Discover Education

Case Study

Assessment, credential, or both? Higher education faculty's design principles for micro-credentials

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Abstract

The rise of small, skills-focused credentials, also known as micro-credentials, has garnered considerable attention in recent years. By offering micro-credentials, institutions of higher education can provide additional credential options, thereby attracting more diverse audiences beyond degree-seekers. However, amidst their growth, fundamental questions surrounding their effective design and pedagogical implementation remain. This lack of clarity may inadvertently hinder their effectiveness. To address this gap, there is a need for studies that examine the perspectives and practices of faculty involved in micro-credential development and delivery. This study employed a single-embedded case design to investigate the perceptions and practices of faculty members who implemented micro-credentials for a pilot program at a large public research university. Specifically, this study aimed to identify faculty perceptions of the assessment and credentialing affordances of micro-credentials, and strategies employed to integrate these affordances into the design of micro-credentials. In-depth interviews were conducted with faculty members representing a diverse array of academic disciplines. Findings revealed that faculty need support in recognizing and integrating certain characteristics of quality assessments when designing micro-credentials, including aligning of assessments with a micro-credential's delivery method, and integrating equity-oriented assessments into the design. These findings underscore the necessity for interventions and training programs aimed at integrating quality assessment practices into micro-credential design.

1 Introduction

Micro-credentials are gaining widespread adoption throughout higher education [48, 51] providing learners with new opportunities to gain knowledge, skills, and experience relevant to their professional goals. A micro-credential is defined as "a qualification that represents assessed achievement of a subset of learning within and beyond the traditional realm of certificates, diplomas, and degrees" providing "recognition for what a person knows and can do at a modular level' ([15], p. 5). "Modular level" in this definition indicates that micro-credentials are smaller than traditional credentials (e.g., degrees) in terms of the length of time they take to earn, and the specificity of knowledge and skills they verify. Expanding on this definition, micro-credentials are often issued digitally, a format that can provide more detailed evidence of achievement than is possible with paper-based credentials [25]. The term "micro-credential" is used throughout this paper to refer to digital micro-credentials specifically.

Micro-credentials are different from other, more commonly used credentials, in terms of size, digital format, and use in verifying both technical and professional "soft" skills [19, 38]. Micro-credentials are emerging across all types of higher education organizations, including community colleges, technical colleges, and universities [46]. But despite

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the growth of micro-credentials, it is still unclear what practices are enacted when they are designed for use in higher education, or what qualities constitute well-designed micro-credentials. Without this information, micro-credentials may continue to be developed, but their design may be sub-optimal, which would likely influence their effectiveness. Research on the design of other educational technologies (e.g., online courses, MOOCs, gamified learning) shows that design has an impact on the effectiveness of the technology and can influence factors such as student satisfaction, persistence, and perceived learning [20, 21]. This point is included to reinforce the importance of examining micro-credentials from the standpoint of design. While there is much value in researching micro-credentials in terms of their impact on learning, this subject is beyond the scope of this study.

Because they have unique characteristics, including size and digital format, and are therefore different from other types of credentials, micro-credential design warrants examination. Considering how many institutions are embracing micro-credentials [7], poorly designed micro-credentials may waste students' time and money, institutional resources, and faculty time and effort. Research on the value of micro-credentials for students and employers is emerging [26, 30], but micro-credentials have rarely been examined from the perspective of the academic faculty who are primarily responsible for their design and implementation.

1.1 Purpose of micro-credentials

The definition of a micro-credential as "a qualification that represents assessed achievement" ([15], p. 5) indicates that micro-credentials serve both credentialing and assessment purposes and can achieve optimal impact when fulfilling both objectives. However, micro-credentials are not always used for both purposes (Table 1). For example, a micro-credential that recognizes completion, participation, attendance, or interest [10] may function as a credential but not as an assessment in that it validates the recipients' knowledge, skills or experience similar to traditional credentials. But these types of micro-credentials are likely to have less value to stakeholders who are concerned with feedback towards an educational objective [49]. Similarly, a micro-credential issued to provide formative and summative feedback or scaffold learning [11] may function as an assessment but not as a credential. This assessment-only application of a micro-credential likely has value for learners within a learning context in that it facilitates communication around learning, but likely would not serve as a mechanism for validating or guaranteeing learning gains across settings [36]. Much of the literature on micro-credentials as credentials is centered on twenty-first century skills and workforce job development. The literature on micro-credentials as assessments is centered on motivation, pedagogy, and gamification. A critical, potential flaw with using micro-credentials as credentials is that until the micro-credential is accepted as a valid representation of performance then it has little currency in employment or the workforce, similar to the degree or certificate that is ignored or perceived as irrelevant. As assessments, micro-credentials can have the critical, potential flaw of having little ongoing value to a learner or educator beyond what it means at the time it is issued. For example, a micro-credential that is issued to provide formative feedback no longer has value if the learner has earned a newer-micro credential or other credentials that supersedes the original.

