

ABSTRACT

STALLARD, MADELINE SHAE. Micro-Credentials as Teacher Professional Development. (Under the Direction of Dr. M. Gail Jones).

This dissertation explored the role and impact of micro-credential-based professional development for K-12 educators, focusing on its potential, challenges, and influence on teachers' beliefs, skills, and self-directed learning. The first study investigated the perspectives of six education policymakers, highlighting both the promise and challenges of micro-credentials as a tool for professional development. Policymakers identified micro-credentials' ability to provide self-directed, mastery-based learning and greater autonomy as key strengths. However, they also emphasized issues such as financial sustainability, quality assurance, and the narrow focus on standardized pedagogical skills over specialized professional growth. The second study, guided by Expectancy Value Theory, examined how teachers' previous experiences and self-efficacy in self-directed learning influenced their engagement with micro-credentials. Despite no significant differences in self-efficacy between the treatment and control groups, the study revealed strong connections between self-directed learning, expectancy-value factors, and self-efficacy. The third study, conducted with rural Appalachian teachers, assessed the impact of micro-credentials on teachers' beliefs, knowledge, and skills, highlighting the differential impact based on teachers' self-directed learning capabilities. Findings suggested that teachers with higher motivation and time availability benefit more from micro-credential programs, underscoring the need for tailored support strategies to address varying levels of self-regulatory skills and contextual challenges.

Micro-credentials as Teacher Professional Development

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DEDICATION

I dedicate this dissertation to the rural teachers who dare to dream and step into the world of education with passion, resilience, and the unwavering belief that knowledge can transform lives. May you always find the courage to take up space, the confidence to lead, and the determination to shape the future of learning in your communities. This work is for you; may it serve as a reminder that your voice, your presence, and your contributions matter.

And to my beloved Bailey Ann, who walked beside me with unwavering love and loyalty. You were more than a companion; you were my heart, my comfort, and my constant source of joy. This journey was made lighter because of you, and I carry your spirit with me always.

BIOGRAPHY

Madeline S. Stallard was born and raised in the Appalachian Mountains of Pound, Virginia, where she experienced firsthand the challenges and limited opportunities of growing up in a rural community. Despite these obstacles, she was driven by a passion for science and pursued a bachelor's degree in biology from The University of Virginia's College at Wise. Following graduation, she began her career as a Research Associate in a research and development laboratory, where she contributed to scientific advancements. However, after being laid off due to the loss of a client, she faced the stark reality of limited job opportunities in her rural area.

During this transitional period, Madeline began substitute teaching and quickly discovered a newfound passion for education. This realization led her to pursue a master's degree in teaching at The University of the Cumberlands, equipping her with the skills and knowledge to inspire the next generation of learners. She went on to teach high school science for three years, fostering curiosity and critical thinking in her students.

In 2021, driven by her commitment to improving science education, particularly for students in underserved communities, Madeline embarked on her journey toward a Doctorate of Philosophy in Science Education at North Carolina State University. Her research and academic pursuits reflect her dedication to advancing professional development opportunities for educators and enhancing science learning experiences for students, particularly in rural settings.

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CHAPTER 1 INTRODUCTION

Definition and Uses of Micro-Credentials

The term "credential" is broadly understood as an achievement, qualification, or attribute that signifies an individual's competence or suitability in a specific domain (Dictionary, O. E., 1989) and traditional academic credentials, such as degrees, diplomas, and certificates, reflect verified expertise in particular areas of study. Recently, micro-credentials (MCs) have emerged as a complementary form of recognition, providing a more flexible and focused approach to credentialing (Kato et al., 2020). While a universally accepted definition of MCs remains undetermined, they are typically described as short-term, skill-based certifications that validate the mastery of specific competencies, often represented by digital badges (Reed, 2023). The State University of New York defines MCs as credentials of limited scope that recognize achievements in narrowly defined areas of learning (SUNY, 2019). In the context of science, technology, engineering, and mathematics (STEM) education, MCs often certify educators' proficiency in particular teaching skills, knowledge, or attitudes necessary for effective instruction (Bruguera & Pagés, 2023; Reed 2023). For the purposes of this study, MCs are defined as digital certifications awarded to teachers upon demonstrating competency in a specific area of expertise.

The utility of MCs has been widely recognized across various educational and professional contexts. Gibson et al. (2015) outlined four primary functions of MCs: credentialing learning, showcasing achievements, encouraging learner progression, and supporting research. Additionally, Carey and Stefaniak (2018) explored their use within higher education, noting their growing role in professional development (PD) and lifelong learning. Randall et al. (2013) highlighted the integration of digital badges (what is received upon successful completion of an

MC), in diverse settings, such as coding boot camps, MOOCs, and teacher training programs, demonstrating their adaptability to different educational formats.

Micro-credentials have also been shown to enhance learning engagement, motivation, and performance (Bruguera & Pagés, 2023). Newby and Cheng (2020) emphasized their role in providing targeted feedback, facilitating goal-setting, and promoting self-directed learning. Similarly, Dowling-Hetherington and Glowatz (2017) identified their value in virtual learning environments, where learners could asynchronously acquire skills, customize their educational pathways, and receive constructive input. Research by Ahn et al. (2014) underscored the potential of MCs to drive behavioral changes and increase productivity through gamification, an approach frequently employed in education to improve motivation.

Several studies have investigated the motivational impact of MCs on learners. For example, Abramović et al. (2013) found that digital badges significantly increased student interest and reduced unproductive motivational goals in a study involving middle school students in a low-income community. Similarly, Iwata et al. (2019) observed that the use of MCs in a medical terminology course enhanced both student motivation and autonomy in an online learning setting. These findings are consistent with recent work by Newby and Cheng (2020), who reported that digital badges positively influenced pre-service teachers, leading to greater motivation, improved skill acquisition, and enhanced knowledge retention.

This research examined micro-credentialing as a form of teacher PD through a series of three interconnected studies. The first study employed interviews with educational policymakers to explore the potential benefits, limitations, and future implications of MC-based PD. The second study utilized an intervention design to survey high school STEM teachers, assessing changes in self-efficacy and self-directed learning as they engaged in an MC-based PD program,

while also analyzing the relationships between these constructs. The third study employed a collective case study approach, documenting the year-long experiences of eight rural science and mathematics teachers participating in MC-based PD.

Teacher Professional Development

The field of teacher PD research continues to identify factors that contribute to its effectiveness (Desimone & Garet, 2015). Allen and Penuel (2015), for example, conducted a multi-case study examining how teachers interpreted and implemented PD in their practice. Their findings revealed that many educators faced challenges, including confusion in aligning PD with their instructional goals, skepticism about its relevance to evaluation and accountability systems, and a lack of resources to effectively integrate new skills. They emphasized the importance of collaborative opportunities, where teachers could engage in dialogue to contextualize PD content and apply it within their classrooms.

Despite the growing focus on teacher PD, numerous studies suggest that it often fails to meet teachers' needs or foster significant changes in instructional practices. Research by Hill et al. (2013) and the Bill and Melinda Gates Foundation (2014) showed that many PD programs fall short in providing practical, actionable strategies that translate into improved pedagogy. This gap is particularly concerning given that effective PD is critical to fostering teacher growth (Darling-Hammond & McLaughlin, 2011) and, by extension, enhancing student achievement (Garet et al., 2001). When PD initiatives lack relevance or fail to promote instructional change, they may inadvertently contribute to stagnant student outcomes (Bill & Melinda Gates Foundation, 2014; Hill, 2013).

Recent studies underscore the urgent need for identifying and designing PD formats that lead to meaningful teacher development and improved classroom practices (Darling-Hammond,

2017). Research suggests that effective PD programs share key characteristics, such as active learning components, alignment with curriculum standards, and opportunities for collaboration (Desimone & Pak, 2017).

Professional Development Effectiveness

Historically, research on PD in education has often employed a cause-and-effect framework, seeking to understand how PD initiatives influence teacher growth and student outcomes (Opfer & Pedder, 2011). This approach typically assumes that providing well-designed PD will enhance teachers' skills and knowledge, which, in turn, will lead to improved student achievement (Desimone & Garet, 2015). Much of the research in this area has focused on identifying the features of effective PD, aiming to establish best practices for its design and implementation (Desimone et al., 2002; Koellner & Jacobs, 2015).

The design of PD activities plays a critical role in shaping educators' knowledge and instructional practices (Guskey, 2000). Studies have consistently highlighted several core design elements associated with effective PD. For example, Penuel et al. (2007) identified six key features that contribute to meaningful teacher learning: a focus on subject content, active learning opportunities, alignment with teachers' instructional practices, coherence with policy standards, collaboration among educators, and sustained duration. Among these, content-specific learning, particularly how to teach content in ways that maximize student understanding, has emerged as one of the most influential factors (Desimone & Pak, 2017) and is typically not examined in research on MC-based PD. Other elements, such as the use of coaching, teacher study groups, and collaborative activities that extend beyond single-day workshops, also play a vital role in promoting lasting change in instructional practices (Darling-Hammond, 2017).

However, some researchers have challenged the idea that PD effectiveness can be fully explained by its design features alone. Opfer and Pedder (2011) argued that many studies oversimplify the complex dynamics of teacher learning by focusing solely on PD programs, neglecting critical factors such as the broader learning environment and the cultural context of schools. They cautioned against an "epistemological fallacy" in earlier research, which they described as an overemphasis on discrete activities without adequately addressing how teachers interact with their environments to construct knowledge and skills (Opfer & Pedder, 2011, p. 377). More recent perspectives suggest that effective PD must account for the interplay between individual teacher characteristics, collaborative learning opportunities, and systemic supports to foster meaningful and sustainable improvements in teaching and learning (O'Leary, 2021; Webster-Wright, 2009).

Many scholars agree that traditional workshop-based PD is one of the least effective methods for improving teacher quality and student outcomes (Scher & O'Reilly, 2009; Wei et al., 2010). Workshops often fail to promote meaningful teacher learning due to several design flaws. These include their reliance on passive instructional methods (e.g., lectures), lack of deep content exploration, and insufficient emphasis on critical thinking regarding pedagogy (Borko, 2004; Garet et al., 2001). Moreover, workshops frequently create a disconnect between the PD experience and teachers' real-world classroom contexts, as they are often delivered by external specialists rather than tailored to the specific needs of educators (Lauer et al., 2014; Webster-Wright, 2009).

Research has consistently demonstrated that PD programs emphasizing reform-based approaches, such as mentoring, coaching, or collaborative inquiry embedded within a teacher's daily work, are far more effective than traditional workshops (Darling-Hammond et al., 2017;

Loucks-Horsley et al., 1998). These approaches provide opportunities for sustained engagement, reflection, and the practical application of learned concepts, all of which contribute to more meaningful teacher growth (Tallerico, 2005).

In-Person vs. Virtual Professional Development

The rise of online PD has sparked interest in understanding its advantages and limitations compared to traditional in-person methods. Wynants et al. (2018) explored this topic by examining the experiences of university faculty members who participated in a disability awareness program. The study revealed that participants found the online format to be an accessible and versatile platform that facilitated cognitive reflection. In a related study, Wasserman and Migdal (2019) investigated the perceptions of teachers participating in either traditional in-person PD or asynchronous online courses. Their quantitative study surveyed 469 educators, and findings indicated a significant preference for online courses. Despite the lack of physical interaction, participants reported strong personal connections and effective communication between students and instructors in the online environment.

Holmes (2013) further underscored the potential of online learning communities to promote teacher development. By examining the cognitive growth of educators within these virtual spaces, they found that online learning communities provided meaningful opportunities for reflection, collaboration, and professional growth. Similarly, Darling-Aduana and Heinrich (2018) emphasized that online PD's flexibility and accessibility enable educators to learn at their own pace and tailor their experiences to their unique instructional needs, a benefit often absent in traditional in-person workshops.

Micro-Credentials as Professional Development

Teachers have long been encouraged to engage in PD as part of their ongoing growth, whether through self-directed efforts or requirements established by school districts and state education departments (Altindag, 2022; Darling-Hammond et al., 2017). Micro-credentials have emerged as a new form of PD, offering educators a flexible, competency-based method to develop specific skills while documenting their progress through videos, work samples, and other artifacts (Hughey, 2020). These digital certifications are typically accessible online, allowing educators to participate at their convenience and tailor their learning to their needs. Additionally, MCs provide opportunities for personalization and choice, covering a wide array of topics. They can be shared electronically on platforms like social media, email, or resumes, enhancing their versatility and visibility (Berry et al., 2016; Erickson, 2020).

Research by Gamrat et al. (2014) explored how educators used an MC system to achieve both personal learning goals and meet workplace requirements. Their collective case study revealed that teachers could customize content and assessments to align with their PD objectives and institutional demands. Furthermore, results revealed that feedback played a crucial role in guiding teachers through the MC process, fostering more meaningful and targeted learning experiences. Similarly, Dyjur and Lindstrom (2017) investigated the perceptions of higher education instructors and graduate students regarding MCs after participating in professional learning programs in Canada. Findings showed that 87.5% of participants appreciated earning online badges through micro-credentialing as part of their PD. However, some respondents expressed concerns about the perceived prestige of digital badges compared to traditional paper certificates, highlighting the need for increased recognition and legitimacy of MCs within professional contexts.

Other studies have also highlighted the benefits of MCs in fostering autonomy and motivation among educators. For instance, Scott et al. (2024) found that educators valued MCs for their ability to address specific instructional challenges and promote self-paced learning. Additionally, researchers such as Darling-Hammond et al. (2017) emphasized that competency-based systems like MCs are well-aligned with principles of effective PD, including active engagement, relevance to practice, and opportunities for reflection.

The acceleration of digital learning platforms and asynchronous PD opportunities following COVID-19 have further enabled the expansion of MCs in teacher education (Trust & Whalen, 2021). Prior to the pandemic, online PD was growing but often remained supplementary to in-person training. The widespread shift to remote learning demonstrated the efficacy of digital platforms for professional learning, making MCs more viable and accessible (Yilmaz & Yanik, 2025).

Addressing Credibility and Standardization. To enhance the credibility of MCs, some regions have begun implementing formal policy frameworks. For instance, the New Zealand Qualifications Authority formalized the recognition of micro-credentials by amending its regulatory framework in 2019 (New Zealand Qualifications Authority, 2019). The regulations stipulate the definition, credit value limitations, and publication authorization. This approach provides a model for other educational systems seeking to integrate MCs into broader learning and certification structures.

Additionally, the development of quality assurance standards, such as those established by Digital Promise's Partnership of States, aims to provide a more uniform framework for evaluating MCs (digiLearn, 2023). These standards help mitigate concerns about quality and

consistency, making it easier for educators and employers to trust and adopt MCs as a legitimate form of professional learning.

Self-Directed Learning

Self-directed professional learning has garnered increased attention as a PD strategy for educators seeking more autonomy in their growth (Bakhshi, 2019). This approach is rooted in the concept of self-directed learning, a foundational principle of adult learning theory (Knowles, 1975). Knowles (1975) defined self-directed learning as a process where individuals take initiative, either independently or with support, in identifying their learning needs, setting goals, locating resources, selecting strategies, and assessing their progress. His work emphasized the importance of learners actively shaping their educational experiences to achieve meaningful outcomes.

Unlike traditional models of PD that are often externally imposed, self-directed professional learning positions teachers as active agents in their development, transforming the process into an engaging and personally meaningful endeavor (Bakhshi, 2019; Merriam & Bierema, 2013). Research has underscored the benefits of self-directed professional learning in fostering sustained engagement and deeper knowledge acquisition. For instance, Turan and Koc (2018) highlighted that self-directed learning encourages the development of critical thinking, problem-solving, and adaptability, skills essential for navigating the dynamic demands of education. Furthermore, binti Mappah (2024) emphasized the role of reflective practice in self-directed learning, enabling educators to continuously refine their teaching practices based on their evolving understanding of their students' needs.

Despite its promise, self-directed professional learning is not without challenges. Educators may face barriers such as limited access to resources, insufficient time, or a lack of

institutional support (Van Rensburg & Botma, 2015). Addressing these issues requires a systemic approach, with schools and districts creating environments that encourage and facilitate self-directed learning. Initiatives such as providing access to online resources, fostering professional learning communities, and offering coaching support can help educators overcome these obstacles and maximize the potential of self-directed professional learning (Brookfield, 1985).

Self-Directed Professional Development

Self-directed PD refers to professional growth opportunities initiated by teachers themselves to address their unique instructional needs and goals (Mushayikwa & Lubben, 2009). Research indicates that many educators prefer this approach because it allows them autonomy to identify and address their professional challenges, fostering a sense of ownership over their learning (Colbert et al., 2008). This process often involves teachers recognizing a gap in their practice and independently exploring potential solutions (Bonner, 2006). Importantly, self-directed PD is not inherently solitary; self-directed learners frequently seek out peers, mentors, or professional networks for support and collaboration, ensuring a more dynamic and interactive learning experience (Voltz et al., 2004). Studies have demonstrated the increasing necessity for such individualized approaches to PD (Lom & Sullenger, 2011; Visser et al., 2014). Although traditional PD programs remain a focal point of research, enabling teachers to self-direct their learning has been identified as a potentially transformative strategy to enhance teacher practice and student outcomes (Riddle, 2018).

Several studies have explored the motivations driving teachers to pursue self-directed PD. For instance, Jones and Dexter (2014) highlighted that dissatisfaction with formal PD programs often pushes teachers toward informal, self-directed learning opportunities that better align with

their individual contexts. Similarly, Mushayikwa and Lubben (2009) found that educators engage in self-directed PD to improve their teaching effectiveness and strengthen their professional identity. These findings align with Tang and Choi (2009), who reported that many educators are driven by a moral imperative to better serve their students and meet their learning needs.

However, there are contrasting perspectives on the efficacy of self-directed PD. Kleickmann et al. (2013) compared teachers who received expert-guided scaffolding of curriculum materials to those in a control group relying solely on self-study. The results suggested that expert scaffolding was more effective in driving teacher improvement. However, the study did not specify whether the self-study group had access to collaborative networks or external resources, leaving questions about the conditions under which self-directed PD might be most effective.

Additionally, some researchers caution against assuming that all educators will embrace self-directed PD. Brown et al. (2001) argued that certain teachers may be more reliant on structured PD due to a lack of motivation or an unwillingness to engage in self-reflection and inquiry. Guskey (2002) similarly noted that teacher beliefs and attitudes toward PD can significantly influence their willingness to adopt self-directed approaches.

Evolution of Micro-Credentials

Micro-credentials were originally developed in the business and workforce sectors to provide targeted skill-based training. Initially, these credentials were predominantly employed in specialized domains, such as digital skills and technical training, where the currency of knowledge was paramount. A salient example of this development is the introduction of the Open Badges system by the Mozilla Foundation in 2011, which represents one of the pioneering

efforts to formalize micro-credentials as a credible and standardized method of skill verification (Stamatakis et al., 2024).

The transition of MCs into K-12 education has been influenced by pre-existing models of mastery-based learning, political dynamics related to teacher workforce challenges, and rapid technological advancements, particularly in the wake of COVID-19.

Mastery-Based Learning

Mastery-based learning is not a novel concept in teacher PD; rather, it has long been a foundational approach in teacher education (Guskey, 2002). Traditional PD programs have often aimed to provide teachers with continuous learning opportunities that align with standards-based competencies (Darling-Hammond et al., 2017). Micro-credentials build upon these foundations by offering bite-sized, competency-based certifications that verify an educator's proficiency in a specific skill or knowledge area. Unlike traditional PD, which often relies on seat-time models, MCs emphasize demonstrable mastery, reinforcing long-standing principles in adult learning and professional growth.

Historical Perspective

While credentialing systems have long existed in various forms, the renewed interest in MCs stems from their ability to offer flexible, competency-based learning opportunities that address modern challenges in education and workforce preparation (Zou et al., 2023). The increasing fragmentation of school systems and persistent teacher shortages have played a significant role in the resurgence of MCs as a viable solution for professional learning and certification (Tooley & White, 2018). Many school districts struggle to attract and retain qualified teachers (Hanushek et al., 2004), leading policymakers to explore alternative pathways for certification and ongoing development. Micro-credentials provide an avenue for teachers to

gain targeted skills without the extensive time and financial commitment required for traditional degree programs (Phelan & Glackin, 2021).

Political and economic factors have also influenced the rise of MCs (Ha et al., 2023). The cost of higher education has continued to rise, while the return on investment for traditional degrees has been increasingly scrutinized (Ralston, 2021). Simultaneously, employers and school districts demand more agile learning models that align with rapidly evolving industry and pedagogical needs (Lang, 2023). However, the credibility and standardization of these credentials remain a significant challenge, as policymakers and educators work to establish frameworks that ensure quality and recognition across institutions (Davis & Singh, 2015; Randall et al., 2013).

The fragmented nature of the U.S. education system, with decentralized school governance and varied state-level certification requirements, has contributed to an uneven adoption of MCs (Albornoz et al., 2022). Additionally, political debates over teacher autonomy versus top-down accountability measures have influenced the implementation and reception of micro-credentialing initiatives in different jurisdictions (Hammersley-Fletcher et al., 2021). For example, Hammersley-Fletcher et al. (2021) explored the delicate equilibrium between teacher independence and regulatory oversight, emphasizing its significance in educational governance. In settings where educators must navigate both professional expectations and governmental mandates, this dynamic influences their reception of micro-credentialing programs (e.g., some may see these credentials as an opportunity for professional growth and autonomy, while others might perceive them as an additional layer of external accountability).

The evolution of MCs reflects a broader shift toward competency-based education and workforce-aligned learning models. While MCs offer significant advantages in terms of

flexibility, accessibility, and targeted skill development, their widespread adoption depends on overcoming challenges related to credibility, standardization, and stakeholder engagement. As educational institutions, policymakers, and employers continue to refine MC frameworks, their role in teacher PD and broader workforce development is likely to expand, shaping the future of skills-based learning and certification. This expansion of micro-credential-based PD highlights the need for research that examines factors that contribute to their effectiveness.

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CHAPTER 2

POLICYMAKERS' PERSPECTIVES ON MICRO-CREDENTIALS IN EDUCATION

Abstract

In recent years, there has been a rapid growth in the use of micro-credentials as a type of professional development for K-12 educators. Micro-credentials allow teachers to document professional knowledge and skills through the use of videos, work samples, and other artifacts. This study interviewed six education policymakers to explore their perspectives and beliefs related to micro-credentials as a form of professional development for K-12 teachers. Policymakers' views of the affordances and constraints of micro-credentials were explored, as well as their perspectives on the future of micro-credentials in education. Results showed policymakers saw micro-credentials as a potential tool for K-12 teacher professional development, emphasizing their ability to provide self-directed, mastery-based learning and foster greater autonomy compared to traditional professional development approaches. However, financial sustainability, quality assurance, and alignment with time-based continuing education programs were identified as critical challenges, alongside a narrow focus on general, standardized pedagogical skills over specialized professional growth and leadership development.

Introduction

Practitioners, academics, and policymakers have begun to explore alternative strategies to enhance teacher learning as the demand for more intricate and complex student learning has grown (Darling-Hammond et al., 2017). The capacity of school districts to attract, develop, and retain exceptional teachers is being impacted by the limited availability of effective continuing teacher professional development to enhance teacher learning, thereby restricting the capacity of schools to assist students in achieving their full potential (Tooley & Hood, 2021). Micro-credentials are an approach to professional development and online learning for individuals (Carey & Stefaniak, 2018; Dyjur & Lindstrom, 2017), and they are one tool that is being considered to resolve some of the current challenges associated with teacher professional development (Tooley & Hood, 2021). But are micro-credentials effective? This paper explores the potential benefits and challenges that micro-credentials present for teacher professional development.

