Article

Badging for Sustainable Development: Applying EdTech Micro-credentials for advancing SDGs amongst Mountain and Pastoralist Societies

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Abstract: Mountain and pastoralist societies around the world have for centuries sustained their livelihoods and cultures by accumulating specialist knowledge about their local and regional socio-ecological environments. Developing traditional knowledge and customary practices takes time, sometimes spanning across generations. As macro-level changes to social and natural environment are now taking place, such as globalization and climate change, local communities could potentially also benefit from complementary, suitably adapted educational opportunities for sustainable development. However, access to education has often required moving to urban centres, which can weaken community structures and cohesion, and could also foster increased dependence on external specialists, providers or decision-makers. Careful introduction of emerging Educational Technologies could alleviate and possibly reverse such trends as mobile Internet access spreads to remote areas. This paper examines the role of education in sustainable development and specifically explores the potential for two educational innovations, open badges and blockchain, to provide a new construct for transformation in sustainable development amongst mountain and pastoralist societies. These technologies could not only facilitate education through online distance learning, but also allow geographically remote populations to highlight the value of their traditional knowledge and to engage more comprehensively in their changing worlds.

Keywords: education; skills development; online distance learning; credentials; open badges; blockchain; sustainable livelihoods; sustainable mountain development; traditional knowledge; culture; Kyrgyzstan; Central Asia.

Introduction

As the influences of geography and culture on *development outcomes* can be substantial, process approaches which emphasize local contexts, problem solving and iterative learning are now broadly preferred to standardized, non-adaptive 'blueprint' development programming approaches [1–4]. In mountains, physical challenges arising from local realities including harsh and unpredictable environments, limited access and political marginality often intersect with complex sociocultural and ecological contexts [5–7]. Such circumstances highlight the need for specially tailored, flexible and adaptive measures in development initiatives, to enable effective responses with lasting outcomes.

Mountainous regions encompass around 22% of the world's land area and provide water for a large portion of the world's population, including more distant, downstream urban centres. High levels of biocultural diversity also are common in mountain areas, though traditional livelihoods are increasingly threatened by globalization as well as climate change, which disproportionately affects mountain regions [7–12]. Furthermore, although pastoralists live in many different environments,

they are predominant in mountain regions, such as the Himalayas and Central Asia, and contribute directly and indirectly to the development and maintenance of mountain ecosystems [13–20].

While many governmental and large non-governmental organizations (NGOs) are acting to protect these areas and communities, such top-down intervention may not be sufficient. One of the major challenges of our times is to recognize, accept and appreciate the multiplicity of knowledge systems and 'ways of knowing' amongst people around the world [21–25], as these are the only proper starting points when engaging with the 'other' within the so-called development entreprise. Recognizing the essential roles of place and culture in achieving sustainability [26–27] and finding appropriate mechanisms or tools that in essence facilitate the natural expression of mountain voices and local visions for the future is of paramount importance for ensuring marginalized populations develop through self-empowerment rather than being transformed into cultures of dependency.

In many instances, however, *development pathways* are seemingly already 'set' – with broad trajectories in place and futures largely determined, or at least significantly constrained by decisions made at critical junctures in the past – at least until a new 'spark' (a novel idea, new instrument, etc.) is introduced that alters the equation. Development pathways are "the particular directions in which interacting social, technological and environmental systems co-evolve over time"[28] and any possibility of *sustainability transitions* is broadly understood as being contingent on the co-evolving nature of both technological and societal change [29].

Recent advances in the democratizing of science, on one hand, and in encouraging and enabling greater agency of the stakeholders most affected by development interventions, on the other hand, are now beginning to converge [30–33], and in the process they are encouraging adoption of more grounded approaches in development. This has been enabled in large part by the crossover between information technologies, such as smartphones, and educational technologies, in particular new apps and platforms for the collection, management and analysis/use of relevant data and content. Taken together, these emerging tools and approaches may now be further repackaged in such a way as to provide new impetus for change – with new ideas or novel applications of existing opportunities that can actually make a difference and bring about desired development outcomes. *Identifying such innovative or inspiring sparks* – and the processes they can enable – has great potential to enable broad transformations in society, leading toward greater sustainability.

