Rethinking and Reinventing Learning, Education, and Collaboration in the Digital Age
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From Creating Technologies to Transforming Cultures

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Abstract
The digitalization of society results in challenges and opportunities for *learning and education*. This paper describes exemplary transformations from current to future practices. It illustrates multi-dimensional aspects of learning which complement and transcend current frameworks of learning focused on schools. While digital technologies are necessary for these transformations, they are not sufficient. The paper briefly illustrates the applicability of the conceptual framework to the COVID-19 pandemic. It concludes that design opportunities and design trade-offs in relation to digital technologies and learning should be explored by envisioning the *cultural transformation* that are desirable for making learning a part of life.

Keywords
Learning, Digital technology, Technology enhanced learning, MOOC, COVID-19, Education, Distance education

1 Introduction

This paper is based on the work conducted at the symposium "Rethinking and Reinventing Learning, Education, and Collaboration in the Digital Age — From Creating Technologies to Transforming Cultures" (https://graderesearch.umu.se/forskarskolan-grade/conference2019/) that took place in Engeltofta outside of Gävle, Sweden in September 2019. The symposium invited scholars in collaborative analysis of design opportunities and design trade-offs in relation to digital technologies and learning and explored design strategies for systematically and proactively increasing digital technology's contributions to learning and collaborating. It brought together representatives from different disciplines, from different countries.

An anchoring assumption for the symposium was that the digitalization of society results in challenges and opportunities for *learning and education* (Collins & Halverson, 2009) . We argue that research on learning and information technology, in the broadest way of defining this field, often falls short of embracing the *transformational aspects* of these drastic changes. When we design technologies and approaches for using technology in educational activities, these can be understood as either attempting to align with or challenge, the implicit or outspoken current practices. Outside of educational institutions information technology is rapidly transforming many practices, leading to a growing gap between education and the world at large. Technology alone does not determine social structure nor does it change human behavior: it creates *feasibility spaces* for new social practices and it can persuade and motivate changes at the individual and social level (Benkler, 2006).

The paper first provides a condensed introduction of a conceptual framework summarizing current practices, their problems, and promising alternatives. Multi-dimensional aspects of learning and lifelong learning will be briefly described as promising future alternatives to school learning. Examples of transformative practices are supporting the major argument of the paper that creating new technologies is an important prerequisite to address the fundamental challenge of transforming cultures. The unanticipated but fundamental event of the occurrence of COVID-19 will be briefly described to provide further evidence for the need and the applicability of our conceptual framework for rethinking and reinventing learning,

education, and collaboration in the digital age. Given the large ambitions of the paper, in combination with a relatively short space for reasoning, there is certainly a need for further exploration of many of the suggested themes, arguments and related fields of research, i.e. we are aware that the paper does not , and cannot provide in depth descriptions of all aspects brought to the reader's attention. Some of the areas are more thoroughly covered in the other papers in this special issue, some are to be considered future work, and some are covered in our previous work.

2 Conceptual Framework Summarizing Current Practices, their Problems, and Promising Alternatives

We believe with Karl Popper (1959) that "the search for knowledge does not start from perceptions, or observations, or collection of data or facts, but it starts from problems". Table 1 summarizes some exemplary transformations that we consider relevant for a transformative conceptual framework for *learning, education, and collaboration* in the digital age. The following sections will explore these transformations in more detail.

Table 1: Exemplary Transformations for Learning, Education, and Collaboration

Established Current Practices	Problems with Current Practices	Promising Future Alternatives
school learning	major learning activities take place outside of schools	explore multi-dimensional aspects of learning
unaided human mind	ignoring the power of hybrid minds	integrate knowledge in the head with knowledge in the world
learning when the answer is known (emphasis on basic skills, curriculum)	learning when no one knows the answer (coping with wicked problems)	support collaborative knowledge construction and social creativity
consumers	active contributors (in cultures of participation)	inclusion of problems owners in knowledge construction
reflective practitioner	reflective community	transcend the individual human mind
"gift-wrapping" and "techno-determinism"	putting old wine in new bottles	co-evolution of learning, media, and learning organizations

3 Multi-Dimensional Aspects of Learning

One of the shortcomings of research in the learning science is that many *approaches are too timid and not thinking radically enough* by focusing on schooling (Bruner, 1996; Resnick, 1987) in its current practices then on the multi-dimensional aspects of learning (see Figure 1).

