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Harnessing Micro-Credentials to Innovate Teaching in the Open University of China: Opportunities and Challenges

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Abstract

The COVID-19 pandemic has dramatically changed teaching patterns, distance education is becoming an important educational mode in all kinds of schools. This is an opportunity for Open Universities, which mainly focus on distance and open education, but at the same time, Open Universities are also facing unprecedented challenges. In the present situation, distance education is no longer the unique feature of Open Universities, it is necessary for the Open University of China to innovate teaching to meet diverse learning needs. This paper puts forward the idea of using the new technology micro-credentials to innovate teaching, summarizes the definition, types, metadata and the educational application of micro-credentials, discusses the value of micro-credentials for innovative teaching in the Open University of China, and the challenges faced by the application of micro-credentials in teaching.

Keywords

Micro-Credentials, The Open University of China, Teaching

1. Introduction

During the COVID-19 pandemic, many educational institutions had to close or partially close and began providing most of their services online. School closures were mandated as part of public health efforts to contain the spread of COVID-19 from February 2020 in most countries (UNESCO, 2022). At the peak of the pandemic, temporary school closures in more than 180 countries lead to 1.6 billion students out of school (Azevedo, Hasan, Goldemberg, & Geven, 2021). When keeping schools open proves difficult to preserve collective health, or students' and staff's safety, distance education could be a better choice. Gov-

ernments were forced to change traditional face-to-face classrooms to distance learning to control virus outbreaks by maintaining social (place) distancing (Mishra, Gupta, & Shree, 2020). As a result, distance education is becoming an important educational mode in all kinds of schools, the largest and longest online learning experiment in human history is gradually unfolding around the world. This is an opportunity for Open Universities, which mainly focus on distance and open education. At the same time, Open Universities are also facing unprecedented challenges. Interim CEO at the Online Learning Consortium, Jennifer Mathes says, "We are seeing an explosion of education shifting online, but it all happened so fast, and so many institutions were not prepared that much of what we are seeing is not effective online learning" (Sara, 2020). In the face of large-scale and diversified demands of distance education, Open Universities need to consider the effectiveness of online teaching such as the quality of courses compared to social expectations, public concerns about learning performance among students (Kanga & Park, 2022). New effective teaching approaches are needed to keep students motivated and engaged during online learning. Furthermore, distance education is no longer the unique feature of Open Universities. In the period of great change when traditional universities carry out distance education on a large scale, the important challenges facing Open Universities are how to effectively carry out online teaching and innovate competitive advantages.

In the current educational environment, new information and communications technology (ICT) is widely used to innovate online teaching and improve teaching effect. Micro-credentials is one of the latest innovations in online education, which is attracting increasing interest from researchers, universities, educational institutions and governments. 2022 EDUCAUSE Horizon Report Teaching and Learning Edition selected six technologies and practices that were most likely to have a significant impact on the future of postsecondary teaching and learning, micro-credentials is one of the six (EDUCAUSE, 2022). This paper puts forward the idea of using the new technology micro-credentials to innovate teaching in the Open University of China. We summarizes the definition, types, metadata and the educational application of micro-credentials, discusses the value of micro-credentials for innovative teaching in The Open University of China, and the challenges faced by the application of micro-credentials in teaching.

2. What Is Micro-Credentials?

2.1. The Definition of Micro-Credentials

At present, the international understanding of micro-credentials has not reached a consensus (Brown, Mhichil, Beirne, & Mac Lochlainn, 2021). Many researchers and professional organizations have defined the concept. For example, The State University of New York defined micro-credentials as "verify, validate and attest that specific skills and/or competencies have been achieved". The National Education Association of US defines a micro-credential is a short, competency-based

recognition that allows an educator to demonstrate mastery in a particular area (Duklas, 2020). The definition of micro-credentials varies significantly depending on who is using the term and in what context (Brown, Mhichil, Beirne, & Mac Lochlainn, 2021; Brown & Mhichil, 2021). In order to solve the problem of definition confusion and lack of common language around micro-credentials, the European Commission's Higher Education Consultation Group developed a definition:

A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards (European Commission, 2020).