Background

Inasmuch as effective access to quality education (including training opportunities, formal and informal) is deemed to be both a fundamental right and a precursor for development [34–38], not only appropriate *content* but also appropriate *forms of delivery* must be identified to ensure that the outcomes sought are achieved in each particular context. In mountain geographies, where livelihoods and sociopolitical characteristics differ from lowlands and where globalization and climate change pose particularly daunting (sometimes even existential) challenges for people, could emerging and rapidly evolving educational innovations and technologies provide us the necessary critical new ingredients for developing solutions at the interface of information and educational domains, where other approaches in development have seemingly thus far failed?

While global SDG targets for *Quality Education* are laudable, the majority of education-oriented interventions to date have shown only limited success in some contexts, particularly for pastoralists and nomadic or seminomadic societies [39–42]. All too often, 'schools' and 'education' have been (wrongly) conflated, and inappropriate indicators selected to measure success. However, new technologies grounded in widely-endorsed educational theories can help resolve, or at least mitigate, some of the main challenges. *Alternative Basic Education* (ABE) and *Open and Distance Learning* (ODL) in particular are increasingly recognized as relevant frameworks and policy responses for the provision of educational opportunities for mobile/pastoralist societies:

"Beyond mobility, the professed strengths of ABE compared with static mainstream provision [of education] are flexibility over curricular content and entry qualifications for teachers; respect for community social values; and capacity to investigate and respond to demand. [Additionally] experience has shown that if mobile pastoralists feel that educational provision is responsive to their

needs and priorities, and if the distance between child and provision is minimised, they are more willing to enrol both boys and girls [43–44]."

For its part, ODL "offers learning without barriers of time, place, pace or methods of study [45]. *It is the only delivery model that really has the capacity to go to scale* and enable the participation of learners who have complex patterns of movement, and there is increasing policy-level awareness of its potential to deliver on commitments [39, 46]" [40] (emphasis added) (also see [47–49]).

Whilst we must remain aware that the measure of 'success' in educational interventions must not focus primarily on project inputs (e.g., financial investment or introduction of new technologies), or even outputs (e.g. curricula, student numbers, etc.), but rather on *educational outcomes*, nonetheless recent advances in educational technologies (as presented herein) could provide an effective means to redress some of the remaining development gaps in ODL, especially as applied for marginalized populations in mountain geographies and pastoralist societies.

Specifically, we argue that use of now widely available smartphones (even with limited Internet connectivity) together with *digital badges* to document achievements (this study) can help 'close the gap' in the educational entreprise – largely by bringing "structured flexibility" [4] to the development process. ODL allows increased access to educational materials that, appropriately designed, could allow individuals to engage with increasingly personalized learning opportunities. Digital badging can both motivate learners with personal records of achievements [50–51] and provide them with credentials that may be transferred to educational programs and institutions, allowing learners more opportunity to transfer, as necessary or desired, into other sectors of the workforce or educational systems. Encouraging learners to progress through a series of small, culturally-relevant educational packages that address personal educational goals, and "badging" their successes in a way that motivates them and validates their achievements, could greatly enhance the overall level of attainment of development goals such as the Global Goal (or SDG) #4, *Quality Education* which aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" [52]. Several of this Goal's ten targets [38,53] could benefit substantially from emerging technologies and approaches such as *smartphones, ODL* and *digital badges*, especially when linked with new *blockchain* technology [54], to enhance content, forms of delivery, and learner motivation – particularly for hard-to-access mountain and pastoralist sociocultural contexts.

