The proposed research aims at exploring teacher learning in a micro-credential professional development arena, as a window into processes of online fragmented learning and its outcomes in terms of knowledge building.

Introduction

Teachers, as practitioners in a continuously changing profession are in need of ongoing professional learning. Teacher learning is an example of adult learning, which is characterized by self-regulation and personal agency in setting goals and content for learning. Given the demanding nature of their profession, teachers value flexible and modular learning opportunities. As adult learners, teachers draw on their experience and professional knowledge to identify areas for further development, often prioritizing issues that address immediate needs stemming from their practice and favoring knowledge that is directly applicable .

Teacher knowledge connects various aspects of their practice such as general pedagogical expertise, disciplinary or content knowledge and pedagogical content knowledge. Teachers are expected to master broad, generic skills such as class management and social-emotional learning. Additionally, they must keep up with advances in their academic discipline, translate these developments into school subject matter and adapt to changes in its various curricula. Furthermore, teachers need to develop their own context specific applied pedagogical content knowledge to effectively teach, scaffold and evaluate specific aspects of the subject matter tailored to their unique students and classrooms. Therefore, teachers must develop a diverse professional knowledge base that coherently connects its various, sometimes disparate dimensions.

To promote teachers’ learning and professional knowledge, teachers are encouraged, and often required to participate in professional development initiatives. While at their best, institutionalized professional development programs can be effective in addressing the unique characteristics of teacher learning, they may also inherently contradict teachers’ need for flexibility, autonomy and context specificity. To allow for increased personalization of professional learning, institutions and educational administrations offer online micro-credential professional development opportunities.

Online micro-credential or micro-badge systems, offering short, competency-based courses are rapidly expanding. These systems are considered to attune both to employers' needs for fast and competency-based professional development and to learners/employees’ needs for a personalized and flexible learning. The personalization of professional learning in micro-credential systems relies on both the wide choice of courses and the flexibility and modularity of learning. This allows practitioners to choose discrete, short courses that align with their personal interests, disciplines or specific challenges faced by their students. Learning in online micro-credential systems can take place whenever and wherever is most convenient for learners, at their own pace and segmentation.

The personalization of learning afforded by micro-credentials is assumed to be tailored to the principles of adult learning, promoting autonomy and relevance for practitioners. We may therefore expect learning in micro-credential systems to be more authentic and meaningful, with learners demonstrating significant engagement, as reflected in learning patterns and learners feedback. Consequently we can expect practitioners to construct connected, applicable and context sensitive knowledge. However, micro-credential based personalized learning may also have counter-effective consequences.

The wide choice and competition in the realm of micro-credentials harbor inherent moral hazards. Learners might opportunistically opt for the least demanding micro-course or engage in instrumental learning, aiming only to achieve the credential. This risk is amplified in institutional context where professional development is mandatory, accompanied by financial or career advancement incentives. Additionally, online modular learning frameworks may also give rise to what has been termed fragmented learning, where learners appear to study intermittently in short scattered episodes. This raises questions as to learners’ engagement and attentiveness. Fragmented learning is assumed to be connected to fragmented knowledge, whether such knowledge is fragmented due to incoherent opportunistic choices or is extremely narrow focus on a single interest.

As micro-credentials are increasing exponentially and are considered as the future of professional learning and development, it is crucial to gain more insight into practitioners’ learning processes and engagement, as well as the characteristics of knowledge they construct in these learning systems. The online learning management systems in which micro-credentials are acquired offer rich data to sustain this much needed insight. Israeli online teacher professional development micro-credential frameworks offer a particularly promising arena, as they contain comprehensive data on learners’ demographics, intentions and goals, course choices, feedback and knowledge application. We therefore propose to apply learning analytics to utilize the vast data in order to explore the following questions:

1. What are teachers’ learning goals and motivations for taking micro credential professional development courses (instrumental vs. Intrinsic; content expertise vs. Personal enrichment)?
2. What are the learning processes and patterns of engagement demonstrated by teachers in micro credential professional development courses?
3. What types of knowledge do teachers construct in a micro-credential professional development system as evidenced by course choices, learner feedback and demonstrations of application?
4. What are the relations between teachers’ professional learning motivations, learner engagement and knowledge construction ?

# Teacher Learning and knowledge construction in online micro-credential professional development

## Overview

In this proposed research we seek to explore diverse aspects of teacher learning in the evolving world of micro-credentials. Relying on theories of adult learning, knowledge construction and personalization we aim to conceptualize teacher learning, engagement and knowledge construction within the eclectic universe of modular online learning. By applying learning analytics to extensive data from micro-credential learning management systems, we propose to trace the relations between personalization, patterns of choice, learning motivations, engagement and knowledge construction.

Initial research questions:

In online teacher micro-credential professional development, we will explore whether teachers can participate, graduate with decent scores, and not learn. We suggest critically examining the relationship between teacher professional development and teacher learning in the micro-credential PD context, taking a critical perspective on the enthusiasm for teacher learning in micro-credential PD.

# Theoretical background

## Teacher Learning

The quality of an education system depends upon the quality of its teachers, and teachers' expertise is crucial for effective practice (Darling-Hammond, 2010). Therefore, many consider the development of teachers as the keystone to educational improvement. The professional development of teachers is studied and presented in educational literature in many different ways. However, at the core of this research is the understanding that professional development is fundamentally about teachers' learning.

Teacher learning refers to the **process** through which teachers move towards expertise (Kelly, 2006). It is an ongoing multifaceted process through which teachers grow professionally, acquire new knowledge, skills, and insights, transform their knowledge into practice and develop their professional identity(Avalos, 2011). This process involves the continuous development of both practical and theoretical knowledge through formal experiences (such as structured courses) and informal experiences (such as interactions with peers and students). Teacher learning preferences and learning profiles tend to vary. While teachers declare strong preference for learning from colleagues in professional learning communities, the actual tendencies are for individual flexible and fragmented learning [(Orland-Barak & Goldberg, 2024)](https://sciwheel.com/work/citation?ids=16863900&pre=&suf=&sa=0). Understanding the process of teacher learning is essential for developing meaningful professional development opportunities that yield lasting results (Darling Hammond, 2011). Theorizing about teachers’ professional learning entails a deep exploration of its complexity, demonstrating how it achieves its effect (Hadar & Brody, 2012). Since teacher knowledge is both a primary goal and an expected result of teacher learning, it also represents a significant aspect of research in this field.

### Teacher knowledge

The concept of teacher knowledge has evolved over the years and is now understood as a multi-dimensional, continuously evolving construct that encompasses various forms of knowledge essential for effective teaching. It is shaped by ongoing professional development. Teacher knowledge can be defined as the blend of different types of knowledge that teachers need, in order to facilitate learning effectively, respond to diverse student needs, and adapt to the complexities of educational environments [(Ben-Peretz, 2011; Kereluik et al., 2013)](https://sciwheel.com/work/citation?ids=3810533,3810606&pre=&pre=&suf=&suf=&sa=0,0). Teachers are expected to master broad, generic skills such as classroom management, social-emotional learning, and knowledge of educational contexts [(Cochran-Smith & Villegas, 2015)](https://web.endnote.%3D). Additionally, teachers are expected to have knowledge of students and their learning processes [(Darling-Hammond et al., 2020)](https://web.endnote.%3D). They also need to translate disciplinary knowledge and its developments into Pedagogical Content Knowledge (PCK) which would enable them to create teachable content that is tailored to their unique students and classroom settings, within specific school subject matter and curricula [(Hashweh, 2013; Shulman, 1987)](https://sciwheel.com/work/citation?ids=3846047,3521908&pre=&pre=&suf=&suf=&sa=0,0). With technological advancement, technological pedagogical content knowledge has also become a crucial component of teacher knowledge, integrating technology into teaching practices [(Mishra & Koehler, 2006)](https://web.endnote.).Consequently, teachers must develop a diverse professional knowledge base that coherently connects its various, sometimes disparate dimensions.

#### Connected and Fragmented Knowledge

Knowledge coherence, or connectedness, is considered a central characteristic of expertise, Expert knowledge is coherent, conceptual and generalizable, making it transferable and flexibly applicable to new contexts [(Anderson & Taner, 2023; Lachner et al., 2016)](https://sciwheel.com/work/citation?ids=6156033,16096912&pre=&pre=&suf=&suf=&sa=0,0). The notion of coherent and connected knowledge is relevant both within and across disciplines. Coherent knowledge refers to an expert's ability to apply a comprehensive model or theoretical knowledge to many specific examples [(Stamovlasis et al., 2013)](https://sciwheel.com/work/citation?ids=16777296&pre=&suf=&sa=0). It also relates to educators’ ability to work across disciplinary boundaries to address meaningful big questions or concepts [(Carr, 2007; Niemelä, 2021)](https://sciwheel.com/work/citation?ids=16786126,16785982&pre=&pre=&suf=&suf=&sa=0,0).

