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Microcredentials as a pathway for the digitisation of engineering degrees

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ABSTRACT

CONTEXT

Responding to the COVID 19 pandemic has seen a sudden influx of digitalisation of engineering teaching through the move to emergency remote instruction. Universities must now choose between reverting back to traditional, largely face-to-face models of education, or moving forwards to more digital native approaches to delivery. Many of these digital native approaches have much in common with the work that is emerging in the field of microcredentials. While often originating in the co-curricular or continuing education space, many of the principles of microcredentials are potentially applicable to engineering degrees, but work in this space is held back by academics either not understanding or misunderstanding what microcredentials are and can be.

PURPOSE OR GOAL

This paper will explore a range of microcredentials, presenting a multidimensional framework of what microcredentials are and can be. It will identify the parts of this n-dimensional space that are relevant for emerging models of engineering education and explore their potential within engineering degrees. It will show that there is an emerging convergence between the objectives of microcredentials and traditional engineering education.

APPROACH OR METHODOLOGY/METHODS

This paper will draw upon the literature and emerging standards in the field of microcredentials, as well as drawing from identified emerging trends in the design of engineering programs. It will also illustrate its key points with familiar but counter-intuitive examples of microcredentials.

ACTUAL OR ANTICIPATED OUTCOMES

The paper will show that the field of microcredentials is much broader than most academics consider, but that current conceptualisations of microcredentials mean that only a very small part of that space is currently in use. The incipient move to digital native models of teaching will inherently lead to learning resources that align with some of the dimensions of the microcredential space. Combining the lessons of both fields will allow for a quicker, more effective and more sustainable transition to new models of engineering education in the future.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Not all types of microcredentials are valuable for engineering education, but the ones that are valuable have the potential to become the dominant modes of delivery for technical content in the future. Providing clear frameworks for what microcredentials are, can be, and should be, will equip curriculum designers to move forward with digital native curricular that can leverage the advantages microcredentials have already demonstrated in co-curricular spaces.

KEYWORDS

Microcredentials, digitisation, curriculum development

Introduction: University teaching is changing

Over a number of years, higher educational institutions throughout the world have undergone a continuous digital transformation that is obvious and necessary (Sjöberg and Lilja 2019), . The COVID-19 pandemic has accelerated this digital transformation even further. New teaching approaches are needed to work with digital technologies if we are not to simply revert back to traditional teaching practices in higher education. This places demands on what universities must be able to do and how they do it. In particular it will affect how institutions relate to employees, partners and students to successfully shape the digital transformation and to use digital technologies to create new opportunities.

The maturation of organisations that is needed for us to move forward in the digital transformation must be helped along and, in that process, it is necessary to work with the way we think and perceive ourselves as organisations (Kræmmergaard 2019). In "*Digital Transformation - 10 skills your organization must master and three that you need"* by Pernille Kræmmergaard, it is described how the technologies themselves are not the crucial part of the digital transformation. "*The crucial thing is the value we can create for our customers (...) in the short and long term*" (Kræmmergaard 2019, pp. 20). Instead, technologies must be seen as a way in which we can bring more value to our customers. They are not the end target in themselves, but the means to reach that target (Kræmmergaard 2019, pp. 20). If we as universities are to help shape the digital transformation and use different technologies to create new opportunities, we need to know something about how the technologies affect us and our world within the organisation and we must use the technologies in a new and ground-breaking way: "*... In the digitally mature company or organization, the technologies are an integral part of mission, vision, etc. ...*" (Kræmmergaard 2019, pp. 22). However, there are few companies and organisations that are at that level of maturity today. Developments towards becoming digitally mature take place step-by-step, some of which are easier to climb than others. As an aid to this step-by-step development, Kræmmergaard developed a model that is divided into five generations, each characteristic of a different level of digital maturity (Table 1).

Based on the model, it can be argued that many universities were in generation one before the COVID-19 pandemic, with IT used primarily in support of face-to-face activities. During the pandemic, many higher education institutions were forced into digital transformation, with their emergency remote instruction taking them to generation two.

As Universities we now find ourselves in a situation where it is necessary to assess whether we will stall in terms of development or perhaps even go back to before COVID-19 or whether we will follow the early adapters and develop the whole organisation even further. If we want to move the organization to generation three, it is about committing the organization to experiment and collaborate with each other and our customers - the students and moving forwards to more digital native approaches to delivery.