1.2 Conceptual framework

This study approaches the subject of higher education micro-credentials from a learning design perspective. Like any educational technology, positive outcomes are not automatic for micro-credentials; successful implementation and outcomes of micro-credentials hinge on intentional design principles and facilitation by educators. Based on their affordances, micro-credential design should exhibit qualities of good assessment design and good credential design. While credentials are awards that show qualification, assessment validates the award, and serves numerous purposes in terms of teaching, institutional quality assurance, and, most importantly, learning. If a credential earner is not assessed then there is no proof that learning occurred, or that the earning of the credential was warranted. Without effective assessment, a credential lacks legitimacy.

1.2.1 Micro-credentials as assessments

An assessment is an appraisal, or judgement, of student work or performance that is intended to collect information about learning gains and guide a students' learning towards an intended goal [39]. A micro-credential provides appraisal

Table 1 Micro-credentials whose focus is either a Credential or Assessment

Aspects of a micro-credential	Credentialing as the objective	Assessing as the objective
Application	Recognition of Completion, Participation, Attendance, or Interest	Provide Formative or Summative Feedback and Scaffold Learning
Communication	Validates the recipient's knowledge, skills, or experience	Defines what the recipient has learned during a specific learning experience
Value to Stakeholders	Guarantee	Vehicle for Communication
Similar Learning Object	Degrees, Certificates	Grades, Personal Communication
Theoretical Framing	21st Century Skills, Workforce Job Development	Gamification, Motivation, Pedagogical Practices
Potential Flaw	Unpromised value in supporting stakeholders in their information needs	Little ongoing value if not continuously useful to the learner or educator
Citations	[10, 30, 45]	[1, 11, 21, 49]

or judgement of learning and therefore is an assessment construct. A micro-credential communicates an appraisal or judgement in the form of feedback to the learner, gauging learning progress toward the intended goal. For example, micro-credentials may be issued during the learning process to communicate to a student that certain competencies have been met. Or, as a result of performance, they may be issued upon completion of a learning opportunity to indicate to learners (and other stakeholders) that specific skills, knowledge, or abilities have been gained [31]. A micro-credential can be added to a learning opportunity that otherwise would not have an assessment, such as co-curricular, non-credit experience, adding an integral learning component. Additionally, faculty can add a micro-credential to a curricular experience to provide an assessment opportunity that is 'above and beyond' what the curriculum typically mandates. For example, the grade in a Computer Science course is based on accredited competencies, while micro-credentials can provide feedback to students on soft skills such as time management [1].

1.2.2 Micro-credentials as credentials

A credential is "a documented award by a responsible and authorized body that attests to the achievement of specific learning outcomes or to a defined level of knowledge or skill relative to a given standard" [28, p. 105]. A credential acts as a communication device that translates learning gains from an educational context to other contexts and serves as "proof" of those learning gains. Micro-credentials are credentials because they are documented awards, issued by institutions of education, or other educational organizations, that attest that specific knowledge or skills have been gained. When a micro-credential is shared (e.g., posted on social media), and then viewed by a third party (e.g., reviewed by potential employer), the knowledge and skills that the earner gained in an educational context is communicated to other contexts, such as the workplace, and serves as proof of learning gains.

Micro-credentials are different from other credentials (e.g., degrees, certifications), though. The "micro" denotes that micro-credentials are meant to be earned in a shorter amount of time than commonly used credentials such as college degrees and industry certifications [33] and to provide recognition of achievement on a more granular level than other credentials [41]. Moreover, micro-credentials, as they are discussed in the context of this study, are digital, which allows them to be easily shared in digital spaces (e.g., social media). Although other types of credentials can also be issued digitally (e.g., digital diplomas meant to ensure security against credential fraud) [40], the digital aspect serves a unique purpose for micro-credentials. Digital credentials are often embedded with metadata, which provides information that helps to validate the credential, such as information regarding the issuing institution, the criteria for earning, and even artifacts of learning (i.e., "evidence"). When combined with "micro" aspects (e.g., specificity of subject matter, short completion time), the digital format of a micro-credential allows for discrete knowledge and skills to be validated, thereby providing more precise recognition of abilities than other (non-digital, broader) credentials offer. For example, a learner who has earned a micro-credential in Data Visualization can share it with a potential employer to indicate their skills in using data visualization tools. When embedded with evidence, the viewer of the micro-credential can see what the earner is capable of producing (e.g., Tableau dashboard). Arguably, digital micro-credentials are more specific and transparent than other credentials in terms of attesting to what the earner knows and can do [27].