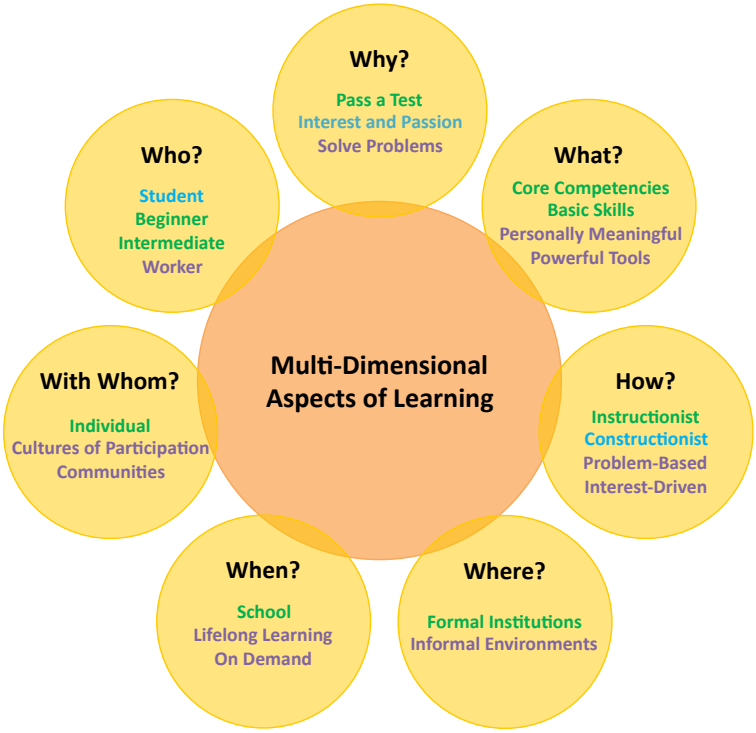

Figure 1: Multi-dimensional Aspects of Learning

We want to stress the importance to focus on who the learner is, and on how people at different places, stages and with various conditions learn. The learner may be a student in education from K-12 to university level, a person working in industry, or a curious citizen attempting to understand more about the world surrounding them, or solve a practical problem in their everyday life. Some of the learners may be beginners (and general and uniform introductory courses might serve them well) whereas other may have a rich knowledge background and very specific objectives requiring more individualized resources and instruction. It is also of importance to include aspects of why people learn, the motivation of the learners. Some people learn because they need to pass a test, fulfill the requirements of a course in school or university, and others learn because they are passionate about some activity. Closely related to why people learn is issues about learning as personal and meaningful. In formal learning environments, students' learning is determined to a large extent by a curriculum (Resnick, 1987). Learners encounter few opportunities to gain experiences by exploring personally meaningful problems that need to be identified and framed. The engagement with personally meaningful problems should be complemented with learning that do not primarily consist of learning and memorizing facts, but should be focused on (1) acquiring and using information; (2) identifying, organizing, planning and allocating resources; (3) collaborating with others; and (4) working with a variety of technologies. This in turn highlights that people learn in different ways. Learning in today's world must conceptualize learning as an inclusive, social, informal, participatory, and creative lifelong activity.