There are already examples of digital native approaches to the delivery of engineering degrees, with the majority of regional Australian engineering programs implemented in this way. There are also specific examples of programs that have gone further into digital native approaches, such as the CSU Engineering Topic Tree (Morgan et al, 2021).

The transition to online digital native approaches brings with it an opportunity for a different granularity of curriculum. Asynchronous delivery frees teachers from the need to conform to a central timetable, and in doing so it frees them from the need to conform to a standardised class length. Many of these digital native approaches have much in common with the work that is emerging in the field of microcredentials and have a similar core business which is to deliver education of differing length with flexible schedules. While often originating in the co-curricular or continuing education space, many of the principles of microcredentials are potentially applicable to engineering degrees, but work in this space is held back by academics either not understanding or misunderstanding what microcredentials are and can be.

Table 1 - Five generations of IT and digital maturity (Inspired by Kræmmergaard 2019)

	Gen. 1	Gen. 2	Gen. 3	Gen. 4	Gen. 5
Digitization is about	*Self-service and automation*	*Process improvement and integration of front and backend systems*	*Services in new ways and co-creation*	*New integrated and coherent services*	*Proactive personalised services*
Preoccupied by	*How do we support our practice with IT?*	*How do we implement new systems?*	*How do we develop new (digital) services that are similar?*	*How can we use our own and other systems, data and services to create coherent services?*	*How can we apply technology and data to personalised hyper-relevant, occasional proactive, services?*
Culture and mindset	*Maintaining existing practices*	*To do what we already do better - low risk and "known projects"*	*Doing the right thing – bold and experimental*	*Seek new collaborations and ecosystem mind set*	*Seek new contexts and patterns and insights*
Changes	*Use IT Instead of manual handling*	*New work processes and new IT systems*	*Change culture, new competencies and collaborative relationships*	*New ways to create value, and new forms of organization with many partners*	*New ways to interact with technology, work, learn, think and make decisions and choices*

Microcredentials are out there

Confusion among academics regarding microcredentials is unsurprising given the historical lack of a recognised definition or terminology for microcredentials in practice. Australia has a record of leadership in this space, with one of the earliest definitions coming from Bev Oliver (2019):

> *"A micro-credential is a certification of assessed learning that is additional, alternate, complementary to or a formal component of a formal qualification"*

Despite this early work, confusion still persists even as organisations such as UNESCO are working towards common definitions of microcredentials, noting that "*acceptance and recognition of microcredentials by employers and policymakers is hampered because, among other challenges, there is no universal recognized definition that clearly communicates to lay users, particularly learners, and employers, what microcredentials are*" (UNESCO 2022).

This process of standardising the term "microcredential" is challenging because of the wide diversity of ways that microcredentials can be and have been implemented. In particular, there seem to be a fixation on the idea that there is "one microcredential to rule them all". The standardisation of traditional academic practice has, in addition, been a challenge for acceptance of microcredentials. The core value of microcredentials is in fact their flexibility; but that flexibility in turn resists the development of a single succinct definition for microcredentials.

The Oliver definition acknowledges that microcredentials can be either standalone external elements, or sub-components of formal education programs. This duality of purpose contributes to the potential of microcredentials to contribute to the future of traditional engineering degrees, while still serving the broader audiences that are driven by the flexibility.

Many institutions have introduced different microcredentials in areas other than their core curriculum, focussing on short courses first then postgraduate courses (Selvaratnam & Sankey, 2019). Some institutions are implementing microcredentials in parallel with their core curriculum, offering recognition that can supplement the tradition degree offering. One example of this is the Deakin Hallmarks, where students are able to claim recognition for capabilities or skills that are important in a workplace environment (Jorre et al, 2016), and are rewarded with a digital credential, that can be shared through social media channels or professional platforms.

An example of the dual purposing of microcredentials is the RMIT Creds (RMIT, 2022). These are standalone modules that are also able to be embedded into traditional subjects within the university. This process of embedding allows for students to engage with repeated content only once as they pass through their degree, with the Cred earned in one subject (or indeed stand-alone) serving as evidence of that learning in subsequent subjects.