Following the European Commission definition, a micro-credential (Duklas, 2020; UNESCO, 2021; Oliver, 2019):

- Is a record of focused learning achievement verifying what the learner knows, understands or can do;
- Includes assessment based on clearly defined standards and is awarded by a trusted provider.
- In addition, a micro-credential (Oliver, 2019):
- Has stand-alone value and may also contribute to or complement other micro-credentials or macro-credentials, including through recognition of prior learning; and
- Meets the standards required by relevant quality assurance.

The micro-credentials correspond to the traditional degrees as macro-credentials. They represent the mastery of a limited set of skills or competencies, rather than the broader, interrelated set of skills represented by traditional degrees in the current credentialing system (Ehler, 2018). From the perspectives of credit, micro-credentials also have been labelled in different ways around different countries or regions. In the United States, they are described as "more than a single course but less than a full degree" (Kato, Galán-Muros, & Weko, 2020). In the European Higher Education Area, the initiated MicroHE project regards micro-credentials as "sub-unit of a credential or credentials that confer a minimum of 5 European Credit Transfer and Accumulation System (ECTS) (credits) and could be part of a portfolio" (MicroHE Consortium, 2019). In New Zealand, micro-credentials are assigned a range of credits from 5 to 40 credits, while in England, the higher education credit framework assigns credit to each qualification based on the expected effort (notionally 10 hours per credit point) (Msweli, Twinomurinzi, & Ismail, 2022).

Furthermore, some definitions specify the characteristics of micro-credentials (Msweli, Twinomurinzi, & Ismail, 2022; Pollard & Vincent, 2022; DeMonte, 2017):

- Competency-based. Micro-credentials focus on explicit evidence connected to the learner's specific competencies, not on the amount of time they spend learning. As for micro-credentials focus on developing a discrete set of competencies, their narrow range of learning enables students to obtain micro-credentials faster than most traditional credentials (Pichette, Brumwell, Rizk, & Han, 2021).

- Personalized. Learners select micro-credentials based on their interests and career goals. They identify specific activities that will support them in developing each competency.
- Flexible/On demand/Self-directed. Learners can earn micro-credentials by undertaking and completing specific activities at their own pace. They also can opt to explore new competencies or receive recognition for existing ones any time of the day.
- Shareable. Learners can share their micro-credentials across many platforms, through email, and on blogs and résumés. As a result, micro-credentials are portable currency that learners can take with them wherever they go.

2.2. The Types of Micro-Credentials

Micro-credential is an umbrella term that encompasses various forms of credential, including "nano-degrees", "micro-masters credentials", "certificates", "badges", "licences" and "endorsements" (Duklas, 2020). Because there are so many types of micro-credentials, people often cannot distinguish the boundaries and relationships between them. Holon's recent report defined six areas on the micro-credential spectrum: 1) short courses and badges, 2) bootcamps, 3) professional certificates and licenses, 4) non-university-issued non-degree certificates, 5) university-issued non-degree certificates, and 6) degree programs or accredited programs (Holon, 2021). The types of micro-credentials are distinguished by calculating the "hours of learner effort". Brown et al. classify credentials into four categories by "bundled and unbundled" and "credit-bearing and non-credit-bearing". Following this typology, micro-credentials are unbundled, credit-bearing, stackable credentials. While digital badges or certificates that are non-status awards are differentiated with micro-credentials.

In addition, according to the relationship with the national qualification framework, micro-credentials can be divided into credit and non-credit-bearing micro-credentials. Credit micro-credentials mean they are recognized by the national qualification framework and the credit they represent is consistent with the traditional credit. Non-credit-bearing micro-credentials exist outside the formal qualifications frameworks of traditional universities and colleges. This mean they are not recognized by the national qualification framework and may not be stackable or combinable towards higher qualifications (McGreal & Olcott, 2022).

At present, the popular micro-credentials are mainly digital badges and open badges

1) Digital badges. Digital badges as a representation of achievement, interest, or affiliation, with visual, online available features, and containing metadata with links to help interpret context, meaning, process, and results of activities (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2015). Grant proposed that digital badges are digital images obtained by accomplishing some pre-specified objectives and annotated with metadata (Grant, 2016).

Digital badges are presented as "visual symbols of certificates" and web technologies with "the potential to identify and connect cross-context learning", designed to reward learners for achievement in specific activities. Unlike regular analog badges, digital badges can contain detailed metadata about the learner, the badge issuer, and the evidence that the badge was submitted. A digital badge is a web-based symbol of learning outcome that contains specific statements and evidence of learning and achievement, consisting of images and associated metadata.