Micro-credentials in education have emerged as compact learning experiences that allow teachers to showcase their mastery and accomplishments by submitting work samples, student work, and class recordings for verification (Berry et al., 2016). This form of professional development enables learners at all levels of education to identify a specific skill or area of competency that they wish to develop, either personally or professionally (Kayyali, 2025). After learners have chosen a particular micro-credential that aligns with their interests, they engage in self-directed learning using the micro-credential's resources to achieve the success criteria. The majority of micro-credential-based professional development models entail educators presenting mandatory artifacts, receiving tangible feedback from a certified approver, and earning a micro-

credential badge that they can publicly display upon demonstrating competency (Newby & Cheng, 2020).

Literature Review

Defining Micro-Credentials

One challenge that the field of education faces is the lack of global consensus on the meaning of the term 'micro-credential' (Oliver, 2021). The present micro-credential environment has been described as inadequately delineated, characterized by numerous conflicting perspectives (Brown et al., 2021b). Kazin and Clerkin (2018) assert that this circumstance is partially due to the field's ongoing evolution and continual transformation. Furthermore, other designations are frequently employed in lieu of, or synonymously with, the word micro-credential, such as digital badges, online certificates, and alternative credentials, among others. Consequently, the definition of micro-credentials varies considerably on a worldwide scale, influenced by the user and the environment in which the phrase is employed (Brown & Mhichill, 2022).

Although there is no consensus on the definition of a micro-credential, it is generally understood to be a credential of shorter duration or restricted scope than traditional credentials such as degrees and certificates (SUNY, 2019). The National Education Association (NEA, 2018) defines a micro-credential as "a competency-based... form of certification," which typically uses a "digital badge" to visually represent the mastery of a skill or behavior (p.1). A micro-credential in science, technology, engineering, and mathematics (STEM) education is typically any qualification of reduced length or limited scope than a traditional credential, such as a degree, that certifies that the recipient has acquired a predetermined combination of knowledge, skills, or attitudes in teaching. For the purpose of this study, micro-credentials refer

to digital certifications that teachers earn which certify the teacher is proficient in a specific skill.

Gibson et al. (2015) classified the affordances of micro-credentials in education into four fundamental categories: “motivation, recognition and credentialing, evidence of achievement, and research on the linkages among and impacts of the affordances” (p.407). The initial three pertain directly to teaching and learning, whereas the fourth relates to educational research. According to Gibson et al. (2015), the acquisition of digital badges motivates certain learners to persistently interact with online resources and activities aimed at facilitating their attainment of specific learning objectives, thus driving the acquisition of knowledge and skills. The second affordance of digital badges for education is to confer acknowledgement of status, which is inherently linked to validation and accreditation. Gibson et al. (2015) used a gaming comparison to explain this affordance:

In the game world, collecting badges often permits new task accomplishments and levels of achievement along the game’s storyline. So, possession of a badge is a credential.

Digital badges in education can similarly provide a direct link to an assessable artifact, or an indirect link to a collection of evidence needed to pass a unit, graduate from a program, or get a job (p. 408).

The third affordance, ‘evidence of achievement,’ is obtained through their direct connection to digital artifacts that demonstrate knowledge, knowledge-in-action, competencies, and accomplishments. Finally, Gibson et al. (2015) argue that digital badges offer numerous novel opportunities for education that require further investigation, such as the effect of badges on intrinsic motivation through the gamification of educational activities and experiences.

Micro-Credentials as Professional Development

Historically educators have been expected and encouraged to participate in professional development (Altindag, 2022), regardless of whether they are self-directed, intrinsically motivated learners or faithfully fulfilling responsibilities defined by their employment districts and state departments (Erickson, 2020). Micro-credentials have emerged as a type of professional development which could allow teachers to acquire knowledge and advance as they teach through the use of videos, work samples, and other artifacts to document their learning (Altindag, 2022). They are competency-based, focusing on the development of specific skills, and are often online and available for educators to access at any time. Micro-credentials are available with a variety of topics to provide educators choices and customization, and they can also be shared electronically on social networking sites, email, resumés, and other platforms (Berry et al., 2016). One argument for micro-credentials is that they have the potential to individualize professional development and improve learning (Hughey, 2020).

Gamrat et al. (2014) examined the way instructors used a micro-credential system to accomplish their individualized professional development objectives and workplace requirements. Using a collective case study methodology, researchers compared eight teachers' experiences in this micro-credential system, and results showed that instructors tailored their content and assessments to their professional development objectives and tailored their learning to the requirements of the workplace.

In a separate study, Randal et al. (2013) described the use of digital badges as an instrument for professional development in coding boot camps, massive open online courses (MOOCs), universities, and, ultimately, for teachers in education. Although content with the badge system they set up, researchers soon found that a major concern for the future was the

financial viability of these programs. Their design (like with all micro-credentials) necessitated an expert to evaluate projects or artifacts according to a rubric, rather than relying on automated grading by a computer or peer assessments.

Similarly, Carey and Stefaniak (2018) have noted that higher education institutions use micro-credentials for learning and professional development. In their exploration study to see how badges were being used in higher education, they noted that an important issue which arose was objective evaluation of micro-credentials, and they described conducting faculty workshops to provide training and opportunities to work in groups to promote evaluation standardization.

Micro-Credentials and Educational Policy

Micro-credentials have been described as “the latest shiny new thing” garnering the attention of educational leaders, policymakers, and politicians (Brown & Mhichíl, 2022, p.1). Reports of new micro-credential initiatives emerge almost weekly from various parts of the world (Brown et al., 2023). In their research, Brown et al. (2023) have argued that what is needed is to develop a strategic institutional approach to micro-credentials, emphasizing that educational leaders face choices and should approach their plans with intentionality. However, they also highlighted that the micro-credential movement is not without its challenges, urging institutions to carefully consider both the risks and rewards of unbundling traditional credentials (Brown et al., 2023).

Brown and Mhichíl (2021) have warned of the potential danger of micro-credentials being a “wolf in sheep’s clothing” (p. 1), suggesting that micro-credentials could be misleading in their promise, pointing out that the job market is shifting towards valuing specific skills rather than traditional degrees or job titles (Economics, 2019). This challenges the long-standing sheepskin effect in higher education, where the primary value of a degree lies not in the actual

learning experience but in the credential itself (de Monterrey, 2019). If micro-credentials follow the same path (valued more for the badge earned rather than the skills acquired), they risk becoming a deceptive replacement rather than a true improvement in education and employability.

Ralston (2021) extended this critique, arguing that micro-credentials are steeped in the laissez-faire, market-driven rhetoric of the new learning economy. He asserted, “The craze represents a betrayal of higher education’s higher purpose and a loss for students and faculty who continue to see university learning as more than vocational training” (Ralston, 2021, p. 92). This critique underscores the broader questions raised by micro-credentials, such as whether higher education institutions are compromising their integrity by unbundling degrees to rapidly enhance their profitability in response to business interests and market forces. Given the diverse forms that micro-credentials take, leaders must carefully evaluate their strategic motivations as part of any institutional response.

The landscape of U.S. micro-credentials is vast, but most of the development has been led by outreach and continuing education departments, which have traditionally focused on corporate training and professional development, especially for credentials that fall outside formal academic credit systems (Varadarajan et al., 2023). Given the wide range of institutions and agencies involved in certifying micro-credentials, establishing consistency and minimum standards for competencies and performance will require significant collaboration and communication among stakeholders. Furthermore, the role of state governments in shaping the policy and regulation of micro-credentials remains uncertain, suggesting that their influence may only become clear as the ecosystem evolves (Olcott, 2022).

A European study including various micro-credential stakeholders (learners, employers, regulators, and higher education institutions) revealed that each group possessed distinct priorities and expectations for micro-credentials (MicroHE Consortium, 2020). For instance, learners desired concise, efficient, and contemporary training. They perceived recognition as a supplementary advantage, whilst employers sought clarity concerning the competencies acquired and esteemed courses that targeted certain skills. Moreover, higher education institutions seemed to anticipate that micro-credentials would be less bureaucratic and would prioritize accreditation to foster confidence (MicroHE Consortium, 2020).

Micro-Credential Stakeholders

The National Education Association (2018) classifies micro-credential stakeholders into three categories: users, issuers, and recognizers. Users pursue qualifications, issuers provide qualifications, and recognizers depend on qualifications. In teacher education, for instance, the issuer may be a university, the users may be practicing teachers, and the state board of education or school district may be the entity that recognizes the qualification for professional development purposes.

Users

Micro-credentials are currently accessible to enrolled high school students, college students, and lifelong learners as well. Colleges and universities also provide students with certificates and digital badges upon completion of specific academic courses, sometimes as part of their degree programs or as extracurricular options. In addition to their academic concentrations and minors, students are obtaining micro-credentials. Clements et al. (2020) defines an earner (user) as a person who successfully fulfills the requirements for badge completion and receives the badge from the issuer.

Issuers

Issuers are the entity that designs and publishes a micro-credential, evaluates badge submissions, issues the badge to a badge earner, and verifies the badge's authenticity digitally (Clements et al., 2020). When issued by universities, micro-credentials are distinct from degrees. In general, they focus on a small set of abilities or competencies. Micro-credentials may be stacked, combined, or aggregated to provide learners additional freedom in building their credentials. While micro-credentials lack the formal accreditation of university degrees and certificates, this can possibly work to their advantage in addressing the rapidly evolving demands of the workforce (Ralston, 2021).

Research Questions

1. What are education policymakers' perspectives about the possible promises, potential, and constraints of micro-credential-based teacher professional development?
2. What do education policymakers believe the future of micro-credentials is for teacher professional development or teacher education?

Theoretical Framework

This study utilized an activity theory framework (Engeström & Escalante, 1996) to examine the role of micro-credentials in teacher professional development. Kuutti (1996, p. 5) describes activity theory as, “a philosophical and cross-disciplinary framework for studying different forms of human practices as development processes.” In this study, the goal was to document policymakers' perspectives which focused on micro-credentials for K-12 teachers across all disciplines, as well as document their beliefs surrounding micro-credentials as a form of professional development. Activity theory offers a theoretical structure for examining teacher education policies and practices situated in community contexts. This theory has also been

extensively utilized to examine the functioning of professional practices, analyze issues in project management, and in educational settings (Blin, 2004; Engeström, 2001). As a tool, it has enabled researchers to gain insight into areas of practice that could be enhanced or improved. Additionally, it can uncover the underlying causes for project failures, going beyond the seemingly obvious explanations (Engeström & Escalante, 1996).

Methods

Participants

This study included six policymakers who held various positions within education (including a non-profit that designs and administers micro-credentials, state level offices of public instruction that administer micro-credentials, university researcher; see Table 1). Four of the six participants had a teaching background before shifting into policy-related work, and all participants had at least two years of experience working with micro-credentials within education (i.e., micro-credential development, implementation, assessment, etc.). All participants were White, and 50% identified as female with the other 50% identified as male.

Table 1

Participant Demographics

	Gender	Ethnicity	Years' Experience with MCs	Role
Participant 1	Female	White	4.5	State Department of Education Administrator
Participant 2	Male	White	2	State-Level Teacher Education Administrator
Participant 3	Female	White	2	State-Level Professional Development Administrator
Participant 4	Female	White	4	Micro-credential Administrator
Participant 5	Male	White	5	Non-profit Micro-credential Leader
Participant 6	Male	White	10	University Researcher and Micro-credential Evaluator

Interview Protocol

The 12-question, semi-structured interview protocol was developed for this study and included questions related to micro-credentials such as participants' prior experiences with them, their potential promises and constraints, leaders' interest, and the future of micro-credentials in education. The interviews lasted approximately 45 minutes and were audio recorded.

An expert panel of two science educators and three science education researchers reviewed the interview protocol to ascertain its face and content validity before implementation (Haynes et al., 1995; Newman & McNeil, 1998). The final version of the interview protocol was achieved through two iterations of review and revision. After making improvements from the first round of review, the panel reevaluated the interview protocol. Following the second review,

one question was clarified, and an additional follow-up prompt was added to one question, resulting in the semi-structured protocol used in the study.

Interview Data Analysis

Interview responses were transcribed and analyzed using ATLAS.ti 23. Using an inductive approach (Bogdan & Biklen, 1997), codes were generated based on the research questions and inferences made from the data. Two researchers independently coded 20% of the data, with a Krippendorff's alpha of .912. All disagreements in coding were resolved through rater discussion.

Ethics Statement

This study was approved by North Carolina State University's Institutional Review Board (eIRB #26717).

Limitations

This study had several limitations that should be considered when interpreting the findings. The small sample size of six policymakers and the qualitative approach limits the generalizability of the results. Additionally, all participants were White, which may not fully capture the diverse perspectives present in the broader policy-making community. While all participants had at least two years of experience working with micro-credentials, their roles and levels of engagement varied. The majority had a teaching background before transitioning to policy roles, potentially influencing their perspectives on professional development and micro-credentials in ways that differ from individuals with administrative, business, or policy-focused careers.

The study also relied on self-reported data obtained through interviews, which are subject to recall bias, social desirability bias, and personal interpretations (Bergen & Labonté, 2020;

Mehra, 2002). Policymakers may have emphasized certain aspects of micro-credentials based on their professional priorities, potentially underrepresenting or over-representing challenges or constraints. Lastly, the data reflect policymakers' perspectives at a specific point in time. Given the rapidly evolving nature of educational technologies, workforce needs, and professional development frameworks, these views may not fully align with future developments in micro-credential design, implementation, or policy integration.

Results

Promises, Potential, and Constraints of Micro-Credential-Based Professional Development

Autonomy and Flexibility

The interview results indicated that policymakers recognized the potential of micro-credentials as a means of professional development for K-12 teachers. Participants noted the advantages of this form of self-directed professional development for educators, arguing that it offers the opportunity to choose and tailor learning experiences based on individual needs. Participants made statements such as, "Educators have a choice in what they're doing. To me, the biggest piece of that is being able to give folks hands-on, mastery-based learning that they get to drive with their own interest" (Participant 4) and "A micro-credential provides a lot more choice and time flexibility (Participant 3)." Policymakers frequently stated that traditional professional development follows a standardized approach that may not always be advantageous for all educators. As an example, Participant 4 stated:

Traditional professional development, oftentimes it's not as organized or structured where the participant can see what steps have to be taken to lead towards mastery. Traditional professional development, you might go and sit and listen to a session; you don't have the same outputs that are clearly identified for you.

Similarly, “From my perspective, it’s the fact that you have some kind of outcome measure, and demonstration of skill [in micro-credentials]. I think that's almost completely lacking [in traditional professional development]” (Participant 2).

The majority of participants suggested that micro-credentials had the potential to provide teachers with greater autonomy. For example, Participant 5 noted, “Research says that professional development that's not relevant, that's compliance-based, that doesn't give teachers autonomy, doesn't fit their own learning goals, those are all issues of what causes professional development, even good professional development, to fall short.” Policymakers suggested that micro-credentials make professional development more professional and could help build teachers’ trust and autonomy by allowing them to select their own professional development.

Participant 1 noted:

The education field likes to add new things every five years or so which kind of aligns with how long superintendents are around. And I have seen teachers be like, ‘Can we just stop with one more thing?’ But if the one more thing is you have all these options [for professional development] that all reach the same goal, I think just trust in educators, that they will choose one that works for them.

Costs and Limitations

The principal limitation of micro-credentials, as articulated by all participants, was the cost of implementing and maintaining micro-credential-based professional development. Upon submission of a completed micro-credential by teachers, the artifacts require evaluation by an impartial assessor, a procedure that necessitates both substantial time and financial resources. Four of the six participants observed that micro-credential-based programs are frequently initiated with grant funding, and upon the cessation of this funding, the programs are unable to

sustain themselves without permanent financial support. Multiple policymakers discussed this concern: “The cost constraint is tremendous. I have seen micro-credentials that have had to collapse or not be continued because you can't find assessors who are adequately looking at the teachers work,” (Participant 4) and:

It's not lost on me that [micro-credentialing] is going to be expensive. This is another underlying problem with education: we like cheap and easy. If you look at students and standardized testing, we do it that way because it's cheap and easy. Wouldn't it be so much better if students could do some kind of performance assessment at the end of their chemistry class? You hand them a bottle of clear liquid, and they can run analyses and tests and tell you what's in that vial. Wow! You know that would be, I would say, chemistry. But we can't, because that costs time and money. Even though it's much, much better...we do things that are cheap and easy, and so micro-credentials will be expensive. (Participant 2)

Relevance

A prevalent drawback noted by 50% of participants was the quality of micro-credentials and the difficulties associated with maintaining their relevance. When asked about their concerns, policymakers stated, “I think we've got a ways to go to figure out where the funding comes from to do the development of them and keeping them current. There's a lot of micro-credentials that have been built [already],” (Participant 5) and:

Standardization on the quality right? And that's not just isolated to micro-credentialing, but we need to know there is quality behind [it]; that there's certain credentials that we recognize and know. So, I think there needs to be standardization on the quality of that piece (Participant 4).

As micro-credentials gain popularity as a learning platform, quality is an ongoing concern.

Despite the establishment of a quality standard criteria for micro-credentials (digiLearn, 2023), many micro-credentials were created and executed before these standards were applied.

An additional constraint that policymakers identified is the process by which educational micro-credentials are converted into continuing education units. At present, the majority of micro-credential programs associate micro-credentials with continuing education units, a time-based recognition system that may not accurately transition to micro-credentials because micro-credentials are a competency-based system, and some continuing education units are based on the time a teacher is engaged in the professional development. Participant 4 noted:

With a micro-credential, you don't really have a set time of how long it will take to complete it. We can come up with an estimated average for the average participant, but if you already have some skill set, you might earn that credential a lot quicker than someone else. Whereas in traditional continuing education units, it's going to be the same [credit] per participant.

Similarly, Participant 5 discussed the issue of time versus competency-based professional development when earning continuing education units:

Right now, most systems are having to align micro-credentials with continuing education units, which is a time-based recognition system. And it's working, I think, but it's not accurate. It's not a one-to-one match, even though that's the way most systems are doing it now. So, there's a real policy issue there: how are systems going to shift to recognize credentials that are not based on time and attendance but are actually based on demonstration of skills?

Alternatively, Participant 3 discussed moving away from continuing education units altogether:

I don't think we'll be in a world [of micro-credential-based professional development] anytime soon unless we change a lot of the ways continuing education units are earned; where we can move fully to micro-credentials, away from continuing education units. So right now, that is a constraint, and we have to have a way for educators to earn a micro-credential to also meet their continuing education units.

Contextual Factors

Most of the policymakers described micro-credentials as a strategy to teach pedagogical skills and none of the participants interviewed described professional dispositions, ethics, or the socialization of the educator as areas of teacher professional development. The range of topics and skills that were discussed appeared to be narrowly confined to standardized pedagogical skills (such as a highly structured literacy program or a class management procedure). There was virtually no mention of developing pedagogical content knowledge, content knowledge, or professional dispositions for leadership or self-directed learning.

Future of Micro-Credentials

When asked about the future of micro-credentials, all but one policymaker (Participant 6) believed they were going to be a long-standing form of teacher education rather than a temporary educational initiative. A few discussed how they would like to see micro-credentials eventually integrated into an educational preparation program; perspectives on this varied greatly though. For example, Participant 3 discussed how micro-credentials could be a pathway to becoming a teacher for individuals who have classroom experience. This policymaker explained:

I have a friend who went into a school system as a paraprofessional where she worked with one student all day. Then she decided to be a teacher and was hired on a temporary license because she already had a Master's degree. I'm talking about ... adults who are

looking at this and saying, ‘Oh, I have some life experience and could show my skills while I work.’

This policymaker suggested that for this paraprofessional, a teacher preparation program might not be useful, and a micro-credential-based licensure could fast track an individual into a teaching position. Other participants discussed how they would like to see higher education develop micro-credentials that could lead to an educational preparation program. One policymaker stated, “You could take all of those skills that they're learning in all of those courses, set up a set of micro-credentials, and then have them come in and pay for the evaluation of various micro-credentials to earn said licensure.”

Discussion

Promises, Potential, and Constraints

The policymakers in this study viewed micro-credentials as a promising, self-directed alternative to traditional professional development, offering K-12 teachers greater autonomy and tailored learning opportunities. To these leaders, micro-credentials have the potential to be an efficacious form of professional development. Policymakers' recognition of micro-credentials as a possible alternative to traditional, one-size-fits-all approaches highlights a critical shift towards more personalized learning experiences. This flexibility has the potential to allow educators to engage in self-directed professional development tailored to their specific needs, interests, and contexts, which can lead to meaningful and effective learning outcomes (Koay, 2023; Kousar & Sadeeqe, 2023), but the evidence has not yet emerged in current research.

The acknowledgment of the limitations of traditional professional development is significant in this study; it reflects a growing understanding that educators benefit from autonomy and the ability to customize their learning pathways (Rarasati & Pramana, 2023). By

empowering teachers to choose their professional development, micro-credentials potentially enhance engagement and foster a sense of ownership and investment in their professional growth (Khan et al., 2024; Romasanta & Diloy, 2024). When teachers have the opportunity to pursue targeted, relevant skills that align with their individual goals, it can potentially lead to improved teaching practices and, perhaps, better student outcomes (Janssen et al., 2023; Nasution et al., 2024).

The primary limitations of micro-credentials described in this study are insufficient financial support, inconsistent quality, sustainability issues arising from reliance on grant funding, and many programs predating established quality standards. These constraints highlight critical challenges facing the implementation and sustainability of micro-credential programs in teacher professional development. The consensus among participants regarding the lack of financial support is particularly concerning, as it reveals a significant barrier to the effective adoption of micro-credentials (Romasanta & Diloy, 2024; Saad et al., 2024). Without adequate funding, the vital processes of assessment and evaluation, which ensure that micro-credentials maintain their integrity and effectiveness (Iniesto et al., 2022), cannot be sustained. This financial strain often leads to programs that rely heavily on initial grant funding but struggle to remain viable once that support ends.

Moreover, the quality and relevance of micro-credentials are paramount for their effectiveness as professional development tools (Myroshnichenko, 2024). The acknowledgment of existing gaps in quality emphasizes the need for ongoing oversight and improvement. As micro-credentials gain traction, it becomes increasingly important to ensure that they are designed and delivered with rigor, aligning closely with current, local, and national educational practices and the evolving needs of educators. This finding calls for a concerted effort from

policymakers, educational institutions, and funding bodies who invest in micro-credential programs to establish robust frameworks for quality assurance. By addressing these financial and quality-related challenges, stakeholders can help ensure that micro-credentials serve as effective and sustainable avenues for professional growth, ultimately enhancing the teaching profession and improving student outcomes (Khan et al., 2024; Lyu, 2023).

Policymakers highlighted a key challenge in aligning micro-credentials, a competency-based system, with time-based continuing education units, raising concerns about policy adjustments needed to recognize skill-based achievements. This finding underscores a critical disconnect between traditional continuing education units and the emerging framework of micro-credentials. Policymakers' recognition of this issue highlights the need for educational systems to adapt and create multi-tiered systems for tracking professional development to allow for a range of professional development experiences and competencies. The predominant reliance on time-based continuing education units for recognition poses significant challenges, as it fails to account for the nuances and benefits of a competency-based approach, which emphasizes mastery of skills rather than the accumulation of hours. This mismatch can lead to confusion among educators regarding how their achievements are recognized and valued, potentially discouraging participation in micro-credential programs. If micro-credentials are not properly acknowledged in professional development pathways, their utility may be diminished, undermining the potential for teachers to engage in meaningful learning experiences that enhance their skills and effectiveness.