In contrast, fragmented knowledge may result from increasing specialization and compartmentalization within disciplines. It refers to difficulties arising from the inability to connect specialized narrow perspectives to address complex problem of practice [(Bruni et al., 2007; Niemelä, 2021)](https://sciwheel.com/work/citation?ids=16785982,6171509&pre=&pre=&suf=&suf=&sa=0,0). Fragmented knowledge is often disjointed knowledge, frequently applicable only to specific examples or contexts, and may result from fragmented learning [(Song & Huang, 2022)](https://sciwheel.com/work/citation?ids=16786261&pre=&suf=&sa=0). Fragmented learning and knowledge are likely to occur when learners acquire knowledge intermittently in discontinuous sessions, which is typical of mobile and asynchronous online learning environments. Adaptive online learning management systems and recommendation algorithms are suggested as counter measures to help “fragmented learners” structure their knowledge [(Gan, 2019; Selvaratnam & Sankey, 2021; Wenxiu, 2015)](https://sciwheel.com/work/citation?ids=11831976,16808136,16808133&pre=&pre=&pre=&suf=&suf=&suf=&sa=0,0,0). Still, these may also be part of the general fragmentation of knowledge, amplifying learners' diversifying and disjointed learning choices.

However, while in general it appears that the wide choice of content, time and venue offered by fragmented learning trajectories challenges learners' knowledge construction, studies of these effects refer mainly to youths and undergraduate students. Learners at this stage do not yet build a clear knowledge structure; fragmented learning may be distracting and disruptive to their knowledge construction. On the other hand, fragmented learning may be especially attuned to teachers’ continuing professional development needs. In-service teachers, assumed to harbor an already comparatively structured professional knowledge, may seek to enhance it along their own paths, as adult learning theory would contend.

### Adult learning theory and personalization of learning

Adult learning theory [(Knowles, 2013)](https://web.endnote.) provides a rich framework for researchers attempting to understand the complexities of how teachers learn. This shifts the focus of professional learning to the needs of teachers and the different contexts in which they learn [(Gregson & Sturko, 2007)](https://web.endnote.%3D%3D). Self-direction is characteristic of adult learning, emphasizing adults' sense of personal autonomy in their learning [(Louws et al., 2017)](https://web.endnote.%3D%3D). It involves adults being actively engaged in and taking control of their goals and purposes through planning, executing, and analyzing their learning experience, thus assuming ownership of their learning [(Knowles, 2013)](https://web.endnote.). Teachers are considered to enter professional development as self-directed learners, bringing previous experience, defined expectations for their learning outcomes, and a willingness to collaborate with colleagues [(Patton & mcmahon, 2014)](https://web.endnote.). Self directed learning theory contends autonomy is a basic psychological need for motivated learning [(Ryan & Deci, 2000)](https://web.endnote.). Hence, teachers are more likely to engage in learning when they are treated as responsible individuals in control of their own learning (Louws et al., 2017).

Another characteristic of adult learners is their wealth of experience. Prior experiences interact with teachers’ learning processes, attitudes, and understanding (Knowels, 2013; [Merriam, 2002)](https://web.endnote.%3D%3D). Experience guides teachers' awareness and ability to identify their learning needs and the knowledge gaps to be filled[(Muijs et al., 2014)](https://web.endnote.). [(Caruth, 2014)](https://web.endnote.%3D). Therefore awareness of specific learning needs characterizes teachers as adult learners. This means that teachers should be actively involved in planning their own professional learning, based on what they believe they need to learn to be better teachers, their career stage and context [(Gregson & Sturko, 2007)](https://web.endnote.%3D%3D). As adult learners, teachers generally have an immediacy of application perspective toward most of their learning [(Knowles, 1973)](https://web.endnote.%3D%3D). They tend to enter learning activities with a specific problem-centered orientation and expectations for applicability [(o'toole & Essex, 2012)](https://web.endnote.%3D)[(Knowles et al., 2005)](https://web.endnote.) Teachers perceptions the value and usefulness of knowledge, determines the time and energy they invest in professional learning [(Caruth, 2014)](https://web.endnote.%3D).

OneThe implication of adult learning theory for teacher professional learning development is the need to personalize learning so as to align with their unique characteristics, goals and learning needs. As noted above, teachers show a marked tendency towards individual, personalized learning patterns [(Orland-Barak & Goldberg, 2024)](https://sciwheel.com/work/citation?ids=16863900&pre=&suf=&sa=0). Ensuring the personalization of teacher learning is therefore essential [(Avidov-Ungar, 2023)](https://sciwheel.com/work/citation?ids=16601376&pre=&suf=&sa=0). Personalization in learning refers to tailoring educational experiences to meet individual learner needs, preferences, and goals [(Bernacki et al., 2021)](https://sciwheel.com/work/citation?ids=15774753&pre=&suf=&sa=0). Current theory emphasizes a multidimensional approach to personalization, encompassing various aspects of the learning process, such as content; pace; path or order of activities; instructional approach and in some cases even method of assessment (USDE, 2016).

The main two axes of personalization are individualization and differentiation. Individualization is the aspect of personalization that accommodates the learners’ students’ degree of special need or a specific level of skill or ability by altering a learning progression. A process that can occur even without learners’ explicit choice [(Plass & Pawar, 2020)](https://sciwheel.com/work/citation?ids=10209397&pre=&suf=&sa=0). While this is criticized as limiting learners choice and agency in learning, contrary to the principles of self regulated and adult learning theories, personalized human (or AI) recommendations possibly help even adult learners make informed and coherent choices which would structure knowledge construction [(Che Ahmat et al., 2021; Liang et al., 2018)](https://sciwheel.com/work/citation?ids=14961534,7771002&pre=&pre=&suf=&suf=&sa=0,0). Differentiation refers to a variety of choices allowing learners to exercise more choice and control over their learning. Learners should be able to determine the place and time for learning, the pace of progress and the segments of knowledge, content and specific topics they prefer, based on interest, prior knowledge, preferences and professional needs (Plass, 2020).

While most of current research points to personalized and individual professional learning as most appropriate for teachers’ needs as adult learners, we should note that teacher professional development does not necessarily align with it.

### Teacher professional development

Teacher professional development (PD) refers to the various avenues through which teachers learn. It is an uptake of formal and informal learning opportunities in which teacher learning occurs (Richter et al., 2014). Formal learning opportunities involve structured learning environments, programs and initiatives typically delivered through workshops, courses, and other formal face-to-face or online learning activities. Informal learning opportunities include individual activities such as reading books and classroom observations as well as collaborative activities like conversations with colleagues and parents, mentoring activities, teacher networks and study groups (Desimone, 2009). Most of the research on PD refers to formal, institutional settings, and stresses prolonged synchronous activities, taking place in PD centers or in schools (Darling Hammonds et al., 2009; Hadar & Brody, 2017;; Margolin et al. 2018; Sims et al., 2021). These stress diverse aspects of best practice in PD, such as building a professional learning community within communities of practice (Little, 2012; Wenger-trainer et al., 2014). Studies point to the need to foster coherence, structure and institutional common language in PD, within schools and districts or subject matter communities (Borko et al., 2010: Hadar & Brody, 2017; Lefstein et al., 2020; Sims et al., 2021).

However, while prolonged, structured, centrally guided or school principal controlled PD appears to suit best practice guidelines and institutional needs, it may be at odds with teachers’ needs and preferences. Teachers tend to find district or ministry directed pd’s irrelevant to their immediate needs and contexts [(Darling-Hammond et al., 2017; Margolin, 2018)](https://sciwheel.com/work/citation?ids=16951613,12459612&pre=&pre=&suf=&suf=&sa=0,0). In-school PD appear to cater to principals’ rather than individual teachers’ preferences and the latter may participate due to instrumental or conformity motivations [(Sella Ela, 2022)](https://sciwheel.com/work/citation?ids=16951457&pre=&suf=&sa=0). Teachers’ needs for more personalized professional development accommodating teachers' schedules and diverse needs for resources are probably better answered through the wide choice and control offered through individualized online teacher PD programs (Dede et al., 2009).

## Online teacher professional development

Online teacher pdprofessional development (OTPD) includes courses, workshops, or learning modules that are delivered reflecting a plethora of purposes, goals, subject areas, pedagogies, and delivery methods and may be asynchronous, synchronous, or blended (Dede, 2006; Powell & Bodur, 2019; Ross & Storey, 2011). Online PD offers spaces for teachers to interact and reflect (Dille & Røkenes, 2021; Philipsen et al., 2019). However, many, if not most Online PD programs also allow highly flexible, self-paced individualized learning achieved mainly in interaction with learning management systems. This led to online teacher OTPD growing rapidly in the last decade and the production of courses and programs has outpaced research in that area (Abe, 2020; Lay et al., 2020). This increased focus is driven by its economic advantages, accessibility, flexibility, and new opportunities for distance collaboration (Lay et al., 2020).

In response to the massive growth in online learning opportunities for teachers, there have been calls for rigorous research on how teachers learn and what, if anything, they learn in online learning environments (Bates et al., 2018). There has also been increasing interest in how the online environment expands what can be discovered about teachers’ professional learning behaviors, as using web analytics in exploring course data systems can be used to extract a big amount of behavioral data collected by course websites [(Salas-Pilco et al., 2022)](https://sciwheel.com/work/citation?ids=15305412&pre=&suf=&sa=0).

