Are micro-credentials valuable for students? Perspective on verifiable digital credentials

Abstract   Higher education institutions are investing more and investigating digital credentials as proof of learning upon completion of learning offerings, such as micro-credentials. Understanding what value these digital credentials hold for learners and what enables the learners to use digital credentials will help higher education institutions focus their efforts. Although there is research available on value of micro-credentials, there is a huge research gap in understanding the value of digital credentials and the metadata that can be included, especially from learner perspective. To address this gap, we conducted a qualitative analysis study with interviews of learners and administrators in higher education institutions. This study contributes to (1) what value do learners perceive of digital credentials, (2) what value digital credentials have compared to other forms of recognition, such as paper certificates, and (3) what factors enable greater adoption of digital credentials by learners. In terms of practice, our findings help higher education institutions in evaluating the use of digital credentials not only for micro-credentials but also extend them to other learning offerings.

1   INTRODUCTION

Multiple stakeholders, including Higher Education Institutions (HEIs), leaders of national qualification reference frameworks, and policymakers, are working together to better define and create necessary frameworks for micro-credentials (Digital Credentials Consortium, 2018; Mathes, 2019; MicroHE, 2021; RMIT, 2021). This effort is leading to a more concise definition of a micro-credential: a credential or record of learning outcomes issued after a short learning experience or a module that focuses on specific knowledge (European Commission, 2022; Oliver, 2019). This concept of micro-credentials is causing a shift in practice by higher education institutions towards unbundling their learning offerings. A micro-credential can be credit bearing (such as ECTS) and include assessment and stackability (Australia, 2021; Colleges and Institutes Canada, 2021; European Commission, 2022; Malaysian Qualifications Agency, 2020), but most importantly, they are developed considering the needs of industry, employers, and the community (New Zealand Qualifications Authority, 2016; SUNY, 2018). Indeed, employer concerns about graduates' skills and competences along with diverse student needs are some of the reasons why higher education institutions are taking a closer look at micro-credentials (Matkin, et al., 2020; Oliver, 2019; Selvaratnam, & Sankey, 2020). They are viewed as a potential way for individuals to upskill or reskill themselves with competences that are in high demand in emerging jobs of the labour market (Kato et al., 2020; Hope 2018).

By separating a micro-credential into a short learning experience and the credential associated with it (Cirlan & Loukkola, 2020; Fong et al., 2016), two distinctive efforts can be seen in the field of micro-credentials. First, the content discussion includes the design of the subject matter, including learning experiences, assessment practices and co-construction in collaboration with the industry (Brown et al., 2021). The credential discussion of micro-credentials focuses on the evidence of achievement given at the completion of the academic endeavor. Currently, this can be a paper certificate, or a digital credential given after successful completion of the short learning experience.

A digital credential can be described as a digital certificate that contain learner achievement, recognition of activities, assessments, competences that is tamper proof and has verification checks built in (Alvarez et al., 2022, European Commission 2022). The digital credentials can include in-depth information, such as learning outcomes, skills and competences and information on the awarding bodies (Colleges and Institutes Canada, 2021; European Commission, 2022; Pichette, 2021), making them transferable and richer in content than paper certificates. At least two major technologies are currently available that offer authenticity and verifiability features. European Digital Credentials (EDC) have a rigid electronic seal and support instant verification (European Commission, 2022), whereas the European Blockchain Services Infrastructure (EBSI) utilizes the blockchain for verification (Digital Credentials Consortium, 2020; EBSI, 2022; Rahardja et al., 2019). Regardless of the method used, it is agreed that verification is a key aspect of digital credentials to make them tamper-proof. Another form of recognition that is widely in use mainly outside higher education is a digital badge. A digital

badge can be defined as an "online representation of a credential earned" (Alvarez et al., 2022). While badges may contain metadata related to learning opportunities, they typically lack verifiability and are connected to non-formal or informal leaning. In this paper, our focus is on verifiable digital credentials, specifically in higher education institution settings and related to formal, credit-bearing learning opportunities and how they are valuable to learners. In this paper, the terms digital credentials and verifiable digital credentials are used interchangeably.

Currently, research on the benefits of micro-credentials tends to focus on the combination of short learning opportunities and credentials together and, the discussion tends to be more about digital badges than verifiable digital credentials. Even so, there is very little research on learners' perspective on how micro-credentials are beneficial to them. The little exploratory empirical research that is available indicates that students have positive attitudes towards micro-credentials in general and see their potential, especially for lifelong learning (Ahmed & Jassim, 2021; Ghasia et al., 2019). Despite the worldwide efforts to develop digital and standardize digital credentials (Digital Credentials Consortium, 2020; European Digital Credential, 2022), there is no empirical research currently available on how the digital proofs associated with credit-bearing short learning offerings (i.e., verifiable digital credentials) are beneficial to learners. Given the importance of the topic and the research gap, we ask the following research question: "*What is the value of verifiable digital credentials for learners?*"

To answer this question, we conducted a qualitative study with two sets of semi-structured interviews. We chose the qualitative approach to gain deeper understanding as micro-credential area is still a new area. Especially issuing/receiving micro-credentials with metadata such as learning outcomes, skills & competences is not widely done. With the availability of small sample size, qualitative approach provided us with an opportunity to have meaningful discussions that led to rich insights. The interviews were conducted in the context of a European University alliance project that pilots and experiments with micro-credentials. The first set of interviews was with learners (n=19) from Tampere University who were participating in a course at the end of which they receive a digital credential. The interviews included asking a few indicative questions to add quantified way of validating the qualitative data. After the initial analysis of the learner data and practical insights from universities, we uncovered richer insights that needed to be addressed further with interviews. We decided to interview administrators from higher education institutions to gather the additional information. Since administrators issue and manage digital credentials, their insights were essential to obtaining a broader view of the value of digital credentials for learners. Consequently, we interviewed administrators (n=19) from 11 higher education institutions. This provided us with another way to validate the insights from the learner interviews by data source triangulation.

We used expectancy-value theory (EVT) (Eccles, 2005; Eccles et al., 1983) as our theoretical framework because it allows uncovering the different types of value and ability perceptions that hinder or enable the adoption of an innovation. Using Hulleman's modified model of EVT model, we were able to do empirical validation including cost as one of the constructs. This paper contributes to the literature on digital credentials' by (1) examining their value to learners from an empirical perspective, (2) explaining the value digital credentials have compared to other forms of recognition, such as digital badges, and (3) by revealing what factors enable greater adoption of digital credentials by learners.