On the other hand, mastery of skills is only one aspect of professional development, which can include the development of dispositions, attitudes, ethics, and other complex dimensions of being a teacher. Furthermore, if earning micro-credentials becomes a rote process

of acquiring digital badges without meaningful reflection, the potential for professional learning to occur may be diminished. As micro-credentials gain popularity, establishing clear, equitable systems for developing and recognizing these competencies is essential if micro-credentials are to be a viable form of professional development.

Contextual Factors

Policymakers primarily viewed micro-credentials as a means to teach clearly defined pedagogical skills, with little emphasis on developing pedagogical content knowledge, content knowledge, professional dispositions, leadership, or self-directed learning skills. This study documented the gaps in micro-credentials as a form of professional development. By revealing that policymakers primarily view micro-credentials as a means to impart standardized pedagogical skills, it raises questions about the narrow focus on technical competencies at the expense of broader educational goals. The absence of discussions around professional dispositions, communities of practice, ethics, and the socialization of educators suggests that essential aspects of teaching, such as fostering ethical leadership, cultivating self-directed learning, and promoting collaborative practices, are being overlooked. This narrow approach may limit teachers' capacity to adapt to diverse and complex classroom environments and to engage meaningfully with students.

Moreover, the lack of emphasis on pedagogical content knowledge and content knowledge in micro-credentials could hinder educators' ability to effectively teach complex topics meaningfully to students, potentially impacting student learning outcomes (Bhagwonparsadh & Pule, 2024; Gelu & Ellianawati, 2024). By broadening the scope of professional development to include these critical areas, educational systems can better support

teachers who must address these complex issues in dynamic educational environments, ultimately fostering a more holistic and effective educational environment.

Future

Most of the policymakers interviewed described micro-credentials as a long-standing form of teacher education rather than a temporary initiative, with varying perspectives on their integration into educational preparation programs. While some saw them as pathways for experienced individuals, such as paraprofessionals, to transition into teaching without having to complete a university teacher education program, others envisioned higher education institutions developing micro-credentials to scaffold teachers' skills and support licensure processes. These findings highlight a growing consensus among policymakers that micro-credentials are potentially a durable and valuable component of teacher education, rather than a fleeting trend. Most participants recognized the potential for micro-credentials to serve as an alternative approach to professional development and teacher preparation. However, their visions for the future integration of micro-credentials into educational preparation programs revealed significant variability in perspectives.

One participant suggested that micro-credentials could serve as a pathway into the teaching profession for individuals with prior classroom or life experience. This perspective underscores the flexibility of micro-credentials to meet diverse needs, such as those of paraprofessionals transitioning into teaching roles. The argument made by advocates of micro-credential-based professional development is that it could provide an alternative to traditional teacher preparation programs, especially for adults who may bring valuable experience to the classroom but face barriers to enrolling in full-length degree programs.

In contrast, other policymakers expressed interest in seeing micro-credentials developed by higher education institutions as components of, or precursors to, traditional educational preparation programs. This approach suggests a complementary rather than alternative role for micro-credentials, emphasizing their utility in scaffolding the skills and competencies required for licensure. One policymaker envisioned a system where micro-credentials align with coursework in teacher preparation programs, enabling candidates to demonstrate mastery of specific competencies through credential evaluation. This model positions micro-credentials as a modular and flexible tool that could be used in teacher education. But what is missing in the arguments for or against micro-credential-based professional development is a strong research base. Without controlled studies, micro-credentials remain an interesting strategy without established validity as a method that genuinely promotes professional development. Given the serious and important role of teacher professional development, we cannot afford to adopt programs without accompanying research to investigate the effectiveness of micro-credential-based programs.

The findings of this study underscore both the promise and the challenges of integrating micro-credentials into teacher education and preparation pathways. While some policymakers view them as a tool for disrupting traditional models and expanding access, others see micro-credentials as an enhancement to existing systems. This divergence raises questions about the standardization and quality assurance of micro-credentials, the roles of institutions in developing and evaluating them, and their implications for equity in teacher preparation.

Implications and Future Research

This research contributes to the literature by presenting the current perspectives of policymakers on micro-credential-based professional development, as well as their predictions

for its future. These findings have the potential to promote new research and provide needed evidence of the use of micro-credential implementation in school systems, and to provide guidance to those who may wish to incorporate micro-credentials into an educational preparation program. This study focused exclusively on policymakers. Future research should examine the perspectives of other stakeholders such as school and university educators, school administrators, and students who may directly interact with micro-credential systems.

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CHAPTER 3

MICRO-CREDENTIAL-BASED PROFESSIONAL DEVELOPMENT: TEACHER SELF-EFFICACY AND SELF-DIRECTED LEARNING

Abstract

Guided by Expectancy Value Theory, this study examined the role of self-directed learning in high school teachers' professional development experiences, particularly in the context of micro-credential-based learning. It explored how teachers' previous experiences and self-efficacy in self-directed learning influenced their engagement with micro-credentials and the value they placed on professional development. The study involved 67 teachers in a clustered randomized controlled trial, where the treatment group engaged in micro-credential-based professional development in place of traditional professional development for one school year. Teachers' self-directed learning experiences and efficacy were assessed through surveys at the beginning and end of the year. While results indicated no significant differences in self-efficacy for teaching or learning between the groups, findings highlighted a strong relationship between teachers' self-directed learning, expectancy-value factors, and self-efficacy.

Introduction

Teacher professional development plays a pivotal role in enhancing instructional practices and improving student outcomes (Desimone & Garet, 2015). Despite its importance, traditional professional development approaches often lack personalization, engagement, and sustained impact, leaving educators with mixed perceptions about their value and utility (Darling-Hammond et al., 2017). To address these challenges, innovative methods such as micro-credential-based professional development have emerged, offering competency-based, self-directed learning opportunities tailored to individual teacher needs (Gamrat et al., 2014). However, limited empirical research has examined the effectiveness of micro-credentials in fostering teacher growth and motivation, particularly in comparison to conventional professional development models.

In addition to exploring the impact of micro-credentials, this study investigated how teachers' prior experiences and self-directed learning efficacy shaped their engagement with this alternative form of professional development. Self-directed learning, defined as the ability to take initiative in diagnosing learning needs and identifying resources (Knowles, 1975), has become increasingly vital in professional contexts where continuous learning is essential (Curran et al., 2019).

By investigating the impact of micro-credentials on teachers' self-efficacy, task value, and self-directed learning experiences, this study contributes to the growing body of literature on innovative professional development approaches. The findings could inform educators, administrators, and policymakers about the potential benefits and limitations of integrating micro-credentials into teacher professional development programs, ultimately enhancing the quality and effectiveness of teacher learning experiences.

Literature Review

Micro-Credentials in Education

Academic credentials, including degrees, diplomas, and certificates, essentially indicate that the holder possesses demonstrable expertise in a particular topic or field. In recent years, micro-credentials have emerged to complement the existing range of academic credentials (Phelan & Glackin, 2021). There is no global consensus on the term 'micro-credential' and to complicate matters and further muddle the terminology, other alternative terms are often used in place of, or interchangeably with, the term micro-credential, such as digital badges, online certificates, alternative credentials, nano-degrees, etc. (Brown et al., 2021). Consequently, the definition of micro-credentials varies considerably on an international scale, contingent upon the user and the context in which the term is employed.

Micro-credentials may be employed for instructional skills, setting goals, providing constructive feedback, and motivating individuals to perform better in their classes (Newby & Cheng, 2020). Randall et al. (2013) has suggested that micro-credentials can be customized for learning and advancement of high-achieving students in higher education settings. In addition, Dowling-Hetherington and Glowatz (2017) reported learners could acquire micro-credentials asynchronously in a virtual learning environment, customize their educational direction, and receive helpful input.

Micro-credentials can be additionally utilized to encourage behavior and increase the quantity of work performed by employees and students (Newby & Cheng, 2020). Utilizing micro-credentials to motivate individuals in education or gamification may be one of the most prevalent applications of micro-credentials (Ahn et al., 2014). Numerous studies have examined the impact of micro-credentials on learning motivation. Abramovic et al. (2013) conducted a

quantitative study at a charter school servicing a low-income North American suburb. The purpose of the research was to determine the connection between learner motivation and educational insignnia. According to the findings of the study, the use of badges increased interest and decreased counterproductive motivational objectives among students.

Recent research by Iwata et al. (2019) hypothesized that micro-credentials would have a positive effect on student motivation and autonomy in an e-learning environment for a college-level medical terminology course. The findings indicated that micro-credentials positively impacted student motivation and enhanced learner autonomy. Recent research conducted by Newby and Cheng (2020) on the effect of digital badges on pre-service teachers yielded similar results to those of previous studies concentrating on the motivational effects of micro-credentials, namely increased motivation, improved knowledge, and skill acquisition.

Self-Directed Learning

Self-directed professional learning is a professional development approach which has attracted significant attention from educators (Bakhshi, 2019). This strategy is founded on the principle of self-directed learning, a cornerstone of the adult learning theory. The most cited definition of self-directed learning by Knowles (1975) states:

In its broadest meaning, self-directed learning describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes (p. 18)

Based on the notion of self-directed learning, self-directed professional learning enables teachers to take charge of their own learning based on their specific requirements, and shifts professional learning from a passive activity into an active experience (Bakhshi, 2019).

Self-Directed Professional Development

Self-directed professional development is defined as "arising from teachers' own initiative" (Mushayikwa & Lubben, 2009, p. 376). According to a small body of research, teachers would rather self-direct their professional development because it gives them the autonomy to satisfy their own professional growth necessities (Colbert et al., 2008). Usually, this entails educators recognizing an issue in their instruction and selecting the optimal solution (Bonner, 2006). Self-directed learning does not necessarily imply that all learning occurs in seclusion and in a solitary manner (Voltz et al., 2004). Self-directed learners frequently reach out to others for support and guidance in their learning processes (Voltz, et al., 2004). Self-directed professional development additionally provides a more diverse and individualized approach to address the needs of individual learners, and research has shown the need for more of this form of professional development (Lom & Sullenger, 2011; Visser et al., 2014). Although the field of professional development research continues to discover methods for bettering the professional learning of in-service teachers, enabling teachers to self-direct their own professional learning could prove to be an effective strategy (Riddle, 2018).

Several studies explored the motivations for self-directed professional development among instructors. Jones and Dexter (2014) discovered that the ineffectiveness of formal professional development on teacher knowledge and practice stimulated a search for informal and personalized learning opportunities. Mushayikwa and Lubben (2009) discovered that instructors actively participate in self-directed professional development to ultimately enhance

their efficacy in and out of the classroom. The majority of instructors desired to improve their teaching effectiveness and professional identity. This finding is consistent with the findings of Tang and Choi (2009), who discovered that instructors engaged in self-directed professional development because they were motivated by a higher moral purpose to serve students and meet their needs.

Additionally, there are some contradictory findings regarding self-directed professional development. Kleickmann et al. (2016) investigated the impact of expert scaffolding versus self-directed study on teacher development by comparing two groups: one that received guided support in using curriculum materials and a control group that engaged in self-study. Their findings suggested that self-study was an ineffective form of professional development, as teachers who received expert scaffolding demonstrated greater improvements in their teaching practices. However, Klieckmann and colleagues (2016) failed to disclose whether or not the control group had any kind of teacher network to assist their learning, or if they were genuinely controlled and restricted to using outside assistance for the purposes of the study. Without this information, it is unclear whether the lack of expert guidance was the primary factor behind the differences in outcomes or if the control group was truly isolated from external learning resources. Furthermore, these variables emphasize the need for complete disclosure of all professional development intervention components.

In addition, Brown et al. (2001) asserted that not all teachers will truly welcome self-directed professional development and that they might depend significantly on formal opportunities. The reason for this, according to researchers, is that teachers must assume an attitude of inquiry and foster the desire to actively participate in self-inquiry and evaluation.

Some may not see the need to do so, indicating that beliefs continue to influence teacher change (Brown et al., 2001; Guskey, 2002).

Teacher Self-Efficacy

According to Bandura (2007), efficacy can be defined as a generative competence in which cognitive, social, emotional, and behavioral sub-skills must be organized and effectively integrated to achieve a range of objectives. When looked at through the perspective of a teacher, self-efficacy highlights the knowledge, abilities, and attitudes that must be possessed in order to accomplish the duties and responsibilities of teaching (Dinçer, 2021). Teachers' self-efficacy is vital when it comes to teachers' instructional effectiveness and impacting student accomplishment (Tongchai, 2021). This makes it crucial to provide teachers with professional developments which increase teacher self-efficacy. Tongchai's (2021) study findings imply that professional development programs should be carefully tailored to accommodate various participants. This is backed by further research which discusses that in any professional development program, self-efficacy should be concerned and addressed when designing the program (Ross & Bruce, 2007; Tebbs, 2000).

Ross and Bruce (2007) discovered a correlation between specific professional development activities and increases in teacher efficacy. In Henson's (2001) one-year study conducted at an alternative high school in the southwestern United States, both quantitative and qualitative measures were utilized to examine the effects of teachers' participation in a joint research project on their sense of teacher efficacy. The results of this study suggested an increase in teacher self-efficacy between pre- and post-tests. Furthermore, the author concluded that a positive correlation between collaboration and teacher self-efficacy was evident throughout the data. In their field research, Bolinger (1988) and Robardeck et al. (1994) concluded that an

increase in perceived efficacy was sufficient evidence that professional development programs influence teachers' perceptions of their efficacy. They argued that professional learning has the capacity to influence self-efficacy, with the greatest impact occurring when it is embedded in an authentic context. Educators need professional development that goes beyond merely accumulating new knowledge and skills as the teaching and learning landscape becomes more complex and continues to evolve at an accelerating rate (Darling-Hammond & McLaughlin, 1995).

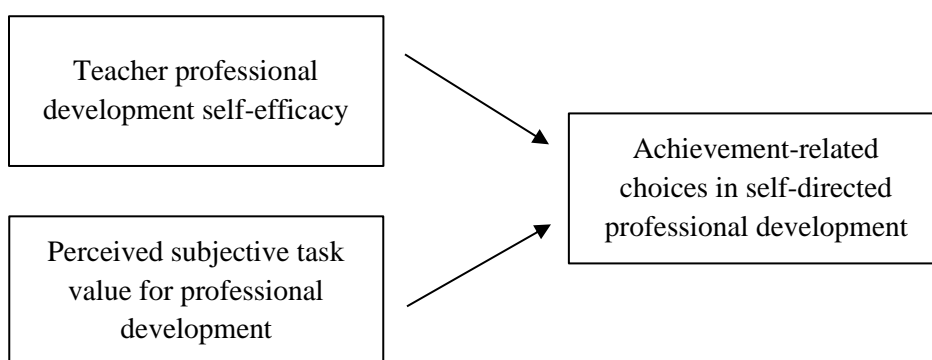
Lieberman (1995) argued that for teachers to participate in meaningful education that has an effect on classroom practices and students, they need a variety of learning opportunities that engage educators in "experiencing, creating, and solving real problems using their own experiences and working together" (p. 1). In Lieberman's 2003 study, he highlighted that in order to effectively support teachers, they must engage in continual professional development that respects their expertise and is integrated into their daily work, as opposed to traditional seminars or isolated training programs.

Theoretical Framework

According to Expectancy Value Theory (EVT), a person's motivation to learn stems from the perceived or subjective value they put on the learning objective and their expectations of success in accomplishing the goal (Eccles & Wigfield, 2020; Wigfield & Eccles, 2000). In this instance, EVT is applicable to teachers as they make judgments about their desire to finish professional development programs. Wigfield and Eccles (2000) identified four subcategories of subjective task value: attainment value (What is the value or prestige gained from this task?), intrinsic value (Will I enjoy this task?), utility value (Is this task useful or relevant?), and costs (How much time, effort, emotional investment, or resources will this task require?). Less

attention has been paid within the field of educational research to the concept of costs, a factor that is of particular interest when examining the time, effort, and resources that teachers must devote to professional development in order to maintain current knowledge of advancements in various STEM fields (Jones & Leagon, 2014). Figure 1 below demonstrates how this theory was used for this study.

Figure 1



Research Questions

1. How does teacher self-efficacy change as a result of participating in micro-credential-based professional development?
2. How does teacher self-directed learning change as a result of participating in micro-credential-based professional development?
3. What is the relationship between teachers' expectancy-value factors, self-directed learning, and teaching self-efficacy?

Methods

Participants

Teacher participants were recruited from high-needs school systems in rural Appalachian counties. For the purpose of clarification, this study defines “high-needs” as any school system

that had greater than 50% of students who receive discounted or free lunches. Participants taught high school students (grades 9-12) in at least one of the four STEM content areas: science, technology, engineering, or mathematics, or be certified in science or mathematics in order to be considered for this study. Teachers were surveyed for treatment (n=25) and control (n=42) groups at the beginning of the school year for each teacher, and again at the end of the school year. All participants identified as White, while 62% of control teachers and 64% of treatment teachers identified as female. Participants' teaching experience and education level can be seen in Table 1.

Table 1

Participant Education and Teaching Experience

	Degree Level				Years of Teaching Experience		
	Total % (n) (Total N = 67)	Treatment % (n) (Total N = 25)	Control % (n) (Total N = 42)		Total % (n) (Total N = 42)	Treatment % (n) (Total N = 25)	Control % (n) (Total N = 42)
Bachelor's	52% (n=35)	60% (n=15)	48% (n=20)	0-5 years	15% (n=10)	8% (n=2)	19% (n=8)
Master's	39% (n=26)	36% (n=9)	40% (n=17)	6-10 years	27% (n=18)	40% (n=10)	19% (n=8)
Doctoral	6% (n=4)	4% (n=1)	7% (n=3)	11-19 years	31% (n=21)	28% (n=7)	33% (n=14)
				>20 years	25% (n=17)	24% (n=6)	26% (n=11)

Micro-Credentials

The micro-credentials that educators in the treatment group completed in this study were hosted on a national micro-credentials website. The micro-credentials encompassed both STEM-specific knowledge and general pedagogical practices. In this study, the organizations tasked with developing the micro-credentials assessed participants' applications for badge allocation.

Micro-Credential Selection

A collaborative panel of school administrators, STEM education researchers, STEM subject specialists, and micro-credential coaches developed an inventory of grade-appropriate and STEM-oriented micro-credentials for the high school educators in this study. This interdisciplinary team evaluated micro-credentials on the platform, concentrating on the research foundation for the assessed competencies and the pertinence of STEM content in the supplied resources. Their assessment produced a curated list of micro-credentials available for selection by participants. These curated options, along with their corresponding links, were hosted on a website page for participants. Before selecting their micro-credentials, participants completed a needs assessment to inform and guide their choices, if necessary. In the process of completing the micro-credentials, participants accessed the website, chose an appropriate micro-credential, and gathered the specific artifacts required for submission.

Micro-Credential Coaches

STEM micro-credential coaches assisted treatment participants in selecting and submitting micro-credentials throughout the study. Two experienced educators served as the coaches, providing targeted support. The first coach was a former teacher and principal with a doctorate in educational leadership, and had two years of coaching experience. The second coach was a former mathematics and science teacher who also had a doctorate in educational leadership, and 10 years of coaching experience. This assistance included guidance on the types of evidence required to earn a badge and support for resubmissions when initial attempts were unsuccessful.

Assessments

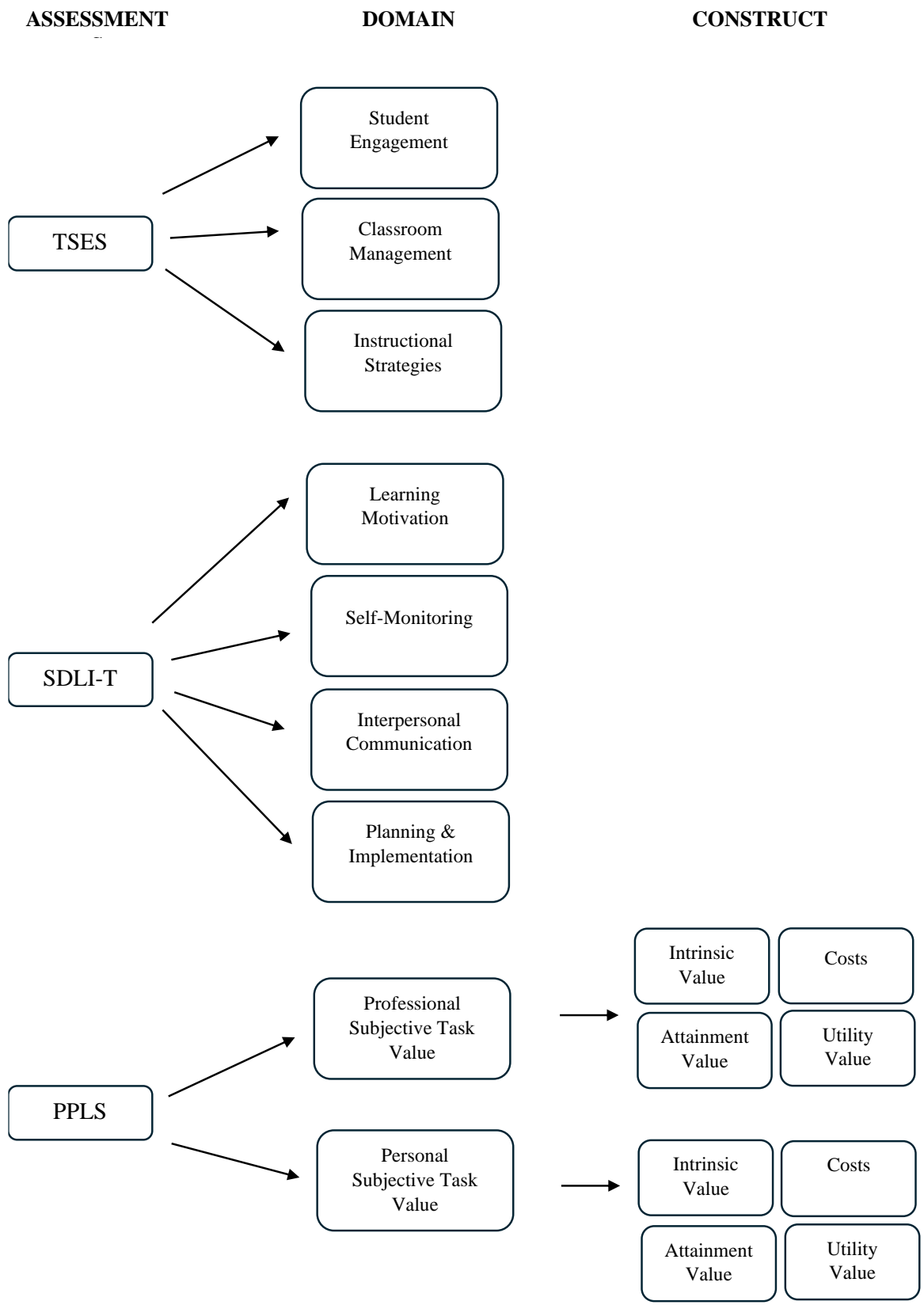
Participants in this study completed a total of three surveys. The first assessment was the Self-Directed Learning Inventory for Teachers (SDLI-T), modified from Cheng et al.'s (2010) SDLI survey. With a Cronbach's Alpha range of 0.765-0.861, the instrument has been determined reliable. The SDLI-T was administered at the beginning and end of the school year to all participants (Appendix A). It utilized Likert scales and asked teachers about their perspectives and motivation toward teacher-centered professional development and other types of self-directed learning. The SDLI-T consists of four domains: learning motivation (six questions), planning and implementation (six questions), self-monitoring (four questions), and interpersonal communication (four questions), for a total of 20 questions (Cheng et al., 2010).