2) Open Badges. The Open Badge is a digital badge based on an open technical specification created and promoted by the Mozilla Foundation in 2010. It allows learners to authenticate their skills, interests, and achievements through trusted institutions, and in order to ensure future access and inspection, metadata such as the awarding organization, awarding criteria, awarding time, corresponding achievement evidence and possible expiration date of the badge were hard-coded and attached to the badge image file (Jovanovic & Devedzic, 2015). In addition, more detailed evidence of learning, such as a study diary or practical work produced during the study process, will be attached to the badge. The main feature of open badges is the collection of meta-badges obtained from different sources in a single digital-space badge, that is, the use of technology to combine selected badges into custom profiles. This way of "merging all information into one" greatly alleviates the boundary problem of different situations and institutions in credit transfer.

2.3. The Metadata of Micro-Credentials

Information about a micro-credential is stored as metadata for future access and review. The metadata makes the "identity" of the micro-credential clear. It answers when the micro-credential was issued, who issued it, who earned it, and what its specific reward was. The metadata of micro-credentials including required data (unique ID, earner's information, issuing issuer information, badge name, description, criteria, and date of issue) and optional data (evidence, narrative explaining evidence, expiration date, corresponding educational standard, label describing achievement, and whether the badge was valid) (Clements, West, & Hunsaker, 2020). According to the metadata, the authenticity of the badge can be verified by referring back to the issuing site.

2.4. Students' and Teachers' Attitudes towards Micro-Credentials

In the field of education, micro-credentials is a new assessment mode and an innovative educational concept. Whether teachers and students accept and support this new mode will become a real issue in the development process of micro-credentials concept.

In terms of student reception, most participants had a positive impression of micro-credentials as credible and innovative (Dyjur & Lindstrom, 2017). An in-depth survey of 104 digital badge recipients at the Irish Institute of Technol-

ogy revealed that while 90% had never come across a digital badge, they found it easy to accept and 75% said they would use it on LinkedIn and their CVs (Curriculum Vitae) (O'Brien, 2019). A comparative study on the attitude of MOOC learners in developed countries (Sweden) and developing countries (Kenya) towards micro-credentials show that learners in both countries regard MOOCs based on micro-credentials as a supplement to traditional learning, but learners in developing countries pay more attention to micro-credentials than learners in developed countries (Jobe, 2014). Students generally agree that micro-credentials can help them better understand course content, focus on specific learning objectives, and explore curriculum competencies in greater depth (Fajiculay, Parikh, Wright, & Sheehan, 2017), but some worry that employers may not recognize the value of micro-credentials (O'Brien, 2019).

From the perspective of teachers' attitude, teachers will face a series of challenges when using micro-credentials, and they may also become a digital badge gainer. Therefore, teachers' attitude towards micro-credentials is also crucial. A study of 99 K-12 teachers who received digital badges in a teacher training program found that teachers were positive about accepting micro-credentials, and many shared their badges through digital media (Jones, Hope, & Adams, 2018). Teachers have a positive view of the use of digital badges as an integral part of their own learning curriculum (Basal & Kaynak, 2019).

3. The Application of Micro-Credentials in the Field of Education

The typical applications of micro-credentials in the field of education include teacher education, classroom teaching, informal learning and so on.

3.1. Teacher Education

Micro-credentials enable teachers' professional development to change to a more personalized direction. They support competency-based, personalized professional development mode, and provide teachers with a more diversified certification system for learning outcomes. The researchers found that "one-shot" workshops are the most prevalent form of teacher professional development, but they did not change teacher practices or improve student learning (Dan & Barnett, 2017). The most effective professional development is contextualized to the specific needs of teachers, where they have opportunities to take ownership of their professional learning (Dan & Barnett, 2017).

It is in this context that micro-credentials have been applied in the field of teacher education, which targets teacher competence promotion, pays attention to teacher needs and interests, focuses on practical outcomes, and allows teachers to show what they can do rather than just what they know. Compared with the traditional teacher professional development system, the advantages of the learning system based on micro-credentials are that it is based on competence, respects personalized characteristics, meets needs and can be shared.