The remainder of the article is structured as follows. First, we present the theoretical background. Second, we describe and justify our research methodological choices. Third, we report our findings, and finally we discuss our contributions, future research directions, practical implications, and limitations.

2   THEORETICAL BACKGROUND

2.1   Digital Credentials

There is an increasing demand to fill the gap between the formal programs higher education institutions provide and the skills industry seeks from employees (Kato et.al., 2020). The new models needed to provide such skills tend to be short, flexible and include industry-embedded learning (Côté & White, 2020). Micro-credentials

fit such requirements and have become widely available, such as massive open online courses (MOOCs) (Bjorn-Andersen et.al., 2013; Calonge et al., 2019; Shah 2020).

Multiple studies have suggested that higher education institutions have a need and desire to offer micro-credentials (Duklas, 2020; Selvaratnam & Sankey, 2019) and, this trend can be seen in practice globally. Formal qualifications frameworks are in place in Europe, Canada, Australia, New Zealand and most of Asia and Africa to align the micro-credentials with formal credits (AQF, 2013; CDQF, 2007; EQF, 2017; NQF, 2008; NZQF, 2011). Even though such frameworks do not exist in USA, they are at the core of the micro-credential movement, partly due to already existing close ties between higher education and industry (McGreal & Olcott, 2022).

Traditionally, academic achievements have been recorded and issued as academic transcripts. While these transcripts provide verifiable proof of completing the courses, they are limited in their ability to demonstrate the skills and competences associated with those courses (Jorre de St Jorre, 2020). This applies to individual courses, entire degree programs and everything in between. Currently there is a movement in higher education to either replace traditional certificates or to complement them with a digital credential (Digital Credentials Consortium, 2020; European Commission, 2022). Digital credentials can have the same information as the traditional diploma but also have the capability to include rich metadata, making them transferable between institutions and users (Kiiskilä et al., 2022). Moreover, digital credentials are rendered to be immutable with built-in verification (Chakroun & Keevy, 2018). They also shift the ownership to learners (self-sovereignty), who are free to share as they deem necessary (European Commission, 2022).

Before the emergence of digital credentials, digital badges were used for almost two decades as an indicator of achievements, especially in nonformal learning environments (Barker B, 2013; Diaz V, 2013). A digital badge is a visual representation of skills and competences acquired by the learner (Gibson et al., 2013). They are typically used as an incentive to encourage and motivate students to learn (Farmer & West, 2016) and can be shared on various social media platforms (Dyjur & Lindstrom, 2017). Digital badges became a gamification element, especially in online learning environments (Duncan, 2011; Gibson et al., 2015; Surman, 2011), to signify accomplishment. HEIs also started adopting digital badges in formal education in recent years (Abramovich, 2016). In higher education, digital badges are mainly used to capture aspects of learning that cannot be recognized through academic accreditation processes (Devedzic & Jovanovic, 2015). Initial findings on digital badges have shown that learners have mixed reactions to them (Dyjur & Lindstrom, 2017). While learners are motivated by the badges, they regard the formal grade and course content as more important (Delello et al., 2018). It is important to note that in higher education settings, digital badges are used as an addition or complement to the formal transcripts given for any course or program and not as a replacement for them. Meanwhile, verifiable digital credentials are digital versions of transcripts, which can include metadata in addition to the information that a formal transcript provides. The digital credentials given by higher education institutions include formal learning data, such as the number of credits (e.g., ECTS), grades along with learning outcomes, which can also include the skills and competences. This also means that the data included in the digital credential are verifiable and subject to the same accreditation standards as traditional transcripts (European Commission, 2022).

There are at least two large initiatives occurring in Europe that involve digital credentials. The European Digital Credentials for Learning (EDCL) program offers higher education institutions an infrastructure (or components) that can be used to manage verifiable digital credentials. These are digital statements issued by an organization to a learner, documenting their learning (EDCL, 2021). This includes digital credentials for individual learning offerings, such as degrees, and diplomas awarded by educational institutions. The second initiative is the EBSI whose vision is "to leverage blockchain to the creation of cross-border services for public administrations and their ecosystems to verify information and make services trustworthy" (EBSI, 2021). This initiative includes HEIs issuing digital credentials that are tamper-proof and verifiable by other educational institutions.

Similarly, Digital Credentials Consortium in USA was founded by several leading universities to build an infrastructure for verifiable credentials including, the design of the digital credentials (Digital Credentials Consortium, 2018). RMIT creds (credentials) offered by RMIT university are industry-relevant digital certifications that can also be applied to formal education. In Malaysia, micro-credential certification programs are paired with digital badges in which metadata with details about what was accomplished are embedded. Since the main purpose of obtaining micro-credentials is to acquire skills and competences that are lacking or needed,

including that data into the credential is imperative. The digital credentials issued upon completion of short learning offering provide several advantages over traditional transcripts or certificates. This includes easier sharing and storage of data as well as complete ownership on the data credentials.

2.2   Value of digital credentials for learners

Micro-credentials have been seen as a potential way to allow learners to fill their skill gaps and receive proof of their newly developed skills (Kato et al., 2020). This is crucial, as industry expects employees to either enter the workforce with necessary skills or take the responsibility for upskilling. As part of this, both learners (future employees) and industry need a more transparent view of the skills acquired by learners (Felton et al., 2022). Traditional transcripts typically list the name of the course and formal academic information, including the number of credits and the grade achieved. Employers cannot view or validate the acquired skills and competences with such brief information (DeMilo, 2017). The digital credentials given at the completion of a micro-credential can include information such as acquired skills and competences as part of metadata thus making it transparent to the employer.

Prior research has shown at least six major benefits of using micro-credentials overall for learners: personalization, cost efficiency (Hunt et al., 2020), transferability (McGreal et al., 2022), portability, transparency, and ownership (Hickey, 2017; ICDE report, 2019). Of these six benefits, transferability, portability, transparency, and ownership relate more to the digital credentials than the content of the actual learning offering (e.g., short course). Hence, the research and studies on the value of micro-credentials also extend to digital credentials. Learners can pursue micro-credentials for a variety of reasons. Depending on what stage of life they are in, it could be to seek new skills, to gain career advantage or simply because of personal interest (Oliver, 2021). They might pursue the them before, during or after the completion of traditional degree program (Woods & Woods, 2021) or completely outside the realm of formal education. Irrespective of the reason, the digital credential acquired will benefit the learner in understanding their current level of skills.