Structure of Article

This article provides a review of the literature at the intersection of sustainable development and educational technology with the aim of highlighting how *digital badges* (or *micro-credentials*) could be utilized as a key to unlock a range of culturally appropriate (internally driven, situationally viable) sustainable transformations for mountain societies. The article then proceeds with general discussion of Educational Technologies in context of Sustainable Development, including the presentation of a 'sample intervention' that applies global experiences to local specificities of Central Asian mountain societies, with the aim to clarify how open and distance learning, assessed and credentialed through digital badges, could bridge several cultural characteristics that otherwise might prevent adoption of educational or other learning pursuits. A final section summarizes findings and future steps.

Education for Sustainable Development

Since the 1987 Brundtland Commission Report "Our Common Future," there has been continual debate about the exact meaning of sustainable development and the means of attaining it [55]. The Brundtland definition focused on sustainability as meeting the needs of the present without putting the future at risk, but it did not clearly define "development" other than to say that it involved the three pillars of environmental, economic, and social factors [56]. Since these three pillars are not clearly discrete, researchers have attempted to distinguish the social pillar from the economic pillar by arguing that the social pillar specifically involves customs that build trust and reciprocity [57] or "the norms and networks that facilitate collective action" [58]. Although ongoing discussions show differences in emphasis and nuance, it appears clear that the social pillar of sustainable development involves the human capacity for problem-solving relationships. As Bryant Myers has pointed out,

"poverty is about relationships that don't work, that isolate, that abandon or devalue" [59], therefore sustaining communities, particularly in an era of globalization, involves developing their capacities to build problem-solving relational networks.

For instance, mountain and agro-pastoralist populations often face significant challenges to access formal educational opportunities under current systems due to their unique environmental and livelihood situations. However, complex social-ecological systems have developed over many generations in mountain regions in response to the needs and opportunities of their environments, as seen, for example, in the Pamirs of Tajikistan (Figure 1). In the Tibetan Plateau region, herders use flexible, adaptive approaches to emerging digital technology to coordinate important decisions and movements (Figure 2). In the Altai Mountains of northern Xinjiang, Kazakh communities undertake seasonal migrations to sustainably manage their natural resources (Figure 3). All of these endeavors depend on well-developed traditional knowledge systems developed by local communities; yet, with current speeds of change in the 21st century, as well as the breadth of transformations taking place, it is unlikely that traditional systems alone will ensure the adaptations necessary to ensure a sustainable future. Access to appropriate educational approaches and to relevant new knowledge is required for sustainability to materialize in practice.

However, much of the literature on sustainable development either mentions education only in passing or mentions it as something provided to the world's elite in the hope of a trickle-down effect for marginalized populations. For instance, Bossel argues for a holistic approach to evaluating sustainability [60] but never directly addresses education. The University of Bern's Centre for Development and Environment (CDE) acknowledges the need for building communal knowledge, but largely outsources the responsibility, saying "This is done by building and supporting strong institutions for equitable and inclusive development through grants, remittances and contributions by the private sector and NGOs" [61]. The Swiss Agency for Development and Cooperation (SDC) agrees that development requires "fostering knowledge generation, dialogue and sharing of information and experience between stakeholders" [62] but gives no indication as to how this should be accomplished.

Figure 1. Complex mountain social-ecological system in the Pamirs mountains in Gorno-Badakhshan Autonomous Oblast (GBAO), Tajikistan [63]. Photo credit: Matthew Emslie-Smith.

Figure 2. Kham Tibetan herder whose flexible, adaptive approach led him to be an early adopter of emerging digital technology on the Tibetan plateau, in Qinghai, China [64]. Photo credit: Marc Foggin.

Figure 3. Kazakh herder undertaking seasonal migration to traditional summer pastures in the Altai Mountains in Xinjiang, China, within Liangheyuan Nature Reserve [65]. Photo credit: Marc Foggin.

