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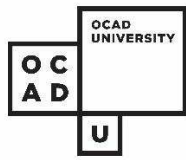
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Life-Long Learning on the Inclusive Web

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Life-Long Learning on the Inclusive Web

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ABSTRACT

If our formal education systems were to be graded on achieving the following assignment: *“to enable all students to reach their diverse, full potential, so that they can be prosperous, self-guided contributors to our global community,”* our systems of education would be flunking. The impact of this failure will exponentially worsen over time, given socio-technical trends. To achieve this crucial learning goal we need more than incremental improvement. We need disruptive innovation. Can the Web be the disruptive impetus and generative scaffolding for an education system that can achieve this goal? How can we both reform and leverage Web accessibility approaches to support this mission? These are the questions explored in this article. Complex adaptive systems, emerging decentralized systems of trust, “small” and “thick” data analytics, Internet of things sensing, open platforms, but most importantly -- connected communities, are all recruited in the thought experiment to craft a candidate response.

CCS Concepts

• **Information systems~World Wide Web** • *Information systems~Information retrieval* • **Human-centered computing~Collaborative and social computing** • **Human-centered computing~Accessibility** • **Social and professional topics~People with disabilities** • *Social and professional topics~Governmental regulations* • **Applied computing~Education**

Keywords

Inclusive design; designing for diversity; social cohesion; disparity; economic inclusion; complex adaptive systems.

1. INTRODUCTION

Our current formal systems of education are failing to address the learning needs of a large number of students, the designs of our schools are a misfit for their requirements, contexts and goals.

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This systemic deficit becomes increasingly dangerous as our society moves inextricably into a knowledge economy and sources of income become more and more dependent on education [1]. We are leaving many students struggling at the margins of our society; this contributes to disparity, which affects the well-being of all community members. There is also a growing consensus that our formal education systems are not designed to address our current transformed realities -- let alone the learning demands of future social and economic scenarios.

To address this situation we must go beyond surface adjustments to our systems of learning. We need to reexamine the foundational structures, deep-rooted assumptions and underlying goals. To truly realize this goal would require at minimum the following transformations:

1. Viewing learning as life-long and not a staged set of age-linked grades or degrees;
2. Empowering learners to assess and guide their own learning;
3. Valuing and recognizing a diversity of skills and competencies that is potentially as diverse as the diversity of learners; and
4. Supporting collaboration and collective production over competition with others.

Transformation is difficult for the highly complex and frequently entrenched “system of systems” that is our collective academy. It is a system that has many established structures designed to resist change and very few mechanisms for renewal, adaptation and responsive reorganization. However, stasis is not an option and the demand and pressure for change is mounting [2].

The movement for accessible and inclusive education for persons with disabilities is juxtaposed on this complex adaptive education system in a heightened state of struggle and resistance [3]. Though the proposed transformation of education is in alignment with the aspirations and ultimate goals of inclusive education, the current strategies for achieving accessibility appear to be more closely aligned with an older paradigm, older tools and a static endpoint. As a social justice movement, accessibility efforts may be pushing to a destination that will be vacated when we finally arrive. To leverage and proactively help guide the educational transformation, the accessibility movement must be open to a number of alternative paradigms and approaches. These include:

1. Accessibility strategies that recognize that accessibility is relative (to the individual requirements, goal and context), not absolute.
2. Guidelines and regulations that are responsive and evolving, not static.
3. Systems of evaluation that are decentralized and vest authority and judgment at the level of the individual with a disability.
4. Measures of accessibility at the level of the system not the instance, or the ultimate outcome, not each step used to get there.

2. CHANGE RESISTANT, CONFORMANT & ELITE

Our institutions of learning grew up as strongholds against parochialism and superstition [4]. They are built to resist the transitory political forces of the day. They have evolved to uphold the principles of science. In the process they have bestowed sanctity to armaments such as statistical power and quantitative evidence, to guard against the whims of popular ideologies and vigilantly arbitrate our understanding of truth. Institutions of higher learning create protected and self-perpetuating silos of expertise, or disciplines, with challenging and strongly fortified gates. Our peer-review processes uphold accepted values and proven knowledge and defend these from upstarts and peerless notions [5].