The emergence and growth of micro-credential platforms that are used to manage digital credentials (Kiiskilä et al., 2022) have helped to increase the awareness of verifiable digital credentials. The standardization of digital credentials into common data models or formats has been discussed around the world. The European Commission recently launched a standard for such digital credentials called European Digital Credentials (EDCL, 2021), which is an extension of the worldwide standard, World Wide Web Consortium Verifiable Credentials (W3C VC). Digital Credentials Consortium in the US is also working on the same W3C VC standard for digital credentials. The main differences between these digital credentials and others such as digital badges, include (1) strong authentication and verification methods, such as advanced e-Seal or blockchain, making them immutable and easy to verify; and (2) the same qualification and accreditation frameworks are used for digital credentials as for traditional programs. Similar projects are in progress in other parts of the world (SHARE, 2022) signalling strong desire to raise the standard of digital credentials to something educational institutions can trust.

Although some research has been done on the benefits of micro-credentials for learners, no empirical research exists today regarding the value of the digital credentials themselves from a learner perspective. What value do learners see in rich the metadata that digital credentials can have, how could they use digital credentials and what factors might affect the wide use of digital credentials by learners? Our empirical research focuses on answering these questions by studying the perception of the value of digital credentials by learners.

3   RESEARCH METHOD

3.1   Research Framework

We chose to use expectancy-value theory (EVT) (Eccles et al., 1983) as research framework to study how digital credentials are helpful for learners. According to EVT, an individual's choice to participate in an activity (e.g., using digital credentials) results from an interplay between the value it brings and their subjective belief in their competence (Cheng et al., 2020). EVT also explains how these individual choice behaviors are affected by both personal and environmental factors, similar to the technology integration barriers (Makki et al., 2018). Even

though traditionally, EVT has been applied to understand the academic performance of students (Perez et al., 2019), it also determines the relationship between beliefs and choices to take part in an activity (Eccles et al., 1983) and thus can also be used in innovation adoption processes to understand and predict the intentions of using an innovation (Wozney et al., 2006), such as adopting a micro-credential platform.

Since higher education institutions issue and manage digital credentials, we believed the administrators of those institutions could provide a different and complementary perspective on the research question. Hence, although EVT is addressed for individuals (Andersen & Ward, 2014), we believed the same model could be applied to administrators' viewpoints. We accomplished this by asking the administrators specific questions regarding the ways that digital credentials can benefit learners. For instance, specific questions included how the data included in digital credentials can help learners and where digital credentials can be used in practice.

In the EVT model (Eccles et al., 1983), two key predictors influence an individual's choice: expectation for success, and value beliefs. Expectation for success is the perceived ability to succeed at a task now and in the future, and value beliefs, also known as subjective task value (STV), are conceptualized as task specific beliefs. In our study that task is using digital credentials.

Subjective task value

This key predictor includes four sub-constructs: intrinsic value, attainment value, utility value and relative cost.

Instrinsic value: This construct was defined as (a) the *enjoyment* individual gets from performing an activity or (b) the *interest* the individual has in the subject (Eccles & Wigfield, 2002). For this study, we chose the construct 'individual interest'.

Attainment value: This construct was defined as the 'value' an activity has for the individual. It includes how important successfully performing an activity is for the individual or how determined the individual is to succeed in doing so (Eccles, 2005).

Utility value: Also known as the usefulness of the task, this construct is defined as how well an undertaking relates to current and future goals (Eccles & Wigfield, 2002).

Cost: This construct is defined in terms of the negative aspects of participating in the task. It refers to the perception of effort and time invested (Eccles & Harold, 1991). It also includes other negative aspects related to performing the task, such as performance anxiety and lost opportunities (Eccles et al., 1983).

Expectations for success

The second key EVT predictor, also known as competence beliefs, is a combination of two related subconstructs: ability beliefs and expectancy beliefs.

Ability beliefs: This construct is defined as individuals' own evaluation of their current competence in the domain (Eccles et al., 1983). For this study, we selected the domain 'using the technology'.

Expectancy beliefs: This construct is defined as individuals' beliefs about how well they will do on future tasks (Eccles et al., 1983).

The expectancy-value model for micro-credentials is built based on the Hulleman's EVT model (Hulleman et al., 2016). In this model, cost has been promoted as a separate construct instead of as one of the value beliefs. This is due to both theoretical and empirical insights that demonstrate the direct influence of cost on intention to take part in an activity (Hulleman et al., 2016). This model suggests that an individual can still choose not to take part in an activity even if the expectation of success and value perception are high if the individual perceives the cost of taking part in the activity to be too high (Barron & Hulleman, 2015). Applying this model to digital credentials, learners' motivation to use digital credentials depends on not only how they perceive the expectancy of success and value perception but also on whether they believe the received value from these credentials is higher than the cost of adopting a new technology (Sipilä, 2011; Wozney et al., 2006). We drew from Hulleman's model to examine value perceptions. Hulleman's paper doesn't directly address micro-credentials or using technological innovations in educational context. We were able to use the model for empirical validation and

extend its use for adoption of new innovations especially in educational context from learner point of view. Using the Hulleman model, we also addressed what motivates learners to use digital credentials in the future and what factors can enable such use.

3.2   Data Validation

For validation of data collected from learner interviews, we chose to use data source triangulation method. Data source triangulation involves collection of data from different sources such as different types of individuals (Carter, 1969). By gathering the information from two different types of sources (learners and administrators), we were able to validate the data collected and thus our analysis. Variance in persons, such as learners and administrators while keeping the same method (semi-structured interviews) adds to the study as it can reveal atypical data as well as the possibility of identifying similar patterns, thus increasing confidence in the findings (Fielding & Fielding, 1986). By using the data source triangulation method of validation, we not only confirmed the findings from learner data but also found more insights from administrator interviews that enhanced our analysis.

3.1   Data Collection and analysis

Data collection was done in two stages as part of a European University-project called ECIU University. ECIU stands for European Consortium of Innovative Universities. The project fits the study objectives well as ECIU University pilots micro-credentials in a higher education context and offers different types of learning opportunities for learners. First round of data collection was conducted in Spring 2021 with learners. Once the data analysis was done and compared to the literature, we concluded that interviewing administrators who are in a position to issue the digital credentials might give us more insights on the overall benefits of digital credentials. The second round of data collection was conducted in Spring 2022.