While much has been written about Global Education for Sustainable Development (GESD), most of it revolves around questions of how to introduce Sustainable Development (SD) themes into

the curriculum of schools and higher-education institutions (HEIs) of developed nations [35,46,62–65]. However, as long as SD education is broadly focused on the urban elites who attend HEIs, it will be seen in some respects as working "against the interests of developing countries in some ways reinforcing international inequalities" [70]. The core countries control the content, finances, and standards of the educational systems; control the language used for instruction and research; control the media that normalizes the ideology of globalization; and control the means that encourage the migration of the most gifted students and scholars away from peripheral areas [60,65–68]. Such disparities in leadership and decision-making seem unlikely to result in equity.

Simply put: for sustainable development to occur, education must not only affect the top decision-makers for societies but must equally empower marginalized communities to develop their own capabilities [55,69]. For instance, in the case of mountain societies, climate change requires either adaptation or emigration [6,70]. Emigration, even for the sake of education, causes an increase in urbanization, a range of losses within communities and cultures, and the loss of a local labor force that can care for the environment by sustainably managing livestock populations as well as local partners suitably engaging with and able/willing to enforce environmental policies [71–72]. How, then, could an educational system incorporate members of mountain societies as stakeholders, not only as users but also in developing curricula that empower them to increase their knowledge, work with teams to solve local problems, and interact effectively with wider society at regional and global levels?

The Emergence of Educational Technology for Sustainable Development

An answer to that question may arise from the relatively new field of educational technology (EdTech). Technology has always been a part of education, but it has gained new momentum with the recent emergence of Web 2.0 in the early part of the 21st century [78]. The term *Web 2.0* is commonly used to refer to the socially interactive and collaborative functions of the Internet, such as wikis, collaborative documents, chat rooms, online forums, and social media communities. These tools have allowed EdTech to move from developing tools based on behaviorism, such as electronic flashcards, to tools based on constructivism, such as group research projects. Lev Vygotsky first articulated the principles of constructivism in the late 1920s – postulating that knowledge is a social construct and, therefore, learning happens most effectively when learners are working in a community to construct a solution to a problem. Since the translation of his work into English in the 1960s and 1970s, these principles have provided the theoretical foundation for problem-based learning, project-based learning, service-learning, group discussion, and almost every other activity involving learners collaborating to find solutions [74–76]. If education in mountain and pastoralist societies could be provided via Web 2.0 technologies, then not only would "compulsory education" no longer need to remove students from their predominantly rural environments, but the educational entreprise could help build their capacities for collaboration, communication, research, and creative problem-solving. In addition, as social media tools increasingly integrate audio and video elements, learners have increasing opportunities to both learn from and contribute to educational processes through direct observational elements rather than requiring foreign-language literacy [77–78].

One of the difficulties of constructivist methods, however, is that the collaborative construction process is difficult to assess in comparison with the more obvious results of reinforced behaviors. This has led educational institutions to increasingly define learning largely in terms of demonstrated competencies, rather than through standardized test results or time spent in a classroom [79–82]. Since competencies involve demonstration of a skill, learners may choose a variety of ways to attain and showcase that skill, and their success can be measured relative to the goal. This allows the implementation of gamified learning, as learners receive challenges that result in rewards when met. These aspects of gamification combine behavioristic reinforcers with the social and problem-solving aspects of constructivism, creating a learning experience with almost universal appeal – as demonstrated from global phenomena like World of Warcraft, Second Life, and Pokemon Go [83–85]. As Jane McGonigal, one of the early developers of World of Warcraft, has observed, social gaming combines urgent optimism, a social fabric, a sense of productivity, a connection to a larger goal, and

hopeful characters – all of which also have been identified amongst the core aspects of the social pillar of sustainable development [91].