Often, there is an understanding within the field that microcredentials are by their nature digital, often understood to be video type replacements of face-to-face teaching – the quintessential example of Kræmmergaard's generation two. If we want to ensure that we move forward in the development and use of digital technologies; we also need innovation in relation to solutions and products - including microcredentials. To be able to think creatively and innovatively in relation to microcredentials and to understand the full potential value of microcredentials in an engineering curriculum it is helpful to look at microcredentials more broadly, and the attributes that they possess.

Some (non-digital) examples of microcredentials

Microcredentials are present all around us and they are not new. We all have different microcredentials, all of which have some things in common and some things that set them apart. By considering a range of everyday microcredentials that lie well outside the Kræmmergaard framework, the attributes and dimensions of microcredentials can be explored without the confounding context of the digital environment.

Driver's license

Our first example is a driver's license. The driver's license is government-issued, and it is mutually recognised across the world. In most countries, it is recognised as valid for some time, after which, it is required to obtain a national driver's license. Before earning the driver's license, the competencies are taught by one professional and then assessed by another. A driver´s license has a very long expiration, but it can be revoked. The driver's licence is stackable, and it is possible to expand the licence to also including motorbikes, trucks, busses and so forth.

Amusement Park driver's license

But this is not the only microcredential connected to driving that a lot of us have obtained at some point. In European amusement parks and on some traffic-focused playgrounds, children can earn their own driver's license after a couple of successful rounds. But unlike our previous example, this driver's license is not government-issued and is not taught. Although the assessment criteria are probably not identical, it is assessed. In regard to the longevity of this kind of driver´s license and the revocability, it varies from park to park, and the amusement park driver's licenses do not have mutual recognition.

Sewing machine license

As part of the curriculum in Danish middle schools, pupils are expected to learn to operate a sewing machine and also to sew different simple patterns. This microcredential is taught and assessed by the teacher, and only when the student earns the microcredential-sewing-license, can the pupil start to sew on their own in class. The sewing-machine license is recognised within one middle school institution and perhaps also across neighbouring schools. It does not expire, but it can be revoked by the teacher and assessor.

Karate grading systems

In karate the ranking-system is based on achieving different coloured belts. To earn a coloured belt your karate practice is assessed by a karate teacher and then the belt is awarded in front of your peers. The different belts are universally recognised, but they are not necessarily transferable from one karate club to the other, owing to differences in curriculum and assessment between different clubs. The belts are 'stackable', and they are qualifying which means that you will have to earn each one in the proper order. The belts also represent a very specific set of values. A karate belt is a lifelong microcredential that does not expire.

COVID vaccination certificates

Many governments provide certificates as evidence that their citizens have been vaccinated against COVID-19. While these are neither taught nor assessed in the traditional sense, they nonetheless require specific action to be earned. While they are government issued, they are not necessarily reciprocated globally. The Australian vaccination certificate is not recognised in Europe, even though the vaccinations required for the certificate are themselves sufficient to earn a European vaccination certificate. The microcredential is not recognised, but the underlying activity it represents is transferrable.

Dimensions of microcredentials

Considering a wide range of microcredentials is a useful way to identify the different attributes of these microcredentials. Some of these attributes are obvious, whereas some require deeper reflection to identify. Similarly, some are of value to the student, some to the provider, and others are valuable to third parties. There are many different dimensions that can be used to describe microcredentials, and these are coalescing into standards. Some of the key dimensions to consider are:

Volume of learning

A key feature of microcredentials is that they are as long as they need to be. While there are certainly emergent common lengths ("half-day training session" anyone?) microcredentials take advantage of the ability to make their learning as long or as short as they need to be. Indeed, for many self-paced microcredentials they are functionally as flexible as the learner needs them to be – they can move to a mastery learning paradigm where the learner takes as long as they require in order to meet the expected standard.

Stackability

Many microcredentials are described as "stackable". Each stackable microcredential is valuable in and of itself, but they are designed to be stacked together to form a more useful larger grouping. These can be stackable on the level of proficiency, as is the case with coloured belts in martial arts. Students are expected to demonstrate higher and higher levels of proficiency in order to attain the higher level belts. Microcredentials can also be stackable on the level of adjacent competencies, such as the case of a driver's license. A truck license stacks on a car license – they have some similar skills in common, but the truck license requires additional extended competence.