We look at online teacher OTPD especially from the perspective of its ability to afford teachers personalized and relevant learning trajectories they need as adult learners. Hence, oonline micro-credential systems with their vast array of choices have a unique potential for personalized and self-regulated differentiation of learning [(Dane, 2024; Hunt et al., 2019)](https://sciwheel.com/work/citation?ids=13829039,16770283&pre=&pre=&suf=&suf=&sa=0,0).

### The promise of Micro-credentials in teachers’ professional development

Within the plethora of online pdprofessional development programs, micro-credentials and micro-badge systems appear to hold the strongest promise for personalization of learning [(Hunt et al., 2019; Tooley & Hood, 2021)](https://sciwheel.com/work/citation?ids=16770281,13829039&pre=&pre=&suf=&suf=&sa=0,0). They are rapidly expanding (especially during and since the Covid-19 epidemic) and have become the focus of increased research interests as evidenced by a series of review articles in the last few years [(Ahsan et al., 2023; Che Ahmat et al., 2021; Selvaratnam & Sankey, 2021; Tamoliune et al., 2023; Thi Ngoc Ha et al., 2023; Tooley & Hood, 2021; Varadarajan et al., 2023)](https://sciwheel.com/work/citation?ids=15382754,11831976,14961534,16770281,15382738,14969417,14847327&pre=&pre=&pre=&pre=&pre=&pre=&pre=&suf=&suf=&suf=&suf=&suf=&suf=&suf=&sa=0,0,0,0,0,0,0). Micro-credentials are short online courses, frequently ranging from an hour to a few weeks, which usually focus on a specific competency or skill-set. Upon completion they award the learner a verifiable certificate or “badge” acknowledged by employers, which details the content and skills acquired [(Varadarajan et al., 2023)](https://sciwheel.com/work/citation?ids=15382754&pre=&suf=&sa=0). Micro-credentials can be single standing or “stackable” into a wider diploma or a professional development threshold requirement [(Tamoliune et al., 2023)](https://sciwheel.com/work/citation?ids=14969417&pre=&suf=&sa=0).

Often reflecting micro-learning theory [(Dolasinski & Reynolds, 2020; Shail, 2019)](https://sciwheel.com/work/citation?ids=16777215,8105636&pre=&pre=&suf=&suf=&sa=0,0), these courses offer learners a wide choice of short condensed units that can fit their personal interest, professional context or employer’s needs. In micro-credntial based online teacher OTPD teachers control the time, duration and location of study and may enjoy an enhanced and repeated sense of achievement as they master comparatively defined competencies, through short periods of study [(Friedler, 2018)](https://sciwheel.com/work/citation?ids=16777262&pre=&suf=&sa=0), supposedly well attuned to their needs and increasing their employability and expertise [(Pollard & Vincent, 2022; Varadarajan et al., 2023)](https://sciwheel.com/work/citation?ids=16772316,15382754&pre=&pre=&suf=&suf=&sa=0,0). Micro-credential based PD is assumed to enable learners to follow their personal goals, interests and preferences ensuring both higher motivation and higher learning gains and satisfaction [(Ahsan et al., 2023; Bernacki et al., 2021)](https://sciwheel.com/work/citation?ids=14847327,15774753&pre=&pre=&suf=&suf=&sa=0,0). Hence it is assumed that mmicro-credentials enrollment and learning stem from intrinsic motivations and mastery goals [(Alt, 2023; Facey-Shaw et al., 2020)](https://sciwheel.com/work/citation?ids=12351840,15195661&pre=&pre=&suf=&suf=&sa=0,0). Learners’ personalized choices are assumed to make learning more relevant, meaningful and authentic, leading to higher engagement and success expectancy [(Hulleman et al., 2017; Walkington et al., 2024; Yang & Ogata, 2023)](https://sciwheel.com/work/citation?ids=16686077,7558064,16685941&pre=&pre=&pre=&suf=&suf=&suf=&sa=0,0,0).

Policy makers and employers view mmicro-credential based pdprofessional development as a more economic and agile way to attune to rapidly changing market needs [(Tamoliune et al., 2023)](https://sciwheel.com/work/citation?ids=14969417&pre=&suf=&sa=0). Higher education consortiums team and collaborate to keep up with the pace of mmicro-credential expansion [(Kumar & Arnold, 2022)](https://sciwheel.com/work/citation?ids=16770284&pre=&suf=&sa=0). Educational policy makers and educational administrations institutionalize mmicro-credential based PD programs on ever growing scales [(Ahsan et al., 2023)](https://sciwheel.com/work/citation?ids=14847327&pre=&suf=&sa=0). It is viewed as an especially promising way for teacher professionalization and satisfaction, overcoming the contradiction between government regulation and teachers’ choice and perceived relevance, which often mars teachers’ perceptions of pdprofessional development [(Tooley & Hood, 2021)](https://sciwheel.com/work/citation?ids=16770281&pre=&suf=&sa=0).

However, this assumption is not fully supported by available research. In fact, many aspects of personalized learning afforded by mmicro-credential based PD may allow for lenient learning or abuse of the affordances of the system. This may relate especially to the differentiation aspect, which may be used to opt for the easiest paths for completing assignments or gaining credentials. Such moral hazards are implied, for example, by issues of trust in micro-credentials which reflect questions as to the authenticity and motivations behind learners’ choice of course, and the quality of learning and evaluation [(Strunk & Willis, 2017; Varadarajan et al., 2023; Willis et al., 2016)](https://sciwheel.com/work/citation?ids=16686464,16686531,15382754&pre=&pre=&pre=&suf=&suf=&suf=&sa=0,0,0). From the perspective of critical social theory, mmicro-credential enhance a perception of learning as capital accumulation and self-perception of learners mainly as economic beings. It may lead learners to focus on maximizing their market value, rather than their competence or coherent knowledge [(Pollard & Vincent, 2022; Wheelahan & Moodie, 2024)](https://sciwheel.com/work/citation?ids=16763804,16772316&pre=&pre=&suf=&suf=&sa=0,0). Instrumental extrinsic motivations do not lead to meaningful engagement but rather to simple focus on completion of micro-credentials [(Abramovich et al., 2013)](https://sciwheel.com/work/citation?ids=6619651&pre=&suf=&sa=0) Such instrumental learning increases the risk of ever narrowing and inconsistent knowledge [(Varadarajan et al., 2023)](https://sciwheel.com/work/citation?ids=15382754&pre=&suf=&sa=0).

Ahsan et al. [(2023)](https://sciwheel.com/work/citation?ids=14847327&pre=&suf=&sa=1) point to several gaps in current research, hinted by this ambivalence towards mmicro-credentials. There is ambivalence and debate whether the vast freedom and choice afforded by micro-credential systems is an essential force behind learning and knowledge acquisition or a neglect leading to incoherence and attrition. It isit is quite unclear whether learning in mmicro-credentials is driven by intrinsic or extrinsic motivations and how these motivations affect engagement. Methodologically, research has not realized the potential of learning analytics to gauge engagement and learning. Little is known about the relations between employer or market needs, micro-credential production and microcredential acceptance (among learners and employers or authorization institutes). This is due both to loose connections between stakeholders and lack of data but also because studies fail to consider the relations between the nature of courses (technology and content), organizational context (relations with employers and supplier, incentives) and stakeholders perspectives.

These caveats align with pressing questions on teachers’ learning, knowledge and professional development. In the Israeli context, mmicro-credentials based teacher pdprofessional development is carried out in a platform connecting all stakeholders, affording access to the wide data furnished by the learning management system and to the wider context. Hence it should serve both as a promising trajectory to deeper insights into the field of teacher professional learning, and as source for knowledge for the general realm of mmicro-credentials. Our research would focus on three central aspects noted as gaps in the research- learners’ motivations to enroll in mmicro-credential units, learners’ engagement and knowledge construction, their interrelations and their relations to the wider context of course characteristics and institutional incentives.

