# The Challenge for the Digital Age: Making Learning a Part of Life

## Abstract

In the digital age more and more knowledge needs to be deliberately acquired well past the age of formal schooling and increasingly through educational processes that do not center on the traditional school. Making Learning a Part of Life will not be an option but a necessity, representing a fundamental challenge to a world in which change is the norm rather than the exception. At the same time, the performance of schools and the basic values of schools should be of increasing concern to society as a whole, rather than being considered professional matters that can safely be left to "educators" or school politics.

The main argument behind this paper is: learning in the digital age should not be restricted to creating digital infrastructures for supporting current forms of learning nor taking schools in their current form as God-given, natural entities, but changing current forms of education by developing new frameworks and socio-technical environments for making learning an integral part of life.

## Introduction

This paper explores the core assumption that the digitalization of society results in challenges and opportunities for learning and education based on fundamental transformations [Collins & Halverson, 2009; Fischer et al., 2020]. The ongoing digitalization processes in society creates a situation in which not only students but citizens at large need competences for handling everyday life that differ from those in predigital time. Digital technologies cannot merely be understood as tools providing access to new resources for learning, interacting, and knowing, but rather as providing new opportunities to improve the quality of life by supporting innovative dimensions of activity. We argue that research on learning and information technology, in the broadest way of defining this field, often falls short of embracing the multidimensional transformational aspects of these drastic changes. And that it also lacks visionary narratives of what education can and should be, in these transformations.

In the digital age more and more knowledge will be acquired well past the age of formal schooling and increasingly through educational processes that do not center on the traditional school. *Making Learning a Part of Life* will not be an option but a necessity representing a fundamental challenge to the world in which change is the norm rather than the exception. At the same time, the performance of schools and the basic values of schools should be of increasing concern to society as a whole, rather than being considered professional matters that can safely be left to "educators" or school politicians.

Addressing learning in the digital age should not be restricted to creating digital infrastructures for supporting current forms of learning nor taking schools in their current form as God-given, natural entities but changing current forms of education by developing new frameworks and socio-technical environments for making learning an integral part of life. Outside of educational institutions information technology is rapidly transforming many practices, leading to a growing gap between the role digital technologies play in 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], whether this is the intention of the designers and developers or not.

The paper is structured as followed: Chapter 2 will briefly characterize two global frameworks for “making learning a part of life”: (1) *cultural transformations* for which technological developments are necessary but not sufficient; and (2) *lifelong learning* as an indispensable activity complementing and transcending school learning by extending learning throughout life. Chapter 3 represents a set of *specific objectives* to move

beyond current conceptualizations of learning. Chapter 4 articulates some conclusions resulting from the transformations indicated in Chapter 3.

## Rethinking School from Cultural Transformations and Lifelong Learning Perspectives

### *Cultural Transformations*

Studying the emergence and establishing of cultural transformations are necessary for understanding how learning, interacting, and knowing with digital technology plays a part of everyday life [Fischer et al., 2020; Thomas & Brown, 2011]. But viewing the digitalization of society in such terms calls for additional research to describe, analyse, understand, and explain learning in a digitalised world, including a focus on lifelong learning. [Livingstone et al., 2018] show that as the internet becomes ever more embedded into children's lives, studies must explore the internet-mediated engagements of children with the world. Research must therefore not be limited to concerns of how children relate to the internet, but rather embrace how children´s life is reconfigured in the digital world as a consequence of being internet-mediated. In a review of social media in relation to education, [Dennen et al., 2020] note that dominant themes of research on social media within education differ from dominant themes on research outside of education, suggesting that researchers and practitioners would benefit from research originating from different disciplines and research areas. For instance, social media platforms as resources for teaching and learning are more present in educational research, while negative behaviours, health issues, and identity development and expression are dominant themes outside of education. Issues of digital citizenship, and social relationships were also more frequent outside of education.

Exploring the future of learning from a transformational 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. When some activities are delegated to machines and some tasks are done by humans this have a number of consequences in relation to what can be understood as relevant knowledge to teach and learn, but also to the agency of humans in such activities. The human part of these practices is adaptable by the persons involved [Lundin et al., 2015], and then also provides space for agency for the involved persons. In relation to educational practices, we see an increased use of data-driven decision support and such efforts where student or learner data are exploited calls for a critical discussion on who benefits from the analysis of digital educational activities [Dignum, 2021]. It is necessary to engage in driving transformations in desired directions, or in terms of digital systems adaptivity, to what degree do our systems adapt education to students in relation to gradually adapting students to educational systems [Hillman et al., 2020].