1.3 Research questions

As the number of higher education micro-credentials grows, so too does the number of faculty performing the work required to offer them. There is now a critical mass of these professionals in higher education, but little is known about this population in relation to micro-credentials [37, 41]. Specifically, we do not know how faculty perceive micro-credentials or the practices they employ when designing and implementing them; without this knowledge, research cannot fully reflect the complexities and realities of how and why micro-credentials are used in higher education. This causes a disconnect between research findings and the practical uses of micro-credentials in the contexts which they are developed.

This study aims to identify perceptions of faculty members, from a range of academic disciplines, concerning the assessment and credentialing affordances of micro-credentials, and strategies employed to integrate these affordances when designing micro-credentials. The following research questions were posed: (1) What are faculty perceptions of micro-credentials as assessments and as credentials? and (2) How do faculty integrate qualities of assessments and credentials when designing micro-credentials?

To answer these questions, we first examined literature on assessment design and credential design to identify key characteristics of quality assessments and quality credentials. We based this approach on educational technology research

that examined the affordances of a technology to derive design principles [16, 18]. By examining micro-credentials in relation to quality design principles, and from the perspective of individuals who developed them, this study aims to locate micro-credentials as "part of a curriculum practice within a broader repertoire of pedagogic practices" ([6], p. 1115). This approach provides a more nuanced, socially situated, and therefore comprehensive understanding of micro-credentials than would be possible otherwise.

2 Characteristics of quality assessments and credentials in the literature

This section provides an overview of key characteristics of quality assessments and credentials. These characteristics were identified through a review of the literature on assessment design and credential design and serve as a frame of reference for determining quality design principles for micro-credentials. We consider each of the principles individually for their impact, and how they are analyzed in our analysis.

2.1 Quality assessment design

2.1.1 Formative and summative components

Learning opportunities should provide opportunities for both formative and summative assessment. These are often distinguished as "assessment to support learning" and "assessment of learning," respectively [44]. Formative assessment guides students toward the learning objectives and provides scaffolding or correction, and helps learners determine knowledge gaps and areas for improvement. Summative assessment is intended to determine what learning has been achieved [14] and is useful so that the learner knows if they have gained the knowledge or skills they need, or if additional learning is needed.

Used formatively, micro-credentials can be issued to learners as they progress toward the learning objectives of a course or program. In this way, micro-credentials may be a feedback mechanism, indicating what progress has or has not been made, and what knowledge or skills have or have not yet been demonstrated as the learner progresses toward meeting the intended learning objectives [27]. As a summative assessment, a micro-credential can be issued, as a validation of achievement, when a learner successfully demonstrates the learning objectives have been met [17, 30]. If the micro-credential is used formatively, the learning experience should also provide an opportunity for summative assessment, and vice-versa. Assessment research underscores the significance of both components in the teaching and learning processes [22, 23].

2.1.2 Sustainable assessment

Education should prepare individuals to be lifelong learners. An assessment is sustainable when it not only helps students meet the specific and immediate learning requirements and outcomes, but also establishes a basis for students to carry out their own assessment activities in future contexts [5]. Sustainable assessment practices offer opportunities for students to establish their own learning goals, judge their own progression towards goals, generate their own feedback, and provide feedback to their peers [31].

A micro-credential can serve as a sustainable assessment by providing an opportunity for learners to become assessors of their own learning, a skill they can later apply in future contexts. For example, an instructor might offer a creative writing course with a standard syllabus that includes predefined learning objectives, and a set of assignments that they assess and provide feedback on. The instructor could augment the course by adding writing prompts that are not included in the final grade for the course but that provide additional opportunities for students to hone their skills. The students could earn a micro-credential if they complete a writing prompt and conduct a self-assessment by reflecting on the extent to which their writing met the criteria. This micro-credential would serve as a sustainable assessment as it would provide an opportunity for students to practice assessing their own skills.

2.1.3 Clarity of outcomes and criteria

For assessments to be understandable to learners and other stakeholders, the learning being assessed should have well-defined outcomes (e.g., what was supposed to be learned) and criteria (e.g., what is evidence of that learning) [2, 42]. If the assessment lacks clarity for students, then they will be hampered in their ability to meet the criteria for the assessment and to achieve the intended outcomes. If the assessment lacks clarity for instructors, then they will not be able to judge whether students met the criteria and will not be able to provide feedback to help meet the intended learning outcomes. If the assessment lacks clarity for other stakeholders, like employers, then they will not be able to make informed decisions about the learner, such as how they were evaluated to prove they possess certain knowledge and skills.

For micro-credentials to be clearly understandable they also need to have well-defined outcomes and criteria; since digital micro-credentials can be shared more widely than paper-based credentials, the clarity of criteria and outcomes is consequential for a wider audience. For example, an earner might share their micro-credential on social media, to showcase the skills they have recently acquired. Someone in their personal network may have interest in gaining similar skills, but if the outcomes and criteria are not clear then a viewer would not be able to make an informed decision about pursuing the micro-credential.