In times of scarcity, our institutions of learning added mechanisms to sort the “deserving” from the “undeserving.” Our halls of learning are home to practices that bolster elitism, competition and exclusion. We sort and filter students well before they are formed [6]. We create tests and instruments of judgment that are deterministic, ignoring lessons regarding self-fulfilling prophecy - - students tend to perform according to their predicted capacity, irrespective of actual potential [7].

Whenever there is pressure to educate at scale or educate the masses, we change our pedagogical approaches to take advantage of economies of scale, resorting to passive, didactic, mass education (e.g., PSYCH 101 lectures for more than 1000 students). This is bolstered by structures of standardization, motivated to control and sustain quality, but also to support equality across schools and districts. This standardization requires and is sustained by increasingly centralized authorities of education. Take for example the US Common Core [8], the Bologna accord, PISA (Programme for International Assessment of Students), PIACC (Programme for the International Assessment of Adult Competencies) [9] or national, statewide or province-wide standards of education. Each was intended to indicate a baseline for schools, provide a comparative measure of quality, and a way to monitor progress. The unintended consequence has been that schools teach to the test and constrain learning. Each unintentionally confiscates self-determination from our teachers and students [10].

Of course economic agendas have influenced our educational structures [11]. During industrial times and again during the rise of white-collar professions we created structures that promote conformance and means of ensuring that we graduate interchangeable and consistent workers. To compete internationally we privilege hard sciences at the expense of art and the humanities. We favour formula over play, sequential competencies over discovery or unbounded creativity.

It is still evident that the foundations of our schools were laid in a time when knowledge was scarce, knowledge storage and access was constrained, only select members could arbitrate and bequeath knowledge, authority structures were centralized to guard the castle, and only the elite few could compete to climb the ladder to higher knowledge [12]. These deep foundations are antithetical to inclusive learning and ill prepared for the changed reality we find ourselves in. A reality where: knowledge is there for the taking, we are connected to a bounty of experts, there are no constraints on stored information, we have tools that can help us self-monitor and self-regulate our progress, everyone must climb the ladder to participate productively in our society, collaboration is essential to deal with the complexity of our

connected world, and we require diversity and creativity, not conformity [13].

Given the armaments against change and deviation in academe, what is the likelihood of the innovative leaps needed to escape our current trajectory? Change theorists point out that the best opportunities for change are during periods of disruption or crisis [14]. The emergence of the World Wide Web and associated practices have wrought this disruption more surely than any other socio-technical change since the printing press [15]. Our education systems are compelled to change from within, or they will be changed from without, or replaced [2].

3. EDUCATIONAL MISMATCH

At the same time as our schools are alarmingly ill prepared for future trends, they also remain a terrible mismatch for students with disabilities [16]. Addressing the second deficit may help to address the first deficit.

It has been 22 years since 95 nations affirmed that all persons deserve equal access to education and that this education should not be segregated or second class (Salamanca Statement) [17]. It can be resoundingly conceded that we have failed to achieve our goal. To add to this, in a time when education is essential, more and more students disengage from formal education. In countries that offer special services to qualified students with disabilities, many students are among the “doubly-marginalized.” They do not qualify for special education but standard education is also a misfit [18]. Not only do students with learning differences face a mismatch, but teachers or professors that support inclusive teaching and assessment methods, and institutions that support inclusive policies, also face a mismatch within their nested context [19]. The tenets of inclusive education are in direct opposition to deep-seated structures of education, especially within higher institutions of learning. We did not take into account the entrenched defenses against difference when we set our targets for inclusion.

4. FROM ABSOLUTE TO RELATIVE

As an accessibility community, how do we leverage and help guide the inevitable transformation of education? In the context of the quickly changing complex adaptive system that is our current society, we need to focus not on righting the inequities of the past (or perhaps even of the fleeting present) but in collectively working toward realizing the inclusive possibilities of the future. We would be more effective if we shifted our focus from the transient instances of inaccessibility and worked toward a more inclusive system.