4 Lifelong Learning: Beyond Schools

If the world of working and living relies on collaboration, creativity, definition and framing of problems and if it requires dealing with uncertainty, change, and intelligence that is distributed across minds, cultures, disciplines, and tools — then education should foster competencies that prepare students for having meaningful and productive lives in such a world. Schools, however, have in many cases moved in the opposite direction. Even as computers become more ubiquitous in schools, curriculum standards and mandated assessments (based on frameworks such as cultural literacy (Hirsch, 1996)) have exercised a conservative force against the proliferation of idiosyncratic interests and passion, by emphasizing that everyone should learn the same thing at the same time, as measured by the same standards. Similarly, the education establishment has tried to control what people learn by defining the curriculum in schools. The

dramatically increasing amount of non-mainstream knowledge indicates a gap between the world we live in and the formal education, where the latter focuses mainly on a limited amount of knowledge.

Exploring the future of learning in a lifelong perspective, one impact of digitalization is that we need to understand and decide on what tasks should be reserved for educated human minds and the collaboration among different human minds, and what tasks can and should be taken over or aided by technological artifacts. In an information-rich world, the ability comes not only from more information, but from information that is personally meaningful, relevant to people's concerns and relevant to the task at hand. We also argue below, that digitalization has so profoundly transformed how learning and knowing is done outside of school, that this is increasingly creating a situation where schools, as they are currently organized, might be outdated.

Many problems (specifically design problems) are *wicked* (Rittel & Webber, 1984) and the knowledge to address them is not "out there", but rather requiring contributions and ideas from all involved stakeholders. Learners in such settings must be *active contributors* rather than passive consumers and the learning environments and organizations must foster and support mindsets, tools, and skills that help learners become empowered and willing to actively contribute (Jenkins, 2009; von Hippel, 2005, Fischer, 2002). Moving away from a conception of learning as something uniquely related to schools, give way to understand learning in different settings. The seeds of a new education system can be seen in the explosive growth of home schooling, workplace learning, distance education, adult education, and a variety of design spaces for learning (e.g.: museums, science centers, environmental centers, etc.). Research on everyday cognition demonstrates that the formal learning in schools and the informal learning in practical settings have important differences (National-Research-Council, 2009). What we discover about learning in schools is *insufficient* for a theory of human learning: schools are often focused on individual cognition, on memorization and on learning general facts whereas learning in the world at large need to rely on shared resources, the use of powerful tools and external information sources, and situation-specific knowing. Situational and individualized needs in turn provide grounds to understand learning as a process over a larger timespan and systemic problems require more knowledge than any single person possesses because the knowledge relevant to either frame or resolve these problems is usually distributed among stakeholders coming from different disciplines. The "Renaissance Scholar" (a person who is knowledgeable in all relevant fields) no longer exists (Csikszentmihalyi, 1996). To deal with complex multi-disciplinary problems, people need to use the powerful tools technology provides for finding, analyzing, manipulating, and communicating knowledge bringing different and often controversial points of view together, to create new insights, ideas, and artifacts.

5 Examples of Transformative Practices

5.1 From "Humans versus Computers" to "Humans and Computers"

Frey & Osborne (2016) investigated how susceptible different jobs are to computerization (i.e. automation using computers). They argue that the introduction of new technologies in the workplace will require different skills and competencies for workers, which in turn will demand new conceptualizations for education. In their analysis they explore how the development of computational environments will lead to automation of human work in vast numbers of work practices, leaving humans only to excel in tasks of perception and manipulation, creativity, and tasks demanding social skills (Markoff, 2016). However, what they do not take into account is that automation might be possible but not economically attractive. Ekbia and Nardi (2017) defines the use of computers in relation to work as either providing *automation*, functionality of performing tasks previously done by humans, *augmentation*, meaning that computers provide functionality which elevate and support human activities, and finally *heteromation*, meaning the, often unpaid, labor that humans do today to uphold the many online systems where automation is either impossible or less economically beneficial to the owners. In practice this connects to what we can experience as interaction overload, or participation overload (Fischer, 2015), where users are asked to perform part of the work but does this without any financial compensation, e.g. rate, provide feedback, personalize. This is often reframed as a service to the customer, but this could certainly be debated. In many online networks work is continuously done by humans, where automation would be possible, but more costly. What should be taught in school, what tools students get introduced to and are given support to master must be related to how tasks are divided between humans and machines in the future. And the not

only to how it is technologically possible to divide these tasks, but also how other aspects divide the work. This then also includes matter of design and choice. School do not only prepare students, but should equip them with skills to alter, design and choose possible futures.