3.2. Classroom Teaching

Micro-credentials are being used to certify learning outcomes during classroom teaching in English, chemistry, medicine and STEM, providing a formal certification mode and framework for multiple content components in a discipline. In the case of a chemistry lab, students submit a video of themselves completing an experiment as a learning outcome to a micro-credential system, which then grades and gives feedback based on a series of criteria. Students who successfully demonstrate the experiment receive a digital badge. In view of the digital nature of micro-credentials, the corresponding learning evidence is also in the form of digital. In classroom teaching, the learning outcomes of Micro-credentials system are generally based on videos, and the characteristics of videos enable students to self-evaluate and evaluate each other before submitting learning outcomes (Seery, Agustian, Doidge, Kucharski, O'Connor, & Price, 2017).

In addition, some scholars pay more attention to the impact of micro-credentials on curriculum design. For example, Song (2018) found that micro-credentials can also be used as an effective tool in curriculum design. Firstly, the digital badges under the micro-credentials system are associated with verifiable data and evidence, and represent a skill that students are expected to develop during the course, and teachers can test whether students have acquired that skill with a question or a series of questions. Among them, digital badges should be as detailed as possible to cover more and more comprehensive knowledge points. Song created 113 digital badges for a single course. Secondly, teachers can design courses based on the knowledge points of digital badges. From the perspective of course management, micro-credentials can also help to better evaluate the teaching effect of teachers and allow teachers to design teaching freely according to their own style.

3.3. Informal Learning

A digital badge system is a nascent technology that intends to recognize, validate, and in some cases even accreditize non-formal learning (Jobe, 2013). As an emerging technology, micro-credentials can achieve certification of learning outcomes in all forms, including informal learning. The process of acquiring comprehensive knowledge, skills and attitudes in different learning environments and different ways at different stages of life can be visualized, and can be digitally displayed and publicized online. That is, a widely recognized organization accorrding to different purposes and methods to evaluate learning outcomes or abilities, and award the learners corresponding qualification or equivalent credits. For informal learning such as online learning and blended learning, micro-credentials can play a key role as a bridge between different learning frameworks. Open Learn of the Open University of UK has thousands of hours of learning materials, and attracts more than 14 million visitors each year from around the World (The Open University of UK, 2022). In 2013, the platform tried to carry out a micro-credentials pilot project and developed a series of

Badged Open Courses (BOCs). Students receive a digital badge when they complete the course and pass a test (Law, 2015). Comparing the demographics of BOCs learners to OpenLearn's overall demographics, they found that more and more learners are keen to achieve this informal learning outcome.

4. Opportunities: The Value of Micro-Credentials for the Open University of China

4.1. The Teaching Support Value of Micro-Credentials

The micro-credentials, especially digital badges have come to be recognized by the education community as an innovative instructional and credentialing strategy. The existing academic literature, project reports, and a large number of case studies suggest that micro-credentials can support teaching in four ways:

1) As a motivational mechanism. Micro-credentials can be used as an effective motivational mechanism to stimulate learners' motivation by giving a series of scientifically planned rewards. They can significantly improve student goal-setting and motivation in learning, especially for students with low self-regulated learning level, the use of micro-credentials has better incentive effect (Cheng, Richardson, & Newby, 2020). A micro-credential assigns a learning goal that each student can achieve at his or her own pace.

For example, Bovermann et al. developed a gamified learning project based on the Moodle learning management system using digital badges and progress bar elements. In this project, the awarding of a digital badge is technically linked to the completion of a specific online activity, task or online group work, and once a student has completed relevant and predefined activities as required, the digital badge is automatically added to their profile. Using micro-credentials as a reward element in game design to develop learning content can incentivize learning (Bovermann, Weidlich, & Bastiaens, 2018).

2) As a means of assessment and credentialing learning. Micro-credentials provide identification and assessment of learning outcomes during teaching. They can be used as a new teaching evaluation method to solve people's dissatisfaction with the current dominant standardized test, especially for the evaluation of specific professional skills and abilities. Micro-credentials' value is largely dependent on the credibility of the recognizing and credentialing process. Artevelde University College (AUC) in Belgium offers a variety of community service learning projects, but these informal learning experiences and achievements are not recognized, which greatly affects the participation enthusiasm of students. To this end, the AUC has developed a micro-credential program called Gentleman Student. Once a student has completed a challenge or learning opportunity according to the relevant criteria, the ability they have gained is recognized and an open badge is awarded.