People with disabilities are more diverse than any other group. The only commonality and centrally defining characteristic of disability is difference [20]. People experiencing disabilities also have far fewer degrees of freedom to adapt to designs that do not fit. Paradoxically we have created systems of accessibility whose implicit assumption is uniformity and homogeneity by attempting to achieve accessibility through one-size-fits-all accessibility requirements. We further constrain our accessibility approaches by striving to create accessibility regulations, guidelines and laws that are simple -- static (or “consistent”) accessibility checklists with absolute and testable criteria [21]. This is understandable. Accessibility is a precarious value [22]. When any excuse can and will be used not to comply; simple, static, absolute rules are seen to be more effective. As an accessibility community, when we are threatened we act like any other group under threat: we resort to rigidity, armor ourselves, appeal to higher authority, use the force

of law, resist change and argue in absolutes. This may allay the immediate threat. But this approach sacrifices the far greater long-term possibilities, and compromises the flexibility needed to address difference.

In the learning context this approach results in maddening scenarios. I recently watched a student use an onscreen scanning keyboard and single switch to go through more than twenty complex steps to simply select a submit button in a mandatory math test. The mechanics of the test took far more physical and cognitive energy than what was being tested, but the school was proud that the test was “accessible” and “WCAG 2.0 compliant.” I witnessed another teacher remove all images and interactive elements from curriculum because it was not “accessibility compliant”, despite the fact that it was known that several students in the class learned best using images and kinesthetic manipulation.

Given that accessibility can be characterized as designing for diversity, and that we have transformable and connected digital systems to work with, can we not move from an absolute to a relative framing, from one-size-fits-all to one-size-fits-one? To encourage an understanding of the responsibilities and potential impact of design, the Inclusive Design Research Centre frames disability as “a mismatch between the needs of the individual and the environment, product or service” and not a personal trait [22]. People are different, we have outfitted our environment and products to fit some of those differences (e.g., clothing for humans whose lack of fur causes a mismatch with cold climates, or glasses for people with different eye shapes), we can extend this same adaptive fitting to encompass the full range of human diversity and thereby spur greater innovation and better tap human potential. Someone who is blind is not disabled when power is lost, the lights go out, and she needs to leave the house; someone who is dependent on sight is disabled in that context, with that goal. Accessibility is framed as the ability of the environment, service or product to match the needs of the individual, in a given context, for a given goal. Both disability and accessibility are seen as relative.

This implies that we need to relinquish the binary classification of disabled and non-disabled and view ability as a jagged spectrum. It creates difficulties for scarce special services that are managed by qualifying recipients, such as accessible parking spots and special education [23]. However, does the current socio-technical transformation provide affordances that can extend special services to the full range of human diversity? We may also object to this deconstruction in defense of emerging disability culture. I would argue that it is not antithetical to a powerful disability culture movement. Culture movements and safe spaces to develop a shared identity remain vibrant when membership criteria are less absolute [24]. It is the common interests and concerns, the affinities that provide strength, more than the criteria for exclusion.

Pragmatically (when given the freedom to reflect away from politicized debates), we “know” that optimal accessibility is relative. We can’t determine whether something is really accessible unless we know the unique needs of the individual, their current goal and their current context. Anything else is a compromise. However, when we have a disability we often become highly skilled at compromising and making do. We fear risking any precious gains we have made. That risk only seems worthwhile when we have nothing more to lose or when we feel highly secure; and disability comes with vicious cycles of insecurity [25].

4.1 Broader Focus

Equality is also frequently simplified or reduced to sameness. Our absolute approaches to equity and accessibility are likely rooted in notions of fairness and prudent judgments regarding compliance [26]. We can claim that anything else is unrealistic, idealistic, abstract and theoretical. It is easier to determine that something is equal at the level of mechanism than at the fuzzy, “subjective” human level. However, it is at the human level that it matters. I could not care less that I can access the same print button you do as long as I can access the function of printing as quickly and efficiently as you do. I could not care less that I go through the same steps to learn division as you do, as long as I know how to divide when that skill is required. In the fields of equity we use the notion of lenses: “the disability lens”, the “gender lens”, etc.. I fear that we have focused our lens too narrowly and specifically. Our measures of equality are on the instance not the system; the Web page, not the function; the interaction not the experience; the sub-sub-goal, not the mission. We need more future-friendly, broader-focused lenses.