### Mmotivations

As we note above motivation and learning goals for engagement in micro-credential courses may vary and are quite contested [(Cheng et al., 2019; Lin et al., 2003)](https://sciwheel.com/work/citation?ids=3366953,8412333&pre=&pre=&suf=&suf=&sa=0,0). Teachers may enroll in micro-credential PD based on intrinsic motivations [(Uyulgan & Akkuzu, 2013)](https://sciwheel.com/work/citation?ids=1876014&pre=&suf=&sa=0). These may be mastery goals, focused on using the wide choice of competency based courses to acquire new competencies related to their current classroom practice or subject matter [(Avidov-Ungar, 2016)](https://sciwheel.com/work/citation?ids=9834176&pre=&suf=&sa=0). Teachers may also enroll in mmicro-credential courses to satisfy personal interest and curiosity and the ability to experiment with new attractive topics which the wide repertoire of courses affords [(Cordova & Lepper, 1996; Oudeyer et al., 2016)](https://sciwheel.com/work/citation?ids=1381822,10551235&pre=&pre=&suf=&suf=&sa=0,0). On the other hand, teachers may enroll in micro-credential PD for essentially extrinsic motivations, such as institutional requirements or eligibility for salary raise [(Avidov-Ungar, 2016; Çakiroğlu et al., 2024)](https://sciwheel.com/work/citation?ids=9834176,16847162&pre=&pre=&suf=&suf=&sa=0,0). Enrolling in micro-credentials may also be motivated by performance goals such as meriting a badge indicating expertise (the equivalent of grades) as a career advancement step [(Zhang et al., 2021)](https://sciwheel.com/work/citation?ids=16847107&pre=&suf=&sa=0). In a similar vein, some teachers view micro-credentials as a way to gain recognition for skills they already possess, rather than as a means to acquire new competencies [(Avidov-Ungar, 2016; Lexman et al., 2020)](https://sciwheel.com/work/citation?ids=9834176,16785911&pre=&pre=&suf=&suf=&sa=0,0).

Teachers' motivations for studying in micro-credential courses may be self-reported in surveys or in entrance expectation statements [(Elliot & Murayama, 2008)](https://sciwheel.com/work/citation?ids=11264900&pre=&suf=&sa=0). Motivation could also be inferred from the wider contextual set of constraints and incentives, assuming extrinsic (in contrast to intrinsic) motivation to be related to mandatory participation in or financial incentives on credentials. They might also be deduced from learners' course choices (such as whether they enroll in more challenging or lenient courses). We assume teachers’ learning motivations and achievement goals would also affect (or be inferred from) their engagement in micro-credential units [(Wang et al., 2021)](https://sciwheel.com/work/citation?ids=12294632&pre=&suf=&sa=0).Extrinsic motivation may be related to regulated and incentivized engagement in response to system feedback, or to minimal investment in learning, focused on grades [(Miao et al., 2024)](https://sciwheel.com/work/citation?ids=16952325&pre=&suf=&sa=0). Intrinsic motivation and mastery achievement goals may be related to more sustained engagement, less dependent on incentives of implied sanctions [(Tranquillo & Stecker, 2016)](https://sciwheel.com/work/citation?ids=13099560&pre=&suf=&sa=0).

### Eengagement

Learner engagement has been the focus of many studies, however with no consensus on its exact definition and operationalization. Broadly speaking, learner engagement is the extent to which learners are involved in learning tasks. It has been widely accepted that engagement is a multidimensional construct which includes four main components: 1) Cognitive engagement, referring to students’ investment in tackling learning-related tasks in terms of time, strategies, etc.; 2) Behavioral engagement, referring to students’ observable behavior, like attending class or asking questions; 3) Emotional engagement, referring to affective responses to educational materials, stakeholders, and institutions; and 4) Social engagement, referring to responding to peers in educational contexts (Finn & Zimmer, 2012; Fredricks et al., 2004).

From this broad perspective, it is understood that engagement can be observed and measured based on a host of indicators, some of which are clearly evident in the physical classroom, e.g., working on a task, or asking a peer a question on topic. However, when it comes to online learning, with no direct contact between learners and instructors, peers - such indicators should be rethought of. On the other hand, with logged data about learners’ activity in online learning environments, other indicators may be more easily measured, e.g., number of resources accessed, or reattempts to solving a task (e.g., Soffer & Cohen, 2019). With this in mind, the very concept of learner engagement in online learning—which is commonly being studied using Learning Analytics (LA)—may be treated differently from its traditional parallel, as in many cases teaching and learning are handled differently compared to their physical parallels, in terms of teaching methods and tasks being administered. In practice, as a recent literature review shows, using Learning Analytics to study engagement have been mostly focused on a narrow conceptualization of engagement, and have mostly relied solely on log files-based indicators. It is therefore our intent to triangulate logged indicators with self-report evidence which may give us a more thorough understanding of learners’ engagement (Bond et al., 2023).

Focusing on learning management system’s log files, there are three main categories of indicators that can inform teacher/learner engagement: usage, performance, and communication (Ahmadi et al., 2023). However, teacher learning student activity may differ based on context, e.g., types or difficulty of activities, and individual differences (Hershkovitz & Nachmias, 2009, 2011; Israel-Fishelson & Hershkovitz, 2021; Kadoic & Oreski, 2018). Therefore, it is recommended—as in many other cases in quantitative analyis—to normalize log-based measures so it would be fair to compare them across different settings and populations.

### Knowledge construction

As we noted above, teachers studying in a micro-credential online professional development, which affords fragmented learning, may construct relatively fragmented knowledge. This may be reflected in fragmented knowledge effects as when the disparate contents or aspects studies in each learning session or micro-unit do not integrate and are transferable to new contexts [(Gan, 2019; Song & Huang, 2022; Stamovlasis et al., 2013)](https://sciwheel.com/work/citation?ids=16786261,16777296,16808136&pre=&pre=&pre=&suf=&suf=&suf=&sa=0,0,0). From a constructivist outlook, we might expect more experienced teachers’ larger knowledge corpus would help integrate even disparate learning experiences, making them applicable to their own unique contexts [(Kereluik et al., 2013; Leijen et al., 2022)](https://sciwheel.com/work/citation?ids=16750139,3810533&pre=&pre=&suf=&suf=&sa=0,0). Study choice could also reflect a coherent perception of professional knowledge. Such coherence might possibly be deduced from course choices centered around a clear common theme such as subject matter expertise. However, curricular coherence theorists also assume that teachers’ coherent knowledge bridges disciplines and cuts across subject matter. [(Niemelä, 2021)](https://sciwheel.com/work/citation?ids=16785982&pre=&suf=&sa=0). Learners ability to trace relations between various courses in a training program and the relation between theory and practice, also seen as the applicability of courses, are indicators of professional knowledge coherence [(Canrinus et al., 2017; Hammerness & Klette, 2015; Smeby & Heggen, 2014)](https://sciwheel.com/work/citation?ids=6261607,16965590,16965591&pre=&pre=&pre=&suf=&suf=&suf=&sa=0,0,0)

## Research goals

Our overall goal is to to examine the relationship between teacher professional development and teacher learning in the micro-credential PD context. We aim to consider teachers’ motivation prior to participation, their choise of courses, their actual engagement, and their learning products. To achieve this goal, we set-up the following research questions. , Consideringtaking a critical perspective on the enthusiasm for teacher learning in micro-credential PD. In online teacher micro-credential pdprofessional development, we aim to explore teacher learning. What can we learn about teachers learning engagement from micro-credntial learning management system data, and how does teacher engagement relate to learning motivations and choices and to knowledge construction and gains?

# Research Questions

1. What are learners' **motivations** to participate in microcredential- based professional development?
   1. What intrinsic and extrinsic motivations are evident in learners’ statements of purpose prior to participation?
   2. What motivations could be deduced from contextual constraints and incentives (mandatory participation and financial incentives versus “autonomous” selection of courses)?
   3. What motivations can be inferred from course characteristics (difficulty and demands, relevance to teacher’ discipline)?
2. What patterns of learning **engagement** do learners in microcredential based professional development present?
3. What kind of professional **knowledge** do teachers construct through learning in a microcredential system?
   1. Do learners' choices of courses reflect fragmented or coherent knowledge (preference/construction)? Is there a clear common denominator to the choice?
   2. Do learners’ evidence of learning in assignments reflect coherent applicable knowledge?
4. What are the relations between teachers’ learning **motivations** and goals and their **engagement** in online Micro-credential professional development?
5. What are the relations between teachers’ learning **motivations** and goals and teachers’ **knowledge** construction?
   1. Are intrinsic and mastery goals associated with more structured and coherent course selection (competence or subject matter focus) and knowledge construction?
   2. Are extrinsic goals associated with more fragmented course selection (mandatory ease of completion focus) and knowledge construction?
   3. How are teachers' motivations related to knowledge construction as indicated in teachers' evidence of learning?
6. What is the relationship between teacher **engagement** in online Micro-credencial professional development and teachers’ construction of **knowledge**?

# Methods

## Context

The context of the proposed research is the micro-credential teacher professional development (PD) platform. Campus-IL (https://campus.gov.il), Israel’s national learning platform for massive open online courses (MOOC), was launched in 2018 as part of Digital Israel, a national program under the Ministry of Social Equality, Government of Israel. This platform has been utilized for teacher PD through micro-credential courses, i.e., short courses designed to develop specific designated skills. These micro-credential courses were developed by Campus-IL in partnership with the Center for Educational Technology and the Ministry of Education.

This platform offers a cutting-edge centralized micro-credential system addressing many of the challenges of micro-credential moocs discussed above [(Lexman et al., 2020)](https://web.endnote.). As a streamlined, self-standing but strongly connected system, it holds a vast amount of relevant data as to learners’ demographics, career points, goals, learning behavior and learning gains. It thus offers an essential and representative model offering insights into the fast growing but understudied world of micro-credentials.