2.1.4 Optimized for the learning opportunity

The type of learning opportunity, and any unique features of the learning opportunity, should be considered when designing an assessment. An assessment that is appropriate for one opportunity might not apply to another [8]. For example, a cumulative exam, or a portfolio, would not be suitable assessments for a succinct learning experience. Similarly, a multiple-choice exam would not be a suitable assessment for a performance-based learning experience. If the assessment is not optimal for the specific aspects of the learning opportunity, it may reduce the validity of the assessment [35].

Micro-credentials have unique features, such as their short length, and granularity of subject matter. Consequently, assessment aspects of the micro-credential need to be appropriate for those fundamental "micro" concepts by evaluating learners' competencies in a focused, concise, and pertinent manner that aligns with the nature of these targeted learning opportunities. The design stage, then, requires the identification of concrete competencies to be assessed, and assessment tasks that support and evaluate competency development [34].

2.1.5 Aligned with the delivery method

An assessment should be designed to suit the context of its intended delivery method [47]. Delivery method refers specifically to modality (e.g., online, face-to-face), meaning the medium through which information is delivered to students. This differs from the quality of being "optimized for the learning opportunity" which refers to designing assessments that are appropriate to the type of learning opportunity. Delivery method does not define a type of learning opportunity but rather a means of offering a learning opportunity.

Delivery method should be considered when determining the criteria to earn a micro-credential. In a face-to-face context, assessment for a micro-credential could be conducted through observation of learners working collaboratively in teams. In an online asynchronous micro-credential, the criteria could not be met through direct observation and would need to be verified through video demonstration or other appropriate assessment that would match the online context.

2.1.6 Equity-oriented assessment

Equity is a critical issue in education that should be addressed through pedagogical practices, including assessment design. Equity speaks to and references fairness, inclusion, and social justice. Equitable education encompasses several aims, including eliminating disparities, providing every student with a chance to succeed academically, and preparing them for participatory, democratic citizenship [43]. Equity-oriented assessment strategies give students some control over how they are assessed, a role that is typically performed only by authority figures. Involving students in their own assessment de-centers authority and provides learners with a sense of agency [50].

Micro-credentials can empower learners to be active players in their own assessment. For instance, micro-credentials can be awarded to show progress toward goals that are set by the learner, therefore focusing on what they deemed important rather than on standards set by an authority. Learners can decide what evidence they want to submit to show they have met their learning goals, and they can decide if they want that evidence to be published as viewable metadata

in their digital credential. This type of participation empowers learners and makes education more pluralistic, teaching that all voices (rather than just the voices of authority) are important.

2.2 Quality credential design

2.2.1 Meets the needs of employers

Credentials should be aligned to the labor market so that they verify skills that are needed by employers and have currency in the job market [45]. Employers will then be able to look for credentials to identify preferred qualifications of employees. If a credential earner can show that they possess the skills that employers need, they will be a strong candidate when seeking a job or advancing their position.

Since micro-credentials can be developed more quickly than traditional credentials, they are well-suited to meet the ever-changing needs of employers. Input from employers and industry experts will lead to the development of micro-credentials that verify skills that are needed [32], thereby increasing the value of the micro-credential to both employers and learners.

2.2.2 Prepares learners to succeed in the workforce

An important aim of postsecondary credentials is to benefit earners through financial returns and upward social mobility [54]. Xu and Trimble [52] found that credentials with "tight labor market alignment and clear indicators of the career trajectory" (p. 273) lead to better economic opportunities for earners than those with only a general approach to workforce preparation.

Micro-credentials could help learners in their career trajectory by preparing them with knowledge and skills that they will need in the workforce, and by providing opportunities to demonstrate these skills. Micro-credentials should include "hands-on" learning that enables learners to gain practical experience and to demonstrate their qualifications [19]. For example, a micro-credential can be earned for completing a project for a local business. The earner can then use that project to demonstrate their experience and preparedness to advance toward a career in that industry.

2.2.3 Understood by stakeholders

According to credentialing theory, the meaning of an educational credential is constructed and maintained through shared beliefs about the value of the credential [29]. "Shared beliefs" means that relevant stakeholders (e.g., educational institutions, employers, professional associations, students) possess mutual understanding of the purpose of the credential and its unique qualities [24]. Shared understanding leads to increased credibility and viability of a credential.

For a micro-credential to be understood by stakeholders, the individual or entity that awards it (e.g., a university) should clearly communicate its purpose and unique qualities. Since micro-credentials are digital credentials, the information that stakeholders need should be embedded as metadata which allows for a level of transparency that is not possible with non-digital credentials.

3 Methods

This study examined faculty perceptions of the assessment and credentialing affordances of micro-credentials, and practices employed when designing micro-credentials to address these affordances. To do this, we applied a qualitative design, specifically an embedded-single case design. This research design is appropriate when examining more than one sub-unit of analysis within a broader organizational context, especially when an examination of those sub-units introduces different perspectives [53]. In this study, a university's micro-credential pilot program constituted the main unit of analysis. The site of the pilot program was a large public research university in the United States. The faculty members who each designed a micro-credential for the pilot constituted the sub-units of analysis.