3) As a means of charting learning routes. Through displaying evidence of learning in an effective, transparent, learner-centered manner, micro-credentials draw a learning roadmap for each learner. A series of standards and requirements

for obtaining micro-credentials are the "signposts" in the learning process. Learners can complete their personalized learning according to the "signposts" provided by teachers. For example, The Center for Cooperative Education (CCE) and The Center for Teaching Quality (CTQ) launched a Learning program (PAL Program) based on micro-credentials, which are designed at three levels (Deklotz, 2016). In the learning process, micro-credentials are regarded as learning "signposts". After the learner completes the learning tasks step by step and obtains the assessment and recognition of the learning results, all micro-credentials are achieved, which means the completion of the learning plan.

4) As a means of supporting self-reflection and planning. A micro-credential is a record of focused learning achievement verifying what the learner knows, understands or can do. This record can be used as feedback in teaching by enabling learners to constantly review what they have learned and consider the next step of learning, to develop their self-reflection and planning ability.

At present, researchers mainly discuss the impact of micro-credentials on learners' learning intrinsic motivation, learning participation (engagement), learning behavior and learning performance.

In terms of intrinsic motivation, specific badges can highlight achievement, and competitive badges can enhance learning motivation (Facey-Shaw, Specht, & Bartley-Bryan, 2018). There is evidence that micro-credentials provided additional formative and summative feedback beyond what is traditionally available in higher education classes and that additional assessments provided by badges had a positive impact on student motivation to learn (Boesdorfer & Daugherty, 2020; Abramovich, 2016; van de Laar, West, Cosma, Katwal, & Mancigotti, 2022). In terms of learning participation (engagement), learners' achievements are displayed and their learning paths are captured by obtaining micro-credentials through the certification of their knowledge, skills and abilities on the online platform, thus motivating them to continue to participate in learning (Mah, 2016). In terms of learning behavior, digital badges that can represent academic performance can be used to influence students' learning behavior and have a certain incentive significance (Hakulinen, Auvinen, & Korhonen, 2015). Micro-credentials can motivate specific behaviors of students with as little change to the course structure as possible (Uanhoro, Young, & Lin, 2016). In terms of learning performance, micro-credentials have a significant positive impact on learners' self-efficacy and learning performance (Yang, Quadir, & Chen, 2016). Learners based on micro-credentials learning not only have higher perceived confidence in their technology integration skills, but also achieve higher levels of coursework and overall course performance (Newby & Cheng, 2020).

In addition, based on the micro-credentials, it can ensure that instructors in the same course have the same coverage of basic concepts/topics, at the same time teachers have flexibility in the course designing. Not only learners but also instructors can carry out personalized teaching according to the learning map drawn by the micro-credentials.

4.2. The Value of Micro-Credentials for Innovative Teaching in the Open University of China

With the mission of promoting lifelong learning for the masses, the Open University of China has been providing adult education with both academic and non-academic degrees all over the country with the support of modern information technology. It uses its own online platform to carry out distance education and open educational resources to learners through the Internet. At present, there are some problems in distance teaching in the Open University of China, such as emphasis on knowledge mastery and neglect of ability cultivation, teachers completely dominate the teaching process, difficulty in ensuring the learning quality and good learning status of students, and low social recognition of non-academic learning outcomes. Micro-credentials can help The Open University of China solve the above problems to some extent.

4.2.1. Developing Competency-Based Learning

Micro-credentials that including assessment based on clearly defined standards focus on explicit evidence connected to the learner's specific competencies. While competency-based learning focuses on mastering measurable student outcomes and its assessment of student progress is based solely on whether students have mastered predetermined competencies. In other words, the premise of competence-oriented learning is explicit and measurable goals clearly communicated to learners. Students can advance or assess new abilities only if they have mastered the necessary materials.

In the process of teaching implementation, The Open University of China can take micro-credentials as a competency-based assessment model to identify learners' skills, achievements and performance, so as to highlight the clearly defined skills displayed in the practice of defined standards or levels and guide learners to competency-based learning.