3.1.1   Data collection - learners

We chose to conduct semi-structured interviews, as they enable addressing new topics with multi-fold contributing factors via open questions (Saunders et al., 2009). For this study, we used purposeful sampling method (Patton, 2002) to select the interviewees. Since digital credentials are new, using purposeful sampling to find learners who just received digital credentials provided us with in-depth information. Learners were invited from a course offered by Tampere University for the ECIU project, and verified digital credentials were given after successful completion of the course.

Nineteen learners responded to the invitation. Of the 19 respondents, two were women (10.5 %) and 17 were men (89.5 %). Sixteen (84.2 %) had a bachelor's degree and three (15.8 %) had an upper secondary school certificate and were currently working towards their bachelor's degree. Nine (47.4 %) of the respondents were between the age of 20 and 24, and ten (52.6 %) were between the ages of 25 and 29, while the average age of the respondents was 24.5 years. All the respondents were students at Tampere University at the time of the interviews. We conducted the interviews during Spring 2021. They lasted from 33 to 75 minutes, with an average of 49 minutes. The interviews were conducted remotely using Microsoft Teams and were recorded with their permissions. The interview questions were based on EVT-based surveys used in the studies of Wigfield & Eccles, (2000) and Kosovich et al. (2015). We adapted the questions to focus on the extent to which students found micro-credentials to be useful, interesting, and important. The questions also addressed how students perceive their competence to use micro-credentials embedded in corresponding platforms, and what costs do they associate in using them. Majority of the questions were open ended, but towards the end of the interview the respondents were asked to give indicative answers to questions, e.g. "How important are micro-credentials to you, on a scale of 1 to 7?". These answers were asked as respondents had limited experience with micro-credentials (even the most experienced respondents only owned a single micro-credential) and because of this most of their answers were estimates.

3.1.2 Data collection - administrators

In Autumn 2021, all the ECIU consortium partners participated in EDCL Early adopter program (EAP). We chose to expand the study and interview administrators from 11 universities who participated in the EDCL EAP. Nineteen people in administrative roles from 11 universities were interviewed. Of the 19 administrators, 12 were active participants in EDCL EAP meetings. Six women (31.5%) and 13 (68.5%) men were interviewed. The interviews were conducted between February and June of 2022 and lasted between 28 and 63 minutes, with an average of 52 minutes. The interviews were conducted remotely using Microsoft Teams and were recorded with the permission of the participants. Similar to the learner interviews, the structure and questions were based on EVT-based surveys and the questions were adapted to focus on what their beliefs are on the value of digital credentials for the learners.

The analysis of the learner data gave us input for expanding our questions for administrators. For example, regarding ability beliefs, along with the question about "how administrators feel about learners' ability to use the technology now and in future," we also asked a question of their ability to issue the digital credentials.

3.1.3   Data analysis

All the interviews were transcribed. We chose to use a combination of deductive and inductive analysis as the approach for coding process. Specifically, we used EVT constructs as initial categories (Table 1). The transcriptions were reviewed, and the text data was sorted into categories matching the operationalized definition. Similar answers were grouped together until patterns started to evolve in the data. We repeated the same process for the administrator interviews.

Table 1: Categories and definitions

Category	Literature definition (Eccles, 2005; Eccles et.al., 1983)	Operationalized definition (learner or administrator)	Example codes
Ability beliefs	Individuals' perceptions of their current competence to complete an activity	Individuals' perceptions of their current competences to use or issue digital credentials	I believe I am better than most of my peers at using digital credentials (learner)
Expectancy beliefs	Individuals' perceptions of their future competence to complete an activity	Individuals' perceptions of their future competences to use digital credentials	I think I am able to find a way to use digital credentials to benefit myself in the future (learner)
Utility value	How useful the individual perceives completing an activity to be	Perceived usefulness of digital credentials for the learner	Digital credentials can help me get a job (learner)
Intrinsic value	The enjoyment that participating in an activity brings or the interest in the activity	Interest in receiving digital credentials	I like receiving digital credentials (learner)
Cost	Things that the individual has to give up to participate in an activity	Things that the individual has to give up to use/issue digital credentials, including time and effort	I don't think I have to put in too much effort to use digital credentials compared to the value they provide (learner)

4 FINDINGS

The findings of the study are presented in two parts. The first section presents the findings from the learner interviews, and the second section presents the insights from the administrators, which enriched the prior findings.

4.1   Value Perceived by Learners

Each of the learners received their first verifiable credentials in the study. For most, this was the first time they had seen a digital credential, the metadata it carries, and the storage and sharing features. Our findings indicated that the value of micro-credential comes from the digital credential itself rather than the platform used to issue it, which allows users to view or share it. The results of the indicative questions from the interviews are summarized in Table 2. Numerical values that the respondents provided were categorized indicatively to low, moderate, and high, to allow for easier pattern recognition.

Table 2 – Learner's perceived competence and value beliefs

Respondent	Ability belief	Utility value		Attainment value	Intrinsic value	Expectancy belief	Cost
		Short-term	Long-term				
A	MOD	MOD	MOD	LOW	MOD	MOD	MOD
B	MOD	HIGH	HIGH	MOD	MOD	HIGH	LOW
C	MOD	MOD	HIGH	MOD	MOD	MOD	MOD
D	HIGH	LOW	HIGH	MOD	HIGH	HIGH	LOW
E	HIGH	MOD	HIGH	LOW	MOD	MOD	LOW
F	HIGH	MOD	MOD	HIGH	HIGH	MOD	LOW
G	HIGH	MOD	MOD	MOD	MOD	MOD	MOD
H	MOD	MOD	HIGH	LOW	MOD	MOD	LOW
I	HIGH	HIGH	HIGH	MOD	HIGH	HIGH	LOW
J	MOD	MOD	MOD	LOW	LOW	MOD	LOW
K	HIGH	MOD	MOD	MOD	MOD	MOD	LOW
L	HIGH	LOW	LOW	LOW	MOD	MOD	LOW
M	HIGH	MOD	MOD	MOD	MOD	MOD	MOD
N	HIGH	MOD	LOW	LOW	MOD	MOD	MOD
O	MOD	LOW	MOD	LOW	MOD	MOD	LOW
P	MOD	LOW	MOD	LOW	MOD	MOD	LOW
Q	HIGH	MOD	HIGH	MOD	HIGH	HIGH	LOW
R	HIGH	MOD	HIGH	MOD	MOD	HIGH	LOW
S	MOD	HIGH	HIGH	MOD	HIGH	HIGH	LOW

All the learners were quite confident in their ability to navigate the technology, such as the platform where they could store, view, and share the digital credentials with 11/19 (58%) of them expressing high confidence. Most of the learners expressed technology not being a barrier currently to use digital credentials. In fact, they hoped there would be more digital credentials issued and expressed that their motivation to use them would increase as a result.