In-depth interviews were conducted with five faculty members, each representing distinct areas of expertise within the university. The participants encompassed a diverse spectrum of disciplines, including Engineering, Pharmacy, University Libraries, Dental Medicine, and Experiential Learning. The participants were assigned pseudonyms- Dr. E, Dr. P, Dr. L, Dr. D, and Dr. EL, respectively. Before their participation in the pilot program, none of the participants had previous experience

designing micro-credentials. However, all participants had extensive experience (i.e., five years or more) teaching and designing learning experiences, including academic courses, programs, and co-curricular learning. The participants designed a range of micro-credentials, including credit-bearing and non-credit micro-credentials, for undergraduate, graduate, and professional students.

The interviews were conducted in-person in secured conference rooms and were audio-recorded. The interview protocol consisted of semi-structured, open-ended questions to elicit the faculty's responses regarding their perceptions of micro-credentials, and their experience designing and implementing micro-credentials. The participants were asked to explain what they knew about micro-credentials before they decided to develop one; to discuss their decision to develop a micro-credential; and to describe their process of designing a micro-credential. Sample questions from the interview protocol included *What was your understanding for why micro-credentials are implemented? Why did you decide to offer this micro-credential?* and *What were some of the design decisions that you had to make?* The interviews were transcribed verbatim. Follow-up emails were sent to participants for clarification or additional questions. Instances that necessitated follow-up inquiry included incoherent portions of the recorded audio and ambiguous statements. For example, one participant frequently used the term "they," but it was sometimes unclear to whom "they" referred.

The transcripts were reviewed, and the authors coded them individually applying deductive analysis using an a priori template [4]. Prior to collecting data, the authors developed a codebook of the design qualities identified through the literature review. This codebook served as the a priori coding system and included a definition for each of the key characteristics of quality assessment and credential design [12]. After individually coding each interview, the authors met to compare codes and reason through any discrepancies in coding. Discrepancies surfaced during individual coding sessions where one researcher applied a code to a particular segment of an interview that other researchers had not considered or where different codes were applied to the same segment by different authors. To effectively manage these discrepancies, the research team adopted a consensus-driven approach, which involved thorough discussions where disagreements were deliberated upon, leading to joint decisions by the team [9]. Through these discussions, each researcher had the opportunity to present and clarify the rationale behind their application of specific codes. This approach was instrumental in ensuring inter-coding consistency across the coding process. Upon reaching consensus, it was established that all of the a priori codes pertained to micro-credential design.

4 Findings

Through a deductive analysis of interview data, we found that all of the participants designed micro-credentials to serve as both assessments and as credentials. Participants' application of the principles is illustrated in Table 2. No additional design qualities were explored in this study. Each of the faculty addressed the assessment and credentialing affordances by applying some of the characteristics of quality assessments and quality credentials, as defined in the literature. No faculty member discussed their application of every characteristic of quality assessment when describing how they designed a micro-credential; however, most of the participants (all but Dr. D) discussed all the characteristics of quality credentials. This section details our findings in terms of how and why the participating faculty applied these design qualities when designing micro-credentials. These findings shed light on how design principles can be applied to address the assessment and credentialing affordances of a micro-credential.

4.1 Characteristics of quality assessments integrated into micro-credentials

The six columns under Assessment Design Principles in Table 2 show which characteristics of quality assessments were applied by each of the participating faculty members when designing a micro-credential.

4.1.1 Formative and summative components

Four of the participants acknowledged that micro-credentials served both formative and summative assessment purposes. While all of the participants discussed their micro-credentials as serving summative assessment purposes, as indicated in Table 2, one faculty member did not perceive the purpose of her micro-credential as providing formative feedback. Dr. P stated "I view it as summative…. but, understand that I'm grounded in professional education culture and graduate education culture…. So, somebody from [another unit] may have a different perspective." While this faculty

Table 2 Participants' Application of Assessment and Credential Design Principles

Assessment design principles							Credential design principles		
Participant	Formative and summative	Aligns with delivery method	Sustainable	Clarity of outcomes and criteria	Optimized for the learning opportunity	Equity-oriented	Meets needs of employers	Prepares Learners to Succeed in the Workforce	Understood by Stakeholders
Dr. E	+	–	+	–	+	–	+	+	+
Dr. P	–	–	–	–	+	–	+	+	+
Dr. L	+	+	+	+	+	–	+	+	+
Dr. D	+	–	+	–	–	–	–	+	+
Dr. EL	+	+	+	+	–	+	+	+	+

[+] Participant discussed application of the principle

[–] Participant did not discuss application of the principle

member acknowledged that others might view micro-credentials as having a formative use, she made an explicit design choice to use the micro-credential as a summative assessment.