Digital Badges

In addition to online distance learning (ODL) founded on constructivist methodologies with gamification elements that provide motivation while developing social capital, 2011 saw the emergence of another EdTech tool that can facilitate education for sustainable development: the digital badge. Digital badges were first developed for the gaming industry in 2005 to allow players in online multiplayer games to record their accomplishments. Mozilla's Open Badge Interface (OBI) in 2010 established an open-source protocol that allows anyone to create or receive a badge. The JavaScript Object Notation (JSON) protocol embeds an image file with metadata including the identification of the issuer and recipient, the date of issue, the title of the badge, a descriptive list of competencies demonstrated, the criteria for assessment, a link to a digital artifact verifying the badge, and an expiration date [87–90] (Figure 1). As open-source objects, badges are owned by the recipient and can be stored electronically and shared in any digital environment. Whereas the value of traditional educational credentials such as transcripts or diplomas has for hundreds of years depended on the reputation of the issuing institution, the value of badges as an educational currency depends more on the quality of the embedded digital artifact [96].

Blockchain and Certification

As badges were being developed in the gaming world and moving into EdTech, bitcoin was being developed as an alternative to traditional currency in the Fintech world. Bitcoin was first conceived by the pseudonymous Satoshi Nakamoto in 2008 [97] as a means of producing unalterable digital ledgers of accomplishments. Nakatomo proposed a means of storing information across multiple servers simultaneously, preventing any single participant from altering the record. This technology, called Blockchain, allowed sequences of transactions to be recorded and verified without any single owner of the transaction records. For instance, whereas, traditionally, banks were responsible for keeping track of how much money came and went from an individual's account, Blockchain allows this same service to be provided without depending on a financial institution. Although there were fewer than 10,000 blockchain transactions in 2009 [98], the technology has grown quickly, leading some at the World Economic Forum of 2016 to name it "the biggest disruptor to industries since the introduction of the Internet" [99]. Blockchain technology is forecast to disrupt "any field of activity that is founded on timestamped record-keeping of titles of ownership" [100] — an observation that has direct implications for educational institutions and records, as elsewhere. By linking educational badges together through Blockchain, yet a further credential appears: Blockcert. Blockcert has the potential of providing chains of educational achievements that can be used to verify courses of study, providing an alternative to traditional academic degrees [100].

The badge-data-credential relationship can be imagined as three layers of information in one file (Figure 4). The first level (a) is a visualization of the badge, highlighting basic information such as branding, an achievement, and a level. The next level (b) is the data embedded in the badge through the JSON coding. This can include links to other digital artifacts as evidence of achievement, and it can include hashes linking it to other badges. These chains of badges, if stored through Blockchain (c) collectively constitute the learner's digital record. The image and embedded data are unalterable due to the JSON code, and the connections between badges are unalterable if stored through Blockchain. The result is a fully-verifiable and unalterable record of educational achievements.