The courses are typically equivalent to a 3 to 10 PD course and are designed to address the specific skill development needs of K-12 teachers in Israel. The micro-learning platform for teachers aligns with the principles of adult and lifelong learning, allowing teachers to create personalized learning paths and develop skill sets throughout their professional careers. This flexibility enables teachers to meet their varied needs and those of their students, without being constrained by location, physical infrastructure, or rigid course schedules. Upon completing a micro-credential course, teachers receive a Digital Badge. To demonstrate their competencies, teachers must build a portfolio of Digital Badges, accumulating 30 credit hours to receive professional development credit, and qualify for salary increase. Teachers in Israel enroll in professional development programs for various reasons. Some PD courses in the micro-credential system may be mandatory for teachers in specific roles or disciplines. Some programs are threshold requirements for advanced career stages. Teachers may take micro-credential courses to enhance professional knowledge or for general self enrichment.

In the 2023-2024 academic year, the micro-credential platform included 5987 courses (some of which had been available since 2020), including 144 courses offered in Arabic for teachers in Arab society. Of these, 365 courses were designed for primary school teachers, 233 for secondary and high school teachers, and 9 of them were blended courses. The Micro-Credential courses addressed a variety of relevant topics, which can be broadly categorized into subject-specific courses (e.g., history, civics, English, math), pedagogy-related topics (e.g., assessment, diversity in the classroom), skills development (e.g., critical thinking, digital literacy, social-emotional learning, independent learning), literacy, and first language skills.

Overall, there were 46,849 course enrollments and 14,291 completions. Since teachers may enroll in or graduate from multiple courses, this data does not reflect the total number of teachers using the Campus IL Micro-Credential platform.

## Participants

We will include in our analysis all teachers participating in Micro-Credential courses on the Campus IL platform between 2021-2025. Based on participation in the past years [(Lexman et al., 2020)](https://web.endnote.), participants will include between 10,000-15,000 teachers, enrolling in a minimum of 300 courses.

## Materials

When learning occurs in online environments, interactions between the learner and the platform are recorded in a log file. These logs generate trace data that can be used to trace a learner’s actions and to infer on their learning-related behaviors [(Bernacki, 2017)](https://web.endnote.%3D). In this research, we utilize existing trace data from the Micro-Credential learning systems to observe and analyze teacher learning processes as a proxy to teachers’ engagement, motivation, and knowledge construction. The value of trace data for testing assumptions related to teacher learning depends on whether, and in what ways, the technology represents learning events. The Campus IL Micro-Credential system log files are built on a Moodle learning system, which records all instances when a teacher interacts with a course feature. For example, text inputs, dropdown menu selections, and written responses can be traced by logging each action.

Once these interactions with the technology are logged, they become observable and can be enriched with metadata describing the teacher, the course, or the learning process within and beyond courses. Course metadata includes details about specific events, such as labels (e.g., unit or problem name), precise actions (e.g., clicking the "forum" button), a timeline of activities, and values entered by the teacher. Metadata can also include labels categorizing events (e.g., applying the value “added content” to each event where a teacher opened a new discussion on a forum). This metadata provides essential information about the context and content of course events. Additional within-course metadata can be retrieved from relational tables, such as assessment entries, test scores, number of attempts, and correctness of responses.

Furthermore, system-wide metadata can be linked to the basic course log file data. This information, retrieved from relational databases, may include teachers' demographics, seniority, subject matter expertise, and other courses in which the teacher has enrolled or graduated. Data about teacher learning motivations would be collected from two main sources, self reports and course stipulations. At the beginning of each academic year teachers fill an expectations survey in which they state their learning expectations and goals. Every year the ministry of education stipulates some of the courses as mandatory (to all teachers or teachers in specific roles, career stages or disciplines). Hence stipulations may determine external/instrumental learning motivations.

The unit of analysis in this study is the teacher. This allows us to track teachers' learning within individual courses and across multiple courses, both within a single academic year and longitudinally over different academic years.

1. To capture teacher learning processes related to the three key areas—engagement, motivation, and knowledge construction—and to test assumptions, it is necessary to consider both categories of indicators and features of the system’s log file data. The treatment of raw log data on learning events requires interpretation, and often involves restructuring and applying operational definitions, all guided by a chosen theoretical framework. Teacher learning can thus be captured through the following operational categories (see Table 1).

## Data collection and analysis

### Motivation

#### Self reported goals

* 1. Collected from open responses to learning expectations questionnaire in LMS
  2. Qualitative analysis and categorization (AI assisted) into intrinsic and extrinsic motivations

#### Course characteristics- internal and contextual

* 1. Internal characteristics: difficulty of requirements (entry demands; relative length of materials; number of tasks/quiz questions; evidence of learning assignment requirements), popularity.
  2. Contextual characteristics: is course mandatory (universally/for specific roles/career stages) based on ministry of education data.
  3. Qualitative analysis, as basis for noting course as potentially related to intrinsic motivation (difficult+non mandatory) or extrinsic motivation (easy/mandatory)

#### Learner course fit

* 1. Teacher professional data from teacher learning expectations questionnaire in LMS and from ministry of education personnel database: discipline, career stage, role.
  2. For each learner we will infer motivation based on learner -course fit.
     1. Extrinsic motivation: a course is mandatory for the teacher (universally or due to stage or role); a course has no relation to discipline and role and is relatively easy
     2. Intrinsic motivation: a course is elective and difficult; a course is clearly related to discipline.

#### Learning motivations questionnaire

* 1. For future cohorts we will administer achievement goals questionnaire [(Elliot & Murayama, 2008)](https://sciwheel.com/work/citation?ids=11264900&pre=&suf=&sa=0) and intrinsic extrinsic motivations questionnaire [(Lin et al., 2003)](https://sciwheel.com/work/citation?ids=3366953&pre=&suf=&sa=0).

### Engagement

#### Time On Task

* 1. Length of engagement, entry times (fragmented versus prolonged learning)
  2. Viewing and reading tasks data

#### Communication

* 1. Number of postings and number of reactions to other in online forums above mandatory requirements

#### Performance

* 1. Quizz taking patterns: single long time attempts + high scores versus repeated short attempts + low scores. Due to the system requirement of 100% success score, and unlimited repeat attempts opportunities, quiz score cannot be an indicator of knowledge.

### Knowledge Construction And Coherence

#### Evidence Of Learning Assignments

* 1. Connectivity and coherence -reference to additional courses; transfer and application of knowledge versus detached and declarative knowledge.
  2. Qualitative analysis (AI on all courses, or intentional sampling)

#### Courses Selection

* 1. Data collected from teacher course completion reports in LMS.
  2. Qualitative analysis (AI assisted) of identifiable common threads among some/all courses taken by each learner (disciplinary; thematic) as evidence of coherent knowledge.

#### Knowledge coherence questionnaire

* 1. Questionnaire to be adapted from teacher training coherence questionnaire [(Hammerness & Klette, 2015; Smeby & Heggen, 2014)](https://sciwheel.com/work/citation?ids=6261607,16965591&pre=&pre=&suf=&suf=&sa=0,0).

## Statistical analysis:

Descriptive statistics of research variables for research questions 1-3:

### Motivation-

Teachers already in the LMS database would be clustered by motivation profiles in two levels

General: with reference to all courses, according to self-report in the initial learning expectations questionnaire.

Course/unit specific learner motivation: according to learner-course characteristic fit.

For prospective learners, learners’ motivational profiles (intrinsic versus extrinsic; mastery vs. Performance goals) would be computed based motivation and achievement goals questionnaires.

### Learner engagement-

Learner engagement measure would be computed based on LMS data of time on task, communication and performance, per course and per individual learner. Learners would be clustered into high and medium and low engagement profiles (per single course unit, and across all completed courses).

### Knowledge construction

Learners’ knowledge would be computed as three separate sub-variables:

Applied integrated knowledge- based on evidence of learning assignments’ degree of applicability of teaching examples and references to contents of additional courses

Course selection coherence- based on relations between completed courses, the higher the number of courses with common threads, the higher the coherence, with additional reference to type of coherence (disciplinary/thematic).

For prospective learners- knowledge coherence questionnaire score.

Inferential statistics:

Research question 4:

Effects of motivation profiles on engagement as a composite parametric variable would be explored using ANOVA. Effects of motivation profiles on performance profiles specifically (as a non parametric variable) would be explored using chi2 tests.

Research question 5:

Effects of engagement on knowledge construction as non parametric variables (applied integrated knowledge and as course selection coherence) would be explored using logistic regression models. Effects of engagement on knowledge construction as a parametric variable (knowledge coherence questionnaire measures) would be explored using linear regression models.

Research question 6:

Effects of motivation profiles on knowledge construction as a parametric variable (knowledge coherence questionnaire measures) would be explored using ANOVA. Effects of motivation profiles on knowledge construction as non parametric variables (applied integrated knowledge and course selection coherence) would be explored using chi2 tests.

Structural equation modeling would be used to explore the relationship between between all the research variables

## Ethical consideration

All system’s log data is anonymized by the system’s internal administrator before we receive access to the data, with each teacher receiving learner ID code, consistent throughout the data and metadata files. Access to the data as well as ethical approval was received from the chief scientist of the ministry of education file number: 13812.