4.1.2 Sustainable assessment

Micro-credentials were described as sustainable assessments by four of the participants. For example, Dr. E described a mock job interview that was required for his micro-credential. The students' mock job interviews were recorded and then "[the students] have to go back, watch themselves and then do one final reflection where they're sort of trying to evaluate How do you think you did on that? How did you do with answering each question in the mock interview? I'm not watching their mock interview, but I am reading their reflection on their own performance." This faculty member designed the micro-credential so that learners were asked to reflect on their own performance to better prepare them for a future "real life" interview. This is an example of a sustainable assessment in that the learners practiced self-assessment in order to be prepared to self-assess in other, future, contexts.

4.1.3 Clarity of outcomes and criteria

Two faculty members discussed the notion that the outcomes and criteria of a micro-credential should be clearly understood by stakeholders. In one example, Dr. EL discussed how she developed resources to assist the students in understanding the criteria for earning the micro-credential that she designed. She stated that she "spent a lot of time creating a template and giving students instructions for how to earn [the micro-credential]." She also discussed working with a colleague to develop an instructional guide. The effort she spent was indicative of her view that it was important for students to clearly understand the criteria for the micro-credential.

4.1.4 Optimized for the learning opportunity

Three faculty members discussed designing a micro-credential to be optimized for the unique aspects of the learning opportunity. Dr. L designed a micro-credential for a self-paced short program to teach what she categorized as "soft skills," including critical thinking, and evaluating digital resources. She stated "we had to build [quizzes] that would measure what we had them watching or reading, so they could actually answer to those competencies. But we had to do it in a way that inspired critical thinking." When the interviewer followed up by asking "and if it weren't a micro-credential, would you have built that?" She replied, "we probably wouldn't have because [we would instead] observe the student or interview the student through the process." Her conjecture is that without the micro aspect of the credential, she could have still assessed the soft skills but that would have required an observation protocol that would require a longer period of time (e.g., a semester) and more resources (e.g., a librarian conducting observations).

4.1.5 Aligned with the delivery method

The importance of aligning micro-credentials with delivery method was described by two faculty members, both of whom offered their micro-credentials fully online. Dr. EL created a micro-credential that students earned through an online, international collaborative experience. She described the culminating assessment in which students developed a "connective narrative" video, created and delivered online, that "integrated their [collaborative] experience and what they gained from it." This is an example of alignment with delivery method because the video requirement was chosen as an activity to be compatible with the online design of the micro-credential.

4.1.6 Equity-oriented assessment

Only one of the faculty members described a micro-credential as an equitable assessment. Dr. EL explained how the micro-credential she designed empowered students by providing them with a sense of agency. She stated, "we have three activities, the first one has three steps to the badge and requires them to look at a list of skills and pick five that they feel are most relevant to their experience and explain why." This can be characterized as an equitable assessment since this micro-credential was designed as an opportunity for learners to participate in their own assessment by selecting the skills they wanted to gain, and also because their personal experiences were recognized as valuable.

4.2 Characteristics of quality credentials integrated into micro-credentials

The three columns under Credential Design Principles in Table 2 show which characteristics of quality credentials were applied by each of the participating faculty members when designing a micro-credential.

4.2.1 Meets needs of employers

Four of the faculty members discussed their micro-credentials in terms of meeting the needs of employers. For example, Dr. P stated that the micro-credential she developed would "help [students] verify to employers that they have the skill-sets employers are looking for." She suggested that although students might have the skills that employers need, they still needed additional methods for conveying those skills. The micro-credential acted as the means by which those skills can be conveyed, such as displaying them on a CV or using them as prompts during an interview (e.g., "I'd like to mention that I earned micro-credential in a relevant skill.").

4.2.2 Prepares learners to succeed in the workforce

All of the participants characterized their micro-credentials in terms of preparing learners for success in the workforce. Dr. P described micro-credentials as a way to gain specialized skill sets that are needed in specific fields, but not currently offered through coursework at the university. She stated "I really think it should be used for a select group of students who want to enhance their skill-set." She designed a micro-credential to assess skills in conducting original research. In describing how she communicated this to students and stated, "if you're interested in this career path [in pharmaceutical research], you may be interested in this micro-credential." This indicated that she viewed the micro-credential as having a role in preparing learners for a career involving research.

4.2.3 Understood by stakeholders

Each of the participants discussed the notion that a micro-credential should be understood by stakeholders, both internal (students, faculty, and an advisory council) and external (industry partners and employers). Dr. D described doubts about his micro-credential from both faculty and students by stating "The faculty, as well as students in most cases, are not seeing the inherent value…. because it's not really mainstream at this point." He also pondered whether employers understood micro-credentials and asked, rhetorically "Is this something that employers are looking at? Are they going to know to click on a digital icon and realize that this is going to provide information on what the student did to accomplish it?" From his perspective, stakeholders lacked an understanding because of the newness of micro-credentials. He did not identify ways to counter stakeholders' lack of understanding but rather expressed his belief that understanding would develop over time.