As an illustrative example, a municipality was recently struggling to regulate Taxis and the mobile transportation platform UBER. The proposal was to require that all vehicles be wheelchair accessible. However UBERX and UBERPool were services that intermediated ride sharing between ordinary citizens. UBER had also launched a wheelchair accessible vehicle service and a service that assisted riders from door to door (with an associated training program for drivers). A more systemically minded approach to regulation, that was likely to be achievable, was to require that riders needing a wheelchair accessible vehicle or assistance from door to door should experience the same timeliness and the same personal fit, at the same cost, as riders without disabilities. This did not require that all vehicles be wheelchair accessible and it leveraged the aggregated data the platform could provide to monitor and measure compliance. The desired result of equitable transportation services for all accessibility requirements was achievable more quickly and reliably than a staged outfitting of all vehicles [27].

Similarly we could demand Web Content Accessibility Guidelines (WCAG) 2.0 AA compliance for every Web page, a uniform accessibility experience for every visitor, assessed at the page level [28]; or we could assess the capacity of the Web site (as a system) to meet the accessibility needs of each individual visitor, meeting the WCAG 2.0 AA criteria at the level of the system, and supporting a personalized experience that recognizes the diversity of disability and making it possible for Web sites to create new ways to provide one-size-fits-one tailored experiences (e.g., AccessForAll portable personal preferences) [29].

I argue that at the same time as we focus more systemically, we can divest authority and judgment to the individual and use more bottom-up approaches to accessibility by employing emerging tools [22]. This allows a diversification of requirements and relinquishes the need to know and predict all current and future requirements. As an illustrative example, a regional authority recently planned the launch of an accessibility certification program for businesses in the region. The original proposal was the formation of a central authority with a centrally determined set of criteria. This quickly led to heated debates about what the certificates should reward, what accessibility requirements and what forms of disability should receive priority, what types of accessibility measures were most achievable and how should they be measured? Most contentiously: who will have the authority to judge? An alternative approach is to create a bottom-up adaptive

system modeled on services like TripAdvisor™ or Google Places™. The platform would support customers in reviewing businesses based on the business's ability to meet the customer's personal accessibility requirements. The benefit of this is: customers with disabilities don't need to fit their needs into pre-defined categories; the categories arise out of the aggregate reviews. Businesses are not constrained from using innovative and personalized approaches to addressing the needs of customers with disabilities. Also accessibility is reviewed and verified by the actual customer with a disability, not by the business or by an authority that is disconnected from the experience of customers with disabilities. The certification would be dependent on a threshold of positive customer reviews. Emerging best practices can be highlighted and celebrated as models. The proposed platform could allow customers with disabilities to search the certified businesses using their individual specific requirements. The model encourages continuous improvement by businesses to maintain or improve their certification level or ranking (not just during a formal centralized audit event but with every customer that comes into the business).

Of course these more systemic and bottom-up approaches do not obviate the need for legal baselines supported by the force of law. We need both the carrot and the stick to drive change. Regulations and meaningful penalties are needed to motivate organizations that do not have the enlightened self-interest to understand the benefits of inclusive design. But while we are maintaining the rear guard we should also help motivate and steer the explorers and innovators. Concern for the laggards should not imply that we sacrifice new and promising possibilities.

5. STRATEGIC INTERVENTIONS IN COMPLEX ADAPTIVE SYSTEMS

Our education systems can be characterized as complex adaptive systems within the larger complex adaptive system of our society [30]. Inclusive education is a highly complex challenge; the failure of education to serve all students is a wicked problem ("a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize") [32]. As complexity theorists point out, we have always existed in a complex adaptive system of systems [33]. Only recently have we instrumented a digital mesh that allows us to see it more holistically (the internet, the Web, mobile systems, the internet of things). That digital mesh has also become a huge and disruptive factor in the rapidly evolving complex global system of systems. Like the person who is blind who has undergone surgery to gain sight, we need to learn to use this new sense and integrate it into our way of being. The question posed in many domains is whether we can learn to use this new sense wisely before the many rapidly moving global crises that threaten humanity overtake us. Can we, as a society, move from data, to information, to knowledge, to wisdom in time? Can we progress through skills, to competencies, to the expertise needed to avoid disaster? Or as some suggest, have we gained sight only to find ourselves in the driver's seat of a vehicle about to crash [34]? Is it possible that the learned resourcefulness and insight gained through lived experience of disability can help in this challenge? By addressing inclusion can we recruit the diverse human capacity to address other global challenges? Microsoft has recently bet that inclusive design can guide the needed transformation of the large, complex Microsoft enterprise [35]. Can we make the same bet with our larger, complex systems of education?