A hybrid mind operates through and with artefacts in the surrounding world (Säljö, 2016). In such a perspective thinking takes places not only with the use of tools but through tools. Distributed cognition (Salomon, 1993) provides an effective theoretical framework for understanding what humans can achieve and how artifacts, tools, and socio-technical environments can be designed and evaluated to empower human beings and to change tasks. Two distinct communities originated several decades ago and emerged with separate traditions, values, priorities, and visions in the computing world (Markoff, 2016):

- one being *Artificial Intelligence (AI)* with the goal of replacing human beings, automating the human experience, and duplicating human behavior with computing systems;
- the other being *Intelligence Augmentation (IA)* (spanning disciplines such as human-computer interaction (HCI), computer supported cooperative work (CSCW), and computer supported collaborative learning (CSCL) with the goal to expand and complement human abilities with socio-technical environments.

One important task where humans still outperform machines are our ability to adapt. This can be understood as part of creativity (Csikszentmihalyi, 1996), i.e. the ability to imagine new futures, but also connects to the versatility of our bodies and minds. Understanding the world in terms of practices where some functionality is bound in machines and some tasks are done by humans, the human part of these practices is adaptable by the persons involved (Lundin, Svensson & Lundh Snis, 2015). To be able to reframe a problem and address it in new ways a machine has to be replaced or rebuilt, which then in turn require human intervention. And in this human activity of designing and building we inscribe our ideas of desired futures (Callon, 1991). Every technology could thus be understood to carry both an understanding of what the world is, as well as how it should be (Postman, 2011). In the future event that education and work merge through the use of digital platforms that provides on-demand work and on-demand labor in unprecedented ways, it is up to human imagination to provide its constraint (Means, 2018), as well as it's ethical direction. One example of how different technologies intertwines with our understanding of knowledge is current platforms for distributing new knowledge and facts. Computers and computer networks are central in making explicit, distributing and valuing information today. One obvious example is Wikipedia, where voluntary work is part of creating and sustaining a freely accessible resource for facts. Norms, rules and moderation supports a continuous negotiation of what knowledge is deemed relevant and correct. The "web of science" is another online tool providing citation data used to evaluate scientific knowledge. Thus this is a website that is severely affecting what research is deemed valuable, having consequences for what researchers are funded and the impact of the research. The main point being that we need to consider what futures that the network of these organizations builds into the main technology for valuing scientific knowledge of our world. So even at this level, science and the value of it, there can be traces from what might be yet another new power network (Williamson, 2019) with non-transparent relations to the defining technologies and their design.

5.2 Massive Open Online Courses (MOOCs)

MOOCs (DeCorte et al., 2016) enrich the landscape of learning opportunities and are argued to have the potential to reduce the digital divide by providing education for everyone by "making the knowledge of some of the world's leading experts available to anyone free of charge". MOOCs deserve credit because they have woken up academia and the media to bring online learning and teaching to the attention of the public. A special challenge of MOOCs is to "force" residential, research-based universities to reflect, define, and emphasize their core competencies. These should consist of moving away from large lectures with learners listening to teachers towards active learning environments characterized by personal attention from teachers and opportunities for participation.