5 Discussion

The findings of this study indicated that faculty did, in fact, apply both assessment design and credential design principles when designing micro-credentials. These principles can serve as foundational recommendations for designing micro-credentials, particularly those meant to function as both an assessment of learning, and as a credential that validates learning. These principles are not unique to micro-credentials, but when integrated may optimize the assessment and credentialing affordances of micro-credentials.

These principles serve as a guide to support quality micro-credential design but is not necessarily meant to be applied in-aggregate; a micro-credential may be well-designed without the inclusion of every one of these design principles. Also, there may be other principles that, when integrated into the design of a micro-credential, may positively serve its assessment and credentialing affordances. Therefore, the design principles examined in this study serve as a foundation for optimizing micro-credential design, not as a definitive formula. Given these caveats, we found that some assessment qualities were overlooked by most of the participating faculty. We also found that all but one of the faculty members

addressed all of the characteristics of quality credentials when designing a micro-credential. Also in our findings, all but one of the faculty members considered and incorporated all of the characteristics of quality credentials when designing a micro-credential.

5.1 Assessment qualities largely overlooked by faculty-designers of micro-credentials

Three characteristics of assessment were largely unmentioned by the faculty, "Aligns with the Delivery Method,""Clarity of Outcomes and Criteria" and "Equity-Oriented." We acknowledge that not all six characteristics of quality assessment need to be present in the design of a micro-credential, as a micro-credential may still function as an assessment if some characteristics are missing. For instance, during the interviews, Dr. E, Dr. P, and Dr. D did not discuss whether or how they addressed "Alignment with the Delivery Method" when designing a micro-credential. The absence of this principle does not necessarily negate the functionality of a micro-credential as an assessment tool, however, misalignment with the delivery method could dimmish the overall quality of a micro-credential. For example, a micro-credential delivered fully online would be misaligned with its delivery method if the learners were required to take a paper-based quizzes and email them to the instructor. While this type of misalignment would cause unnecessary burden, the micro-credential would still function as an assessment. Alignment with the delivery method positively impacts the design of an assessment, and therefore faculty should be supported in designing micro-credentials that are well-suited to their chosen delivery method.

"Equity-Oriented" is another quality of assessment that may not be present in all micro-credentials, but, when missing, may diminish the overall quality of a micro-credential. Equitable assessment was the least mentioned assessment characteristic, discussed only by Dr. EL. The limited discussion regarding micro-credentials as equitable assessments was surprising because micro-credentials are often publicized as opportunities to gain skills that are relevant to an individual's goals. Equitable assessment involves learners as active participants in their own assessment and therefore is well-aligned with this aim of "individualizing" learning. The limited discussion regarding micro-credentials as equitable assessments was concerning because inequity is a major issue in the United States, one that pervades all aspects of society, including education. We do not claim that micro-credentials are a solution to inequality or social injustices. We do, however, believe that it is imperative that equity-oriented processes be incorporated into pedagogical practices. Therefore, faculty should be supported in designing micro-credentials that focus on individual progress, and that welcome the voices of all learners.

"Clarity of Outcomes and Criteria" was also largely unaddressed, discussed only by Dr. EL, and Dr. L, but we believe this is an important characteristic that may lead to damaging consequences if not included in the design of a micro-credential. For students, if this characteristic is missing, and they are unable to understand the assessment criteria and expected outcomes, then they may not be able to meet those outcomes and earn the micro-credential. For other stakeholders such as employers, if this characteristic is missing then they would not be able to make an informed decision about the earner (e.g., placing them in a job where the credentialed skill would be optimal). Faculty should be supported in developing well-defined outcomes and clear criteria for a micro-credential, and also supported in making this information readily accessible to stakeholders.

Given the scarcity of empirical research on micro-credential design it is not clear whether the assessment design qualities examined in this study commonly characterize micro-credentials across varied contexts. Several conceptual papers advocate for the importance of high-quality curriculum design in the realm of micro-credentials [3, 32, 37]; however, there remains a scarcity of research concerning the application of principles and strategies to ensure this quality. For example, Desmarchelier & Cary [13] argue for equitable approaches to micro-credentials but do not examine specific strategies for assuring equity, such as equity-oriented assessments,