Wicked problems are impervious to traditional means of research, established forms of project management, and currently prescribed modes of planning [31]. Effects cannot be isolated -- they are complexly entangled. Outcomes cannot be engineered, they are unpredictable and influenced by unexpected factors. Policy analysts argue that complex problems cannot be solved through simple solutions or you engender "cobra effects" -- the unintended effects of over-simplistic or reductionist characterization of issues [37]. There is general agreement that the only approach is to gather the broadest diversity of perspectives, choose a spectrum of small, full-cycle interventions, monitor what happens, and be prepared to adjust and pursue successful directions. This process works better if you fail early and often and learn from mistakes. Bottom-up, open processes are more successful; the bureaucratic skeletons many of our large institutions have constructed hamper the speed and agility required.

5.1 Collaborate with Others, Compete with Yourself

There is general consensus among complexity theorists that collaboration is essential to solve complex problems [30]. Our systems of education focus on individual excellence, we do not reward or teach collaborative excellence. Obvious forms of collaboration are called cheating and strictly punished. We ask each student to redundantly repeat the same steps taken by the previous cohort, rather than starting from where predecessors have left off. Our structures of intellectual property discourage sharing and remixing knowledge and innovations. We rarely recognize the pooling of complementary skills to achieve academic milestones [37]. This structure also fails to take advantage of the diversity of skills learners represent and the powerful potential of orchestrated collective effort. Can we use ever more sophisticated data capture tools to better support attribution so we can set knowledge free for collaborative use without losing credit?

A key to our global systemic health may lie in the critical balance between supporting diversification while maintaining social cohesion and inclusion. Several programs are beginning to experiment with this dynamic balance. The Inclusive Design graduate program at OCAD University recruits a cohort that is as diverse as possible with respect to disciplinary and experiential background, stage in career, language, culture and ability. The students become co-constructors of an inclusive learning community and an inclusive learning experience. It is this process of creating social cohesion and collaborative problem solving that it is the most powerful learning tool in mastering inclusive design and generating individually unique and impactful innovation. In another effort, Christine's Ortiz, the Dean of Graduate Education at MIT, recently announced that she is establishing a University without majors, lectures, classrooms, disciplines or degrees [39]. Students design their unique curriculum online to complete a collaborative project with mentorship from faculty and peers. The goal is to harness collective intelligence to address global challenges such as health, water and climate.

5.2 Individually Unique Life-long Journey

In his book "The End of Average" Todd Rose marshals evidence that our assumptions about the sequential stages of cognitive development, upon which we have developed our grade structure, do not hold true; neither do the developmental milestones associated with "normal" development. Routes to excellence are highly variable in path and pace. Competencies and skills do not

need to be constructed through a fixed set of building blocks, one piled upon the other [40]. We can achieve expertise backwards and sideways. More importantly students should not be measured using a mythical yardstick of average.

The world is also changing too quickly to support the assumption that learning is ever complete. In many subjects what we learn one year is no longer the accepted truth the next year. Skills and competencies in all professions require continuous renewal and relearning. New forms of work are superseding longstanding professions. The very nature of work is changing. To avoid obsolescence we must all continue to learn.

5.3 Self-Guided Learners

Just as grades have disadvantaged learners with disabilities, so has ranking and systems of grading. Todd Rose shows persuasive evidence that there are no fixed personal traits or strengths – our traits are highly influenced by context (I may be an introvert at school and an extrovert at home, a perfectionist at sports but carefree in English). People cannot be ranked; their skills and strengths are diverse and jagged (good in one thing but poor in another) [40]. IQ measures are reductionist and misleading.