Issues of power, and new relations between who has the right to define knowledge and to give it away for free, in turn leads the thought to MOOCs and such opportunities that in one sense bridge the global with the local, the past and the future. But at the same time it might rest on older traditions and forms and also be said to provide for a digital neocolonialism (Adam, 2019), where the business models of the MOOCs as they evolve move the old to the new, the global to the local, in ways we do not yet see the outcomes of (Fischer, 2014). The data revolution ("Big Data") Mayer-Schönberger and Cukier (2013) provides insight

to analyze and document human behavior to an extent considered impossible a few decades ago. MOOCs provide rich data sets about interactions, collaborations, and engagement that computational processes can exploit. This means that efforts exploiting student or learner data must currently engage in a critical discussion on who benefits from the analysis of online educational activities. In terms of adaptivity there is a possibility such analyses just as much could be used to adapt educational to students as it could be used to gradually adapt students to educational systems (for a challenging discussion on this see Hillman, Rensfeldt & Ivarsson, 2020).

5.3 Evidence-Based Education and Learning Analytics

New technologies for learning may be more or less overly optimistic in their hopes to overcome educational desires and issues such as inequity, privacy, and achievement differences. This is particularly relevant in relation to transformations through datafication and more specifically learning analytics (Macgilchrist, 2019). Thompson & Sellar (2018) argue, what is being ruptured by datafication and testing is yet to be understood, perhaps in terms which are not yet all familiar to neither education nor to design. Learning analytics (Larusson & White, 2014) focuses on measuring, collecting, analyzing, and reporting data about learners and their contexts. It attempts to understand the background knowledge of learners and it adds to online education as a dissemination method an important data-gathering resource.

The following issues related to learning analytics should be pursued and investigated further:

- what are the fundamentally new aspects of learning analytics? The idea of collecting data about student behavior and actions is not new (e.g.: it has been pursued with user modeling in intelligent tutoring systems).
- how valuable will the insights be that learning analytics environments are able to collect and analyze? by observing low-level, quantifiable events (such as material looked at, how long and how often, errors made, help requested) how can the intentions, problems encountered, and objectives of the learner be inferred?
- learning analytics will provide us with insights to understand the past and the present ("how things are"), but how much will it help us to envision and design alternatives to improve our approaches to learn and teach something ("how things could/should be")?

6 From Creating Technologies to Transforming Cultures

Information and communication technologies provide new opportunities for rethinking and reinventing learning, education, and collaboration in the digital age. But technology alone does not determine social structure nor does it change human behavior: it creates feasibility spaces for new social practices and it can persuade and motivate changes at the individual, group, and community level in all domains of human existence and activities.

To identify relevant knowledge for the future is thus partly a matter of predicting future usefulness of knowledge, but also a question about how school is intended to function as part of a society. The narrative and purpose of schooling has to be constantly reiterated. Given the current emphasis on individual accomplishment it is only logical that individual skills become of great importance. And without an outspoken purpose, it is fruitless to engage in transformational activities to improve education, if we do not know where we are going there is no right way to choose to get there. And given that machines will outperform humans in a number of different aspects do we still want to educate kids in these, and why? Rather than educating kids in analytical tasks, we could shift focus towards social, perceptual and creative skills. This is turns leads to a whole new set of challenges to our current systems for measuring, evaluating and testing knowledge, as well as to teacher's role in this process as data users nested in-between public-private sector mediations of test data (Ratner et al, 2019). Our point being that this is a matter of choice and design, rather than bound by natural or technical logics.

The context for human development is always a culture, never an isolated technology (Bruner, 1996). Innovative technological developments are *necessary* to achieving new objectives and empowering learners and workers but they are not *sufficient*. For example:

- putting all schools on the Internet is a *necessary* requirement to exploit the power of learners of all ages and all over the world interacting with each other but it is not *sufficient* for (1) creating

learning webs (as envisioned by Illich, 1971) and (2) for supporting a substantial number of the multidimensional aspects of learning (as indicated in Figure 1);

- getting stuck in "gift-wrapping" and avoiding to put old wine in new bottles (see Table 1), as indicated by the opportunity that "distance learning (e.g. as supported by MOOCs) is different from classroom learning at a distance".