Participants also completed the Teacher Sense of Efficacy Scale (TSES) pre- and post-intervention to measure any changes in teacher self-efficacy in both learning and teaching STEM (Tschannen-Moran and Hoy, 2001). According to Klassen et al. (2011), the most widely used instrument to determine teacher efficacy is the TSES. The TSES is a validated instrument ($0.87 < \alpha < 0.94$) that measures teachers' perceptions of their sense of self-efficacy related to classroom instruction using Likert scales (Tschannen-Moran & Hoy, 2001). The TSES is made up of three specific domains of teacher self-efficacy: student engagement, classroom management, and instructional strategies. Each domain consists of eight questions each on the TSES for a total of 24 questions.

The final assessment completed by participants was the Professional and Personal Learning Scale (PPLS), which incorporated specific elements of Expectancy Value Theory as they pertained to teacher professional development (Appendix B). The assessment consisted of 28 Likert-scale questions and was modified from the NextGen Scientists Survey (Jones et al.,

2020) that was designed and validated to measure prior experiences and expectancy-value within an EVT framework. Minor revisions were made to change items from an individual's science experience (i.e., *My friends think I am good at science*) to reflect a STEM teacher's experiences (i.e., *I enjoy talking with my colleagues about the new things I have learned about teaching*). The revised items were pilot tested with six science educators who were all experienced teachers for clarity. The PPLS consisted of two domains: professional subjective task value (14 questions) and personal subjective task value (14 questions). Each domain consisted of the four constructs of subjective task value: intrinsic value, utility value, attainment value, and costs (Wigfield & Eccles, 2000). Figure 2 below shows a breakdown of each assessment with their respective domains and constructs.

Figure 2



Analysis

Research Questions 1 and 2

For research questions one and two, this study utilized a clustered randomized controlled trial (RCT) with blocking using a mixed model analysis of covariance (ANCOVA) designed to examine the impacts of a micro-credential-based professional development intervention on high school STEM teachers' self-efficacy and self-directed learning (Twisk, 2021). Teachers were asked to volunteer to participate and their respective schools (treated as clusters) were randomly assigned to treatment or control groups.

Likert scale responses from each participant on the TSES and the SDLI were converted into numerical values, and responses were averaged to compute overall composite scores for each assessment, respectively, pre- and post-intervention. These composite scores served as the primary data points for the ANCOVA, enabling statistical comparisons to assess changes in self-efficacy and self-directed learning.

Research Question 3

To examine the relationships between the three assessments measuring teacher self-efficacy (TSES), self-directed learning (SDLI-T), and learning perceptions (PPLS), Pearson correlation analyses were conducted using baseline composite scores. To provide a more comprehensive analysis, correlations were also examined at the domain level of each assessment. Specifically, composite scores were calculated for the three subdomains of the TSES: instructional strategies, classroom management, and student engagement (Tschannen-Moran & Hoy, 2001), as well as for the four subdomains of the SDLI-T: learning motivation, self-monitoring, planning and implementation, and interpersonal communication (Cheng et al.,

2010). Pearson correlation analyses were then conducted to look at the relationship of each domain on the TSES with each domain on the SDLI-T.

Additionally, composite scores were computed for the two PLS domains: personal subjective task value and professional subjective task value. Further, composite scores were calculated separately for each of the four EVT constructs (attainment value, intrinsic value, utility value, and costs), within both the personal and professional subjective task value domains. These scores were analyzed to determine their relationships with self-directed learning and teaching self-efficacy, providing deeper insight into the motivational factors influencing these constructs.

Limitations

Although this study provides valuable insights into the impact of micro-credential-based professional development on high school STEM teachers' self-efficacy and self-directed learning, several limitations should be acknowledged. The study was conducted with a sample of 67 teachers, all from rural, high-needs Appalachian school districts. While this setting allowed for a focused examination of micro-credentials in a specific context, the findings may not generalize to urban, suburban, or less economically disadvantaged school settings. Additionally, the relatively small sample size, particularly for a clustered RCT may limit the statistical power to detect subtle differences between groups or interactions among variables.

All participants identified as White, which limits the ability to explore how demographic diversity, such as race, ethnicity, or cultural background, might influence the outcomes of micro-credential-based professional development. Research suggests that cultural and contextual factors can shape teachers' engagement with professional development (Desimone, 2009; Darling-Hammond et al., 2017), so a more diverse sample may have yielded different findings.

Lastly, the intervention was conducted over one school year, which may not have been sufficient to capture long-term impacts of micro-credential-based professional development on teacher efficacy, task value, or self-directed learning. Professional development effects often unfold over extended periods as teachers apply new skills and knowledge in their classrooms (Guskey, 2002).

Results

This study explored how micro-credential-based professional development influenced teachers' self-directed learning and self-efficacy, with a focus on the relationships between teachers' expectancy-value factors, self-directed learning, and teaching self-efficacy.

Effect of Micro-Credential-Based Professional Development on Teacher Self-Efficacy and Self-Directed Learning

Findings from the RCT indicated that participation in micro-credential-based professional development did not lead to significant changes in teacher self-efficacy or self-directed learning. Comparing pre- and post-intervention composite scores from the TSES and SDLI showed no significant differences between the treatment and control groups, indicating that the intervention had little effect on these constructs.

Relationship Between Self-Directed Learning, Teacher Self-Efficacy, and Prior

Experiences

Analysis of demographic factors showed that SDLI-T overall composite scores were positively correlated with National Board certification ($r = .30, p = .02$) but not with the possession of a master's degree. Conversely, the TSES overall composite score was negatively correlated with having a master's degree ($r = -.24, p = .03$) but was not associated with National Board certification.

Correlations Between Expectancy-Value Factors, Self-Directed Learning, and Teacher Self-Efficacy

Results showed that professional subjective task value items on the PPLS exhibited moderate positive correlations with both overall TSES ($r = .51, p < .001$) and SDLI-T ($r = .48, p < .001$) composite scores. However, personal subjective task value items were only correlated with SDLI-T overall composite scores ($r = .30, p = .01$) and did not significantly correlate with TSES overall composite scores.

Domain-specific analyses revealed that professional subjective task value items correlated with all subdomains of both the TSES and SDLI-T (Table 2). The strongest correlations were observed between professional subjective task value and the SDLI-T self-monitoring domain ($r = .51, p < .001$) and the TSES instructional strategies domain ($r = .50, p < .001$). In contrast, personal subjective task value items did not correlate with any TSES domains and only demonstrated modest correlations with two SDLI-T domains: learning motivation ($r = .35, p < .001$) and self-monitoring ($r = .30, p = .01$).

Table 2*Correlations of SDLI-T, TSES, and PPLS Domains*

	PPLS- Prof. Task Value	PPLS- Pers. Task Value	TSES- Student Engagement	TSES- Classroom Management	TSES- Instructional Strategies	SDLIT- Learning Motivation	SDLIT- Planning and Implementation	SDLIT- Self Monitoring	SDLIT- Interpersonal Communication
PPLS- Prof. Task Value	1.0000								
PPLS- Pers. Task Value	0.3833* 0.0013	1.0000							
TSES- Student Engagement	0.4762* 0.0000	-0.0080 0.9483	1.0000						
TSES- Classroom Management	0.4071* 0.0006	-0.0482 0.6961	0.7272* 0.0000	1.0000					
TSES- Instructional Strategies	0.4966* 0.0000	0.2241 0.0662	0.7292* 0.0000	0.6724* 0.0000	1.0000				
SDLI- Learning Motivation	0.4043* 0.0006	0.3466* 0.0038	0.2039 0.0954	0.2185 0.0734	0.3583* 0.0027	1.0000			
SDLI- Planning and Implementation	0.2945* 0.0148	0.1815 0.1386	0.2655* 0.0286	0.3303* 0.0059	0.4106* 0.0005	0.5589* 0.0000	1.0000		
SDLI- Self Monitoring	0.5140* 0.0000	0.3029* 0.0121	0.3452* 0.0039	0.3327* 0.0056	0.4434* 0.0002	0.5540* 0.0000	0.5494* 0.0000	1.0000	
SDLI- Interpersonal Communication	0.3296* 0.0061	0.1129 0.3591	0.3935* 0.0009	0.2131 0.0810	0.3413* 0.0044	0.3693* 0.0019	0.2890* 0.0168	0.5309* 0.0000	1.0000

Note: Values with * represent a p-value less than or equal to 0.05.

Examining domain-level relationships between the TSES, SDLI-T, and PPLS subdomains, several significant correlations were identified. The TSES student engagement domain correlated with three SDLI-T domains: planning and implementation ($r = .27, p = .03$), self-monitoring ($r = .35, p < .001$), and interpersonal communication ($r = .39, p < .001$), but did not significantly correlate with the final SDLI domain, learning motivation. Student engagement also correlated three subdomains under professional subjective task value on the PPLS: professional intrinsic value ($r = .35, p < .001$), utility value ($r = .36, p < .001$), and costs ($r = .41, p < .001$). However, no significant correlations were found between the student engagement domain and personal subjective task value items from the PPLS. The TSES classroom management domain exhibited moderate correlations with two SDLI-T domains: planning and implementation ($r = .33, p = .01$) and self-monitoring ($r = .33, p = .01$), but did not correlate with any personal subjective task value factors. However, it did correlate with two subdomains under professional subjective task value: utility value ($r = .36, p < .001$), and costs ($r = .41, p < .001$).

The instructional strategies domain of the TSES demonstrated the strongest relationships with SDLI-T subdomains, correlating with all four: planning and implementation ($r = .41, p < .001$), self-monitoring ($r = .44, p < .001$), interpersonal communication ($r = .34, p < .001$), and learning motivation ($r = .36, p < .001$). Additionally, the instructional strategies domain showed a moderate correlation with the PPLS subdomain of personal costs ($r = .27, p = .03$), the only domain on the TSES or SDLI-T which correlates to a personal subjective task value domain.

The SDLI-T learning motivation domain correlated with professional intrinsic value ($r = .40$, instructional strategies), professional utility value ($r = .27, p = .03$), and professional costs ($r = .29, p = .02$). The planning and implementation domain of the SDLI-T correlated with professional intrinsic value ($r = .28, p = .02$) and professional costs ($r = .25, p = .04$). The third

SDLI-T domain, interpersonal communication, only correlated with one construct of professional subjective task value: intrinsic value ($r = .41, p < .001$). The final SDLI-T domain, self-monitoring, was the only domain which correlated with all four professional subjective task value items: intrinsic value ($r = .50, p < .001$), utility value ($r = .25, p = .05$), costs ($r = .43, p < .001$), and attainment value ($r = .25, p = .04$). This was the only domain from the TSES and SDLI-T that had a correlation with professional attainment value.

Discussion

This study examined the effects of micro-credential-based professional development on teacher self-efficacy and self-directed learning, as well as the relationships between teachers' expectancy-value factors, self-directed learning, and teaching self-efficacy.

Impact of Micro-Credential-Based Professional Development on Teacher Self-Efficacy and Self-Directed Learning

Results from the RCT indicated that participation in micro-credential-based professional development did not significantly impact teacher self-efficacy or self-directed learning in this study. One possible explanation for these null results is that micro-credentialing, while structured, may not provide the depth of sustained coaching, collaboration, and practice-based reinforcement necessary for meaningful changes in self-efficacy (Garet et al., 2001).

Additionally, self-directed learning tendencies may require long-term engagement and reflective practices beyond the timeframe of the intervention to show measurable change (Mann et al., 2009).

The Role of Prior Experiences in Self-Efficacy and Self-Directed Learning

This study also examined whether self-directed learning and teacher self-efficacy were associated with teachers' prior professional experiences. Results indicated that SDLI-T overall

composite scores were correlated with National Board certification but not with the attainment of a master's degree. Conversely, TSES scores were correlated with holding a master's degree but not with National Board certification. National Board certification, which emphasizes continuous professional growth and reflective practice (Sykes, 2006) may be more aligned with self-directed learning preferences. In contrast, earning a master's degree, which often involves structured coursework and theoretical learning, may contribute more directly to a teacher's confidence in instructional effectiveness. These findings suggest further research is needed to better understand the relationship of prior experiences and micro-credential-based PD.

Relationships Between Expectancy-Value Factors, Self-Directed Learning, and Teacher Self-Efficacy

The findings provide strong evidence that expectancy-value factors play a meaningful role in shaping both self-directed learning and teacher self-efficacy. Professional subjective task value items from the PPLS exhibited moderate correlations with overall TSES and SDLI-T scores, suggesting that teachers who place a higher professional value on their work are more likely to feel efficacious and engage in self-directed learning. However, personal subjective task value items correlated only with SDLI-T scores and not with TSES, indicating that personal motivations for teaching may influence self-directed learning but do not necessarily translate into higher self-efficacy in instructional contexts.

At the domain level, professional subjective task value was correlated with all subdomains of both the TSES and SDLI-T, with the strongest relationships emerging between professional task value and the SDLI-T self-monitoring domain, as well as the TSES instructional strategies domain. These findings align with prior research demonstrating that teachers who perceive their professional role as highly valuable are more likely to engage in

reflective, self-regulated learning practices and exhibit confidence in their instructional effectiveness (Khanshan et al., 2020).

Interconnections Between Teaching Self-Efficacy, Self-Directed Learning, and Expectancy-Value Factors

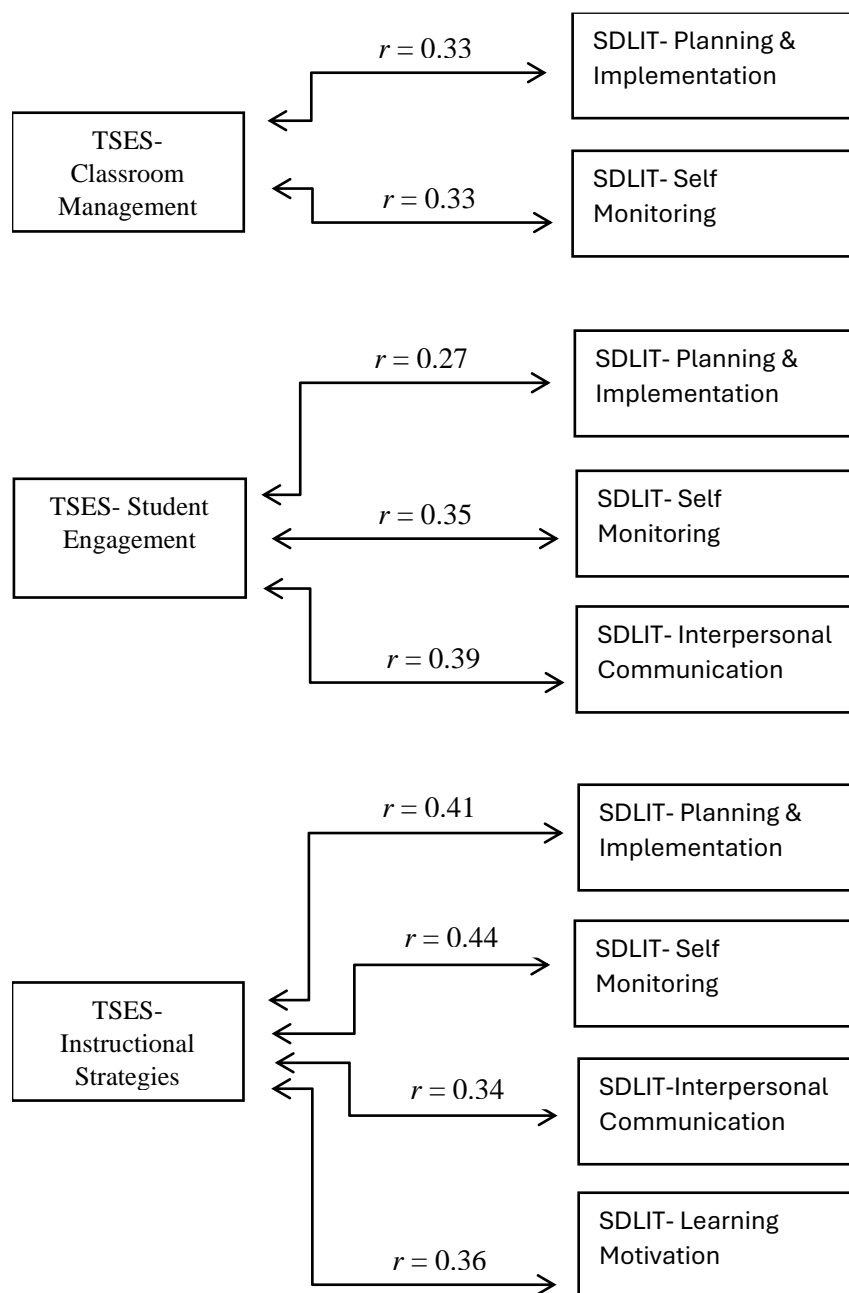
Additional analyses at the domain level revealed nuanced relationships between self-efficacy, self-directed learning, and expectancy-value factors. The student engagement domain of TSES was positively correlated with three SDLI-T subdomains: planning and implementation, self-monitoring, and interpersonal communication (Figure 3). Notably, student engagement was also correlated with three professional subjective task value subdomains from PPLS (professional intrinsic value, utility value, and costs), but did not correlate with personal subjective task value items. These findings suggest that teachers' beliefs about the professional importance of their work may be more influential in shaping their ability to engage students than personal intrinsic motivations.

The classroom management domain of TSES correlated with two SDLI-T domains (planning and implementation, self-monitoring) and two PPLS professional subjective task value subdomains (utility value and costs), reinforcing prior research indicating that teachers who perceive strong professional value in their work tend to demonstrate greater self-regulation and structured planning in their instructional practices (Wigfield & Eccles, 2000).

The instructional strategies domain of TSES exhibited the broadest correlations, linking with all four SDLI-T subdomains and one PPLS personal subjective task value subdomain (personal costs). This was the only TSES or SDLI-T domain that correlated with a personal subjective task value factor, suggesting that the perception of personal costs may influence teachers' instructional strategies. The SDLI-T learning motivation domain was correlated with

multiple professional subjective task value subdomains, reinforcing the idea that a teacher's motivation to engage in self-directed learning is closely tied to their professional value beliefs.

Figure 3



Interestingly, the SDLI-T self-monitoring domain was the only construct correlated with all four professional subjective task value factors, including attainment value. This suggests that

self-monitoring, or the ability to reflect and regulate one's own learning and teaching practices, may be particularly sensitive to teachers' perceptions of their professional achievement and long-term career goals (Schunk & Zimmerman, 1998).

Implications and Future Research

The findings from this study have several implications for the design and implementation of teacher professional development programs. First, the lack of significant change in self-efficacy and self-directed learning following micro-credential-based PD suggests that such programs may need to incorporate additional support mechanisms, such as mentorship, collaborative learning communities, and sustained follow-up opportunities (Darling-Hammond et al., 2017).

The strong correlations between professional subjective task value and both self-efficacy and self-directed learning highlight the importance of reinforcing the professional relevance and impact of teachers' work. Professional development programs should consider integrating expectancy-value interventions that help teachers connect their instructional practices with their broader professional goals and intrinsic motivations (Eccles & Wigfield, 2020).

Finally, given that educational background factors (National Board certification vs. master's degree) were differentially associated with self-directed learning and self-efficacy, it may be beneficial to design PD experiences tailored to the specific needs of teachers based on their prior professional learning experiences. National Board-certified teachers, for example, may benefit from advanced opportunities to engage in self-directed learning projects, whereas teachers with master's degrees may benefit more from applied, practice-based interventions focused on enhancing instructional strategies.

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CHAPTER 4**RURAL HIGH SCHOOL SCIENCE AND MATH TEACHERS' EXPERIENCE WITH
MICRO-CREDENTIAL-BASED PROFESSIONAL DEVELOPMENT: A COLLECTIVE
CASE STUDY**

Abstract

This study investigated the impact of micro-credential-based professional development on rural Appalachian teachers' beliefs, knowledge, and skills. Using a collective case study methodology, data were gathered through surveys and a series of semi-structured interviews conducted across one academic year. Participants were asked to complete three curated STEM-focused micro-credentials hosted on a national micro-credential platform and were supported in their professional development by instructional coaches who guided evidence collection and resubmissions. Findings showed that the micro-credential program had a differential impact on teachers depending on their capacity to engage in self-directed learning. Those teachers who had the motivation and time to commit to self-directed professional development benefited more than their peers who had struggles with motivation, as well as time and work demand challenges. These results suggest that the effectiveness of micro-credential-based professional development may depend on teachers' capacities for self-directed learning and the context under which they are receiving it (e.g., the support teachers have for professional development such as time, resources, and materials). These findings highlight the need for tailored support strategies to ensure equitable benefits across varying levels of self-regulatory skills.

Introduction

Deep understanding of a demanding topic, critical thinking, complex problem solving, effective communication and cooperation, and self-direction to teaching are all required to build the necessary 21st century student abilities (Koh et al., 2015; Pamungkas et al., 2023; Sonnleitner et al., 2017). In turn, opportunities for teachers to study and enhance the pedagogies required to teach these skills are needed (Darling-Hammond et al., 2017). Prior research has indicated that the most significant school factor on student achievement is a highly qualified teacher (Strong, 2007). However, research on professional development (PD) has yet to fully address and document how PD programs and initiatives influence teacher change (Riddle, 2018).

Teacher PD is essential for refining instructional methods and boosting student achievement (Desimone & Garet, 2015). However, traditional approaches to PD often fall short in terms of personalization, engagement, and long-term impact, which can lead educators to view them as less valuable or ineffective (Darling-Hammond et al., 2017). To overcome these limitations, strategies like micro-credentialing have gained attention, providing self-paced learning experiences tailored to the unique needs of educators (Gamrat et al., 2014). Despite this promise, there is limited research exploring the impact of micro-credentials (MCs) on teacher development and motivation, particularly when compared to traditional PD methods.

According to Gibson et al. (2015), MCs demonstrate a person's knowledge and skills within a specific domain. They are usually awarded based on specific criteria as opposed to attendance (Dyjur & Lindstrom, 2017). Thus, MCs are a form of competency-based PD as opposed to a time-based PD format. In addition, MCs typically employ web-based technologies and are available to anyone with Internet access, especially in remote and rural areas (Hughey, 2020).

Literature Review

Teacher Professional Development

Teacher PD is essential for enhancing student outcomes (Alt, 2018). However, due to the multimodal nature of PD and its evolution over a teacher's career, defining PD is complex, and current research inadequately articulates its significance (Sancar et al., 2021). A significant proportion of the literature on PD for educators has relied on established definitions rooted in traditional frameworks (Sancar et al., 2021), meaning that much of the research and writing on PD for educators has been based on well-known and widely accepted definitions that come from traditional theories or models. According to Guskey (2003), PD is predominantly characterized as a series of processes and activities designed to enhance teachers' professional knowledge, skills, and attitudes, ultimately aimed at improving student learning.

While traditional PD programs remain prevalent in educational settings, they have faced criticism for inadequately addressing the individual characteristics, needs, competencies, participation, and prior knowledge of teachers (Craft, 2000; Morgan & Neil, 2004). These conventional approaches often emphasize a standardized model or traditional framework of PD that may not resonate with the diverse experiences of educators. In contrast, the situative perspective offers alternative frameworks that prioritize the individual teacher's context and experiences (Morgan & Neil, 2004).