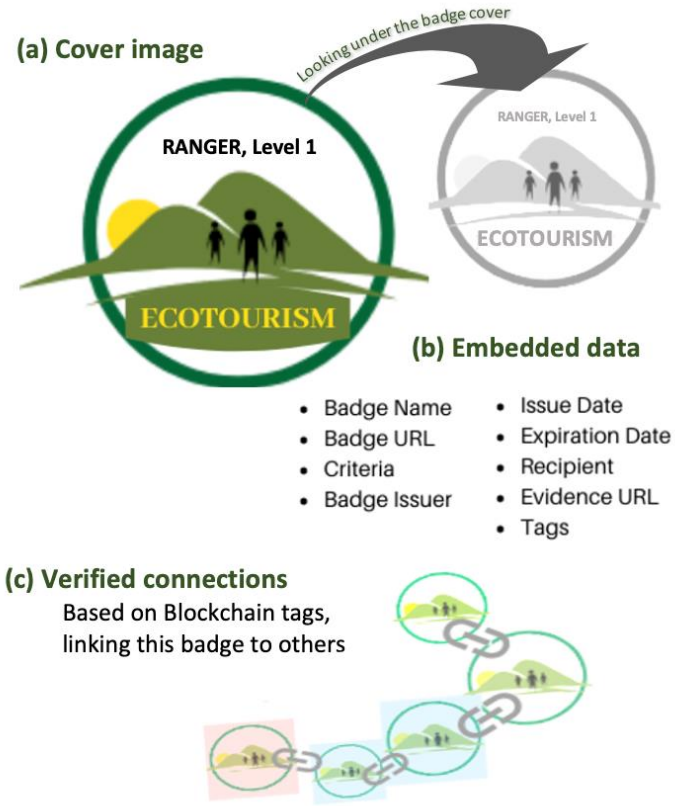

Figure 4. Opening Open Badges: Visual representation of types of data contained in digital badges and how they can be linked through Blockchain to provide a synthesis of verified achievements.

However, as Friesen and Wihak noted, "It is one thing to bring educational content and credentialing data to the celebrated speed and ubiquity of the Internet; it is another to establish fruitful connections with systems of economic value and social capital" [101]. New questions arise. *How could universities or employers know the value of the badge? How can they be institutionalized? How can they be systematically disseminated?* These questions have yet to be answered.

Open badge technology was first developed only in 2010, and badges did not become major influencers in education until 2015 [78]. However, they are spreading rapidly:

- Universities in Canada and the United States are developing micro-credentialing platforms that compile badges sequentially to form the equivalent of a traditional academic credential [102];
- Programs offering professional development for teachers and medical workers are using them in the North America, Africa, and Australia [97–100];
- In Kenya, initial studies are underway to use badges for cloud-based university that could be accessed through mobile devices [101–103];
- City governments and NGOs are using them in supplemental education programs [104–105];
- Public and private universities are re-examining their admissions practices to incorporate badges [112];
- Higher-education institutions worldwide are considering their impact as members of the Millennial generation increasingly choose to leave the educational system once they have enough badges to find a job [107–111].

Although there are no large-scale attempts to restructure educational systems completely around badges, diverse populations worldwide are increasingly recognizing their value [112–114].

Here we propose that not only is "ODL, validated by badging" a potential breakthrough tool for sustainable development, but cultural values present in some societies may render them particularly receptive to adopting these technologies for positive educational reform.

Case Study from the Mountains of Central Asia

Not only are open badges (or micro-credentials) a potential breakthrough tool in education for sustainable development, they are ideally suited for mountain communities in Central Asia. This region became independent in 1991, and Central Asia's oldest educational institutions date back only a few generations. Moreover, the educational system in most of the countries is crippled by lack of funding, corruption, and lack of teachers [111,115–116]. All of the countries have large portions of their populations geographically marginalized from most of the educational system (Figure 2), making them ideal candidates for ODL approaches. Furthermore, mountain pastoralists tend to have "a flexible, opportunistic approach to all aspects of livelihood" [76] and are thus ideal candidates for the "just-in-time" learning approach as facilitated by badged learning [123] (Figure 2). Many people in Central Asia's mountain societies also tend to have cultural affinities with Western Millennials, whose preference for badging is shaking traditional HEIs. In terms of Hofstede's cultural dimensions, these two distinct and geographically distant groups nonetheless share several important features, including a short-term orientation, a combination of individualism and tribal identity, and a preference for indulgence over restraint, which tend to attract them to similar educational institutions and methods [118–119].

What could constructivist ODL verified by digital badges look like in the high mountains of Kyrgyzstan? Communities wishing to expand their capacities in community-based tourism could advertise themselves with badges containing links to videos verifying their safety, hygiene, or food preparation techniques. Pastoralists could partner with scientists to recognize their familiarity with wildlife species and receive badges demonstrating their proficiency with GIS, camera traps and other tools. Mountain guides could demonstrate their skills by badges with videos pertaining to specific terrains or outdoor sports. Translators could verify skills with badges showing them in conversation.