Taking this stance has consequences for the conceptualization of technology. Perspectives on technology as tools or resources supporting *current* practices limits the potential to understand and analyse transformational change. Or in the words of [Bayne, 2015] *"By casting technology as being simply about 'enhancement' of existing practices <…> we execute <…> an elision of a 'fuller understanding of technologies as social objects'."* Understanding the relationship of technologies with knowing and learning as cultural transformations will allow the formulation and exploration of more radical ideas and changes. Opening up for formulating visions of future educational practices.

Educational systems of today are surprisingly dependent on a traditional ideas of how to organise school, and to distant from how out of school learning is taking place in a digitalized society [Collins & Halverson,

2009; Resnick, 1987]. Schooling as such has long traditions and implications [Hamilton, 2015], which brings with them certain already fixed ways of describing and understanding learning and what learning might be [Tanner, 2013]. The organization of activities for learning in these settings is often defined by premade notions of content, often placing a curriculum of the future *within* a context of a curriculum of the past [Young, 1999; Young, 2003] limiting the possibilities of including a workable notion of what the future might bring [Levine, 2002]. A curriculum of the future in a digital world has been described as centrifugal [Williamson, 2013], in which content cannot be altogether predefined relying more on dynamic sources of a more open character. Defining competence for the digital world is not a new or easy task. Early versions such as being fluent with technology [National-Research-Council, 1999] can today be complemented with ideas of a digital competence [Erstad et al., 2021] leading to the fundamental challenge framed by the question: *"What should be taught and learned in school curricula in the 21st century"* [Collins, 2017; Erstad & Voogt, 2018]. The process of technological innovation is not solely about the design and development of new products or services, but rather is central to the very process that creates cultural change. Such a perspective also echoes Papert's view that computers can be the carrier of *"seeds whose intellectual products will not need technological support once they take root in an actively growing mind"* [Papert, 1980].

### *Lifelong Learning*

Lifelong learning [Fischer, 2000] is an essential challenge for inventing the future of our societies; it is a necessity rather than a possibility or a luxury to be considered. Lifelong learning is more than adult education and/or training — it is a mindset, a skillset and acquired tools, and a habit for people to acquire. It creates the challenge to understand, explore, and support new essential dimensions of learning and it requires new media and innovative technologies to be adequately supported. The major dimensions of our framework for lifelong learning are described and discussed in section 3 of the paper.

A theory of lifelong learning must investigate new frameworks to learning required by the profound and accelerating changes in the nature of work, education and life outside of work and school. 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 "institutionally sanctioned" knowledge indicates a gap between the world we live in and our formal education, where the latter focuses mainly on a predefined and limited amount of knowledge. 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.

Moving away from a conception of learning as something uniquely related to schools, gives way to understand learning in different settings. The seeds of a new education system can be seen in the explosive growth of workplace learning, adult education, open, online learning environments (e.g., courses such as Massively Open Online Courses (MOOCS) [DeCorte et al., 2016], resources such as Wikipedia [Pirolli et al., 2009], and programming communities such as Scratch [Resnick et al., 2009]), and a variety of design spaces for learning (e.g.: museums, science centers, and digital fabrication laboratories (FabLabs) [Walter-Herrmann & Büching, 2014]).

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. Consequently, insufficient theorization of learning means insufficient possibilities for informing the organization of education.

In our research we developed design requirements and supported them with the development of innovative socio-technical systems in support of lifelong learning including:

- *Learner-directed and supportive:* the choice of tasks and goals (including the learning opportunities offered) must be under the control of the learner and support for contextualization to users' tasks must be provided.
- *Contextualized presentation and personalization:* information presented should be maximally relevant to the learner's chosen project or task.
- *Breakdowns as opportunities for learning:* provide means for allowing learners to understand, extricate themselves from, discuss, and learn from breakdowns—turning breakdowns into opportunities rather than failures.
- *End-user development:* support significant modification, extension, and evolution by learners.
- *Supporting a range of expertise:* accommodate learners at progressively different levels of expertise.
- *Promoting collaboration:* include means for collaboration between learners.

## Components of a Framework for "Making Learning a Part of Life"

### *Beyond Current Schools: Not being God-given natural entities but social constructs*

In the scientific debate on education and the learning science, schools are often perceived as a part of nature, not as artifacts produced in a specific cultural, political, and historical context [Simon, 1996]. Illich [Illich, 1971] envisioned fifty years ago (before computers and the Internet became part of our everyday lives) alternative visions of schools for increased possibilities for learning: *"The inverse of school is possible: that we can depend on self-motivated learning instead of employing teachers to bribe or compel the student to find the time and the will to learn; that we can provide the learner with new links to the world instead of continuing to funnel all educational programs through the teacher."* However, the idea of such an "*inverse school*" is dependent on further exploration and explanation, and maybe also provocation of thinking and debate.