"*I feel that I can use these myself and I have some visions what I could do with [microcredentials]*". – Fourth-year learner

15/19 (79%) of learners placed the utility value to be moderate or high in short term and 17/19 (89%) learners in long term. The utility value of digital credentials expressed by students is higher for long-term than short-term. 9/19 (47%) of learners expressed 'high' value for long-term and only 3/19 (16%) for short-term. One of the reasons noted by learners for this variance is that digital credentials need to be widely used by institutions and recognized by employers which takes time. Only 4/19 (21%) of the learners found the utility value low in short-term and only 2/19 (10%) in longterm indicating the learners see this as a long-term goal.

The metadata included in the digital credential were the highlight of the digital credential for the learners. Our findings suggest learners like the idea of having descriptive data in the credential and find the descriptions valuable. The learning outcomes, which also include skills and competences associated with the course, gave them an overall view of what they just learnt. Although the data can be viewed in the learning management system, having them in the digital credential, which learners can access along with the course was a feature the learners appreciated.

"I feel that if you pull a transcript of studies from [national information system] the course doesn't... well it's just the name of the course. Here [in the digital credential] you have clearly separated what did you learn on the course. So if you want to keep track of what you have already learned, and I have noticed this myself, that if you categorise the information like it's categorised here it does help you long-term in utilising the information. So you won't just forget about what was done on a course when it's finished. I think that's a useful utilisation of this system. Especially if you could plan out what you want to learn. So, in a sense, you could keep track of what you are and what you want to be." – Sixth-year learner

Only 11/19 (58%) of them felt digital credentials have some importance to them (moderate and high). Our analysis shows that although digital credentials are currently not important to the learners but will be when they are widely available and accepted. 8/19 (42%) learners assigned low importance to receiving digital credentials. Reasons for the low attainment value includes, learners being in their last stages of their current studies and do not feel they can add value to them currently and no current way to share them. A wider array of digital credentials along with wider acceptance seems to be what learners would like and hope to have in future. The more digital credentials they can receive, the better their chances of learning and showing their skills to potential employers. Another practical aspect of digital credentials according to the learners is transferability. For example, to get credit for a course completed at a different institution, learners currently need to submit not only the transcript but also a description of the course, learning outcomes and other details about the course. Transcripts only include limited information, such as the name of the course, the grade, and the number of credits. Learners must find that information in the institution's learning management system. But with digital credentials, all that data already exists, making it much easier way to get credits transferred. Since the digital credential is issued by another higher education institution, which follows similar accreditation, it is trusted as well.

Learners who indicated low importance added that micro-credentials would be more important to them if they were more widely accepted and used or that if they had received micro-credentials from all the courses they had completed in the university. 2/19 (10%) learners indicated that they would consider micro-credentials very important to them if they had a wide array of them.

"You would need to have them all in the same place. If there are only a few courses sharing, sharing them won't bring any benefits." – Third year learner

18/19 (95%) learners expressed either moderate or high intrinsic value. Even the only learner who expressed low intrinsic value said while the digital credentials don't get them overly excited, it would be nice to have them still. We also noticed that 5/19 (26%) learners expressed high intrinsic value in learning about their current skills using digital credentials. They believe it will enable them to choose a path to achieve their final goal. Some of the learners also considered themselves to be early adopters of new technologies, which also plays a role in their higher intrinsic value. The interoperability of the systems was raised as a critical factor, as learners are unlikely to be tied to one system only. The portability of digital credentials (e.g., through common data models) is another feature.

"because they lose value if they are exclusive [to a certain service]." - Sixth year learner

While learners placed high confidence in their ability to navigate the digital credentials, their expectancy value was lower than their ability beliefs. While none of them expressed their future technological abilities to be low, only 6/19 (26%) of them expressed to be high. This is because digital credentials and the technologies used are relatively new in addition to the many unknowns regarding future technologies.

In the long run I think using the system would be made so easy that it wouldn't differ from using the systems we have today. So, I would say it would not be limited by technological capabilities – Third year learner

Our findings suggest that learners believe that digital credentials have high long-term value, and they would like to use them in the future. One of the most commonly reported uses of digital credentials was for job searching.

Learners intuitively felt this would give them an edge since they could present more information about their abilities when applying for a specific job. Our data also show that learners believed that digital credentials with skill-related data would be especially useful when searching for work internationally.

"I could imagine this would be useful when searching for a job. Job-hunting is what first comes to my mind" – Sixth year learner. "… you can't see what is included on a course from a transcript of studies, only thing visible is the name of the course and the grade. At least from this you can see that more clearly … an employer can't have a picture of the course based on the name, because they don't know what is included. For example, something like "Development 1": The name does not say what programming language was used. So, in those cases [digital credentials] would be useful." – Fourth-year learner

Our data indicates learners perceive the cost of receiving and using digital credentials not to be a barrier. 14/19 (79%) learners indicated the cost is low in terms of time it takes to learn the technology and effort it takes to use them. The learners who rated higher cost indicated that they had to use multiple platforms to receive and manage digital credentials and that affects the value of digital credentials as well. Table 3 shows the themes that emerged from the analysis of learner data.

Our analysis further shows that learners' current intentions to start using digital credentials are also affected by factors other than those based on our EVT constructs. According to our findings, the high perceived value of digital credentials is weakened by other factors. We were able to narrow these to (1) personal, (2) institutional, and (3) external factors that affect the adoption of digital credentials. By working on these factors, the value perception could be increased.

Personal factors: The learners indicated that it is a problem that they lack a wide array of owned digital credentials. The adoption of digital credentials is new even for institutions, which explains the lack of a wide array of credentials. We believe that this reduces the learners' value perception since they cannot present their entire array of competences because few courses offer digital credentials'.

Institutional factors: Learners also indicated that it is problematic that institutions - or at least the one they attend - do not award digital credentials to learners to a large extent. This affects their value perception in two ways: (1) learners cannot show their wider range of competences through skill information from digital credentials and, (2) affects the utility beliefs (from STV), such as being able to use them for transfer of credits. This also suggests that if they could receive a wider array of digital credentials for their higher education courses, their perceived value of digital credentials will be higher, and the negative effects of personal factors would be reduced as well.

