would be expected, there is a negative correlation with Intrinsic Motivation and Identified Regulation. Whereas External Regulation and Amotivation have positive moderate correlations with Q4. Overall, the correlations between digital badge perceived utility questions and situational motivation factors had low to moderate coefficients, with the strongest correlations between Q5 with Intrinsic Motivation (r = .595) and Identified Regulation (r = .487). Finally, there is no relationship between Q6 and any of the four situational motivational factors. Details are in table VI.

TABLE VI. MULTIPLE BIVARIATE CORRELATIONS OF DIGITAL BADGE QUESTIONS AND SITUATIONAL MOTIVATIONS

	Intrinsic Motivation	Identified Regulation	External Regulation	Amotivation
Q1. I believe this digital badge is a valuable tool to help promote myself professionally	.324*	.324*	-	-.278*
Q2. I believe this digital badge is a valuable way to demonstrate my skills	.477**	.401**	-	-.299*
Q3. Display this digital badge on my social media	.367**	.346**	-	-
Q4. I don't think this digital badge will make any difference for my career	-.257*	-.341**	.360**	.388**
Q5. I think it's fun to earn digital badges	.595**	.487**	-	-
Q6. I don't think employers really care about digital badges.	-	-	-	-

V. DISCUSSION AND CONCLUSION

This study explores the value that micro-credentialing participants attribute to the digital badge as well as their situational motivation for participation. Overall findings from this study suggest that participants are both intrinsically and extrinsically motivated to participate in co-curricular micro-credentials and earn digital badges. As well, findings of the current study align with Schuman's (2019) study using the SIMS scale [15]. The current study lays the groundwork for future research pertaining to motivation, micro-credentialing activities, and digital badges in engineering education.

Findings suggest that students attribute some value to the digital badge as a token in and of itself in terms of professional promotion (4.77/6.0) and skills demonstration (4.33/6.0). We surmise that as employers begin to recognize digital badging during recruitment activities, learners will value the digital badge itself even more.

In terms of motivational states along the self-determination continuum (see Fig 1), students that participated in micro-credentialling had higher degrees of self-determination: i.e., intrinsic motivation and identified regulation compared to external regulation and amotivation. As engineering programs consider supplementing professional skills into co-curricular learning to better align with industry needs [8], [9], this study lays important groundwork. Findings show that students that participate in these types of co-curricular learning opportunities may do so because they are more internally motivated and have the choice to participate as opposed to a more extrinsic motivator like a requirement in a course or a program

Concerning gender and motivation, female identified participants seemed to be slightly more intrinsically motivated than male identified participants. Other research has suggested that females experience more self-determination (and less external regulation) in non-traditional engineering education settings, which is consistent with the format of micro-credentials [16]. Regarding the six questions pertaining to the value of the digital badge to promote oneself professionally, five of them showed significant differences with females agreeing more strongly than males that the digital badge is a good way to demonstrate their skills. Given the continued gender disparity in engineering and the need to better align student preparedness to workplace needs, continuing to explore the potential of educational opportunities that are seen as valuable and allow for greater degrees of self-determination, such as micro-credentials

Ultimately this study suggests that students that participate in a co-curricular micro-credential are more internally motivated while also perceiving professional value in the digital badge itself. In addition, as Intrinsic motivation and Identified Regulation increased so did ratings of value in the digital badge as a tool to promote themselves professionally and to demonstrate their skills. This is different from the findings regarding the theory of gamification in that receiving a digital token in a game does not pertain to professional value but rather the "reward" of earning the badge [13]. Results of this study added value to an engineering education community concerning the development of co-curricular micro-credential courses that will issue digital badges. As a steppingstone to the development of this relatively new instructional and rewarding system, understanding students' various motivations to acquire digital badges was particularly imperative to promote and disseminate the value of micro-credential courses. These findings suggest that co-curricular or optional offerings may increase participation in micro-credentialing and digital badging efforts.

VI. LIMITATIONS AND FUTURE STUDY

There are several limitations that constrain the generalization of results. First, we used self-reported survey data with a relatively small number of participants. Next, there is no independent verification of what participants claim is their motivation for participating in micro-credentialing activities. While we were able to explore gender differences, the numbers were too small to consider other underrepresented populations in and of themselves.

There are multiple avenues for continuing this line of research. The nuances of students' motivation for micro-credentialing could be further captured through focus groups and interviews. Future work could also consider the perspective of employers as whether employers value digital badges and micro-credentialing experiences will likely influence student motivation. As well, further studies could also explore the motivation for and perceived value of these micro-credentialing and digital badge opportunities within other underrepresented groups.

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