Table 1 provides a comparison between major characteristics resulting in differentiations between school and lifelong learning.

**Table 1: A Comparison of Different Conceptualizations of School and Lifelong Learning**

| Specific Dimensions | School Learning | Lifelong Learning |
|---|---|---|
| emphasis | generic basic skills | learning embedded in personally meaningful problems |
| focus | learning when the answer is known | learning when the answer is not known |
| potential drawbacks | decontextualized, not situated | important concepts are not encountered |

| | | |
|---|---|---|
| problems | provided with emphasis on problem solving | constructed with emphasis on problem framing |
| new topics | defined by curricula | arise incidentally from being in the world |
| structure | pedagogic or "logical" structure | dynamic for coping with wicked problems and work activity |
| roles | expert-novice model | reciprocal learning |
| teacher | "sage on the stage" expounding subject matter | "guide on the side" helping learners solve their problems |
| mode | instructionism (knowledge absorption) | constructionism (knowledge construction) |

### *Beyond the Individual Human Mind: Complementing Renaissance Scholars with Renaissance Communities*

Historically the emphasis of education has been to educate and support individual "Renaissance scholars". In today's world, most of the significant problems are *systemic problems* that transcend not only the individual human mind but cannot be addressed by any one specialty discipline. To cope with these problems requires not only "Renaissance Scholars" but "Renaissance Communities" [Fischer, 2013] in which stakeholders coming from different disciplines collaborate to create new knowledge.

Based on the constraints on human abilities to learn during a lifetime, we cannot expect individuals to maintain the prerequisite knowledge in their technological discipline, and at the same time to have the needed competence in the social sciences and in domain-specific application domains (e.g., a computer scientist knowing about a variety of tools and at the same time understanding relevant issues in cognitive science, sociology, anthropology and having acquired substantial knowledge in specific domains). While being a "Renaissance Scholar" (such as Leonardo da Vinci, who was equally adept in the arts and the sciences [Shneiderman, 2002]) was a realistic possibility in the 15th century, the objective of learning and education in the 21st century should be focused on "Renaissance Communities". Although humans can delegate some functionality to more or less intelligent machines, such systems are highly dependent on providing support for solving already known problem-solution pairs.

Despite the current rhetoric to avoid a primary focus on the Renaissance scholar in education, the dominant form of school learning and performance is understood as individual. Although group activities of various kinds occur in school, students ultimately are judged on what they can do, know, and solve by themselves. Furthermore, a major part of the core activity of schooling is designed as individual homework. Collaboration is often stigmatized as cheating [Norman, 2001]. Students is framed to succeed or fail at a task independently of what other students do. In contrast, much activity outside school is socially shared [Resnick, 1987]. Work, personal life, and recreation take place within social systems of interdependence, and each person's ability to function successfully depends how this functionality relates to what others do.

### *Beyond the Unaided Human Mind: Distributed Cognition*

In many educational approaches, human cognition has been seen as existing solely "inside" a person's head, and studies on cognition have often disregarded the physical and social surroundings in which cognition takes place. *Distributed cognition* [Hollan et al., 2001; 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.

Regardless of our acceptance of a theory of distributed cognition, it raises the fundamental question concerning what it means to learn in the 21st century in which powerful tools are available for many intellectual activities. Our research has identified and explored a distinction about distributed cognition and the change of tasks in a tool-rich world by identifying two major design perspectives [Fischer & Konomi, 2007]:

- *Tools for living* (such as eyeglasses) are grounded in a distributed cognition perspective, in which intelligence is mediated by tools for achieving activities that would be error prone, challenging, or impossible to achieve.
- *Tools for learning* (such as training wheels) are grounded in a 'scaffolding with fading' perspective in which the ultimate goal is autonomous performance by people without tools.

This distinction raises the fundamental question concerning what it means to learn in the 21st century in which powerful tools are available "anywhere, at any time, for anyone" for many intellectual activities – allowing people to have instant access to facts, assisting people in spelling, doing arithmetic, memorizing experiences, making sense of a large amount of information, connecting, and collaborating with others, and performing numerous other intellectual activities. There is also a possibility of extending educational activities outside of the educational institutions, allowing for example for microlearning educational activities embedded in our everyday lives [Jahnke et al., 2020]. These tools' ubiquitous availability provides numerous benefits but potential *pitfalls* (e.g., overreliance caused by the fact that tools for living need to be present and accessible when stakeholders are confronted with problems) need to be taken into account.