5.2 Credential qualities applied by faculty-designers of micro-credentials

While few characteristics of quality assessments were consistently mentioned by the faculty, they consistently discussed the characteristics of quality credentials. This was surprising, as we had speculated that faculty would be more focused on assessment of learning than with credentialing. Our assumption was that faculty, when teaching, are asked to engage in curriculum design and revision. Naturally, curriculum design must include assessment since it determines if students meet the learning outcomes of the curriculum. Engaging in the design of credentials necessitates decision-making that transcends the context of a course (i.e., "What are the needs of employers?""What skills do graduates need to be successful in the workforce?"). Although it is the responsibility of all faculty to consider and ensure credential-like goals when designing curriculum, it is likely that faculty members have various levels of responsibility regarding credential-like goals. Some instructional faculty may not have as much experience or knowledge concerning those goals than others (e.g., deans,

department chairs, registrars, experienced faculty members). Our study reveals that credential design was ubiquitously perceived as an important aspect of designing a micro-credential. This suggests an unexpected result of micro-credential design may be an expansion of faculty responsibilities into regular consideration of credentials, or a merging of faculty and administrative duties regarding the use of micro-credentials outside of the original learning context.

We also note that while the credential quality of being "Understood by Stakeholders" was discussed by each of the faculty members, the participants largely expressed doubt in both internal and external stakeholder understanding of micro-credentials. For example, Dr. D, Dr. L, and Dr. EL voiced uncertainty about whether students see value in earning micro-credentials. Similarly, both Dr. P and Dr. EL expressed doubts about how well employers understand micro-credentials. Each of these participants were cognizant of the need for stakeholders to understand micro-credentials, but they either did not know how to design to address this quality or questioned their role in addressing this quality. This suggests that stakeholder acceptance of micro-credentials is a perceived gap by faculty designers, and an area where additional support is needed.

6 Limitations

We acknowledge that our research findings are constrained in their generalizability due to methodological limitations, including the study's small sample size and the inherent constraints of a single-case research design. Research that includes a larger dataset, including a range of institutions, is needed.

The use of interviews was critical to our study as this technique provided detailed information regarding faculty perceptions and rich descriptions of their design decisions and processes, however, we acknowledge that self-reported data introduces potential flaws to the study. It is possible that more design principles may have been integrated but not broached in the interviews. We acknowledge that the use of additional data sources, and the triangulation of data would have benefited this study.

7 Conclusion

The design principles investigated here, derived from empirical research on educational design in other learning contexts, lay the groundwork for establishing a crucial knowledge base necessary for future micro-credential design research. Further research is needed to refine these principles and to determine their applicability across other settings of higher education. We anticipate that additional research will build upon this work, as it is likely that there are other principles that, when integrated into the design of a micro-credential, may positively serve its assessment and credentialing affordances.

Our findings show that some critical design principles, particularly assessment design principles, were largely not discussed, or not applied, by the faculty in this study. While there may be higher education institutions where faculty have mastered the merger between assessment and credential when designing a micro-credential, based upon our study some faculty may need support in recognizing and integrating quality assessment principles. For future research we suggest the development and testing of interventions, such as trainings that focus on applying quality assessment principles when designing a micro-credential.

Lastly, we would like to emphasize that all of the design principles examined in this study were extracted from the literature and are not indicative of the authors' views. For example, the literature pertaining to credentials is focused on the workforce, and "consumers" of credentials are largely identified as employers and other individuals involved in hiring (e.g., recruiters, hiring managers). We believe that this is a limiting framing of the purpose of credentials. Employment-related goals are not the only aim of learners who pursue higher education. For a critical analysis see Wheelahan and Moodie's [51] examination of micro-credentials as a tool to re-orient higher education curriculum towards a narrow focus on employability. More research on the use of micro-credentials by other stakeholders, besides employers (e.g., admissions officers), is needed to better understand how micro-credential design can be optimized for use in other contexts.

Author contributions AR served as the project lead. For the data collection AR co-wrote the interview protocol, arranged the interviews and co-conducted interviews. AR served as data custodian by safely storing and anonymizing data. AR led the data analysis by serving as initial coder and developing the codebook. With input from co-authors, AR conducted the literature review and served as the primary author of the manuscript. YK supported data collection by transcribing the interviews and following up with participants when clarity was needed. YK participated in the data analysis by serving as second coder and editing the codebook. YK also participated in writing the manuscript by

providing substantive revisions. SA supported the data collection by co-writing the interview protocol and co-conducting the interviews with AR. A3 also edited the manuscript and provided substantive feedback on revisions. All authors collaborated on the design of the study. All authors read and approved the final manuscript.

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Data availability The datasets generated and analyzed during the current study are available from the corresponding author upon request.

Code availability Not applicable.

Declarations

Ethics approval and consent to participate All standard practices for minimizing risk to participants were followed, including ethical guidelines for data collection, protecting participants by using pseudonyms, and securing storage were followed. Analyzed data came from an internal review of the studied programs. The university does not require a statement from an institutional ethics committee for such non-invasive work.

Consent for publication Faculty participants were informed of the potential for research outcomes and gave permission to use collected data.

Competing interests The authors declare no competing interests.

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