The more unique you are as a learner, the more likely education designed for the masses will be a misfit for you, and the less likely anyone will have expertise or competency in optimizing your learning potential. Even if you happen upon a dedicated personal tutor or mentor, learning is life-long and this assistance will be transient. The only sustainable approach is to become an expert in your own evolving learning requirements [41].

Can we use emerging learning analytics to support this goal? Yes, with some fundamental modifications. Traditional research, including big data and learning analytics, aspires to draw generalizable conclusions that can be applied to the majority, or a large prescribed group, with predictable results. The veracity of the conclusions depends upon an accurately representative group of “subjects”, and the accuracy of predictions depends upon statistical power through numbers. By definition these generalizations do not hold true for learners that are outliers. This is in large part due to the fact that there are no representatives that meaningfully reflect the unique interconnected complexity of requirements to be represented, let alone a large enough group of representatives to garner conclusive results. This means that there are large knowledge gaps regarding how learners who are not “average” learn best or what causes failure. These outlying students frequently outnumber the norm [42].

The only viable alternative is to represent yourself and to iteratively discover and refine your understanding of your own learning requirements with the help of supportive facilitators or tools. Tools can support this discovery by measuring and presenting “small” data (n=1) and “thick” data (contextualized or situated, without isolating the conditions) about the factors that optimize learning for a given context or learning goal, allowing you to refine these conditions and monitor the results [43]. Taking from models in sports and gaming, students can hone their learning performance. We can create novel ways of presenting the data that are personalized to student mental models and socio-emotional affinities. Students can become investigative scientists in their own learning: constructing experiments, monitoring progress, garnering metacognition and progressively mastering life-long learning.

However, the structural barriers to this approach are many. Education itself is grounded in paternalism and the belief that

students do not know what is best for them. Students who have disabilities or students who are at risk face a strange duality of infantilization or demonization. Either there is an added layer of protection or assumed vulnerability, dependence or incapacity; or the students are blamed for failure and distrusted. Any understanding of their “condition” is usually hidden from them [44].

Like all discovery, this is an evolving, messy, risky process requiring trial and error, play, mistakes, failure and patience. Learners with disabilities, especially, are protected from failure and using failure and error as a tool for learning is rarely valued. Failure in current education is deterministic and used to predict all future performance (an indelible mark on the *tabula rasa*), putting students further at risk [7]. Patience is rare in our rushed society where hot-housing often begins at infancy [45].

Standardization, establishing norms, and corraling and guiding performance through impact measurement and statistical evidence regarding the majority, are inextricably fused with our values and aspirations in education. Individualization will lead to divergence and may go astray. The individually chosen approach won't conform to the target metrics -- causing systemic disruption to reward systems and existing certification of academic achievement.

5.4 Learning Outcomes as Diverse as Learners

Counter to our intuitions, in these times of increased complexity, accelerated change, amplified instability, and global entanglement, we need human diversity, not uniformity or simplicity. The benefits of diversity have been acknowledged for centuries in domains such as biology and economics. Evidence of the striking advantages of human diversity is steadily mounting. Including diverse perspectives and skills makes for significantly better planning, more accurate prediction, more successful risk-aversion, more effective response to threats, dynamic resiliency and greater innovation. Or as amply supported by Scott Page “diversity trumps ability.” Creativity and novel strategies are also most at home at the margins, where we find the greatest variability [46].

Our current and planned aspirations for education seem counter to these findings. Diversity is generally seen as an issue to be addressed, not an important outcome to be fostered. We attempt to simplify diversity by categorizing the norm and the outliers or special – a costly and destructive approach for both sides of the equation.

However, our education system does not need to produce graduates that are replaceable copies of each other. In today's economy and increasingly connected growing global society (beyond contested foundational building blocks for learning) we don't all need identical toolkits of skills and knowledge. People are social beings. We may need survival skills if caught alone in the wild, but in our connected communities we can depend on others to fill in most skills we haven't adequately learned or knowledge we have forgotten from our schooling (if not on ever more capable machines, and computers). Even in standardized essential professions and tightly controlled disciplines, the knowledge and skills that can be replicated are the skills that machines can help with or replace [47].