External factors: The learners felt it was necessary that digital credentials are accepted by the industry. Currently, industry awareness of digital credentials is rather low. One of the key takeaways of the learner interviews is that they believed they were useful for demonstrating their abilities while searching for jobs. Thus, if industry is not aware of digital credentials or does not appreciate their potential, it affects the value perception for the learners. Conversely, when industry recognizes digital credentials and appreciates the data learners can present regarding their abilities, the learners' value perception will be higher.

Table 3 – Values perceived by learners

Category	Theme emerged	Example excerpt
Ability beliefs	Technology usage	*"I feel I have the skills, or that I would learn them if I needed to."* – Fourth-year learner
	Using digital credentials	*"I think you could use this if you e.g. take courses through open university channels, or in the city centre campus and they require certain base level information, you could prove pretty easily that you have that information and you are qualified to take the course"* – Fourth-year learner
Utility value beliefs	Job search	*"if you are searching for work globally, or you are working in a company which has global competition, you can prove that you have a competent degree or that you possess qualified competence."* – Fifth-year learner
	Applying for studies	*"Applying for student exchange - that was agonising, I had to come up with all sorts of files for them and ask for signatures and stuff. But if all my courses would go straight to the "European Standard form", I feel the process to apply for an exchange would have been much easier. The exchange destination university could verify my information more easily … you could also use [micro-credentials] when searching for work, or if you want to apply to a different master's program in another university."* – Fourth-year learner
	Transparency and descriptiveness	*"you get a better overview of the course than in Sisu, where you see just your grade. For example we had to go through a lot to get individual grades from this course, which affect the overall grade, from the course personnel. But in here you can see them straight away, and they are explained clearly, so this is much better, clearly. That all the information is viewable in one place* – Fourth-year learner
	Information overview	*"There's always the trouble when you want to go look at your grade from a course and what affects it and where, because some of the information is in [national information system], some of it is in Moodle and some is in PDF documents in Moodle. So of course, when all of the information is in one place it speeds up and simplifies working."* – Third-year learner
	Comparison with regular transcript	*"Nobody asks for your transcript of studies, but maybe [micro-credentials] would be more meaningful to look at, as there is information besides just the name of the course."* – Sixth-year learner
Attainment value	Importance	*"I think they could help with your professional development, and help a person keep their own competence portfolio in check. You could notice what you are missing, and can help you if you are interested to learn more about something you see you are lacking in. On a short-term, when you are studying, it could help you think about what skills are supported with your current studies and it could maybe help you see what skills are lacking and then you could find studies to support those skills."* – Fifth-year learner
	Learning motivation	*"if this were to take off and gain a larger user base and it would really bring some benefits, then in the future I could actually see myself using micro-credentials as one criteria of choosing courses."* – Fifth-year learner
Intrinsic value	Excitement about digital credentials	*"It would be exciting to see that where I am currently with the skills I have and that I could be on a path where I would like to go, It would make it easy to be aware of what skills I need."* – Sixth-year learner
Expectancy beliefs	Future abilities	*"I believe it wouldn't be too difficult to use. I think I'd definitely know how to send them to whoever wants to view them."* – Fourth-year learner
	Future use	*"I think they are going to be useful in the future, so you could share them to your employer when applying for a job or changing study programs or going to get another degree."* – Fifth-year learner
Cost	Compared to value	*"Right now, it feels like a burden, because information is spread to so many places and you would have to amass it from so many places."* – Sixth-year learner

4.2 Insights on the value of digital credentials by administrators

The analysis of the administrator interviews confirmed many of the findings from learner interviews but also showed multiple other benefits. Regarding the ability beliefs, the administrators felt confident learners would be able to use the technology to navigate the digital credentials now and in the future.

Utility value for learners

The administrators expressed high enthusiasm and confidence in the utility value of digital credentials for learners. Our administrator data analysis also confirmed what the learners said about how they would use the digital credentials. The administrators felt this will give learners an edge, as they could present digital credentials and showcase their abilities better in the job market. With metadata on skills and other competences, the administrators felt the learners could better define their pathways to the final goals. This would help learners navigate academia and learn the skills they are lacking, enabling them to be more proactive in acquiring the skills they want or need. They also indicated that credit transfers and admission processes could become simpler in the future if more digital credentials were issued and used.

"we have institutional strategies and there's a nice phrase one of our directors use – about preparing students for unscripted future" – Micro-credential content development officer

"It's really good because when the students want to take some credit transfer, it's not enough that they have transcript of records where is name of the course and how many ECTS points they have got. We also need information about learning outcomes. Today it doesn't exist in transcript of records. Students always have to when they apply for credit transfer, they always have to describe for themselves or take it from curriculum what is mentioned there. In DCs, if it's stated there, it will be easier for the students.." – Head of unit, Services for Educational Leadership

Administrators also believe that in future learners need to be flexible and adapt continuous learning concept leading them to be more lifelong learners.

"Working market is changing a lot. it's not like you learn this and you are an expert in this, and everyone needs you. You have to be flexible in what your interests are, what your competences are, and your skills are. Therefore, the verification of these kind of sorts, small micro-credentials in DCs are very high advantage for learners." – Project manager

The administrators conveyed high attainment value for learners using digital credentials. We believe the active participation in the early adopter program gave the administrators much broader view of where and how the digital credentials can be used, and thus came to the conclusion that digital credentials would become important to the learners. They also stated that the interest in digital credentials would increase when more digital credentials are issued.

"I think it will be very good for the students because one of the problems when they have the degree and have to apply for the job, they have difficulty explaining to the company what their skills and competences are. If they just have a piece of paper. sometimes it's not good enough and sometimes they have to dig deeper themselves to explain to the companies what they can and cannot" – Chief consultant and co-ordinator

"I really like this because it seems to me that students at different universities can take more of these modules and get credentials for them, which they then can also use their own home universities and so more students have more access to courses and modules and, you know, sources of knowledge. And, you know, what seems also to be a very strong European network. And it's good for them also to engage in these international activities. Because there might be possibilities to engage with other students at other universities through digital activities and what not, so you never know what comes out of this" – Project manager

The administrators did feel the cost of issuing the digital credentials is currently high for the institutions due to the time and effort required to integrate the platform with local learning management systems. The data included in digital credentials, such as learning outcomes and competences, already exist in all the institutions involved in our study. These data have been part of the curriculum for learners. Adding that information to the digital credential is easy but requires some effort according to the administrators. Easy because the data exists but takes effort at the same time because the data exists in different learning management systems and need to be

consolidated. Despite the high cost, all the administrators felt the need to issue digital credentials and recognized the value.