New digital technologies make a cultural transformation of learning possible, but they certainly do not guarantee it. Many changes where new technologies are being used in education today, the technologies are used simply to reinforce traditional approaches to education. Even as scientific and technological advances are transforming agriculture, medicine, and industry, ideas about and approaches to teaching and learning remain largely unchanged. Most current uses of technology to support life-long learning and distant learning are restricted to a "gift wrapping" approach: they are used as an add-on to existing practices rather than a catalyst for fundamentally rethinking what education and learning should be about in the next century. Established frameworks, such as instructionism, fixed curriculum, memorization, decontextualized learning, etc., are not changed by technology itself. This is true whether we use computer-based training, intelligent tutoring systems, multimedia presentations, or distance education approaches.

To understand the cultural transformations and the design trade-offs associated with these technological developments a framework is required for understanding when collaborative approaches are useful and which types of collaboration are best suited in which situations. Sometimes collaboration might be useful for "getting the job done *more effectively and more quickly"*, at other times it might be useful "in providing *richer learning opportunities* or suggesting *new ways of thinking about problems"*. Research on learning and collaboration have been predominantly focusing on the first category representing a *social* challenge in how to support distributed activities (e.g., comparing weather conditions at different places) — these approaches can be very effective in giving people a sense of pleasurable participation in a wider community which represents a non-trivial benefit to education. And very little into the second — an *epistemological* question focusing on opportunities whether the distributed approach lead us to think and learn about a domain (such as the factors contributing to different weather conditions) in a new and fundamentally different way.

Exploring the mutual interdependencies between technologies and cultures provides evidence that technologies are not merely received but through processes of adoption socially defined and socially embedded in new practices. Transformations do not happen when societies adopt new technology, it happens when new behaviors develop that provide the foundations for cultural changes (Shirky, 2010).

Another challenging domain for rethinking and reinventing learning, education, and collaboration in the digital age is centered around *digital literacy* (Fischer, 2005; Jenkins, 2009; Littlejohn, Beetham & McGill, 2012). Unfortunately, a large number of digital media are designed to see humans only as consumers rather than as active contributors. Other approaches conceptualize digital literacy as a technological challenge (e.g.: creating or using the most suited programming language or app). Slightly more culturally oriented approaches (such as computational thinking (Wing, 2006)) explore it as a fundamental skill for everyone (not just for computer scientists) to empower all citizens. These approaches pursue the objective that digital literacy should complement and extend printed literacy (the three Rs: reading, writing, and arithmetic. But the true cultural transformation may be envisioned in analogy to the widespread acquisition of printed literacy in the middle age which reduced to power of scribes (e.g.: monks) that digital literacy will reduce the power of high-tech scribes by providing all citizens with the means to become co-creators of new ideas, knowledge, and products in personally meaningful activities (Fischer, 2005; Papert, 1980).

7 Rethinking and Reinventing Learning, Education, and Collaboration in the Age of COVID-19

In the months since the workshop from which the papers in this special issue were developed, an unanticipated but fundamental event has taken place: the occurrence of COVID-19. In the COVID-19 age *creative thinking* have proven one of the most important activities. It is required by politicians and public-health professionals to develop strategies for limiting the spread of the virus, by doctors and hospitals to treat patients, by researchers and scientists to develop a vaccine, and by the creativity of learning scientists, teachers and parents to provide learning opportunities for children while schools are closed.

The pandemic is a prime example of a *wicked problem* requiring that we practice new ways to live and learn together by facing the challenge "to learn when no one knows the answer". COVID-19 is one instance

for a new problem requiring all stakeholders “to think outside the box”. It illustrates the need to deal with unexpected challenges which will occur in today’s fast-changing world, in which people are facing increasingly increasing numbers of unknown, unexpected, and unpredictable situations. It also points to the necessity of iterative experimentation to gain new knowledge. It provides a unique opportunity to design new technologies for real humans needs beyond **productivity, efficiency, and usability.**

The pandemic has *forced* change in educational practices - the dominant change being to make temporarily *distant learning* the primary way to offer learning opportunities for people of all ages.