For instance, consider applying badging and Blockchain technology to the field of ecotourism for sustainable development amongst mountain communities. Community members could receive training via ODL in principles and skills in the realms of hospitality, business management, horse riding safety, mountain guiding, and even foreign languages. This training would be based on mastering specific competencies that could be verified by photo or video evidence, such as a video posted on YouTube of a potential Kyrgyz guide explaining and demonstrating her or his horse riding skills, animal welfare and/or client safety in English. The video evidence could be embedded into a badge and presented on the guide's personal social media or national ecotourism webpages. As the badges accumulate, they could be gathered via Blockchain to show mastery of a wide variety of relevant skills, thus attracting more clients.

At the same time, clients also could receive badges for the skills that they develop through the ecotourism experience, such as setting camera traps for monitoring wildlife, horseback archery, or climbing frozen waterfalls. Further, as tourists show such unusual credentials via social media, the ecotourism market could expand, allowing mountain communities to develop in new ways with a growing tourism market supportive eco-friendly sustainable development.

Concluding Remarks

The central role of education in sustainable development has for too long been overlooked, either limited to the establishment of schools or educational programs in traditional educational institutions that are for the most part far removed, both physically and figuratively, from mountain and herding communities, or failing to be appropriately leveraged to integrate competing interests into a common vision for the future of mountain regions. Education does more than impart information – it has the potential to bring people together [126]. The growth of Internet-related infrastructure in remote mountain areas combined with Web 2.0 technology and ODL programs now allows people to access education without leaving their communities. The recent innovations of Blockchain and badges allow the verification of ODL as well as the verification of other specific skills. If this technology were used to provide mountain communities with the personalized training they need, and a way to verify that training for people outside their immediate community, they may have at hand new ways both to preserve and to develop their communities, their livelihoods and their cultures.

The best route to implementation would begin with local stakeholders becoming early adopters – proven to be feasible, e.g. in the case of pastoralist communities in Naryn, Kyrgyzstan co-creating relevant knowledge on basis of digital technologies to support decision-making [127] – and recruiting local people of influence to oversee the program in partnership with outside technical specialists [128]. As international stakeholders from the development or business sectors become aware of the value of badges, especially over potentially corrupt degrees, the perceived value of the currency would increase [129], and as professionals such as teachers and healthcare workers use them for their own development, they would become normative [130].

However, education for remote populations has never been easy or straightforward and there will of course be obstacles to overcome. Change may threaten some individuals who currently benefit from established educational systems or from the exploitation of marginalized populations. The advantages of any EdTech innovation also depends on infrastructure, therefore the benefits of this approach still would be limited to populations with at least some access to the Internet. Additionally, all systemic changes involve a range of unforeseen consequences in diverse sectors of society.

However, if and where quality education is made more accessible and as educational outcomes are achieved by an increasing portion of target populations, greater social cohesion also would likely result. For example, enhanced education and related socioeconomic attainments may lead to a lesser perceived need for out-migration and dependence on remittances, in turn resulting in strengthened cultural identities and sense of wellbeing. With culturally-appropriate and educationally valid ODL as means, combined with unalterable digital badges for verification, these types of change are now realistic possibilities.

With the promise (or at least the potential) of such badges already being recognized in the so-called developed world as an alternative path to job success through "targeted, bite-sized chunks of education"[119], their use may offer something even richer for communities in developing countries. Digital badges offer an opportunity to access further education with content and delivery designed for unique geographic, cultural and livelihood settings; particular needs, interests, and aspirations; current skills and knowledge, along with diverse 'ways of knowing'; and seasonal time constraints. In short, ODL and digital badges may be the means for mountain children to access basic education, while their parents may gradually attain an 'executive masters' in sustainable development (i.e., a degree specially designed for mid-career professionals, who remain in full time employment).

Digital badging as novel approach, as a spark that enables transformation, can furthermore bring opportunity for people not only to receive information and knowledge, but even more importantly also to co-create new content and learning systems, thus contributing to future knowledge as part of an inclusive development and learning entreprise in the fullest possible sense of the term.

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