Research has highlighted the effectiveness of these alternative PD approaches in enhancing teachers' learning and instructional practices by incorporating their individual, social, and occupational dimensions within collaborative, inquiry-based, and self-directed learning environments (Borko et al., 2010; Derri et al., 2015). For example, Borko et al. (2010) and Fraser

et al. (2007) emphasized the importance of creating supportive learning communities that fostered teacher collaboration and inquiry.

The shift towards more individualized and contextually relevant PD reflects a growing recognition of the need for educators to engage in meaningful professional learning that is responsive to their unique circumstances and the demands of their teaching environments (Dhungana et al., 2021). This shift in PD frameworks underscores the importance of moving away from traditional, one-size-fits-all models towards more flexible and tailored approaches that empower teachers to take ownership of their professional growth (Kumaravadivelu, 2006).

Teacher Identity and Professional Development

Teacher identity, which encompasses educators' beliefs, values, and self-perceptions (Beijaard et al., 2004), significantly influences their engagement with PD and their effectiveness in the classroom (Høydalsvik, 2019). Galanti and Holincheck (2022) assert that the identities teachers bring to PD significantly influence their engagement and the adoption of innovative practices in science, technology, engineering, and mathematics (STEM) education. This study highlighted the importance of context in shaping teacher identity, suggesting that PD should be designed to align with the specific needs and experiences of STEM educators.

Galanti and Holincheck (2022) have emphasized that a well-defined model of integrated STEM teacher identity could guide the design of effective PD programs. They argued that understanding the multifaceted nature of teacher identity allows for the development of PD that resonates with educators' professional aspirations and personal values. However, challenges remain in effectively integrating teacher identity into PD frameworks (Day et al., 2006). Shernoff et al. (2017) highlighted that many PD programs fail to consider the individual identities and

contexts of teachers, resulting in a disconnect between the training provided and the realities of classroom practice.

Effective Professional Development

There is increasing research that documents the factors that contribute to effective PD (Riddle, 2018). Allen and Penuel (2015), for instance, used a multiple case study to investigate how teachers made meaning of their PD and what obstacles existed to the implementation of PD training into practice. They discovered that teachers encountered confusion and skepticism in linking and executing their PD with their educational objectives within their evaluation and accountability systems, as well as a lack of resources. Researchers concluded that developers of PD should provide collaborative opportunities for instructors to participate in conversations about how to make sense of the PD material and apply these newly gained ideas and skills in the setting of their own classrooms.

Other studies have found that teacher PD seldom addresses teachers' needs and may not result in a change in pedagogical knowledge or skills (Guskey, 2003; Owens et al., 2018). If the objective of PD is to promote teacher development and improve student achievement, but the PD offered to teachers seldom achieves this goal, this could explain the recurring pattern of lagging student achievement (Bill and Melinda Gates Foundation, 2014). Researchers have argued that it is imperative that more research is needed to document the elements of PD that can result in a positive change in teachers (Riddle, 2018).

Effective teacher PD is crucial for enhancing the instructional practices of educators, particularly in the STEM fields (Du et al., 2019; Shernoff et al., 2017). Traditional PD models, often characterized by episodic workshops and one-time training sessions, have been criticized for their ineffectiveness in fostering meaningful change in teaching practices (Schmitt-Mcquitty

et al., 2019). These conventional approaches tend to be fragmented and lack a focus on the specific needs and contexts of STEM educators, leading to minimal impact on student learning outcomes (Garet et al., 2001).

In contrast, contemporary frameworks for PD emphasize the importance of ongoing, collaborative, and contextually relevant learning experiences (Adeoye et al., 2023; Dhungana et al., 2021). For instance, Garifullin et al. (2021) highlighted the necessity of integrating technology into PD programs to enhance the professional competencies of teachers, particularly in technical fields such as physical education and STEM. This situative perspective on PD has gained traction as it focuses on the individual teacher's context, emphasizing the social and collaborative dimensions of learning (Opfer & Pedder, 2011). Moreover, effective PD for STEM teachers often involves a community of practice model, where educators collaborate to share knowledge and resources (Aksela, 2019; Townley, 2020). This approach fosters a culture of inquiry and supports teachers in developing their professional identities (Nagdi et al., 2018).

The importance of self-directed learning in PD has gained interest. Research by Shurr et al. (2014) emphasized the need for teachers to take ownership of their PD, allowing them to identify their learning needs and pursue relevant opportunities. This autonomy is particularly beneficial in STEM education, where teachers must stay current with rapidly evolving content and pedagogical approaches.

Ineffective Professional Development

Numerous researchers concur that brief workshops are the least successful approach for increasing teacher quality and student achievement (e.g., Scher & O'Reilly, 2009; Wei et al., 2010). These types of PD often miss the depth of content and critical thinking about instruction (Borko, 2004) and may cause a gap between the work that teachers do in their classrooms and

the PD they attend, since it takes place outside of the teachers' classrooms and is taught by administrators and experts from outside the school (Lauer et al., 2014; Webster-Wright, 2009).

Studies such as Desimone et al. (2002) and Garet et al. (2001) have suggested that PD programs with an extended duration are more likely to be effective in promoting teacher change. In Desimone et al. (2002) study, duration was comprised of contact hours devoted to engaging in a PD program, as well as the length of time it lasted. Based on their results, ineffective PD lasted a single week and had a median of fifteen contact hours. Instructors noted greater change as an outcome of PD programs that encouraged collaboration among teachers from the same school, department, or grade level (Desimone et al., 2002). The authors attributed this finding to the fact that educators from the same school, department, or grade level are more inclined to exchange PD content with one another, resulting in greater comprehension and, consequently, teacher growth (Garet et al., 2001).

The lack of alignment between PD offerings and the actual classroom practices of STEM teachers has also been highlighted in the literature. Nelson et al. (2018) argued that merely providing PD experiences or reading materials did not translate into effective classroom practices. They advocate for a more nuanced understanding of how educators select and retain ideas about STEM education, suggesting that PD must be tailored to support teachers in constructing coherent narratives that align with their instructional goals. Similarly, Dejarnette (2018) highlighted that simply informing teachers about STEM concepts was insufficient; they must actively participate in learning experiences to fully grasp the content and pedagogical strategies required for effective implementation.

In-Person Versus Online Professional Development

In-Person Effectiveness

In-person PD has traditionally been viewed as the gold standard for teacher training, offering opportunities for direct interaction, hands-on experiences, and immediate feedback (Desimone, 2009; Kennedy, 2016). For instance, a comparative study by Russell et al. (2019) found that in-person PD sessions often resulted in higher engagement levels and stronger professional relationships among participants, which can enhance the overall learning experience (Thibaut et al., 2017). In-person PD also allows for real-time modeling of instructional strategies, enabling teachers to observe and practice new techniques in a supportive environment (Saville et al., 2022).

However, the effectiveness of in-person PD can be limited by logistical challenges, such as scheduling conflicts and geographical barriers, which may prevent some teachers from participating (Goldberg et al., 2022). Additionally, the one-size-fits-all nature of many in-person workshops can fail to address the diverse needs of STEM educators, leading to a disconnect between PD content and classroom practice (Nagdi et al., 2018).

Online Effectiveness

Online PD has been recognized as a flexible alternative to traditional in-person training, particularly in the wake of the COVID-19 pandemic (Guppy et al., 2022; Mishra et al., 2020). The asynchronous nature of online courses allows teachers to engage with content at their own pace, accommodating their individual schedules and learning preferences (Bates et al., 2016). Studies have shown that online PD can effectively improve teachers' knowledge and pedagogical skills, particularly when designed with interactive elements and opportunities for collaboration (Lesiak et al., 2021).

However, challenges persist in online PD, including issues related to engagement and the lack of personal interaction (Marrero et al., 2010). Teachers may struggle with motivation in a virtual environment, leading to lower completion rates and diminished learning outcomes (Dixit, 2024). Additionally, the absence of face-to-face interaction can hinder the development of professional relationships and support networks that are often cultivated in in-person settings (Powell & Bodur, 2019).

Challenges of Professional Development for Rural STEM Educators

An estimated 19% to 30% of teachers leave the profession within their first five years, with STEM educators experiencing particularly high attrition rates (Sutcher et al., 2016). This trend is especially pronounced in high-need schools, where the loss of STEM teachers contributes to significant learning gaps for students most in need of support (Simon et al., 2015). Kirchoff and Lawrenz (2011) highlighted the need for research focusing on STEM educators in high-need schools, citing the unequal distribution of adequately trained STEM teachers in these settings.

According to Viloría et al. (2021), rural communities are geographically isolated, which limits their access to specialized services and ongoing support from educational experts in STEM fields. This isolation could lead to feelings of professional disconnection and inadequacy, as rural teachers may not have the same opportunities for collaboration and networking as their urban counterparts (Shume et al., 2022). Additionally, the shortage of specialized STEM teachers in rural areas often results in educators teaching subjects outside their area of expertise, further complicating their PD needs (Viloría et al., 2021). Goodpaster et al. (2018) identified community interactions and PD as key factors influencing rural teacher retention.

Research indicates that effective PD for rural STEM teachers must be contextually relevant and responsive to the unique challenges they face (Shume et al., 2022; Maina et al., 2021). Maina et al. (2021) carried out a partnership between universities and school districts that provided rural STEM teachers with PD focused on data science and cybersecurity. This program emphasized immersive, research-rich environments where teachers could explore STEM career opportunities and develop the skills necessary to prepare their students for future success. The situative perspective used in this study highlighted the importance of contextualizing PD to enhance teachers' conceptual growth and instructional practices.

In contrast, online PD has emerged as a viable alternative to traditional in-person training, particularly in rural settings where access to resources may be limited. Thiele and Bogdon (2022) explored the experiences of rural teachers engaging in virtual and hybrid STEM professional learning opportunities, finding that these formats increased collaboration and equitable access to resources.

Micro-Credential-Based Teacher Professional Development

Micro-credential-based teacher PD has gained traction as an innovative approach to enhancing educators' skills and competencies in a rapidly evolving educational landscape (Kahn, 2024; Tamoliune et al., 2023). MCs, often delivered in the form of digital badges, provide a flexible and personalized method for teachers to engage in professional learning that is relevant to their specific needs and contexts (Khan, 2024). Digital badges are visual representations of achievements that signify the completion of specific learning experiences, skills, or competencies (Gonzalez & Hodge, 2020). These badges are typically issued by educational institutions, professional organizations, or online learning platforms and can be shared on digital portfolios, resumes, or social media to showcase an educator's accomplishments (Tamoliune et

al., 2023). This model contrasts with traditional PD, which is frequently criticized for being one-size-fits-all and lacking in practical application (Raj, 2024).

The significance of MCs lies in their ability to facilitate ongoing professional growth through competency-based learning. This is an educational approach that focuses on individuals demonstrating mastery of specific skills or knowledge at their own pace, rather than simply completing a set amount of coursework or instructional hours (Torres et al., 2015). MCs allow educators to document their achievements in acquiring specific skills, which can be shared across various platforms, enhancing their visibility and potential impact (Abdullah, 2024). This shift towards a more personalized and skills-oriented approach aligns with broader trends in education that emphasize lifelong learning and adaptability in the workforce (Lang, 2023).

Despite the potential benefits, the implementation of MCs is not without challenges. Issues related to the standardization and recognition of these credentials remain prevalent in the literature. Carey and Stefaniak (2018) emphasized the need for objective evaluation criteria to ensure the credibility of MCs in higher education. Furthermore, Wheelahan and Moodie (2021) cautioned that while MCs could enhance educational access and flexibility, they may also contribute to the fragmentation of qualifications and undermine the coherence of educational pathways.

Digital Badging

Digital badging has emerged as a significant innovation in the realm of MCs within educational contexts (Pitt et al., 2018). Digital badges serve as digital representations of accomplishments, interests, or affiliations, and they include metadata that provides context and meaning to the skills acquired (Gibson et al., 2022; Maina et al., 2022). This capability not only

enhances the visibility of learners' skills but also facilitates the sharing of these credentials across various platforms, thereby broadening their impact and recognition (Davis & Singh, 2015).

The integration of digital badges into educational frameworks has been shown to motivate learners by providing tangible recognition of their efforts and achievements (Gibson et al., 2015). Jones et al. (2017) found that teachers perceived digital badges as a valuable form of recognition for their PD, which helped to reinforce their learning experiences and foster a sense of accomplishment. This aligns with the findings of Ha et al. (2023), who conducted a systematic literature review and highlighted the potential of digital badges to enhance learner engagement and motivation in various educational settings. Lang (2023) discussed how universities are increasingly adopting MCs, including digital badges, to meet the demands of a rapidly changing job market.

However, the implementation of digital badges is not without challenges. The need for objective evaluation of these credentials has been a recurring theme in the literature. Carey and Stefaniak (2018) noted that standardizing evaluation processes is essential for ensuring the credibility and effectiveness of MCs in higher education. This concern is echoed by Dyjur and Lindstrom (2017), who emphasized the importance of establishing robust evaluation criteria to enhance the acceptance and recognition of digital badges among stakeholders in higher education.

Coaching

Coaches serve as facilitators of professional learning, providing personalized support to teachers as they navigate the complexities of implementing new instructional practices and achieve their PD goals (Kraft et al., 2018). Research indicates that coaching can significantly influence instructional practices and student achievement. A meta-analysis by Kraft et al. (2018)

synthesized findings from 60 studies, revealing that teacher coaching yields substantial positive effects on instructional quality, with smaller but notable improvements in student achievement. This evidence underscores the potential of coaching as a powerful form of PD, particularly when integrated with micro-credentialing systems that allow teachers to document their learning and skill acquisition.

The effectiveness of coaching is further enhanced when coaches actively engage in modeling instructional practices. Saclarides and Kane (2023) explored how mathematics coaches made professional learning accessible to teachers, highlighting the importance of coaches' expertise in mediating learning opportunities within schools. By modeling effective teaching strategies and facilitating reflective discussions, coaches helped teachers translate theoretical knowledge into practical application, thereby fostering a culture of continuous improvement in instructional practices.

Despite the promising potential of coaching, challenges remain in the implementation of effective coaching practices. For instance, Saclarides and Lubienski (2018) identified tensions within coaching structures that could hinder access to coaching support, suggesting that a blended approach—where teachers can initiate PD while coaches also take the initiative—may enhance the effectiveness of coaching.

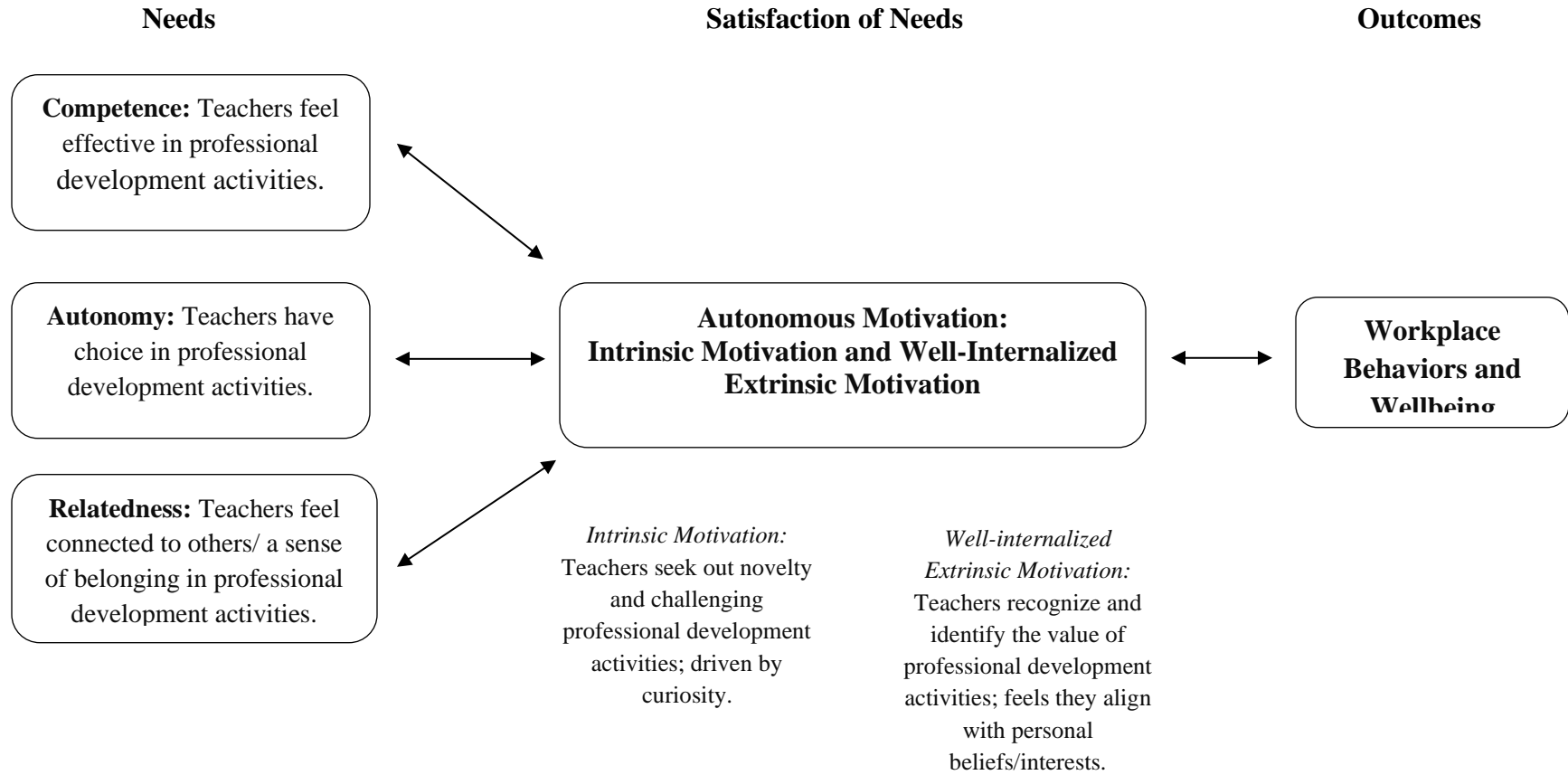
Theoretical Framework

This study was informed by Self-Determination Theory (Deci et al., 1991) and was used to frame the research questions and analyses. This theory allows for the examination of the decision-making process, especially as it pertains to motivation, and it consists of three main constructs: competency, relatedness, and autonomy (Deci et al., 1991). According to Self-Determination Theory, circumstances that nurture an individual's competence, relatedness, and

autonomy promote motivation or the execution of deliberate acts. As defined by Ryan and Deci (2000), “to be motivated means to be moved to do something” (p. 54), and they argued that “when people are intrinsically motivated, they experience interest and enjoyment, they feel competent and self-determining, they perceive the locus of causality for their behavior to be internal” (p. 34).

In the instance of teacher PD, MCs offer an environment in which instructors may show mastery in their learning activities by earning badges. As teachers choose and finish their MCs, they have the ability to direct their own professional learning. This theory can also be useful as a tool to understand how social contexts may be structured to enhance individuals' development, performance, and well-being (Goemaere et al., 2016). Figure one below shows the conceptual framework based on Self-Determination Theory that was used to guide this study, adapted from Ryan and Deci (2017).

Figure 1



Competence

The need for competence signifies humanity's aspiration to proficiently navigate their surroundings and attain a sense of efficacy within it (Adams et al., 2017). A crucial contrast is that individuals perceive the fulfillment of the demand for competence not merely as a definitive level of accomplishment, but rather as a “phenomenological” experience characterized by a sense of growing mastery and efficacy (Deci et al. 2013, p. 112). When individuals perceive competence, they feel proficient and accomplished in navigating their surroundings. It is the belief that one possesses the capacity to affect significant outcomes (Goemaere et al., 2016).

Competence is not merely a static achievement; rather, it is perceived as a dynamic experience characterized by a sense of growing mastery and efficacy (Deci et al., 2013). This understanding is vital for educators, as it underscores the importance of continuous PD that fosters a sense of mastery over time. For STEM teachers, who often face rapidly evolving content and pedagogical demands, the ability to feel competent in their subject matter and teaching strategies is essential for maintaining engagement and effectiveness in the classroom.

The concept of competence, as described by Adams et al. (2017), Deci et al. (2013), and Goemaere et al. (2016), holds significant implications for K-12 teacher PD. The belief in one's ability to affect meaningful outcomes is critical in fostering teacher self-efficacy and effectiveness, both of which are linked to improved student outcomes (Tschannen-Moran & Hoy, 2001). In addition, teachers with high perceived competence are also more likely to stay in the profession, reducing burnout and attrition rates (Klassen & Chiu, 2011).

Relatedness

The need for relatedness is linked to social belonging (Adams et al., 2017). Relatedness is the fulfillment obtained from a sense of connection with others; to provide care and receive care

from others (Deci et al., 2013; Ryan & Deci, 2000). Individuals who experience relatedness feel a sense of connection and caring for persons through fulfilling and supportive social relationships (Goemaere et al., 2016). In the context of teacher PD, relatedness plays a crucial role in creating a sense of community among educators. Collaborative approaches such as professional learning communities, peer mentoring, and group workshops provide opportunities for teachers to build supportive relationships, share experiences, and collectively solve problems (DuFour, 2004).

Research shows that when teachers feel connected to their colleagues, they are more likely to engage in PD and apply new strategies in their classrooms (Vescio et al., 2008) and are also better equipped to handle the stresses of the profession and are less likely to experience burnout (Skaalvik & Skaalvik, 2011). Furthermore, strong relational ties among teachers contribute to a positive school climate, which research has linked to improved student outcomes (Bryk & Schneider, 2002).

Autonomy

In Self-Determination Theory, autonomy is not synonymous with independence, meaning it does not entail making decisions without external direction. Autonomy is characterized as self-endorsement, relating to the extent to which an individual fully agrees with the reasons or motives for their acts, ensuring that these activities are rooted in genuine beliefs and interests (Ryan & Deci, 2006; Ryan & Lynch, 1989). Autonomy pertains not to the locus of decision-making (i.e., Who is making the decision?), which ranges from complete independence (i.e., not relying on anyone) to absolute dependency (i.e., entirely relinquishing decision ownership). Autonomy pertains to the reasons for making decisions either independently or dependently (i.e.,

What motivates the independent decision-making, or why is the decision delegated to another individual?) (Chen et al., 2013; Goemaere et al., 2016).

Autonomy is fulfilled when an individual recognizes choice and agency in their activities, viewing themselves as the source of those actions (Adams et al., 2017). Autonomous behaviors are self-affirmed and aligned with an individual's values and interests (Vansteenkiste et al., 2010). Individuals who experience autonomy see a sense of personal choice, volition, and psychological freedom by acting in accordance with their personally endorsed values and interests (Goemaere et al., 2016).

Autonomy is crucial in helping teachers feel confident and capable in their roles, reducing burnout and promoting job satisfaction (Skaalvik & Skaalvik, 2011). Teachers who experience autonomy are more likely to innovate, adapt to the diverse needs of their students, and remain engaged in lifelong learning (Ryan & Deci, 2017). Moreover, when PD aligns with teachers' intrinsic motivations and values, they are more likely to implement and sustain changes in their instructional practices (Desimone & Garet, 2015).

Research Questions

1. What are teachers' perceptions of the benefits and challenges in participating in micro-credential-based professional development?
2. How does micro-credential-based professional development influence teachers' perceptions of their own knowledge and/or skills for teaching?