Distant learning (see our brief discussion on MOOCs earlier in the paper) has been a component of learning environments for a long time — but in the age of COVID-19 is not a choice but a necessity because universities and schools are closed.

Rethinking and reinventing learning, education, and collaboration in the age of COVID-19 can be differentiated in two responses: (1) immediate actions in response to the urgency of using remote learning as the primary medium and (2) reflections and strategies to envision learning in a “new world” providing opportunities to shape the learning environments of the future after COVID-19.

In the short run: immediate actions in response to the urgency. Large-scale and indefinite school closures (as they exist in April 2020) are uncharted territory, altering the lives and routines of millions of teachers, children, and parents. The most urgent activities are: (1) teachers must engage themselves as lifelong learners to understand the systems that will facilitate their remote teaching activities; (2) the availability and reliability of the hardware and software to support remote teaching must be guaranteed; (3) the creation of a new “digital divide“ must be avoided by eliminating the technology gap that exists among our school communities; and learners must learn to cope with the new environments.

In the short run “gift-wrapping” (see Table 1) is a reasonable and adequate approach that teachers "remotify" (or “moocify”) their courses that they taught in a physical classroom.

In the long run: exploiting opportunities to shape the learning environments of the future. We as human societies are not defined by the conditions we face (“how things are”), no matter how challenging they seem at this moment but we are defined by how we respond to them (“how things could or should be”). It is a fair and valuable assumption that the world after COVID-19 will not be the same like it was before: there will be a “new normal”. Crises always offer opportunities for new beginnings and transformation. When we will emerge from the worst of the current pandemic, we might have gained a better understanding of more robust online education, have created a better IT infrastructure, and gained criteria for a more successful mix between online and residential education. Going online also have helped us to discover or explore already existing challenge in previous educational configurations.

We should explore the opportunity to move beyond “Gift-Wrapping” (based on what we argued before: "distance learning is not classroom learning at a distance”). If we are freed from COVID-19, the constraints imposed by it may have provided us with new insights for some of the exemplary transformations mentioned in Table 1. For example: different remote teaching environments such as global MOOCs and more local SPOCs (Small Private Online Courses representing localized instances of MOOCs focused on certain groups of students, which are qualified to take the course) need to experiment with their native technology. Instead of just sticking full lectures online, the support for interactions and feedback between teachers and students should be (one of) the most important priorities.

8 Conclusions

The future of how we live, think, create, work, learn, and collaborate is not out there to be “discovered”— it has to be *invented and designed*. The main message of this paper is the argument that new technologies are necessary but not sufficient. There is a need to transform cultures by exploring the co-evolution of new ideas about learning and teaching, new media and new learning organizations. We need to understand that going to school is more than getting exposed to new information but it is participating in a community. “Learning about” needs to be complemented with “learning to be” (Brown & Duguid, 2000). A lesson learned from COVID-19 in addition to keeping “social distance” are ideas to create frameworks and support environments for *“distant socializing”* meaning: while we continue to keep our physical distance during COVID-19, tightening our social and emotional connections and maintaining our own self-care are more important than ever. There is overwhelming evidence that students who felt they *had* to go to school before the pandemic forced them to stay home now *want* to go to school. The pandemic offers an opportunity to recreate the narrative of education.

Schools and universities are social constructs — they do not exist in nature. As our world changes, our objectives for learning and our educational institutions need to change (see Table 1).

Current research on designing IT for learning and education rarely take these aspects into account, but continues to engage in either automating or augmenting small scale practices of teachers and students. A wish for usefulness thus drives alignment with current models of education and learning practices. This alignment in turn cements and supports, rather than questions and transforms, the current systems and structures. To be able to engage in change awareness of the status quo and visions for the future are necessary to reach new goals.

Rethinking and reinventing learning, education, and collaboration in the digital age should provide researchers, practitioners, and decision makers with insights to understand the past and the present ("how things are") in order to envision and design alternatives to improve our approaches to learn and teach something ("how things could/should be")?

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