In our administrator data analysis, more themes started to emerge, providing additional insights on how digital credentials are useful for learners and what educational institutions can provide with the help of digital credentials. These themes included not only benefits for the existing or traditional learners but also create opportunities for lifelong learners.

Digital credentials make unbundling easier

The administrators felt that issuing digital credentials would also help them to offer smaller micro-credentials to all students, including "lifelong learners." Lifelong learner can be described as learners who have enrolled full-time in an educational institution or are interested in upskilling or reskilling for other reasons (e.g., career path, change of career). The administrators also stated that learners from one field might wish to take a smaller number of credentials from another field or possibly even another institution. The inclusion of metadata such as learning outcomes, skills and competences and possibly even levels associated with the skills added to the digital credential provides a clear and transparent picture of each micro-credential and makes it easier for institutions to accept transfers of credits. This would extend the value of micro-credentials to more diverse types of learners including wider geographical area.

Verification of credentials

One of the core aspects of higher education institutions is the trust and security of the transcripts the learners receive. Micro-credentials offered by higher education institutions are expected to have the same trust and verifiability. Digital credentials issued by these institutions could be made more transparent by including not only the learning outcomes but also the assessment criteria, accreditation, and a strong verification method such as electronic seal or blockchain technology, thus increasing the trust. The administrators felt having the ability to verify the credentials issued by other institutions and authenticate the ones issued by their institutions is an important feature of digital credentials. This would benefit the learners, as the verification is faster than the traditional method. Currently, for admission and similar situations, learners either have to request the issuing institution to authenticate or send credentials directly to the institution they need to present. This requires time and effort for both the learner and the institution. Issuing digital credentials that have the authentication and verification built in would make the process easier and faster. As more educational institutions start issuing digital credentials, the admission process will become more streamlined.

The institutional and external factors we observed in the learner analysis that affect the adoption of digital credentials also emerged in our administrator data. The administrators also felt that not issuing a wider array of digital credentials and the lack of adoption by industry affect the utility value for learners and thus negatively affect the usage of digital credentials. Another external factor also emerged from the analysis of the administrator data. The administrators expressed that the adoption of digital credentials within their own countries would also affect how and when their institutions could issue and use such credentials. Some of the administrators shared that they also have national registries for students and credentials they issue, such as degree certificates and transcripts, and a major change like issuing digital credentials would depend on national program as well.

As with the learners, the administrators also believed that when the factors that negatively affect the usage of digital credentials are resolved, the value perception for learners will increase. Table 3 shows the analysis of administrators' data for the same themes as the learner analysis.

5   DISCUSSION AND CONTRIBUTIONS

Our analysis based on EVT provided insights on the value perception of learners as well as on some of the enabling factors that could further increase the value perception. Fig 1 depicts the modified Hulleman model (Hulleman et al., 2016), including the enabling factors that would influence learners' value perceptions and intentions to continue using digital credentials. Our findings are consistent with prior research on the influence of ability beliefs on learners' use of digital credentials in future (Eccles & Wigfield, 2002). The learners' high

confidence in their ability to use technology now and in the future indicates it will not be an obstructive factor in their adoption of digital credentials in future. Similarly, the data show that learners perceived the cost of digital credentials to be low compared to the value and so would influence positively on future adoption (Barron & Hulleman, 2015). The learners recognized the value of digital credentials for their future activities, such as job searching, viewing their abilities and transfer credits (Kato et al., 2020; Oliver, 2019). The modified model shows that when the expected success in using the digital credentials and value perception are high along with a low perceived cost, the adoption of digital credentials will be higher. This is a significant insight, especially for higher education institutions in their overall planning of micro-credentials and verifiable digital credentials. Our analysis highlight that the learners recognized the value of verifiable digital credentials and would like to receive a wider array of them. The enabling factors that our analysis found also provide insights into the value perception of digital credentials. The interest in and importance of digital credentials will increase when learners receive more digital credentials allowing them to gain a more comprehensive view of their abilities and proof of their learning. *Our first theoretical contribution to the literature on verifiable digital credentials is improving the understanding of the relationship between different factors that influence learners' adoption of digital credentials.*

One of the major benefits learners perceived with digital credentials is that they can share information about their abilities with employers. This implies that recognition of digital credentials by industry will contribute to an increase in the value beliefs of learners. It is worth noting that while research on micro-credentials has shown that potential employers might not trust the credentials (Kato et al., 2020), this only applies to credentials such as digital badges, as they can be issued by any organization. We would like to highlight here that verifiable digital credentials are issued by higher education institutions and include the same or more information than paper transcripts. These transcripts are accepted by industry as a measure of quality. The learning outcomes and associated skill and competence data are developed in higher education institutions following pedagogical guidelines and quality frameworks. Hence, we argue that the inclusion of these metadata in digital credentials will increase their value beyond that of paper credentials and differentiate them from digital badges. One of the factors the administrators felt equally important is authentication and verifiability using methods like strong electronic seal or the blockchain. This would ensure that the data are not tampered with and can be easily verified. These features of digital credentials also differentiate them from digital badges. In addition, the evolution of standards around the world based on W3C Verifiable Credentials data model (Digital Credentials Consortium, 2018; European Learning Model, 2021), also confirm that the digital credentials differ from digital badges. *Our second theoretical contribution to the literature on digital credentials is demonstrating that verifiable digital credentials are different from digital badges.*
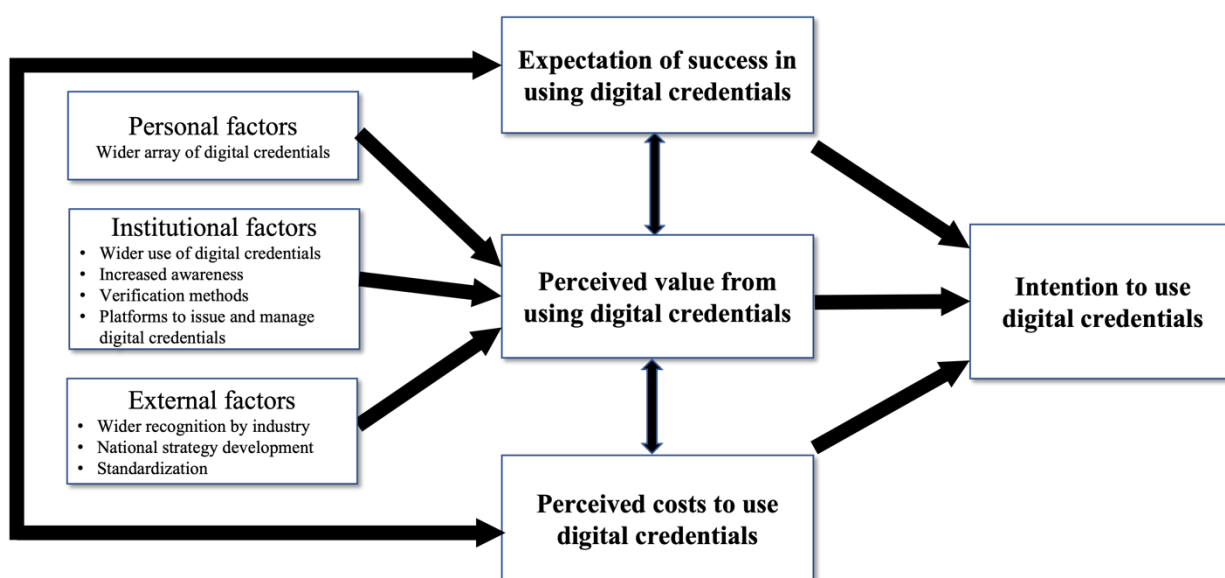
Fig 1. Summary of the research findings on the enabling factors of digital credential value and use intention formation (modified from Hulleman et al., 2016)