# Research plan

|  |  |
| --- | --- |
| Goal | Date span |
| Course mapping and characterization (difficulty, contextual characteristics) | October 2025  December 2025 |
| Individual learner course selection analysis | December 2025  February 2026 |
| Analysis of learning expectations statements | January 2026  April 2026 |
| Teacher demographic/professional data collection | April 2026  May 2026 |
| Creation of learner motivational profiles (on the basis of statements, professional data and course selection) | May 2026  September 2026 |
| LMS Data structuring and unification | September 2026  November 2026 |
| LMS engagement Data analysis | November 2026  February 2026 |
| Evidence of learning data structuring and analysis | February 2026  June 2026 |
| Descriptive and Inferential statistic analysis  Consultation with stake holders | July 2026  October 2026 |
| Administering motivations and goals questionnaire | October 2026  November 2026 |
| Coherent teacher knowledge questionnaire construction | December 2026  March 2027 |
| Administering Coherent teacher knowledge questionnaire | March 2027  May 2027 |
| Collecting and analyzing 2027 data | June 2027  October 2027 |
| Matching teacher’s motivation and knowledge coherence data based profiles with teachers’ motivation and questionnaire data. | October 2027  December 2027 |
| Statistical analysis of cross year data | January 2028  March 2028 |
| Writing and editing | April 2028  August 2028 |
| Workshops with stake holders |  |

# References

[Abramovich, S., Schunn, C., & Higashi, R. M. (2013). Are badges useful in education?: it depends upon the type of badge and expertise of learner. *Educational Technology Research and Development*, *61*(2), 217–232. https://doi.org/10.1007/s11423-013-9289-2](https://sciwheel.com/work/bibliography/6619651)

Ahmadi, G., Mohammadi, A., Asadzandi, S., Shah, M., & Mojtahedzadeh, R. (2023). What are the indicators of student engagement in learning management systems? A systematized review of the literature. *International Review of Research in Open and Distributed Learning*, *24*(1), 117–136. Https://doi.org/10.19173/irrodl.v24i1.6453

[Ahsan, K., Akbar, S., Kam, B., & Abdulrahman, M. D.-A. (2023). Implementation of micro-credentials in higher education: A systematic literature review. *Education and Information Technologies*. https://doi.org/10.1007/s10639-023-11739-z](https://sciwheel.com/work/bibliography/14847327)

[Alt, D. (2023). Who benefits from digital badges? Motivational precursors of digital badge usages in higher education. *Current Psychology*, *42*(8), 6629–6640. https://doi.org/10.1007/s12144-021-02002-0](https://sciwheel.com/work/bibliography/15195661)

[Anderson, J., & Taner, G. (2023). Building the expert teacher prototype: A metasummary of teacher expertise studies in primary and secondary education. *Educational Research Review*, *38*, 100485. https://doi.org/10.1016/j.edurev.2022.100485](https://sciwheel.com/work/bibliography/16096912)

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and teacher education*, *27*(1), 10-20.

[Avidov-Ungar, O. (2016). A model of professional development: teachers’ perceptions of their professional development. *Teachers and Teaching*, *22*(6), 653–669. https://doi.org/10.1080/13540602.2016.1158955](https://sciwheel.com/work/bibliography/9834176)

[Avidov-Ungar, O. (2023). *The personalized continuing professional learning of teachers: A global perspective*. Routledge. https://doi.org/10.4324/9781003424390](https://sciwheel.com/work/bibliography/16601376)

Bates, M. S., Phalen, L., & Moran, C. (2018). Understanding teacher professional learning through cyber research. *Educational Technology Research and Development*, *66*, 385-402.

[Ben-Peretz, M. (2011). Teacher knowledge: What is it? How do we uncover it? What are its implications for schooling? *Teaching and Teacher Education*, *27*(1), 3–9.](https://sciwheel.com/work/bibliography/3810606)

[Bernacki, M. L. (2017). Examining the cyclical, loosely sequenced, and contingent features of self-regulated learning: Trace data and their analysis. In *Handbook of self-regulation of learning and performance* (pp. 370-387). Routledge.](https://web.endnote.com/reference-list/)

Bernacki, M. L., Greene, M. J., & Lobczowski, N. G. (2021). A systematic review of research on personalized learning: Personalized by whom, to what, how, and for what purpose (s)?. Educational Psychology Review, 33(4), 1675-1715.

Bond, M., Viberg, O., & Bergdahl, N. (2023). The current state of using learning analytics to measure and support K-12 student engagement: A scoping review. *ACM International Conference Proceeding Series*, 240–249. Https://doi.org/10.1145/3576050.3576085

[Bruni, A., Gherardi, S., & Parolin, L. L. (2007). Knowing in a system of fragmented knowledge. *Mind, Culture, and Activity*, *14*(1–2), 83–102. https://doi.org/10.1080/10749030701307754](https://sciwheel.com/work/bibliography/6171509)

[Çakiroğlu, Ü., Özkan, A., Çevi̇k, İ., Kutlu, D., & Kahyar, S. (2024). What motivate learners to continue a professional development program through Massive Open Online Courses (MOOCs)?: A lens of self-determination theory. *Education and Information Technologies*, *29*(6), 7027–7051. https://doi.org/10.1007/s10639-023-12087-8](https://sciwheel.com/work/bibliography/16847162)

[Canrinus, E. T., Klette, K., & Hammerness, K. (2017). Diversity in coherence: strengths and opportunities of three programs. *Journal of Teacher Education*, *70*(3), 002248711773730. https://doi.org/10.1177/0022487117737305](https://sciwheel.com/work/bibliography/16965590)

[Carr, D. (2007). Towards an educationally meaningful curriculum: epistemic holism and knowledge integration revisited. *British Journal of Educational Studies*, *55*(1), 3–20. https://doi.org/10.1111/j.1467-8527.2007.00363.x](https://sciwheel.com/work/bibliography/16786126)

[Caruth, G. (2014). Learning How to Learn: A Six Point Model for Increasing Student Engagement. *Participatory educational research*, *1*(2), 1-12.](https://web.endnote.com/reference-list/) [Https://doi.org/10.17275/per.14.06.1.2](https://doi.org/10.17275/per.14.06.1.2)

[Che Ahmat, N. H., Bashir, M. A. A., Razali, A. R., & Kasolang, S. (2021). Micro-Credentials in Higher Education Institutions:  Challenges and Opportunities. *Asian Journal of University Education*, *17*(3), 281. https://doi.org/10.24191/ajue.v17i3.14505](https://sciwheel.com/work/bibliography/14961534)

[Cheng, Z., Richardson, J. C., & Newby, T. J. (2019). Using digital badges as goal-setting facilitators: a multiple case study. *Journal of Computing in Higher Education*. https://doi.org/10.1007/s12528-019-09240-z](https://sciwheel.com/work/bibliography/8412333)

[Cochran-Smith, M., & Villegas, A. M. (2015). Framing teacher preparation research: An overview of the field, part 1. *Journal of Teacher Education*, *66*(1), 7-20.](https://web.endnote.com/reference-list/)

[Cordova, D. I., & Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology*, *88*(4), 715–730. https://doi.org/10.1037/0022-0663.88.4.715](https://sciwheel.com/work/bibliography/1381822)

[Dane, Z. R. (2024). *… Relevant Professional Learning Opportunities: An Evaluation of the Perceived Efficacy of Micro-Credentials & Digital Badges Upon K-12 Educators in a Large …*.](https://sciwheel.com/work/bibliography/16770283)

Darling-Hammond, L. (2010). Teacher education and the American future. *Journal of teacher education*, *61*(1-2), 35-47.

[Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied developmental science*, *24*(2), 97-140.](https://web.endnote.com/reference-list/)

[Darling-Hammond, L., Hyler, M., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute. https://doi.org/10.54300/122.311](https://sciwheel.com/work/bibliography/12459612)

Dede, C. (2006). *Online professional development for teachers: Emerging models and methods*. Harvard Education Press.

Dede, C., Jass Ketelhut, D., Whitehouse, P., Breit, L., & mccloskey, E. M. (2009). A research agenda for online teacher professional development. *Journal of teacher education*, *60*(1), 8-19.

Desimone, L. M. (2009). Improving impact studies of teachers’ professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181-199.

Dille, K. B., & Røkenes, F. M. (2021). Teachers’ professional development in formal online communities: A scoping review. *Teaching and teacher education*, *105*, 103431.

[Dolasinski, M. J., & Reynolds, J. (2020). Microlearning: A new learning model. *Journal of Hospitality & Tourism Research*, *44*(3), 551–561. https://doi.org/10.1177/1096348020901579](https://sciwheel.com/work/bibliography/16777215)

Eduvate Rhode Island. (2017). Creating a shared understanding of personalized learning for Rhode Island.