You may ask: how can our education system support a unique learning experience for each learner? We barely have the capacity to deliver mass education. If designed correctly one answer may

lie in the Open Education Resource ecosystem on the Web. An open license enables use by anyone, but more importantly it allows the creation, pooling and sharing of variants. This means that a truly open resource pool that supports modification and mashups will always be richer and more diverse than a locked collection. Correctly designed digital resources can transform to the unique specifications of each learner, presenting the visual layout, presentation modes (e.g., audio, visual, tactile), and method of control that suits the individual learner. Metadata associated with each resource can help match the resource to the unique needs and learning goals of each learner [48].

What happens to assessment if everyone has a different desired outcome or a different role to play? As discussed earlier, we need to explore the option of engaging learners themselves, supported by personalized learning analytics -- as aspiring research scientists in the important subject of self-regulation and self-determination. There is also the rich pool of peer learners who will simultaneously gain the critical skill of giving, receiving and valuing constructive critique. As for maintaining quality control of the ever growing, diverse pool of learning resources, we should all master the learning potential of the impermanent, incomplete and imperfect. The act of improving and refining resources for the next learner may be one of the most effective learning experiences [41].

5.5 Trust and Quality

There is no clearer sign that our systems of education are fraying at the edges, than in the many challenges to academic qualifiers. We have come to recognize that our hallowed halls of learning are not the only purveyors of knowledge and expertise --with Wikipedia, Google, Blogs, MOOCs and burgeoning communities of interest on the Web. The proposed response has been to reserve certification of academic achievement to formal and established educational institutions. The proposal is that you can learn the content through mechanisms such as MOOCs and online courses and then pay Universities to verify what you have learned and certify this with a degree or diploma [49]. However, even this role has been contested. It appears that university degrees and high school or college diplomas do not cover the diversity of skills and forms of expertise required in today's economy or of interest to the diversity of learners our society needs. Formal education is not the only way to achieve competency or provide evidence of learning. Some say it is an inferior alternative.

Innovations that deconstruct, decentralize and dis-intermediate accreditation and certification of academic achievement are proliferating. From ePortfolios that provide an online record of evidence of achievements, to Open Badges that provide more granular certifications of competencies, to Prior Learning Assessments that support the integration of experiential learning outside the institution -- all iterate toward more diverse ways of recognizing learning achievements [50].

One of the latest candidates is the blockchain. "A blockchain is a massive, fraud-resistant distributed ledger that could be the new infrastructure of the future. The open ledger uses consensus algorithms to transparently record and verify any transactions without a third party. It replaces the middleman with mathematics. Because the blockchain infrastructure is decentralized, there's a lot less friction and time wasted than traditional, centralized processes." [51] The blockchain is seen as a way to create an immutable record of human capital that does not require a central authority. The hope is that by removing the central authority there is freedom to diversify and proliferate the competencies that can

be certified. So far existing schools and institutions have experimented with blockchains to create trusted certificates. There is yet to be an implementation that removes a central authority and allows the diversification of certified competencies.

6. THE WEB AND DISPARITY

Educational disparity is a cog in the vicious cycle of other disparities. While the Web was heralded as a mechanism of democratization, the design directions that ignore inclusion and diversity also feed into these cycles of disparity. Many of our current political, economic, technical, social and commercial structures are inclined to accentuate disparity. The rich will get richer, those with influence will garner more influence, knowledge about the majority will increase; while those at the margins are caught in vicious cycles of poverty, lack of influence, and lack of being understood [52]. This is the dominant pattern experienced not only by individuals, but also organizations, communities, companies and even universities. Our current socio-technical advances associated with the Web, while promising to disrupt these systemic patterns, have also accentuated these dominant trends. From popularity echo-chambers in social media that speed the rise of items with the most hits and cause the less popular to disappear, to recommender sites that offer choices from users "like us" shielding us from difference, to big data analytics that privilege dominant patterns and eliminate the outliers or "noise", to computer-mediated financial trading systems that give advantage to the well-resourced -- all amplify the trend toward greater disparity [53].