Methods

This research employed Stake's (1995) collective case study methodology to investigate MC-based PD. Specifically, the use of multiple cases allowed for the examination of diverse perspectives, as outlined by Creswell and Poth (2016). The study investigated the experiences

and viewpoints of teachers who engaged in MC-based PD over the course of one academic school year.

Micro-Credentialing Process

Educators in this study completed STEM-focused micro-credentials through a national web-based platform. These MCs covered both subject-specific knowledge and general pedagogical practices. A collaborative panel of school administrators, STEM education researchers, and MC coaches curated a selection of MCs based on research-backed competencies and relevant instructional resources. These curated MCs, along with access links, were made available to participants via a dedicated website.

To support educators, two experienced STEM micro-credential coaches provided guidance in selecting, completing, and submitting MCs. The coaches, both holding doctorates in educational leadership, offered targeted assistance on evidence submission and resubmission processes. An external evaluation team, blind to participant identities, assessed submitted evidence to ensure objectivity in badge allocation. Each participant was asked to complete three MCs over one academic year.

Participants

Teacher participants were recruited from a larger study that examined the impact of MC-based PD on teacher retention and student achievement. All eight selected participants were rural Appalachian high school science and math teachers who taught at high-needs school systems and were participating in a MC-based PD program, which were requirements to be considered for this study. For clarification, this study defines “high-needs” as any school system that has greater than 50% of students who receive discounted or free lunches.

All participants identified as White, with two males and six females. Four teachers taught secondary science courses, and four teachers taught secondary math courses. Years of teaching ranged from four to 29 years of experience, however, most participants (63%) had 10+ years of teaching experience. The majority of teacher participants (63%) had a Bachelor's degree, while the remaining 37% had a Master's degree. All teachers were currently licensed and 25% (2/8) of teacher participants were National Board Certified (see Table 1).

Table 1*Participant Demographics*

	Gender	Ethnicity	Grades Taught	Subjects Taught	Years Teaching	Level of Education	NBCT*
Wendy	Female	White	9-11	Science	18	Master's Degree	No
Alicia	Female	White	9-12	Mathematics	10	Master's Degree	Yes
Marsha	Female	White	9-12	Science	25	Bachelor's Degree	No
Glinda	Female	White	9-12	Science	8	Bachelor's Degree	No
Ariel	Female	White	9, 11-12	Mathematics	15	Bachelor's Degree	No
Erik	Male	White	9-11	Science	4	Bachelor's Degree	No
Billy	Male	White	9-10	Mathematics	29	Bachelor's Degree	No
Isabel	Female	White	10-12	Mathematics	9	Master's Degree	Yes

Note: NBCT* stands for National Boards Certified Teacher.

Data Collection

Interviews

The eight teachers who agreed to participate in interviews were asked about their experiences and perspectives with MC-based PD. The interviews were conducted over zoom and were audio recorded and transcribed. Interviews lasted approximately 30–45 minutes. Participants were interviewed a total of three times over the course of one academic school year. The initial pre-interview took place at the beginning of the academic year (August–September), prior to the completion of any MCs. The second, or mid-interview, was conducted midway through the school year (November–December), and the final post-interview occurred at the end of the school year (April–May).

The 13-question pre-interview protocol (Appendix C) was developed by the researchers and designed to explore teachers' ideas and perspectives surrounding MC-based PD before participating in it. For example, participants were asked questions such as, 'What components of MCs sound interesting and effective so far?' and 'What concerns or questions do you have about MC-based PD?' Participants were also asked about effective elements of PD, the value of PD, and how PD relates to professional growth. All three interviews focused on these topics in order to track teachers' changes in perspectives over time.

The 22-question mid-interview (Appendix D) expanded on the pre-interview questions to delve into characteristics and experiences of the MCs participants had completed up to that point. Example questions about specific MCs included, 'Why did you select this MC?' and 'Do you think you will use anything you learned from this MC?' The mid-treatment interview also probed participants to discuss the differences in traditional PD and MC-based PD.

Lastly, the 27-question post-interview (Appendix E) included questions from the pre- and mid-interviews related to MC-based PD, such as affordances, constraints, and value, to analyze the change of teachers' perspectives over time and address the research questions. Participants were also probed about their overall perspectives of MCs, with questions such as, 'Are there any skills that you think cannot be taught through MC-based PD?' and 'What do you think is the ideal setup for MC-based PD in K-12 schools?' All interviews were semi-structured (see description below) and allowed teachers to share their unique experiences and perspectives (Briggs, 1986). To check the content validity of the interview protocols, they were each reviewed by three science teachers and two science education researchers.

The mid- and post-interview protocols were adapted for one case study participant who was unable to complete any of the MCs. In this case, the mid-interview protocol was adapted to include 13 questions (Appendix F) and the post-interview, 10 questions (Appendix G). This participant was probed on the main reasons for not completing any MCs throughout the year, and barriers that contributed to not being able to complete the MCs.

Surveys

All participants completed micro-credential feedback surveys after completing each micro-credential. These surveys consisted of 10 short-answer response questions (e.g., 'In order to complete this micro-credential, did you seek out additional resources other than those provided to you?' and 'Which category of continuing education units does this micro-credential satisfy? [General, Digital Learning or Subject Area]'), and six Likert scale response questions (e.g., 'This micro-credential took a lot of effort for me to complete' and 'This micro-credential required a high level of skill/knowledge to complete'). Surveys were administered via Canvas.

Data Analysis

Interview data were subjected to content analysis. According to Krippendorff (1989), “content analysis is a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use” (p. 18). The raw data from the interviews were coded using the codebook developed by the author for this study. To generate the codebook, transcripts were analyzed using open coding. After coding, the outputs were analyzed by theme and grouped into broader categories that represented overarching ideas or patterns within the data. Another experienced researcher in STEM education was sought for assistance in coding and categorization. Based on the study's problem and goals, codes that were not needed were taken out and new codes were added. The qualitative data were quantified by computing frequencies and percentages (see Table 2), resulting in three categories and 10 sub-categories. The categories included affordances related to teacher PD, constraints related to teacher PD, and theoretical factors of self-determination theory as they apply to teacher PD.

Table 2

Theme	Code	Frequency	Percentage
Affordances	MC Affordances	137	27.2
	Coaching Value	56	11.1
	Effective PD	31	6.2
	Traditional PD Affordances	22	4.4
Constraints	MC Costs	102	20.3
	Traditional PD Costs	41	8.2
	Ineffective PD	20	4.0
Theoretical Factors	Autonomy	58	11.5
	Relatedness	29	5.8
	Competence	7	1.4
	TOTAL	503	100

Methodological triangulation between the micro-credential feedback surveys and participants' interview responses was employed to ensure consistency and deeper insight into the participants' perspectives (Locke, 2002). Key themes from the interview transcripts were systematically

compared with survey data to identify patterns, consistencies, and discrepancies (Miles et al., 2019). Triangulation helped reduce the risk of self-reporting bias or misinterpretation by cross-checking participants' self-reported survey data against their more detailed interview narratives (Maxwell, 2013).

Limitations

While this study provides insights into the experiences of teachers engaging in MC-based PD, several limitations should be acknowledged. The small sample size of participants, all from rural Appalachian high-needs schools, limits the generalizability of the findings. Although the study offers an in-depth exploration of this specific context, the results may not fully capture the experiences of teachers in urban, suburban, or non-high-needs schools. All participants also identified as White, and the majority had significant teaching experience (10+ or more years). This lack of diversity in demographic and professional backgrounds may restrict the applicability of findings to more diverse teacher populations, including those earlier in their careers or from different cultural or geographic contexts.

Participants self-selected into the study, which may have introduced a bias toward teachers who are more motivated or open to engaging in PD, potentially limiting the applicability of the findings to less intrinsically motivated educators.

Results

After analyzing the data, teachers were divided into two groups to discuss the results of this study: strong self-directed learners (Wendy, Alicia, Marsha, Ariel, and Isabel) and struggling self-directed learners (Glinda, Erik, and Billy). These groupings were based on participants' MC completion rate (how many MCs they completed), as well as those who voiced struggling with MC-based PD throughout the school year in interviews.

Strong Self-Directed Learners

Marsha, Isabel, and Alicia

Marsha (science teacher), Isabel (math teacher), and Alicia (math teacher) were strong self-directed learners who completed three MCs by the end of the school year. These teachers had very few critiques and constraints when it came to completing MC-based PD, and consistently through all their interviews discussed MCs as a possible avenue for K-12 teacher PD. Alicia and Marsha received their digital badges for all three of their completed MCs on the first submission attempt. Isabel received her digital badges for her first two MCs on the first submission attempt, and on the second submission attempt for her third MC.

Wendy and Ariel

Wendy (science teacher) and Ariel (math teacher) were also strong self-directed learners who completed all three MCs by the end of the school year. However, they had more of a skeptical view of MC-based PD, such as the quality of MCs and who would be assessing them. Ariel received digital badges for three MCs on the first submission attempt. Wendy received her digital badges for her first and third MCs on the first submission attempt, and on the second submission attempt for her second MC.

Struggling Self-Directed Learners

Glinda, Billy, and Erik

Glinda (science teacher) and Billy (math teacher) were two educators who struggled with MC-based PD because of other responsibilities outside of the classroom. Glinda is a single parent of two school-aged children who worked two part-time jobs outside of teaching. Similarly, Billy worked three part-time jobs outside of teaching. Glinda completed two out of three MCs through the school year. Her first MC submission was denied but then awarded on the

second attempt, and her second MC submission was awarded on her first attempt. Billy was unable to complete any MCs.

Erik (science teacher) struggled with the self-directed format because of time constraints and “overestimating” what he could get done. Though he was awarded his digital badges for both of his MCs on the first attempt, he failed to complete a third MC. In order to gain a comprehensive understanding of the application of MCs as teacher PD, it is crucial to understand the reasons why certain educators encountered difficulties while others experienced a seamless process. Below is a table of the MCs participants completed throughout the study (Table 3).

Table 3*Micro-credentials Completed by Participants*

	Name of 1st MC Completed	Badge on 1st attempt	Time Spent on MC	Name of 2nd MC Completed	Badge on 1st attempt	Time Spent on MC	Name of 3rd MC Completed	Badge on 1st attempt	Time Spent on MC
Wendy	Incorporating Global Ed. Into Practice	Yes	3-5h	Communicating with Guardians	No	6-8h	Design & Evaluate Multiple Choice Items	Yes	3-4h
Alicia	Building Connections with Students	Yes	4-5h	Incorporating Global Ed. Into Practice	Yes	6-8h	Coaching for Improvement	Yes	4-5h
Marsha	Team Agreements for Student Collab.	Yes	1.5h	Facilitating Collaborative Discussion	Yes	3-5h	Challenge-Based Learning- Nano Challenge	Yes	3wks
Isabel	Using Data to Communicate with Families	Yes	12h	Technology Management	Yes	15h	Design an Analytic Rubric for Formative Assessment in Collab. with Students	No	20h
Ariel	Think-Pair-Share for Critical Thinking	Yes	2-3h	Jigsaw	Yes	2.5h	Incorporating Global Ed. Into Practice	Yes	2.5h
Glinda	Think-Pair-Share for Critical Thinking	No	5h	Collab. to Support Student Learning in Digital Learning Environments	Yes	2-3d	Did not complete	--	--
Erik	Adopt Inquiry for Learning	Yes	4-6h	Assessing Inquiry	Yes	6h	Did not complete	--	--
Billy	Did not complete	--	--	Did not complete	--	--	Did not complete	--	--

Affordances of Micro-Credential-Based Professional Development

Autonomy

All eight participants discussed choice and individualization as a key benefit of MC-based PD. Both strong and struggling self-directed learners expressed that being able to choose PD which interests them was an affordance of MCs. For example, Wendy stated, “We can specifically pick things we'd like to work on. We know the areas we need help in the classroom or help in our profession. That's what I've been focusing on; areas I feel weakest in.” In similar perspectives, Glinda noted, “I can tailor it to my personal needs; whatever my personal weaknesses are or interests.”

In her pre-interview, Isabel discussed how this autonomy could be beneficial to rural teachers:

I was very interested in [MC-based PD] being so individualized. Coming from a very small county, we don't have a lot of options for PD that is specific to either content, the high school level, or what I feel like I need to work on the most. So I really liked the idea that I could pick and choose, and work around what I felt was needed, and also what worked best for my class that semester, because we know every class can be different. Another participant also discussed, “I think [MCs] will be more valuable [than traditional PD] because every one of them will be something I want to do. I'll be more invested in it because I chose it. I have ownership in it” (*Glinda*)

Another affordance of choice within MC-based PD which teachers voiced as beneficial was getting to choose the timing of when they were completed. Participants made statements like, “I like that it is self-paced” (*Wendy*), and “One of the better things is that you can do it on

your own time. You can do it when it fits best in your curriculum” (*Ariel*). Even struggling self-directed teachers enjoyed this aspect of MCs, with one teacher stating this was his favorite part:

I like that the timing is also self-directed. The order you do them in and when you do them is up to you. I think having choice of the timing that you do it has been my favorite aspect of [MC-based PD]. (*Erik*)

This autonomy for the time of their PD also played into what they perceived as the next benefit of MCs: being able to stay in their classrooms.

Fifty percent of participants reported that a benefit of MC-based PD was being able to stay in the classroom with their students. For example, when asked about the affordances of MC-based PD, Alicia stated:

You're not having to miss class time with your students. That's the worst part of being sent to [traditional] PDs, you're out of class with your kids. Being able to do this during your day, not having to take the school day off, not having to get a substitute; that's the biggest thing.

In a similar perspective, Glinda discussed this benefit of MCs when compared to traditional PD: “Sometimes I don't need help with [certain PD topics] and others might. So, it's a whole day out of my classroom learning about something I might already have mastered personally.” One participant stated, “I think [teachers] are afraid to leave class now because you don't know what you're going to find. You always have that kind of weird, what's going to be there when I get back” (*Marsha*), concerning the uncertainty over the type of substitute teacher you could encounter (e.g., inexperienced or retired educator) and the condition of your classroom upon your return (e.g., student conduct and development achieved while in your absence).

Relevance and Applicability

The relevance and applicability of MCs emerged as a key theme discussed by 75% (6/8) of the participants. Isabel emphasized the contextual relevance of MCs, particularly in addressing the unique challenges faced by rural educators. She stated, “I think [MC-based PD] is relevant. It's relevant to our 21st century skills, it's useful. But also, the students that we see are very rural. It's going to be different from PD for your more urban schools.” In a similar vein, Alicia noted that she chose her second MC because, “It was something that I related to and thought my students related to, and that I could grow not just me, but my students.”

Participants also valued the immediate applicability of MCs in their teaching practices. Ariel, a veteran teacher with 15 years of experience, stated, “I really like things that I can take and implement in my classroom right away.” She emphasized her preference for targeted, classroom-specific resources that align with her current teaching needs, reflecting a common desire for PD that directly enhances instructional effectiveness. Alicia echoed this sentiment, noting:

I like how I can choose what I'm wanting to do and cater it to my teaching. That's one of the things I have found most effective is that I've been able to find something I'm interested in and put it into my classroom.

Micro-Credential-Specific Benefits

In analyzing the data, it became apparent that the benefits of using MCs differed by the kind of MC participants undertook. For example, in comparing her first MC (*Incorporating Global Education into Practice*) to the second one (*Communicating with Guardians*), Wendy stated in the first MC:

You didn't have to collect evidence. It was more about reading the articles and resources they supplied, and analyzing and reflecting on those articles, how you put them into practice, and what you do. Whereas [the second] one was more evidence-based. I had to explain how I met certain standards and have evidence to back up those standards.

Because of this, Wendy later mentioned, “The first [MC] I did, I didn't get as much from it as I thought I would.” In a similar situation, Alicia discussed two of her MCs as being beneficial, but not the third one. This was because of the level of difficulty Alicia encountered when trying to complete this MC (*Incorporating Global Education into Practice*). She explained:

It was difficult. This is not in my realm of anything I've ever done, other than when I was in graduate school. I didn't know a lot about global education, so having to go and research about something I didn't know a lot about, I wasn't sure if my articles were credible or not.

There were also MCs which teachers indicated benefited their students. For example, when asked about the pros of her second MC (*Facilitating Classroom Discussion*) Marsha listed, “Student agency, student responsibility, student collaboration, student driven, reflection on both pieces. I particularly like the reflection for the kids, and problem solving.” In a similar context, Isabel discussed the advantages of her first MC (*Using Data to Communicate with Families*) for students and parents:

I loved the greater piece of it. We have check-ins and I broke down specific standards for every student, and sent that to the parents, and the amount of parent feedback I got that was positive. I found it to be very informative and the kids all said they loved it. They found it very beneficial, and we had really good test scores at the end of when I did this, and I do think this actually played into that.

Digital Badges. While all participants who completed and passed MCs received digital badges, Marsha was the only participant in this study who mentioned them as a benefit of MC-based PD. In her second interview, she shared:

I love sticking the [badges] down at the bottom of my emails. For me, it's just self-validation. I don't know that other people know how to use them yet. I don't know that my county is looking at my emails and going, 'Look at all those all those micro-badges!' I don't know that education level is out there yet for people to recognize those, which is sad.”

When probed further about why she believed education was not there yet, she responded, “I don't know how many administrators buy into it yet. I think that's part of the problem is, people just are not aware of badging as much yet.”

Challenges of Micro-Credential-Based Professional Development

Relatedness

While MCs offered significant benefits, participants noted relatedness as a key challenge for this type of PD. Teachers in this study completed a total of 19 MCs, and collaboration with others was acknowledged for only three (16%) MCs. The individualized nature of this PD format sometimes led to feelings of isolation among educators. Isabel highlighted this issue, stating:

With individualization, how much support can come along with that? There are only [a few] of us in our school that are actually participating [in MCs] and we don't ever get a chance to talk. I would love to have more support in terms of teachers that are in the process with me.

She further noted, “I think it would have been more beneficial had I had some other, one other, person that was going through the process, but we are so separated. We never get to talk or

discuss anything.” Similarly, Ariel expressed concerns about the lack of collaborative opportunities, saying:

There's definitely advantages to working with other teachers you don't get when doing MCs, especially if you're not doing it with somebody. I don't know that I would ever want to go to completely MCs and never go to in-person training.

Alicia also missed the interpersonal aspect of traditional PD, explaining, “I missed the collaboration when you do get with other teachers. Even if they're not in the same content, they have experiences you can still relate to. That is one thing you don't get in MCs.” Erik echoed these concerns, stating, “If everybody is doing their own [MCs], you might lose out on those opportunities to get people to collaborate.”

Traditional Professional Development Value. Since the majority of teachers expressed social collaboration as a missing piece of MC-based PD, they were asked if there were any other aspects of traditional PD they missed or they found to be valuable. All of the participants acknowledged the value of traditional PD, particularly for its ability to foster collaboration and build professional networks. Marsha expressed this benefit succinctly, stating:

I like to go to [traditional PD] because not only am I going to get PD that's geared towards me, but I'm in a network of teachers and getting to meet other teachers in the same field as me that are probably having the same issues as me. I like to be able to build a network of friends in that community.

Isabel also emphasized the collaborative aspect of traditional PD, stating, “I really like just getting to talk to other teachers. Sitting at a table and saying, 'Here's what works for me,' or 'Here's how I would use this in my classroom.'”

Glinda highlighted the role of administrative teams in enhancing the relevance and engagement of traditional PD, explaining, “Our admin team knows the school, they know what it's like to be in the school system as a teacher. So when they provide us with PD, it's always fun and engaging; they know what we need.” However, she noted that mandated state-level sessions often lacked this tailored approach, saying, “The last [traditional PD] we sat through, was all day on a Friday... [It was] really a PD that beginning teachers needed, not the seasoned teachers.”

Content Knowledge

Interviews highlighted the challenge of addressing content knowledge effectively through MCs. Participants consistently expressed concerns that MCs often failed to provide the depth of subject-specific knowledge and resources that traditional PD offers. Ariel described her experiences with traditional PD as being particularly beneficial due to the provision of “materials and resources to use” as well as opportunities for “interaction and feedback.” She emphasized the value of such offerings, particularly in subject-specific contexts like PD for Advanced Placement training. Similarly, Marsha highlighted the advantages of face-to-face networking opportunities in traditional PD, which often lead to deeper engagement with content. She explained, “The biggest takeaway from going to traditional [PD] is your networking. You're actually face-to-face with people and potentially finding interest and content.”

Ariel noted a lack of content-focused MCs, explaining, “Whenever I was searching for MCs, I didn't really come up with anything that was [math-specific].” She further suggested that MCs could improve by being “sorted by subject, or even by things like calculus or precalculus,” making it easier for educators to locate content-aligned resources. Wendy also underscored the critical role of content in PD. Reflecting on her long teaching career, she noted that “the most effective PD I've ever had...was specifically content-based.” However, she expressed frustration

with the scarcity of effective content-related PD opportunities for science and math teachers, particularly within the MC framework. Wendy elaborated on the challenges of finding relevant content, stating, “Science content and math content...need to be face-to-face opportunities. But content-related [MCs]...there’s not a lot of those opportunities.”

When asked in their final interviews whether MC-based PD improved their content knowledge or subject-specific skills, five teachers (63%) reported that these opportunities were either not available or not prioritized. Ariel reflected on her experience, stating the MCs she chose “were more on implementing a strategy with content that I already taught.” Isabel admitted that her MC choices were not focused on content: “Not content-specific, because I didn’t look to see if there was anything content-specific.” Her response implies that even when content-focused opportunities exist, teachers may not readily identify or prioritize them within the available options.

Erik noted a similar limitation, emphasizing the lack of content-specific learning in his experience: “There wasn’t any specific content stuff. There wasn’t any new science I learned.” Glinda echoed this sentiment, stating, “I didn’t really see anything content-related specifically for what I do, but I think it’s broad enough that it could fit into almost any discipline.” While she acknowledged the versatility of MCs, her statement reinforces the concern that broad applicability may come at the expense of targeted, content-specific learning.

Micro-credential Assessment

Wendy and Alicia were the only two participants who were skeptical regarding the MC assessment process. Their interview data revealed several challenges related to the assessment process of MCs. Participants highlighted concerns regarding the credibility, consistency, and transparency of the evaluation process, as well as the lack of timely and actionable feedback.

Alicia expressed skepticism about the qualifications and practices of MC assessors, questioning, “Who is on the other side of reading those? Who is on the other side of grading it? And what kind of feedback are they giving?” Her concerns extended to the authenticity of the learning outcomes, as she noted, “You really don’t know if [teachers are] gaining knowledge from that PD or not, because even with the artifacts, they don’t really know if that’s not me or my students in those pictures.” Similarly, Wendy shared apprehensions about the rigor and reliability of the evaluation process, particularly in instances where her submissions were misjudged: “My second [MC] I submitted got denied the first time. [The feedback] said all the evidence wasn’t there, and I was like, ‘It’s there’ ...The evaluator evidently didn’t see part of my PDF, and it was there all along.”

A recurring theme among these two participants was the inconsistency in the standards and expectations across different MCs. Wendy noted disparities in submission requirements, observing, “Some of them you had to submit a video, and it had to show XYZ, and then others were just like, ‘Read these articles and tell me what you got from the articles.’” She concluded that the requirements were “not evenly weighted in regard to the expectations for submission.” This lack of uniformity in the assessment criteria was further compounded by vague rubrics, which Wendy described as “very vague in regard to what they’re looking for.”