4.2.2. Enabling Learners to Learn Personalized and Self-Directed

As a teaching means of charting learning routes and supporting self-reflection and planning, micro-credentials have the characteristics of personalized and self-directed. Firstly, learners can select micro-credentials based on their interests and career goals. As a supplement to higher education, The Open University of China has been taking on the heavy responsibility of adult education, and its learners have diversified structure and needs. Micro-credentials supports large-scale distance teaching and enables learners to learn personalized at the same time, meeting learners' personalized needs in content level, schedule arrangement, method selection and other aspects. This is in line with the teaching development trend of the organic combination of scale and individuation in The Open University of China. Secondly, Learners can earn micro-credentials by undertaking and completing specific activities at their own pace. For example, in the arrangement of learning time, most adult learners have a certain contradiction between work and learning. They can only participate in learning after work

and during holidays, while the free time of learners is difficult to be completely consistent. Teaching with micro-credentials support learners to schedule their studies at any time of the day.

4.2.3. Stimulating Students' Learning Motivation

Micro-credentials can be used as an effective motivational mechanism to stimulate learners' motivation by giving a series of scientifically planned rewards. Recognizing and rewarding learners' learning outcomes can help motivate students to complete learning tasks and improve their academic performance. Moreover, micro-credentials are rewards that can be easily shared. Learners can share their micro-credentials across many platforms, through email, and on blogs and résumés. Adult learners of The Open University of China can gain better career development by presenting micro-credentials to employers, which can also motivate students to learn.

4.2.4. Constructing the Framework of Non-Degree Learning Outcomes Certification

The study of The Open University of China is not only limited to academic degree study, non-academic degree study also occupies a large part. Especially in recent years, the non-degree learning is increasing, and the corresponding non-degree learning outcomes are increasing. These learning outcomes are expected to be recognized. How to scientifically recognize various non-degree learning outcomes without certain forms is an important problem faced by The Open University of China. As a means of assessment and credentialing learning, micro-credentials provide identification of learning outcomes during teaching. Micro-credentials can be used to certify the learning outcomes obtained through any learning method. They provide open and transparent authentication method for non-degree learning outcomes. Therefore, constructing the framework of non-degree learning outcomes certification based on micro-credentials can solve the problem of low social recognition of non-degree learning outcomes to a large extent.

5. Challenges: The Difficulty of Harnessing Micro-Credentials in Teaching

For the Open University of China, there are many potential barriers to the use of micro-credentials in teaching. The first and most important thing is to identify the required capabilities and articulate them. Each micro-credential corresponds to a specific skill, and competency-based is an important characteristic of micro-credential. However, how to accurately identify the skills needed by adult students that will benefit their career development is a key difficulty that the Open University of China has to overcome.

The second is the readiness for micro-credentials of teachers and students, the direct stakeholders of teaching. For the teachers and students of the Open University of China, micro-credentials is an innovative teaching concept, which needs a process of recognition and acceptance. How do direct stakeholders

perceive micro-credentials? Are they willing to participate in teaching that combined micro-credentials? Not only that, teachers need to learn how to use micro-credentials to teach effectively, and students need to learn their new roles and methods in this innovative pedagogy. This may cause teachers and students to "do not want to add to the trouble" psychological resistance, thus increasing the difficulty of using micro-credentials to carry out teaching.

Last but not least, in order to ensure the fair and just operation of the micro-credentials system, the Open University of China needs to develop a set of standardized and strictly followed certification norms, so that the micro-credentials system has a high credibility. Only by being recognized and trusted by learners, educational institutions, employers and other public stakeholders, micro-credentials can play a role in teaching.

6. Conclusion

How to make full use of modern information technology to help online education after the pandemic, how to maintain the core competitive advantage in the face of fierce competition of many online education institutions in the critical period, and how to continuously enhance the attraction of students through innovative teaching methods are the important issues facing the Open University of China at present. In view of the above problems, this paper puts forward the idea of using micro-credentials to carry out teaching innovation, draws a conclusion that competency-based, personalized, self-directed, shareable micro-credentials can play a role in teaching of the Open University of China through as ways of motivational mechanism, assessment and credentialing learning, charting learning routes, supporting self-reflection and planning. However, the deficiency of this paper is that it only discusses from the theoretical level. How to use micro-credentials to carry out teaching in the Open University of China, especially how to solve the challenges will be faced, needs to be further studied.

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Conflicts of Interest

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