A global effort is attempting to leverage the Web and Web technologies to counter this trend and create a platform for economic inclusion [22]. Originating in Canada (but at various stages of implementation in the US, Europe and across Spanish-speaking nations), is an approach and multi-sided platform called AccessForAll (also referred to as Cloud4All, Prosperity4All, Web4All, FLOE and GPII). Simply described, AccessForAll provides a means to discover, explore, refine and declare (using an ISO AccessForAll standard), what it is that works best for each individual user with respect to digital resources and user interfaces; the infrastructure then delivers a personally customized resource or user interface wherever and whenever the individual happens to access services. When they request a specific service or resource this infrastructure matches the stated individual preferences by transforming the resource or interface, augmenting it, replacing it with an equivalent resource from a federated repository of pooled resources or reaching out to producers and suppliers who can fill any gaps. This approach capitalizes on the pace and path of technical innovation rather than trying to continuously catch up to it.

While not originally intended to address the needs of marginalized producers and suppliers, the AccessForAll platform is being tested as a means of removing barriers to market entry for young entrepreneurs (including youth with episodic or invisible disabilities), small enterprises, indie developers and emerging economies. It offers a potential means of supporting a new, organic, agile, inclusive market or flexible economy. Individuals that face barriers to employment and have disengaged from education have access to training in portable skills that are directly linked to demands, then given demands to fill, reviewed for their work, paid for their service, and certified for the skills acquired in progressive iterative cycles. Once they have mastered a skill, they act as mentors for less experienced youth. Once they have acquired a threshold of skills they are supported in forming service entrepreneurship. The same process will be offered to

youth in refugee camps to build portable skills and to reduce barriers to accessibility regulations by increasing human capacity to achieve the regulations. Thus, potential suppliers and producers at the margins are meeting the unmet demands of consumers at the margins [22].

We need to create mechanisms that attend to the edges, connect us with people that are different from us, invite the serendipitous and unexpected, and create systems that are not dependent on categories, limited containers, and homogenous impact thresholds to assign value. The Web has released us from the linear and two-dimensional representation of knowledge and forged a global mesh of connections. Can we design the next generation of the Web as a learning platform to support human variability, navigate rather than reduce complexity, and engender collaboration and trust?

7. THREE DIMENSIONS OF INCLUSIVE LEARNING

Ideally, learning is a continuous and iterative process of designing a fulfilling life. At the Inclusive Design Research Centre we apply a framework called “the three dimensions of inclusive design” that recognizes that inclusive design in a digitally transformed and connected society can be relative to the individual, the goal and the context [54]. The same framework can be used as a notional scaffold for inclusive learning [22].

The first dimension is the understanding that full inclusion requires the recognition of **individual difference** and uniqueness; that design, and learning must be individualized; that individual requirements vary given the context and the goal; and that inclusion requires personal agency by fostering the self-knowledge of each learner. Adaptations to individual needs must be integrated, not segregated, to remain sustainable and current. Choices must vest with the learner, and any intelligence gained about the learner must be shared with the learner to support meta-cognition and self-guidance.

The second dimension is an **inclusive process** of design or learning design. This ensures that the learner is an active participant in the full design cycle through co-design. The design, development or instructional tools used must be accessible to the full diversity of co-designers. The design team should consist of a diversity of perspectives. This would mean that learners co-create with diverse peers and experts and that all learners not only consume curriculum but also produce curriculum.

The third dimension recognizes the **larger context**: the complexity and interconnectivity of phenomena and systems. The design and learning process must take into account the greater impact of any design and strive to effect positive systemic change and at minimum do no harm to linked systems. Here the learner recognizes their unique, evolving role and impact within the complex and evolving global community.

8. CONCLUSION

In our interconnected and crowded society we need to go beyond tolerating or respecting diversity, we need to prize and learn to orchestrate and create synergy out of our differences. We should shift focus from how we are each better or worse in the same skills, to the unique, evolving set of talents, passions and competencies we each bring to tasks at hand. It is our variability that gives us collective strength. We can “complete” or complement each other by negotiating the fluid merger of diverse strengths, making the whole far greater than the parts. Can we

design the Web inclusively so that it becomes a platform *to enable all students to reach their diverse, full potential, so that they can be prosperous, self-guided contributors to our global community?* Our collective well-being and survival may depend upon our success.

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