[Elliot, A. J., & Murayama, K. (2008). On the measurement of achievement goals: Critique, illustration, and application. *Journal of Educational Psychology*, *100*(3), 613–628. https://doi.org/10.1037/0022-0663.100.3.613](https://sciwheel.com/work/bibliography/11264900)

[Facey-Shaw, L., Specht, M., van Rosmalen, P., & Bartley-Bryan, J. (2020). Do badges affect intrinsic motivation in introductory programming students? *Simulation & Gaming*, *51*(1), 33–54. https://doi.org/10.1177/1046878119884996](https://sciwheel.com/work/bibliography/12351840)

Finn, J. D., & Zimmer, K. S. (2012). Student engagement: What is it? Why does it matter? In J. D. Finn & K. S. Zimmer (Eds.), *Handbook of Research on Student Engagement* (pp. 97–131). Springer US. Https://doi.org/10.1007/978-1-4614-2018-7\_5

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*(1), 59–109. Https://doi.org/10.3102/00346543074001059

[Friedler, A. (2018). Teachers Training Micro-Learning Innovative Model: Opportunities and Challenges. *2018 Learning With MOOCS (LWMOOCS)*, 63–65. https://doi.org/10.1109/LWMOOCS.2018.8534647](https://sciwheel.com/work/bibliography/16777262)

[Gan, X. (2019, October 24). An analysis of the status quo of college students’ “fragmented” learning and its countermeasures\*. *Proceedings of the 6th International Conference on Education, Language, Art and Inter-Cultural Communication (ICELAIC 2019)*. Proceedings of the 6th International Conference on Education, Language, Art and Inter-cultural Communication (ICELAIC 2019), Paris, France. https://doi.org/10.2991/assehr.k.191217.148](https://sciwheel.com/work/bibliography/16808136)

[Gregson, J. A., & Sturko, P. A. (2007). Teachers as Adult Learners: Re-Conceptualizing Professional Development. *Journal of adult education*, *36*(1), 1.](https://web.endnote.com/reference-list/)

[Hammerness, K., & Klette, K. (2015). Indicators of Quality in Teacher Education: Looking at Features of Teacher Education from an International Perspective. In G. K. LeTendre & A. W. Wiseman (Eds.), *Promoting and sustaining a quality teacher workforce* (Vol. 27, pp. 239–277). Emerald Group Publishing Limited. https://doi.org/10.1108/S1479-367920140000027013](https://sciwheel.com/work/bibliography/16965591)

[Hashweh, M. (2013). Pedagogical Content Knowledge: Twenty-Five Years Later. *Advances in Research on Teaching*, *19*, 115–140.](https://sciwheel.com/work/bibliography/3846047)

Hershkovitz, A., & Nachmias, R. (2009). Consistency of students’ pace in online learning. *EDM’09 - Educational Data Mining 2009: 2nd International Conference on Educational Data Mining*, 71–80. Http://www.educationaldatamining.org/EDM2009/uploads/proceedings/hershkovitz.pdf

Hershkovitz, A., & Nachmias, R. (2011). Online persistence in higher education web-supported courses. *Internet and Higher Education*, *14*(2), 98–106. Https://doi.org/10.1016/j.iheduc.2010.08.001

Hulleman, C. S., Kosovich, J. J., Barron, K. E., & Daniel, D. B. (2017). Making connections: replicating and extending the utility value intervention in the classroom. Journal of Educational Psychology, 109(3), 387.

Hunt, T., Carter, R., Zhang, L., & Yang, S. (2020). Micro-credentials: The potential of personalized professional development. *development and Learning in Organizations: An International Journal*, *34*(2), 33-35.

Israel-Fishelson, R., & Hershkovitz, A. (2021). Micro-persistence and difficulty in a game-based learning environment for computational thinking acquisition. *Journal of Computer Assisted Learning*, *37*(3), 839–850. Https://doi.org/10.1111/jcal.12527

Kadoic, N., & Oreski, D. (2018). Analysis of student behavior and success based on logs in Moodle. *2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics, MIPRO 2018 - Proceedings*, 654–659. Https://doi.org/10.23919/MIPRO.2018.8400123

Kelly, P. (2006). What is teacher learning? A socio‐cultural perspective. *Oxford review of education*, *32*(4), 505-519.

[Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What knowledge is of most worth: Teacher knowledge for 21st century learning. *Journal of Digital Learning in Teacher Education*, *29*(4), 127–140.](https://sciwheel.com/work/bibliography/3810533)

[Knowles, M. (2013). Andragogy: An emerging technology for adult learning. In R. Edwards, A. Hanson, & P. Raggat (Eds.), *Boundaries of adult learning* (pp. 82-98). Routledge.](https://web.endnote.com/reference-list/)

Knowles, M. S. (1973). The adult learner : a neglected species.

Knowles, M. S., Holton Iii, E. F., & Swanson, R. A. (2005). The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development.

[Kumar, S., & Arnold, P. (2022). Weaving It All Together: Micro-Credentialing Professional Development to Build Quality Online Learning. In *Quality in online programs: approaches and practices in higher education* (pp. 229–247). BRILL. https://doi.org/10.1163/9789004510852\_013](https://sciwheel.com/work/bibliography/16770284)

[Lachner, A., Jarodzka, H., & Nückles, M. (2016). What makes an expert teacher? Investigating teachers’ professional vision and discourse abilities. *Instructional Science*, *44*(3), 197–203. https://doi.org/10.1007/s11251-016-9376-y](https://sciwheel.com/work/bibliography/6156033)

Lay, C. D., Allman, B., Cutri, R. M., & Kimmons, R. (2020). Examining a decade of research in online teacher professional development. Frontiers in Education,

[Leijen, Ä., Malva, L., Pedaste, M., & Mikser, R. (2022). What constitutes teachers’ general pedagogical knowledge and how it can be assessed: A literature review. *Teachers and Teaching*, *28*(2), 206–225. https://doi.org/10.1080/13540602.2022.2062710](https://sciwheel.com/work/bibliography/16750139)

[Lexman, R. R., John, J., & Friedler, A. (2020). Campus-IL: Enhancing Teachers' Learning Experience. *South Asian Journal of Management*, *27*(2), 189-216.](https://web.endnote.com/reference-list/)

[Liang, K., Wang, C., Zhang, Y., & Zou, W. (2018). Knowledge aggregation and intelligent guidance for fragmented learning. *Procedia Computer Science*, *131*, 656–664. https://doi.org/10.1016/j.procs.2018.04.309](https://sciwheel.com/work/bibliography/7771002)

[Lin, Y.-G., McKeachie, W. J., & Kim, Y. C. (2003). College student intrinsic and/or extrinsic motivation and learning. *Learning and Individual Differences*, *13*(3), 251–258. https://doi.org/10.1016/S1041-6080(02)00092-4](https://sciwheel.com/work/bibliography/3366953)

[Louws, M. L., Meirink, J. A., van Veen, K., & van Driel, J. H. (2017). Teachers' self-directed learning and teaching experience: What, how, and why teachers want to learn. *Teaching and teacher education*, *66*, 171-183.](https://web.endnote.com/reference-list/)

[Margolin, a. (2018). *Professional development: final research report 2018* (H. Regev, L. Dushnik, & V. Raphaeli, Trans.). MOFET INSTITUTE. [Hebrew].](https://sciwheel.com/work/bibliography/16951613)

[Merriam, S. B. (2002). Introduction to qualitative research. *Qualitative research in practice: Examples for discussion and analysis*, *1*(1), 1-17.](https://web.endnote.com/reference-list/)

[Miao, M., Ahmed, M., Ahsan, N., & Qamar, B. (2024). Intention to use technology for micro-credential programs: evidence from technology acceptance and self-determination model. *International Journal of Emergency Management*, *38*(4), 948–977. https://doi.org/10.1108/IJEM-02-2023-0066](https://sciwheel.com/work/bibliography/16952325)

[Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers college record*, *108*(6), 1017-1054.](https://web.endnote.com/reference-list/)

[Muijs, D., Kyriakides, L., van der Werf, G., Creemers, B., Timperley, H., & Earl, L. (2014). State of the art - teacher effectiveness and professional learning. *School effectiveness and school improvement*, *25*(2), 231-256.](https://web.endnote.com/reference-list/) [Https://doi.org/10.1080/09243453.2014.885451](https://doi.org/10.1080/09243453.2014.885451)

[Niemelä, M. A. (2021). Crossing curricular boundaries for powerful knowledge. *The Curriculum Journal*, *32*(2), 359–375. https://doi.org/10.1002/curj.77](https://sciwheel.com/work/bibliography/16785982)

[Orland-Barak, L., & Goldberg, T. (2024). *From Teacher Learning to Teacher Performance*. MOFET.](https://sciwheel.com/work/bibliography/16863900)

[O'Toole, S., & Essex, B. (2012). The adult learner may really be a neglected species. *Australian Journal of Adult Learning*, *52*(1), 183-191.](https://web.endnote.com/reference-list/)

[Oudeyer, P. Y., Gottlieb, J., & Lopes, M. (2016). Intrinsic motivation, curiosity, and learning: Theory and applications in educational technologies. *Progress in Brain Research*, *229*, 257–284. https://doi.org/10.1016/bs.pbr.2016.05.005](https://sciwheel.com/work/bibliography/10551235)

[Patton, W., & mcmahon, M. (2014). *Career Development and Systems Theory*. Sense.](https://web.endnote.com/reference-list/)

Philipsen, B., Tondeur, J., mckenney, S., & Zhu, C. (2019). Supporting teacher reflection during online professional development: a logic modelling approach. *Technology, pedagogy and education*, *28*(2), 237-253.