Our data and analysis demonstrate that digital credentials issued by higher education institutions provide value to learners. This is significant in at least three ways. (1) It confirms through empirical research what experts and exploratory research have shown regarding learners' positive view of micro-credentials (Ahmed & Jassim, 2021; Ghasia et al., 2019; Kato et al., 2020). (2) It also confirms the emerging definition of a micro-credential as a combination of a short learning offering with proof of learning, including the competences acquired (Digital Credentials Consortium, 2018; European Commission, 2022). Learners participate in a particular learning offering knowing what content they will learn, but our data suggest that receiving a digital credential with descriptive and transparent data for that learning offering is also perceived as valuable by the learners. This is because, they could, at a later day, review what knowledge or skills they learnt in that learning offering. The administrators from higher education institutions also agree with this observation. This leads us to the third significant observation: (3) Learners would like to receive a wide array of digital credentials. From this, we can deduce that they would like to receive digital credentials with rich data, for example, data on learning outcomes and competence related data. Importantly, the administrators' data analysis revealed that such data might already exist for every learning offering in higher education institutions. By receiving the verifiable digital credentials for every learning offering, including micro-credentials, learners can build their portfolio of skills and competences. Further, we argue that by including digital credentials in more of their learning offerings, institutions would provide learners with more information on how and which skills they are accumulating and allow them to better showcase their abilities. This would also allow higher education institutions to plan and unbundle their offerings to create flexible learning paths for learners. *These findings make a significant theoretical contribution by adding to the empirical research on verifiable digital credentials and their value to learners.*

As a practical contribution, we believe our findings provide insights for higher education institutions regarding attaching verifiable digital credentials to credit-bearing short learning opportunities to properly develop micro-credentials. We also strongly suggest that higher education institutions consider different ways to attach skill- and competence- related information to digital credentials, as it would be highly appreciated by learners. Digital credentials could also be used for other types of learning offerings besides micro-credentials. We recommend exploring the options together with students. Although our study illustrates many learners' value perceptions, we recommend cocreating digital credentials together with learners in order to promote wider adoption of digital credentials, awareness of their value and further planning and development.

Based on our findings, we also believe there is a need for discussions between higher education institutions and industry in two equally important areas. (1) Discussions are needed to better understand the skills gap that industry is currently facing and anticipating in the near future. As part of that understanding, in order to prepare future employees for work, higher education institutions should work with industry more closely in designing micro-credentials, including the addition of real-life industry problems for learners to solve. This would enrich the short learning courses with real-life industry needs without sacrificing the high quality expected from higher education institutions. (2) Increase awareness in the industry regarding digital credentials and the rich data it can provide. This will enable employers to see the comprehensive abilities of potential employees, which go beyond a diploma or a transcript.

5.3 Research limitations and future research

We acknowledge certain limitations of our study. First, we acknowledge that the data sample for the learner perspective is limited. This was because awareness of digital credentials is currently low among learners, which affected our ability to find participants. Similarly, the administrators we interviewed, although pioneers in the field of digital credentials, currently have limited experience in issuing digital credentials in practice. Second, due to the lack of empirical research on verifiable digital credentials, we relied on comparing our data with the literature on micro-credentials and digital badges. Third, verifiable digital credentials have multiple aspects, including the verification methods used (Duffy et al., 2020; European Commission, 2022), but we focused on the data the digital credentials carry and the value that learners attribute to the data. The administrator data show that the authentication and verification are important enabling factors and should be examined in future research.

Fourth, the learners as well as the administrators recruited for the study were all located in Europe and so limited in geography. Despite these limitations, we believe the results of this study to be highly relevant and valuable to both the research community and higher education institutions providing insights on digital credentials and value seen by the learners.

Based on our analysis, there are areas for further research. Broader empirical research is needed to further study the potential value of verifiable digital credentials both for learners and higher education institutions. In addition, research is needed on how digital credentials can be extended to other learning opportunities offered by higher education institutions. As the Micro-credential-area grows and more micro-credentials are issued, future research should emphasize surveys with larger number of learners. Not only learners from higher education institutions but also lifelong learners should be included to study how and what aspects of the micro-credentials are valued. Theoretical research on how verifiable digital credentials differ from other forms of recognition is also required to obtain a broader understanding of their value proposition. As our analysis pointed out, receiving a wider array of digital credentials is of interest to learners. This emphasizes the need to study the stackability of these credentials to allow learners to view the abilities and competences they have acquired. Finally, the findings reveal enabling factors that could increase learners' value perception of the digital credentials. Therefore, we encourage researchers to examine how institutions and external sources (e.g., councils) could increase the adoption of digital credentials by learners.

Compliance with Ethical Standards

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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