Participants also expressed concerns about the potential for academic dishonesty and questioned the effectiveness of the screening processes. Wendy noted, “I don’t know if there is a screening tool on the assessor’s side. If people are working together on it... they’re not necessarily getting anything out of it. They’re just copying and pasting.” Alicia raised similar concerns, particularly in the context of advancements in AI, asking, “In the AI world, how do you know that they’re actually doing the things they’re doing?” While she acknowledged that

some MCs required artifacts as evidence, she noted that others lacked mechanisms to verify authenticity.

Micro-Credential-Specific Challenges

Participants encountered significant challenges associated with specific MCs. These challenges included confusion over instructions, lack of relevant resources, time investment, and the format of the tasks required. Marsha reflected on her experience with the *Facilitating Collaborative Discussion* MC, describing the process as “very confusing.” She noted difficulties in understanding the requirements, which impeded her ability to complete the MC efficiently.

Alicia described frustrations with the *Incorporating Global Education into Practice* MC, particularly regarding the provided resources. She chose not to use the articles included in the MC, explaining, “When I started looking at those, I was like, ‘I don’t know that I can use this.’” Instead, she conducted her own research, which significantly increased the time required to complete the MC. This extra effort led to moments of discouragement, as she recalled, “There were a couple of times I thought, ‘I’m scrapping this one. I’m not going to go through with it,’ because it was taking me a lot longer than I was wanting it to.” Ariel also noted challenges with the *Incorporating Global Education into Practice* MC, particularly with the task of condensing her responses to meet word count limits. She described the experience as burdensome, stating, “It was not as much fun to do because I was not implementing it in the classroom. It felt like writing a paper for college.” Her comments reflect the difficulty of engaging with MCs that feel disconnected from immediate classroom application or that impose rigid academic structures on tasks.

Isabel encountered similar challenges with the *Using Data to Communicate with Families* MC. She noted the lack of accessible examples and functional resources as a major drawback:

“Some of the research links that were posted were not live or I could not access them. Not having all of those resources [was] a little bit of a con.” Isabel also expressed a desire for examples of completed work from other teachers, which she believed could have clarified expectations and supported her progress in completing the MC.

Teaching Skills

The interviews revealed that while MCs provide opportunities for PD, they are limited in their ability to address certain skills, particularly those requiring hands-on, practice-based, or deeply contextualized learning. Participants consistently identified areas where MCs fall short, highlighting gaps in the types of skills they effectively teach. Marsha emphasized the limitations of MCs in teaching hands-on skills, particularly those critical to science instruction. She stated, “If you were teaching somebody how to run a science lab, you can't do that online. There's just certain hands-on things like that you can't teach online.” Marsha further noted that some content areas, such as chemistry, are inherently unsuitable for online PD formats, as they require physical engagement with materials and laboratory techniques.

Wendy similarly underscored the difficulty of teaching complex, practice-based skills through MCs. She reflected on her experience transitioning to inquiry-based teaching, explaining, “The training I went through where I shifted my whole entire teaching practice to where it is inquiry-based instead of just designing a lesson to be inquiry-based... I feel like that would be difficult to do micro-credentially.” Wendy’s comments suggest that skills involving significant pedagogical shifts or immersive practice may require in-person, sustained PD rather than the self-paced, often asynchronous nature of MCs.

Alicia pointed to lesson planning as another area where MCs may not be effective. She explained, “Lesson planning, I think, is difficult for teachers. I don't know that a MC would

show a teacher how to lesson plan.” Her remarks highlight the challenge of addressing nuanced, iterative skills that rely on individualized feedback and contextual understanding. Similarly, Isabel expressed skepticism about the ability of MCs to address content-specific instructional skills, stating, “It would be difficult to look specifically at content skills.”

Motivation and Self-Direction

Interviews revealed that motivation and self-direction pose significant challenges for teachers engaging with MCs. While the flexibility of MCs is often seen as an advantage, participants highlighted that this same flexibility could lead to procrastination, minimal effort, and a lack of meaningful engagement. Marsha emphasized the importance of intrinsic motivation, noting that the value derived from MCs depends largely on the teacher’s personal investment: “I think if you're not self-driven, you're not going to do [well in MC-based PD].” She further pointed out that when MCs are mandated, teachers may complete them with minimal effort, explaining, “You do it, but you do it kind of slack. So, you're really not getting anything out of it. You've accomplished what [the state] asked you to do.”

Participants also noted the difficulty of maintaining self-discipline and prioritizing MCs amidst the competing demands of teaching. Ariel highlighted the dual nature of flexibility, describing it as both a benefit and a drawback: “One of the pros [of MC-based PD] is that you can work on your own schedule. One of the cons is also...you’re working on your own schedule.” She observed that this can lead to procrastination, particularly if the teacher is not deeply invested in the content: “You are likely to approach it with, ‘what’s the minimal effort that I can put into this to get this box checked?’”

The struggling self-directed learners in this study also expressed how motivation and time management affected their experience with MCs. Erik described his own struggles with

accountability, recounting how he delayed completing his last MC: “It can be easy to push off. I didn’t get my third one done because I was like, ‘alright, I’m going to get it done after spring break.’ And then...it’s a tough time to get stuff done.” Glinda similarly noted the challenge of staying motivated without external support, stating, “It’s harder to stay motivated when you’re by yourself; not having someone right there physically to help keep you motivated.” She further explained that the competing demands of teaching and other outside responsibilities can make it difficult to prioritize MCs: “It’s harder to make it a priority when your plate already runneth over.”

Who Benefits

Four out of the eight participants (50%) in this study believed that every type of K-12 educator would benefit from MC-based PD. Three participants were strong self-directed learners (*Marsha, Alicia, and Isabel*) and one was a struggling self-directed learner (*Glinda*). They believed there were so many options for MCs that all teachers would be able to find something beneficial. They made statements like, “It’s so broad, the options, that there should be something for everybody” (*Glinda*) and “I think there’s so many options for MCs that everyone could find something that could be beneficial” (*Isabel*).

However, the remaining 50% of participants had opposing views, and discussed educators who may not find MCs beneficial due to their preferences, teaching contexts, or professional outlook. Wendy identified a key limitation of MCs, noting that they are less suitable for teachers who struggle with remote learning or self-directed PD. She explained, “If you’re not comfortable with remote learning...if you’re one that needs somebody in front of you to tell you and to teach you what you’re doing, then I don’t know that it would be beneficial for you.” Ariel shared a similar perspective, recounting the reluctance of a veteran colleague to engage with

online training, stating, “My neighbor who’s taught for 35 years...does not like to do any type of training in general, but especially not online. So, I think there would be some [educators] that would resist it.” This resistance may stem from a lack of familiarity with digital platforms or a preference for traditional PD formats.

Self-Directed Learning is Not for Everyone. The experiences of Billy, a math teacher who struggled with MC-based PD, illustrate how personal and professional constraints can limit the feasibility and effectiveness of this approach for certain educators. His comments highlight that time limitations, competing responsibilities, and overwhelming workloads can make MCs inaccessible or a low priority.

Billy described the numerous demands on his time, which included balancing his full-time teaching responsibilities with multiple part-time jobs, including cleaning elementary schools, substituting as a bus driver, and working at a hospital. He was also implementing a new classroom strategy with his students and explained:

I just don’t have time [to complete MCs]. I’m doing interactive notebooks this year. I’ve never done that before, and I decided to do it for all my classes. And that’s a lot of work in itself. The MCs have just fallen on the low side of the priority list.

The primary barrier for Billy was time. He elaborated on how his other PD obligations and outside work prevented him from engaging meaningfully with MCs: “I’ve been in another year-long PD, and I’m sure there were probably MCs I could have done. But working outside of school, it’s just hard to get it all done.”

Billy’s experience highlights a key limitation of MCs for teachers with demanding schedules and multiple obligations. For educators like him, the independent, flexible nature of MCs may not be enough to overcome the practical constraints of time and competing

responsibilities. His situation suggests that PD opportunities need to be tailored to accommodate the realities of teachers' lives, particularly those juggling multiple jobs or intensive teaching practices. Integrating MCs into existing PD structures, providing built-in time for completion, or offering more supportive formats may help make this approach more feasible for teachers facing similar challenges.

Teachers' Perceptions of Their Knowledge and/or Skills for Teaching

Knowledge/Skills of Teaching Strategies

Teachers reported a generally positive impact of MC-based PD on their knowledge and skills related to teaching strategies. These experiences highlighted how MCs can address specific instructional needs, promote innovative practices, and encourage sustained implementation of new strategies in the classroom. Alicia emphasized the value of MCs in allowing teachers to focus on areas of personal or professional interest. When asked if she felt MC-based PD had improved her knowledge or skills of teaching strategies, she explained:

It's allowed me to focus on areas I want to focus on. I don't feel like it's busy work. I don't feel like I'm being sent to something I don't think I can use. I'm not sitting there just listening to another person. I'm doing the teaching and the learning.

For Wendy, MCs provided strategies to address the unique needs of her students, particularly in culturally diverse and linguistically challenging classrooms. She noted, "[MC-based PD] was more about meeting the needs of my students regarding cultural populations ... especially as I have some that have come in at the secondary level with little to no English." While her MC choices focused less on general teaching strategies and more on adapting instruction to specific student populations, her experience illustrates the flexibility of MCs in addressing diverse educational contexts.

Several teachers credited MCs with helping them break away from routine teaching practices. Glinda shared, “I think all teachers get in that rut of doing the same thing year after year, and [MC-based PD] is shaking it up a little bit, which is good.” Erik highlighted how MCs expanded his repertoire of teaching strategies, stating, “[MC-based PD] has given me some new skills and introduced me to some ideas that I hadn’t encountered before.” Isabel reflected on the long-term impact of MCs, remarking, “I think I took something positive away from every single MC that I did. And it’s a thing that I will continue to use and implement in my classes in the future.”

Reflection

Reflection emerged as a central element in the experiences of teachers engaging in MC-based PD. Teachers reported that the reflective nature of MCs not only encouraged a deeper understanding of their teaching practices but also fostered personal and professional growth. MCs prompted teachers to critically analyze their teaching methods and explore new strategies. Erik reflected, “It did get me thinking about things to try in my class, had me think about what was successful previously and why those things were successful, and why other things might not be.” He also remarked that this process made the MCs feel “more valuable” because they encouraged meaningful introspection about past successes and challenges.

The reflective process also helped teachers identify their areas of improvement and set actionable goals. Isabel described how selecting MCs forced her to evaluate her weaknesses: “It made you reflect on, ‘What do I want to improve on, or what do I need to improve on?’” She added that stepping out of her comfort zone, such as completing video-based MCs, was initially uncomfortable but ultimately led to significant growth. Alicia noted that reflection also influenced her approach to coaching other teachers. She explained that MCs allowed her to “lay

out [her] thoughts” and reflect on how she could better support colleagues. By reflecting on the coaching process, she gained insights into how to structure her support more effectively, stating, “It helped me see a process of talking to [teachers] first, getting an idea of what’s in their classroom.”

Control

Control over PD emerged as a key factor influencing teacher engagement and perceived value in MC-based PD. The flexibility to select topics aligned with individual needs and professional goals was consistently highlighted as a major advantage by teachers. Participants expressed that the ability to choose MCs tailored to their interests and needs made the process more meaningful and impactful than if they were controlled by school administration. Wendy emphasized:

I feel like if I was told, ‘You need to complete these MCs,’ they may not be as beneficial to me. Whereas here, I am handpicking things I know I want to improve upon... that makes them more valuable to me as an educator.

Similarly, Alicia highlighted the value of a district policy that emphasizes teacher autonomy, stating, “[Our administration] is letting you choose, what do you think you need? What do you think you want? Then they let you do it. I think that is valuable because they’re taking a lot of teacher input.” Districts that prioritize teacher autonomy in selecting PD were praised for fostering a sense of ownership and accountability. Alicia described her district’s approach as “It’s all about where can we put the teacher where they think they’re going to be successful,” emphasizing the value of respecting teachers’ professional judgment.

The freedom to select MCs was seen as an opportunity for teachers to align their PD with their immediate professional needs and long-term career goals. Isabel noted the importance of

choosing PD that she felt was relevant and beneficial, explaining, “I feel I’m at that stage in my career that it’s okay to say no. But if [the PD] is something I feel that I know I could benefit from, [I’ll engage with it].”

Discussion

RQ 1: Challenges and Benefits of Micro-Credential-Based Professional Development

Autonomy

The results of this study highlighted autonomy as a critical factor in the perceived effectiveness of MC-based PD for educators. Participants consistently emphasized the value of being able to choose PD experiences tailored to their specific professional needs and interests. This finding aligns with previous research suggesting that personalized PD fosters greater engagement and relevance for teachers (e.g., Darling-Hammond et al., 2017). By allowing educators to focus on areas of personal and professional growth, MCs could potentially provide a more targeted and meaningful learning experience than traditional, one-size-fits-all PD.

The reported benefits of choice and individualization appeared to be significant for teachers in rural areas, where PD options are often limited. Isabel's insights underscore the potential for MCs to address the unique challenges faced by rural educators, including access to specialized content and flexible formats that align with the needs of varying classroom dynamics.

Another key benefit identified was the flexibility in timing and pacing afforded by MCs. These findings support previous research indicating that flexibility in PD fosters increased teacher agency and satisfaction (Kennedy, 2016).

Self-Awareness. However, motivation and self-direction emerged as significant challenges in MC-based PD, with participants highlighting that the flexibility of MCs often leads

to procrastination, minimal effort, and a lack of meaningful engagement. These findings highlight the critical role of self-awareness in effectively engaging with MC-based PD. Participants consistently emphasized that the success of MCs hinges on teachers' ability to assess their intrinsic motivation, self-direction, and personal learning needs. Marsha's reflection on intrinsic motivation encapsulated this idea, and underscored the necessity for teachers to recognize their readiness for self-directed learning and their capacity to remain invested in professional growth without external pressure.

This self-awareness extends beyond recognizing motivation; it also involves understanding personal tendencies toward procrastination or superficial engagement. For example, Wendy's observation that mandated MCs may lead to minimal effort suggests that some teachers may require external accountability to fully engage. This aligns with theories of adult learning, such as Knowles' (1975) concept of self-directed learning, which posits that learners must be both willing and able to take responsibility for their educational experiences.

The dual nature of flexibility in MCs further underscores the importance of self-knowledge. While flexibility allows teachers to tailor PD to their schedules and needs, it also places the responsibility on them to manage their time and prioritize tasks effectively. Teachers like Ariel identified this tension, noting, "One of the pros is that you can work on your own schedule. One of the cons is also...you're working on your own schedule." This paradox highlights the need for teachers to evaluate whether they possess the time management skills and intrinsic motivation required to thrive in a flexible learning environment.

Overall, these findings suggest that MC-based PD is most effective when participants are equipped with a clear understanding of their own motivational drivers and potential barriers to

engagement. Without this self-awareness, the flexibility and autonomy offered by MCs can become liabilities, leading to procrastination and diminished learning outcomes.

Addressing the Challenge of Relatedness

While MCs offered participants significant benefits, this study highlighted relatedness as a key challenge. Isabel noted that the lack of interaction with colleagues made the process less supportive and enriching. Similarly, Ariel and Alicia expressed concerns about the absence of collaborative opportunities, with Ariel emphasizing the value of traditional PD formats where teachers can interact and share experiences..

To address the challenge of relatedness in MC-based PD, stakeholders could consider integrating collaborative elements into its design. Participants' feedback suggests that a balance between individualized and collaborative PD approaches is essential. While MCs allow educators to tailor learning to their specific needs, the absence of interpersonal engagement may diminish the overall effectiveness and satisfaction with this format. Incorporating opportunities for collaboration could address this gap without sacrificing the flexibility that educators value. By combining the strengths of MCs and traditional PD, educational leaders can offer a more holistic and effective approach to PD.

Relevance and Applicability

Rural educators emphasized the critical role of relevance and applicability in the effectiveness of MC-based PD. Isabel's observations highlight the unique challenges faced by teachers in rural settings, particularly in accessing high-quality professional development and instructional resources. She noted that MCs provide a more effective approach to addressing the diverse and context-specific educational needs of rural schools compared to traditional PD, which is often designed with urban or generalized audiences in mind. This finding underscores

the importance of differentiated PD models that account for the geographic isolation and distinct instructional demands of rural educators, ultimately supporting more equitable professional learning opportunities.

The immediacy of application emerged as another vital component, with participants like Ariel stressing the importance of classroom-relevant strategies. Ariel's preference for PD that she could "take and implement in [her] classroom right away" points to the necessity for professional learning experiences that directly impact day-to-day instructional practices. Alicia echoed this perspective, highlighting how MCs allowed her to align PD with her specific teaching needs and goals. This reflects broader trends in PD literature, which emphasize that adult learners are more likely to engage with and benefit from learning experiences that have clear, practical implications for their work (Knowles, 1975).

Influence of Micro-Credential Type on Perceived Benefits and Challenges

Results underscored how the perceived benefits and challenges of MC-based PD are closely tied to the specific type of MC undertaken. Participants highlighted that differences in focus, structure, and resource quality significantly impacted their engagement, perceived relevance, and ultimately, the value they derived. For instance, Wendy compared two MCs with contrasting formats: one emphasizing reflection on supplied readings and the other requiring evidence-based submissions. She reported gaining less from the reflective MC, emphasizing the importance of a structured, evidence-driven approach for deeper professional growth.

Participants also identified content familiarity and classroom applicability as key determinants of a MC's effectiveness. Alicia found the *Incorporating Global Education into Practice* MC particularly challenging due to her limited prior knowledge of global education and difficulty integrating its content into her teaching context. This highlights the need for

differentiated levels of support based on educators' prior experience and the specific classroom demographics they serve. Alicia's challenges also demonstrate how a mismatch between MC content and teaching context can hinder practical implementation, particularly when the classroom composition limits opportunities to apply new strategies.

However, participants also identified significant challenges associated with certain MCs. These included unclear instructions, time-intensive tasks, and insufficient or inaccessible resources. Offering differentiated levels of difficulty and accessible examples of successful implementation could further enhance the effectiveness of MCs, supporting both novice and experienced educators.

Addressing Buy-In and the Limited Value of Digital Badges

A significant challenge to the broader adoption and impact of MC-based PD lies in the issue of stakeholder buy-in, particularly concerning the perceived value of digital badges. Among the participants in this study, only one teacher, Marsha, expressed enthusiasm for the digital badges associated with MCs. Her experience highlights both the potential and the current limitations of this feature in motivating educators and fostering recognition for their achievements. Marsha described using digital badges as a form of self-validation, displaying them in her email signature as a visible marker of her professional accomplishments. However, she noted that their broader value remains limited due to a lack of awareness and recognition among colleagues and administrators. Her observation underscores the nascent state of digital badge adoption within the educational landscape. Without systemic understanding and support, digital badges fail to serve as meaningful incentives or as symbols of professional growth that are widely respected.

The limited buy-in from administrators appears to be a critical barrier to the effective use of digital badges. As Marsha noted, “I don’t know how many administrators buy into it yet.” This lack of administrative support could diminish the extrinsic value of earning badges, potentially reducing their motivational appeal for teachers. When MCs and their associated badges are not tied to tangible outcomes—such as career advancement, formal recognition, or actionable feedback—they risk being perceived as peripheral rather than integral to PD.

Addressing Content Gaps

While MCs offer flexibility and personalization, this study highlighted significant limitations in their ability to address content-specific knowledge and skill development. Participants consistently reported a lack of depth in subject-specific offerings, which they viewed as critical for effective professional growth. Several participants noted that MCs often focus on general pedagogical strategies rather than the deep, subject-specific content knowledge they need. These findings suggest that MC designers need to prioritize the inclusion of content-specific learning opportunities.

Addressing Challenges in the Micro-Credential Assessment Process

Findings from this study revealed several challenges associated with the evaluation process of MC-based PD, including concerns about assessor qualifications, inconsistencies in evaluation standards, and the potential for academic dishonesty. Two participants expressed skepticism about the expertise and practices of those evaluating MCs. Alicia’s question, “Who is on the other side of reading those? Who is on the other side of grading it?” highlighted the ambiguity surrounding assessor qualifications. This lack of transparency undermines confidence in the rigor and credibility of the process. Additionally, Alicia and Wendy emphasized the inadequacy of the feedback provided. Wendy recounted a frustrating experience where her

submission was denied due to an oversight by the evaluator. Such incidents not only delay progress but also call into question the reliability of the evaluation process.

Participants noted disparities in the rigor and expectations across different MCs. Wendy highlighted the unevenness in submission requirements, contrasting the detailed expectations of some MCs (e.g., video submissions with specific criteria) with the minimal requirements of others (e.g., reflections on assigned readings). She described the rubrics as “very vague in regard to what they’re looking for,” suggesting a need for clearer and more consistent evaluation criteria. This variability contributes to confusion and a perception of inequity in the assessment process.

Wendy and Alicia questioned whether assessors could reliably verify the authenticity of submissions. While some MCs required artifacts as evidence, others lacked mechanisms to ensure the authenticity of submissions. The development and implementation of consistent, detailed rubrics across all MCs would also help standardize expectations and reduce confusion among participants. While standards have been developed, the Quality Assurance Standards for Micro-Credentials report and policy brief was not released until March 2023, leaving many MCs out which were created before the release of these standards. Incorporating tools and processes to verify the authenticity of submissions, such as plagiarism detection software, artifact authentication protocols, or proctored assessments, could also mitigate concerns about academic dishonesty.

Limitations of Micro-Credentials in Teaching Practice-Based and Contextualized Skills

While MCs offer personalized learning opportunities, this study highlights their limitations in fostering certain skills—particularly those requiring hands-on practice, iterative development, or deep contextualization. Participants emphasized that the asynchronous and

individualized nature of MCs often precludes the development of complex, practice-based competencies integral to effective teaching. Marsha's insights underline the fundamental limitations of MCs in teaching hands-on skills, particularly in STEM fields, noting a MC would not be able to teach you how to carry out a lab. Her observation reflects the importance of physical engagement with materials and real-world practice in science education. This challenge is particularly pronounced in areas such as chemistry and laboratory-based instruction, where online formats cannot replicate the tactile, experiential learning necessary for mastery. The inability of MCs to adequately address hands-on skills underscores the need for alternative PD formats for educators in fields requiring physical or technical proficiency.

Wendy highlighted the limitations of MCs in supporting significant pedagogical transformations, such as transitioning to inquiry-based teaching. Pedagogical shifts often require immersive, iterative learning experiences where educators benefit from real-time feedback modeling, and sustained support (Gonzalez & Hodge, 2020; Thompson & Braude, 2016). MCs, by contrast, are typically self-paced and rely heavily on individual initiative, potentially making them less effective for fostering the depth of engagement and reflection necessary to enact meaningful instructional changes.

Participants also noted the limitations of MCs in addressing iterative and context-specific skills like lesson planning. Effective lesson planning often requires personalized feedback, collaboration, and adaptation to diverse classroom contexts (Black et al., 2019)—elements that could be challenging to replicate in a MC format. While MCs offer valuable opportunities for professional growth, their limitations in fostering hands-on, practice-based, and deeply contextualized skills highlight the need for a diversified approach to teacher development. These findings suggest that MCs should complement, rather than replace, traditional PD formats,

ensuring educators have access to the comprehensive support necessary to master both theoretical and practical competencies.