Plass, J. L., & Pawar, S. (2020). Toward a taxonomy of adaptivity for learning. Journal of Research on Technology in Education, 52(3), 275–300. [Https://doi.org/10.1080/15391523.2020.1719943](https://doi.org/10.1080/15391523.2020.1719943)

[Pollard, V., & Vincent, A. (2022). Micro-credentials: A Postdigital Counternarrative. *Postdigital Science and Education*, *4*(3), 843–859. https://doi.org/10.1007/s42438-022-00311-6](https://sciwheel.com/work/bibliography/16772316)

Powell, C. G., & Bodur, Y. (2019). Teachers’ perceptions of an online professional development experience: Implications for a design and implementation framework. *Teaching and teacher education*, *77*, 19-30. [Https://doi.org/10.1016/j.tate.2018.09.004](https://doi.org/10.1016/j.tate.2018.09.004)

Richter, D., Kunter, M., Klusmann, U., Lüdtke, O., & Baumert, J. (2014). Professional development across the teaching career: Teachers’ uptake of formal and informal learning opportunities. In S. Krolak-Schwerdt, S. Glock, & M. Böhmer (Eds.), *Teachers’ professional development* (pp. 97-121). Sense.

Ross, J. D., & Storey, R. (2011). Online professional development : design, deliver, succeed!

[Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, *25*(1), 54-67.](https://web.endnote.com/reference-list/)

[Salas-Pilco, S. Z., Xiao, K., & Hu, X. (2022). Artificial intelligence and learning analytics in teacher education: A systematic review. *Education Sciences*, *12*(8), 569. https://doi.org/10.3390/educsci12080569](https://sciwheel.com/work/bibliography/15305412)

[Sella Ela, N. (2022). *Summative evaluation report of professional development courses in Jerusalem district’s profesional development center 2020- 2021*. Ministry of Education. [Hebrew].](https://sciwheel.com/work/bibliography/16951457)

[Selvaratnam, R. M., & Sankey, M. (2021). An integrative literature review of the implementation of micro-credentials in higher education: Implications for practice in Australasia. *Journal of Teaching and Learning for Graduate Employability*, *12*(1), 1–17. https://doi.org/10.21153/jtlge2021vol12no1art942](https://sciwheel.com/work/bibliography/11831976)

[Shail, M. S. (2019). Using Micro-learning on Mobile Applications to Increase Knowledge Retention and Work Performance: A Review of Literature. *Cureus*, *11*(8), e5307. https://doi.org/10.7759/cureus.5307](https://sciwheel.com/work/bibliography/8105636)

[Shulman, L. (1987). Knowledge and teaching: foundations of the new reform. *Harvard Educational Review*, *57*(1), 1–23. https://doi.org/10.17763/haer.57.1.j463w79r56455411](https://sciwheel.com/work/bibliography/3521908)

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. [*Educational researcher*, *15*(2), 4-14.](https://web.endnote.com/reference-list/)

[Smeby, J.-C., & Heggen, K. (2014). Coherence and the development of professional knowledge and skills. *Journal of Education and Work*, *27*(1), 71–91. https://doi.org/10.1080/13639080.2012.718749](https://sciwheel.com/work/bibliography/6261607)

Soffer, T., & Cohen, A. (2019). Students’ engagement characteristics predict success and completion of online courses. *Journal of Computer Assisted Learning*, *35*(3), 378–389. Https://doi.org/10.1111/JCAL.12340

[Song, Y., & Huang, T. (2022). Influence of students’ online fragmented learning on learning effect: the mediating effect of the internet. *International Journal of Emerging Technologies in Learning (IJET)*, *17*(01), 179–190. https://doi.org/10.3991/ijet.v17i01.28471](https://sciwheel.com/work/bibliography/16786261)

[Stamovlasis, D., Papageorgiou, G., & Tsitsipis, G. (2013). The coherent versus fragmented knowledge hypotheses for the structure of matter: an investigation with a robust statistical methodology. *Chem. Educ. Res. Pract.*, *14*(4), 485–495. https://doi.org/10.1039/C3RP00042G](https://sciwheel.com/work/bibliography/16777296)

[Strunk, V., & Willis, J. (2017). Digital badges and learning analytics provide differentiated assessment opportunities. *EDUCAUSE Review. Retrieved from Https://Er …*.](https://sciwheel.com/work/bibliography/16686531)

[Tamoliune, G., Greenspon, R., Tereseviciene, M., Volungeviciene, A., Trepule, E., & Dauksiene, E. (2023). Exploring the potential of micro-credentials: A systematic literature review. *Frontiers in Education*, *7*. https://doi.org/10.3389/feduc.2022.1006811](https://sciwheel.com/work/bibliography/14969417)

[Thi Ngoc Ha, N., Spittle, M., Watt, A., & Van Dyke, N. (2023). A systematic literature review of micro-credentials in higher education: a non-zero-sum game. *Higher Education Research & Development*, *42*(6), 1527–1548. https://doi.org/10.1080/07294360.2022.2146061](https://sciwheel.com/work/bibliography/15382738)

[Tooley, M., & Hood, J. (2021). Harnessing Micro-Credentials for Teacher Growth: A National Review of Early Best Practices. *New America*.](https://sciwheel.com/work/bibliography/16770281)

[Tranquillo, J., & Stecker, M. (2016). Using intrinsic and extrinsic motivation in continuing professional education. *Surgical Neurology International*, *7*(Suppl 7), S197-9. https://doi.org/10.4103/2152-7806.179231](https://sciwheel.com/work/bibliography/13099560)

U.S. Department of Education. (2016). Future ready learning: reimagining the role of technology in education. Office of Educational Technology, Washington, D.C. Http://tech.ed.gov/files/2015/12/netp16.pdf

[Uyulgan, M. A., & Akkuzu, N. (2013). An Overview of Student Teachers’ Academic Intrinsic Motivation. *Educational Sciences: Theory & Practice*, *14*(1). https://doi.org/10.12738/estp.2014.1.2013](https://sciwheel.com/work/bibliography/1876014)

[Varadarajan, S., Koh, J. H. L., & Daniel, B. K. (2023). A systematic review of the opportunities and challenges of micro-credentials for multiple stakeholders: learners, employers, higher education institutions and government. *International Journal of Educational Technology in Higher Education*, *20*(1), 13. https://doi.org/10.1186/s41239-023-00381-x](https://sciwheel.com/work/bibliography/15382754)

[Walkington, C., Bernacki, M. L., Vongkulluksn, V., Greene, M., Darwin, T., Leyva, E., Istas, B., Hunnicutt, J., Washington, J., & Wang, M. (2024). The effect of an intervention personalizing mathematics to students’ career and popular culture interests on mathematics interest and learning. *Journal of Educational Psychology*, *116*(4), 506–531. https://doi.org/10.1037/edu0000840](https://sciwheel.com/work/bibliography/16685941)

[Wang, H., Xu, M., Xie, X., Dong, Y., & Wang, W. (2021). Relationships Between Achievement Goal Orientations, Learning Engagement, and Academic Adjustment in Freshmen: Variable-Centered and Person-Centered Approaches. *Frontiers in Psychology*, *12*, 767886. https://doi.org/10.3389/fpsyg.2021.767886](https://sciwheel.com/work/bibliography/12294632)

[Wenxiu, P. (2015). Analysis of fragmented learning features under the new media environment. *International Journal of Learning*, *13*(1), 55–63.](https://sciwheel.com/work/bibliography/16808133)

[Wheelahan, L., & Moodie, G. (2024). Analysing micro-credentials in higher education: a Bernsteinian analysis. In *Towards Powerful Educational Knowledge: Perspectives from Educational Foundations, Curriculum Theory and Didaktik* (pp. 70–86). Routledge. https://doi.org/10.4324/9781032712802-6](https://sciwheel.com/work/bibliography/16763804)

[Willis, J. E., Strunk, V. A., & Hardtner, T. L. (2016). Microcredentials and educational technology: a proposed ethical taxonomy. *EDUCAUSE*.](https://sciwheel.com/work/bibliography/16686464)

Yang, C. C., & Ogata, H. (2023). Personalized learning analytics intervention approach for enhancing student learning achievement and behavioral engagement in blended learning. Education and Information Technologies, 28(3), 2509-2528.

[Zhang, X., Admiraal, W., & Saab, N. (2021). Teachers’ motivation to participate in continuous professional development: relationship with factors at the personal and school level. *Journal of Education for Teaching*, *47*(5), 714–731. https://doi.org/10.1080/02607476.2021.1942804](https://sciwheel.com/work/bibliography/16847107)