Standards and Recognition

A key part of the value of a credential is whether you can trust the standards to which it is assessed. Microcredentials offer a wide range of options with regards to how they assess: some are attendance only, some are assessed to internal standards, and others are assessed against recognised frameworks set by external bodies. Ultimately it comes down to who you want to trust that the learner is competent. Do you trust the provider of the credential? Or do you trust the body that developed the standards that are used by the provider?

This dimension can be further broken down by who actually undertakes the assessment. Does the provider do the assessment, or do they use assessment instruments from others, or do they have someone else do the actual assessment?

Verification

In order for a microcredential to be valuable, it must be verifiable – third parties must be able to confirm that the learner has in fact earned the microcredential. The simplest – and potentially least valuable – method of verification is a certificate of attendance. Giving all the attendees in the room a piece of paper that says they were there is easy, and simple to implement for both the provider and the learner. Unfortunately, this ease of use means that they are also easily counterfeited, and as a result they are potentially difficult for a third party to trust. The format of the microcredential is important when it comes to determining how easy it is for third parties to verify that it is authentic.

Trustworthy verification requires the ability for third parties to check with the provider that the credential is (still) valid. Providing validation represents an ongoing cost for the provider; but it comes with the benefit of the increase in trust of the specific credential. Validation can be a light touch, such as the Luhn algorithm that verifies that a credit card number is real; or they can be real-time registers that have to be maintained every day.

Which dimensions do Universities focus on?

The strength of universities has long been the trust in the credentials that they provide. Initially this came from having a monopoly over the smart people; only a university had the critical mass of people with the specialist knowledge to provide advanced education. More recently universities have provided trust in their credentials through their quality assurance processes. Australian universities are self-accrediting institutions; while TEQSA reviews universities' quality assurance processes, they do not make judgements at the individual degree level.

Stackability is also an important dimension for universities, noting that it usually manifests in much larger size blocks than in the microcredential space. Concepts such as credit points, or ECTS, are nearly universal in higher education, and degrees are comprised of stackable blocks we call subjects. Engineering degrees in particular have long prerequisite chains where students are required to complete subjects in a particular sequence in order to be able to understand the material they are learning.

Historically, universities have been responsible for both the teaching and the assessment of the material in their degrees. They maintain control over both the learning environment and the assessment environment, and in doing so they are able (as far as is possible) to guarantee the learning outcomes for each student.

This coupling is weakening, however, as newer forms of assessment become more prevalent. In particular, the concept of portfolio assessment allows for students to be assessed on things that they have learned in places other than a university-controlled classroom. This approach is particularly powerful in workplace learning contexts, where students acquire all sorts of tacit knowledge as part of their internships and can demonstrate this through a portfolio.

Other forms of teaching, often outside the university, round out the taught / assessed quadrants (table 2). Online resources such as MOOCs can often represent a situation where material is taught but is not assessed. A certificate of attendance is evidence of attendance, but it is not necessarily evidence that anything was actually taught nor actually learned.

Universities have traditionally operated in quadrant one of Table 2; but they are increasingly utilising approaches from the other quadrants, which align more strongly with microcredentials. These other quadrants present opportunities in the flexibility that they can offer engineering curricula in the future.

Table 2: Approaches to teaching and assessment

	Taught	Not taught
Assessed	Traditional university subjects	Portfolio
Not assessed	MOOCs	Certificate of attendance

Conclusion: There is a convergence

There are emergent similarities in the affordances of traditional engineering curricula and microcredentials. Recent developments in higher education are seeing the two approaches beginning to converge: engineering degrees are seeking the flexibility that microcredentials provide, while microcredentials are seeking the trust and credibility of the university environment. This convergence provides an opportunity to advance the development of engineering curricula by drawing upon the experience and learnings of the microcredential community.

Emergency remote instruction has pushed many engineering schools to Kræmmergaard's generation two. Drawing upon the experience of microcredentials will allow engineering educators to more rapidly move to generation three and beyond. Building on the emerging standards and experiences of microcredentials will allow engineering educators to skip some of the early prototype phases of flexible curriculum development. Many of the earlier lessons have been learned elsewhere already; by transferring that learning we can improve the quality of our flexible curricula, while reducing the risks involved in making the transitions to new modes of teaching.

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