Limited Applicability of Micro-Credentials Across Educator Populations

Findings from this study suggest that MC-based-PD may not be universally beneficial to all educators. The data revealed a divide among participants: half of the teachers believed the breadth of MC options ensured relevance for all, the other half identified significant barriers tied to teaching contexts, preferences, and professional outlooks. Four participants expressed confidence in the universal applicability of MCs, highlighting the variety of topics available as a strength. Their perspectives reflect the adaptability of MCs to diverse teaching contexts, allowing educators to tailor their professional learning to their needs and interests. This optimism underscores the potential for MCs to meet individual educators' goals, particularly in contexts where choice and autonomy are valued. However, this perceived universality does not account for the challenges faced by educators who may be less inclined to engage with this type of PD.

The remaining 50% of participants articulated concerns about MCs' limited applicability for certain educators, pointing to factors such as technological proficiency, professional motivation, and teaching preferences. Wendy noted that MCs may not benefit teachers who struggle with remote learning or self-directed formats. This finding aligns with broader research suggesting that comfort with technology is a critical factor in the effectiveness of online PD (Junyan et al., 2022; Read & Cox, 2020).

This suggests that educators with limited exposure to technology may face additional barriers to fully engaging with MCs.

Several participants also pointed to generational and personality differences that influence preferences for PD formats. Erik noted that "more social teachers" may prefer

traditional, collaborative settings over the independent nature of MCs. This observation aligns with the broader critique that MCs often lack opportunities for interpersonal interaction (Wheelahan & Moodie, 2022), a key feature of traditional PD. These findings suggest that while MCs offer many benefits, they may not serve all educators equally. While MCs represent a promising avenue for PD, they are not a one-size-fits-all solution.

Challenges of Self-Directed Learning in Micro-Credentials

A primary limitation of MCs was that while they are designed to be flexible and self-paced, they often required significant time and energy that were unavailable to educators with competing obligations. Billy's experiences, who did not complete any MCs, highlighted the difficulty of prioritizing PD when it competes with both work-related and personal responsibilities. Billy also noted that his participation in another year-long PD initiative further reduced his capacity to engage with MCs. This example highlights a structural issue: MCs are often positioned as supplemental rather than integrated forms of PD. Without dedicated time or alignment with existing obligations, they may become an added burden rather than a practical learning opportunity.

While the flexibility of MCs is often viewed as a strength, Billy's experience suggests that this autonomy can also be a drawback for educators who lack the time or intrinsic motivation to prioritize self-directed learning. For educators like Billy, traditional PD that includes scheduled sessions, external accountability, or collaborative opportunities may be more effective. Billy's experience highlights the need for PD models that account for the diverse realities of educators' lives.

RQ 2: Impact of Micro-Credentials on Knowledge and/or Skills for Teaching

This study revealed that MC-based PD positively influenced teachers' reported knowledge and skills related to teaching strategies. Participants highlighted how MCs allowed for targeted, flexible learning aligned with their instructional needs, promoted innovative practices, and supported sustained application in the classroom. Alicia's experience exemplified this, as she explained that MCs enabled her to engage in meaningful, self-directed PD that avoided the perception of "busy work." This self-directed approach contrasts with traditional PD, where content may not always align with teachers' immediate needs or interests. The targeted nature of MCs, therefore, helps ensure that PD feels relevant and actionable.

The flexibility of MCs also allowed teachers to address specific challenges in their classrooms. Wendy, for example, selected MCs that focused on meeting the needs of culturally and linguistically diverse students. This ability to tailor PD to specific student populations or instructional contexts highlights the potential of MCs to support educators in diverse teaching environments.

Several participants described how MCs helped them break away from routine practices and explore new strategies. This finding aligns with research suggesting that PD fostering exploration and innovation can rejuvenate teaching practices and combat stagnation (Johnson & Nicol, 2023). The personalized and practical nature of MC-based learning may contribute to its sustained impact, as teachers are more likely to implement and retain strategies they find relevant and effective.

The positive experiences of the participants suggest that MCs can be an effective tool for enhancing teachers' knowledge and instructional practices, particularly when designed to address relevance (offering a wide range of MCs tailored to various instructional needs and classroom

contexts), flexibility (allowing educators to engage with content at their own pace and select topics of interest), and sustainability (embedding strategies for long-term implementation within MCs). However, its success depends on its ability to address diverse classroom needs, support long-term application, and provide meaningful, relevant learning experiences. By continuing to refine the design and delivery of MCs, PD providers can better support educators in meeting the dynamic demands of their profession.

Administrative vs. Teacher Control in Micro-Credential-Based Professional Development

The degree of control teachers had over their PD emerged as a critical factor in shaping their engagement, satisfaction, and perceived value of MC-based PD. The findings suggest that PD opportunities allowing for teacher autonomy are more impactful than those dictated by administrative mandates. Participants consistently highlighted the importance of autonomy in PD selection. Wendy underscored the value of self-directed choice, explaining, “I feel like if I was told, ‘You need to complete these MCs,’ they may not be as beneficial to me.” This sentiment suggests that teacher-driven PD fosters greater ownership and motivation, as educators can address areas of interest or need rather than completing tasks that may feel irrelevant or arbitrary. This approach not only respects teachers’ professional judgment but also enhances their sense of agency and accountability in their professional growth.

The findings also suggest that when teachers perceive PD as directly benefiting their practice, they are more likely to engage meaningfully. By contrast, mandated PD risks being perceived as disconnected from classroom realities, potentially leading to lower engagement and less effective implementation. Administrative policies play a significant role in shaping the PD landscape (Desimone, 2002). Districts in this study that supported teacher autonomy in PD were praised for their forward-thinking approach. Alicia described her district’s policy as fostering

teacher success: “It’s all about where can we put the teacher where they think they’re going to be successful.” Such policies recognize the diversity of teacher needs and experiences, creating a more individualized and empowering PD process.

However, the tension between administrative goals and teacher autonomy remains a challenge. While administrators may prioritize district-wide initiatives or compliance-based training, the findings suggest that balancing these with opportunities for teacher-driven choices can enhance the overall impact of PD programs.

Implications and Future Research

The study indicated that not all teachers benefit equally from MC programs, particularly those who struggle with motivation and time constraints. Therefore, it is crucial for educational leaders and policymakers to develop tailored support strategies that address the specific needs of teachers. This could include providing additional resources, mentorship/coaching, or structured time for PD activities, ensuring that all educators have equitable access to the benefits of micro-credentialing. Expanding the sample size, including more diverse participants, and exploring long-term impacts, will enhance the generalizability and robustness of findings related to MC-based PD.

Future research should explore the long-term impacts of MC-based PD on teacher practices and student outcomes. Longitudinal studies can provide insights into how teachers' beliefs and instructional strategies evolve over time as they engage with MCs, as well as the sustainability of these changes in practice. Further research should examine the broader contextual factors that influence the effectiveness of micro-credentialing for rural teachers. This includes exploring how community support, school leadership, and access to resources impact

teachers' engagement with PD opportunities. Understanding these factors can inform the design of more effective and contextually relevant PD programs.

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CHAPTER 5 DISCUSSION AND CONCLUSIONS

Overview of the Research and Findings

This dissertation explored the potential of micro-credentials as a form of teacher professional development through multiple lenses, including policy perspectives (Chapter 1), empirical investigation of their impact on teacher self-efficacy and self-directed learning (Chapter 2), and an in-depth analysis of educators' experiences (Chapter 3). Findings from the three interconnected studies provide a nuanced understanding of the promises and challenges associated with MC-based PD and its implications for teachers, policymakers, and administrators.

Micro-Credentials as a Self-Directed Alternative to Traditional Professional Development

Policymakers recognized MCs as a promising, self-directed alternative to traditional PD, emphasizing their potential for increased teacher autonomy and tailored learning opportunities. This aligns with prior research suggesting that personalized PD fosters greater engagement and relevance (Koay, 2023; Kousar & Sadeeque, 2023). However, policymakers also acknowledged significant barriers, such as insufficient financial support, inconsistent quality, and the challenge of aligning MCs with traditional time-based continuing education units. These constraints highlight the broader systemic challenges in integrating competency-based credentials within existing PD frameworks.

From the teachers' perspective (Chapter 3), autonomy was both a strength and a challenge. Educators valued the ability to select PD experiences aligned with their professional goals, particularly those in rural areas where PD options are often limited. However, flexibility also led to reported issues such as procrastination, minimal effort, and a lack of engagement. Self-directed learning, while beneficial for some, requires strong intrinsic motivation and time

management skills, and not all educators are equally prepared for such a model. This underscores the importance of understanding individual teacher needs when implementing MCs at scale.

Promise and Potential of Micro-Credentials

Policymakers largely viewed micro-credentials as a promising alternative to traditional, one-size-fits-all PD models (Chapter 1). They recognized the potential for micro-credentials to provide self-directed, competency-based learning tailored to individual teacher needs. Teachers echoed this sentiment, emphasizing the autonomy and flexibility micro-credentials offered in allowing them to select PD relevant to their classroom practice (Chapter 3).

Additionally, policymakers envisioned micro-credentials playing a role in teacher preparation, with some advocating for their integration into licensure pathways or as alternative routes to certification (Chapter 1). While these perspectives indicate growing institutional interest in micro-credentials, their integration into formal teacher preparation programs remains inconsistent, largely due to concerns regarding standardization, narrow focus, and recognition for license renewal.

Constraints and Challenges of Micro-Credentials

Despite their potential, the studies revealed significant challenges in the adoption and implementation of micro-credentials. Policymakers and teachers alike identified financial barriers, inconsistent quality, and sustainability concerns as major limitations (Chapter 1 and Chapter 3). Many micro-credential programs rely on initial grant funding, raising concerns about their long-term viability. Furthermore, without established quality standards, micro-credentials risk becoming fragmented and variable in rigor. Recent policy efforts to standardize micro-credentials (e.g., the 2023 Quality Assurance Standards for Micro-Credentials) aim to address

these concerns, but many existing programs predate these standards and lack robust evaluation frameworks.

The lack of alignment between micro-credentials and traditional continuing education unit-based PD structures presented another significant challenge (Chapter 1). Teachers expressed frustration with the absence of clear recognition for their micro-credential achievements, which could deter participation (Chapter 3). If micro-credentials are to become a viable PD alternative, they must be integrated into formal teacher advancement and compensation structures.

Impact of Micro-Credentials on Teacher Self-Efficacy and Self-Directed Learning

Despite their potential benefits, results from the randomized controlled trial did not indicate significant changes in teacher self-efficacy or self-directed learning after engaging in MC-based PD. This suggests that while MCs may offer valuable learning opportunities, they may not provide the depth of sustained coaching, collaboration, and practice-based reinforcement needed for meaningful shifts in self-efficacy. The lack of significant findings also raises questions about the time required for teachers to internalize and apply new knowledge effectively. One possible explanation is that effective PD requires sustained coaching, collaboration, and reflective practice, elements often lacking in micro-credential-based learning.

While self-directed learning is a core feature of micro-credentials, Chapter 3 findings suggested that many teachers struggle with motivation, time management, and procrastination, undermining the effectiveness of self-paced learning. The study also found that teachers with National Board certification exhibited higher levels of self-directed learning factors, whereas those with a master's degree showed lower scores of teaching self-efficacy. These results suggest that different forms of professional learning experiences influence distinct aspects of teacher

development. Micro-credentials may be more effective when integrated within a broader, scaffolded approach to PD rather than serving as a standalone intervention.

The Role of Expectancy-Value Factors in PD Engagement

Teachers' professional subjective task value played a critical role in shaping both self-directed learning and self-efficacy. Those who placed a high value on their professional work were more likely to engage in self-directed learning and exhibit confidence in instructional effectiveness (Chapter 2). However, personal subjective task value was only correlated with self-directed learning, suggesting that intrinsic motivation for teaching does not necessarily translate into greater self-efficacy. These findings reinforce the need to align MC content with teachers' professional values to maximize engagement and impact.

Moreover, expectancy-value theory analyses demonstrated that teachers who placed high professional value on their work were more likely to engage in self-directed learning, reinforcing the alignment between micro-credentials and intrinsic motivation (Chapter 2). When teachers perceive PD as directly applicable and valuable to their professional practice, they are more likely to engage deeply and implement new strategies effectively (Desimone et al., 2002).

Addressing the Assessment and Recognition Challenges of Micro-Credentials

A recurring concern across all chapters was the inconsistency and credibility of micro-credential assessments. Chapter 3 participants questioned the qualifications of assessors and the reliability of evaluation processes. Vague rubrics and lack of clear assessment criteria led to frustration and skepticism about the rigor of micro-credentials. In some cases, teachers reported inconsistencies in evaluation standards, further undermining confidence in the process.

Furthermore, the limited recognition of digital badges emerged as a key barrier to broader adoption. While digital badges serve as a form of micro-credential verification, they are not

widely acknowledged by administrators or colleagues (Chapter 3). Without institutional buy-in, digital badges fail to function as meaningful incentives for teacher participation. Establishing clearer policies for recognizing micro-credentials within teacher evaluation and promotion systems could enhance their perceived value and effectiveness.

Future Directions and Policy Implications

This dissertation underscores the need for further research on the effectiveness of micro-credentials as a form of professional development. Despite their potential advantages, the absence of controlled studies validating their impact remains a significant limitation. As educational institutions, policymakers, and funding bodies consider expanding micro-credential initiatives, they must prioritize rigorous evaluation, quality assurance, and mechanisms for sustained engagement.

While micro-credentials represent a promising and innovative approach to teacher professional development, their success hinges on overcoming significant financial, quality, and implementation challenges. Striking a balance between flexibility and structure is vital to their effective integration. By leveraging the strengths of micro-credentials and addressing their inherent limitations, stakeholders have the opportunity to develop a more effective, equitable, and sustainable model for teacher professional growth that can adapt to the evolving demands of education.

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APPENDICES

Appendix A

1. I know what I need to learn. (5=Strongly agree, 4=Somewhat agree, 3=Neither agree nor disagree, 2=Somewhat disagree, 1=Strongly disagree)
2. Regardless of the results or effectiveness of my learning, I still like learning.
3. I hope to continually improve and excel in my learning.
4. My successes and failures inspire me to continue learning.
5. I enjoy finding answers to questions.
6. I will not give up learning because I face some difficulties.
7. I can establish goals for my own learning.
8. I know what strategies work best for me to reach my learning goals.
9. I can set priorities for my own learning.
10. Whether in the classroom or on my own, I am able to follow my own learning plan.
11. I am good at managing my time spent learning.
12. I know how to find resources for my learning.
13. I can connect new knowledge with my own personal experiences.
14. I understand my learning strengths and weaknesses.
15. I can monitor my learning as it occurs.
16. I can evaluate my own learning outcomes.
17. Interacting with others helps me plan for future learning.
18. I would like to learn about the language or culture of those with whom I frequently interact.
19. I am able to communicate effectively during oral presentations.
20. I am able to communicate effectively in writing.

Appendix B

1. I enjoy learning new things about my hobbies or leisure interests. (5=Strongly agree, 4=Somewhat agree, 3=Neither agree nor disagree, 2=Somewhat disagree, 1=Strongly disagree)
2. I sometimes lose track of time when learning new things about my hobbies or leisure interests.
3. I enjoy talking with others outside of the workplace about the new things I have learned about my hobbies or leisure interests.
4. I feel empowered when I learn something new about my hobbies or leisure interests.
5. I enjoy learning new things about teaching.
6. I sometimes lose track of time when learning new things about teaching.
7. I enjoy talking with my colleagues about the new things I have learned about teaching.
8. I feel empowered when I learn something new about teaching.
9. When learning something new about my hobbies or leisure interests I feel the need to master the topic I am learning.
10. When I have learned something new about my hobbies or leisure interests, it is important that others perceive me an expert.
11. When learning something new about teaching I feel the need to master the topic I am learning.
12. When I have learned something new about teaching, it is important that others perceive me an expert.
13. Learning new things about my hobbies or leisure interests benefits me financially.
14. Learning new things about my hobbies or leisure interests helps me advance my career.
15. When I learn something new about my hobbies or leisure interests it increases my desire to learn more.
16. When I learn something new about my hobbies or leisure interests it makes me better at my hobbies.
17. Learning new things about teaching benefits me financially.
18. Learning new things about teaching helps me advance my career.
19. When I learn something new about teaching it increases my desire to learn more.
20. I learn something new about teaching it makes me better at teaching.
21. It is worth my time to learn more about my hobbies and leisure interests.
22. I am willing to spend money to learn more about my hobbies and leisure interests.
23. It is worth my time to learn more about teaching.
24. I am willing to spend money to learn more about teaching.
25. Learning new things about my hobbies and leisure interests requires too much effort.
26. Learning new things about my hobbies and leisure interests takes me away from more important things.
27. Learning new things about teaching requires too much effort.
28. Learning new things about my teaching takes me away from more important things.

Appendix C

Case Study Pre-Treatment Interview Questions

1. You have been introduced to micro-credential-based professional development. What components of micro-credentials sound interesting and effective so far?
2. What concerns or questions do you have about micro-credential-based professional development?
3. How is micro-credential-based professional development different from traditional PD?
Probe
4. Do you think your micro-credential coach will be useful to you? If so, in what ways? If not, why?
5. Ideally, how could your coach in this program support your PD?
6. When you think of effective teacher professional development, what elements come to mind?
7. Do you think the professional development provided by your school system is valuable? Why or why not?
8. Do you think micro-credential-based professional development will be valuable to you as an educator? Why or why not?
9. What do you give up to participate in school-based PD?
10. What do you think you will give up to participate in micro-credential-based professional development?
11. When you reflect on traditional professional development experiences (e.g., workshops, conferences, presentations), what do you find beneficial to helping you grow as a teacher? Probe- Can you think of anything else you do that makes you a better teacher (i.e., read journals, magazines, listen to podcasts)? We're interested broadly in what influences you as a teacher and how you grow professionally.
12. Do you voluntarily sign up for professional development experiences that are not required by your school administration? Probe- if yes, for each activity/experience: why did you choose that, would you choose it again, why/why not? -if no, why do these PD experiences/activities not appeal to you, what would entice or cause you to sign up for such experiences, if anything?
13. What do you think helps you grow the most as an educator? Probe- based on answer

Appendix D

Case Study Mid-Treatment Interview Questions

1. How many micro-credentials have you completed so far? Tell me about each one (how long they took, difficult/easy, when did you complete them (time of day), by yourself or with another teacher, pros/cons of specific MCs etc). Probe by pulling up MC artifacts and asking about about experiences with each specific MC:
 - a. Why did you select this MC?
 - b. Were you awarded a badge after your first attempt? If not, how many times was it denied before being awarded.
 - c. Did you find it interesting? informative? Why/why not?
 - d. Do you think you will use anything you learned from this MC?
 - e. Have you already used anything? Was implementation easy/difficult and why?
 - f. What motivated you to complete the MC(s)?
2. What do you see as the benefits/affordances of micro-credential-based professional development?
3. What do you see as the concerns or disadvantages of micro-credential-based professional development?
4. Do you feel MC-based-PD has improved your knowledge or skills of teaching strategies? Your knowledge or skills related to the subject you teach? Probe- in what ways?
5. What elements of micro-credential-based professional development do you find most beneficial as an educator? Least beneficial?
6. Do you miss any elements of traditional PD? If yes, what elements and why?
7. Is your micro-credential coach useful to you? If so, in what ways? If not, why?
8. Do you think you would have gotten as much out of your MC if you did not have a coach?
9. Do you think micro-credential-based professional development is valuable to other educators? Why or why not? Are there teachers who you think would not benefit from MCs?
10. What do you have to give up to participate in micro-credential-based professional development?
11. Have you discussed your MC with other teachers or family members? Probe- would you share what you might have discussed?

Appendix E

Case Study Post-Treatment Interview Questions

1. How many micro-credentials have you completed so far? Tell me about each one (how long they took, difficult/easy, when did you complete them (time of day), by yourself or with another teacher, pros/cons of specific MCs etc). Probe by pulling up MC artifacts and asking about about experiences with each specific MC:
 - a. Why did you select this MC?
 - b. Were you awarded a badge after your first attempt? If not, how many times was it denied before being awarded.
 - c. Did you find it interesting? informative? Why/why not?
 - d. Do you think you will use anything you learned from this MC?
 - e. Have you already used anything? Was implementation easy/difficult and why?
 - f. What motivated you to complete the MC(s)?
2. What do you see as the benefits/affordances of micro-credential-based professional development? Probe- what's your favorite part of MCs as an educator?
3. What do you see as the concerns or disadvantages of micro-credential-based professional development? Probe- least favorite part of MCs?
4. Do you feel MC-based-PD has improved your knowledge or skills of teaching strategies? Your knowledge or skills related to the subject you teach? Probe- in what ways?
5. What elements of micro-credential-based professional development do you find most beneficial as an educator? Least beneficial?
6. Do you miss any elements of traditional PD? If yes, what elements and why?
7. Are there any skills that you think cannot be taught through MC-based PD? If so, what skills?
8. Is your micro-credential coach useful to you? If so, in what ways? If not, why?
9. Do you think you would have gotten as much out of your MC if you did not have a coach?
10. Do you think micro-credential-based professional development is valuable to other educators? Why or why not? Are there teachers who you think would not benefit from MCs?
11. What do you have to give up to participate in micro-credential-based professional development?
12. Have you discussed your MC with other teachers or family members? Probe- would you share what you might have discussed?

13. Do you plan on completing any additional MCs? Why or why not?
14. What do you think is the ideal setup for MCs in K-12 schools?
15. Anything else you'd like to say about MC-based PD?

Appendix F

Case Study Mid-Treatment Interview Questions (No MCs Completed)

1. What are the main reasons you haven't completed any micro-credentials yet? Probe- can you talk to me about that bc as a teacher in NC you have to have a certain number of CEUs to keep license. Have you earned all credits for license renewal? Is it less attractive than other models? Is it bad timing in your personal life?
2. Does the idea of MC-based PD seem unattractive/not useful for you?
3. Do you plan to do one MC? All 3? Probe
4. Would anything motivate you to complete an MC? Probe- more money, release time, different topics, etc.
5. Do you feel like others at your school are interested in MCs?
6. What do you see as the benefits/affordances of micro-credential-based professional development?
7. What do you see as the concerns or disadvantages of micro-credential-based professional development?
8. What elements of micro-credential-based professional development do you find most beneficial as an educator? Least beneficial?
9. Is your micro-credential coach useful to you? If so, in what ways? If not, why?
10. Do you think micro-credential-based professional development is valuable to other educators? Why or why not? Are there teachers who you think would not benefit from MCs?
11. What would you have to give up to participate in micro-credential-based professional development?
12. Have you discussed MCs with other teachers or family members? Probe- would you share what you might have discussed?
13. Are there any topics, knowledge or skills you would like to have PD for?

Appendix G

Case Study Post-Treatment Interview Questions (No MCs Completed)

1. What are the main reasons you haven't completed any micro-credentials yet? Probe- can you talk to me about that bc as a teacher in NC you have to have a certain number of CEUs to keep license. Have you earned all credits for license renewal? Is it less attractive than other models? Is it bad timing in your personal life?
2. Does the idea of MC-based PD seem unattractive/not useful for you?
3. Do you plan to do any MCs? Probe- when? why/why not?
4. Would anything motivate you to complete an MC? Probe- more money, release time, different topics, etc.
5. Do you feel like others at your school are interested in MCs?
6. Was your micro-credential coach useful to you? If so, in what ways? If not, why?
7. Do you think micro-credential-based professional development is valuable to other educators? Why or why not? Are there teachers who you think would not benefit from MCs?
8. Are there any topics, knowledge or skills you think an MC cannot teach/assess?
9. What do you think is the ideal setup for MCs in K-12 schools?
10. Anything else you'd like to say about MC-based PD?