### *Beyond Instructionist Environments: Learning When the Answer is not known*

New discourses are required, because one of the major roles for new media and new technologies is not to deliver predigested information to individuals, but to provide the opportunity and resources for social debate and discussion. One of the most impoverished paradigms of education is a setting in which *"a single, all-knowing teacher tells or shows presumably unknowing learners something they presumably know nothing about"* [Bruner, 1996]. Despite the fact that significant efforts are under way to change the nature of school discourse to make it more of a collective inquiry, this traditional model of education is still widely practiced in our educational institutions, leading critics such as Illich [Illich, 1971] to claim that our schools and universities are the "reproductive organs of a consumer society" and that "people who are hooked on teaching are conditioned to be customers for everything else."

Many problems (specifically design problems) are *wicked* [Rittel & Webber, 1984] and the knowledge to address them is not "out there", but require contributions, innovative ideas, and new forms of activity from all involved stakeholders. Learners in such settings must be *active contributors* rather than passive consumers [Fischer, 2002] 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, 2006; von Hippel, 2005]. Our argument here is not that it is meaningless to teach what is already know in schools, this is necessary and deserves the greatest care and effort, but schools must also increasingly prepare students for skillfully involving themselves in collaborative knowledge construction.

### *Beyond Supply Models of Knowledge: Learning on Demand*

Learning in schools is based on a supply-push model. Based on curricula students are taught in different disciplines that are supposed to be relevant and of value in their later life and work. In today's world this approach encounters major obstacles because change is inevitable, complete coverage is impossible, and over a life-time obsolescence is unavoidable. Given the explosion of knowledge, people simply cannot learn in school all or even most of what they will need to know in later life [Sloman & Fernbach, 2017].

Learning on demand [Fischer, 1991] is a promising approach for addressing these problems because: (1) it contextualizes learning by allowing it to be integrated into work rather than relegating it to a separate phase, (2) it lets learners see for themselves the usefulness of new knowledge for actual problem situations, thereby increasing the motivation for learning new things, and (3) it makes new information relevant to the task at hand, thereby leading to more informed decision making, better products, and improved performance.

While learning on demand is an indispensable component of lifelong learning, the following limitations need to addressed: (1) the acquisition of certain essential skills should not be deferred until they are needed, because the time to learn them may be not available or the environment may be too dangerous for safe learning processes; (2) learning on demand is task driven and therefore may be limited to exposing users to isolated pieces of knowledge providing only limited support for learning essential principles; (3) users may encounter difficulties in decontextualizing knowledge so that it can be used in new settings, and (4) whereas learning on demand may be well suited for evolutionary extensions of a knowledge base, it may not support substantial restructuring because the additional features learned occur only in the neighborhood of what learners already know; (5) it is dependent on the ability to formulate a problem in a way that resonates with available knowledge.

### *Beyond Curriculum and Cultural Literacy: Interest-Driven and Long Tail Learning*

The phrase "*The Long Tail"* was coined by Chris Anderson [Anderson, 2006] to describe how our culture and economy is increasingly shifting away from a focus on a relatively small number of "hits" (mainstream products and markets) at the head of the demand curve toward a huge number of niches in the tail (as exemplified by companies such as Amazon or Netflix, that sell a large number of unique items in relatively small quantities).

Envisioning *long-tail learning* inspired by Anderson's model represents a *fundamentally different objective* compared to cultural literacy [Hirsch, 1996]. The web gives children and adults the ability to pursue topics they are particularly interested and feel passionate about.

Innovative computational environments provide *unique possibilities for an educational interpretation of the "Long Tail"* [Brown & Adler, 2008; Collins et al., 2009] thereby creating new feasibility spaces for making learning a part of life by exploring the following questions:

- How can we envision a productive synergy between the head and the tail and create mechanisms to support and exploit this synergy? How can the passion associated with topics from the tail be integrated with important basic knowledge and skills from the head that they successfully complement each other?
- Do we want to keep requiring everyone to learn the same thing in school rather than pursuing their deep interests?
- Do we want to keep extending the years of schooling to encompass the expanding knowledge base?

- Do we want to support kids to pursue more deeply the topics of interest to them — and if so, where can we find that space for kids to pursue and how can it be supported?
- How does access to tools and learning resources influence long tail learning?

Additional differentiations are summarized in Table 2.

**Table 2: Design Trade-Off: Curriculum-Driven versus Interest-Driven Learning**

| | Curriculum-Driven Learning | Interest-Driven Learning |
|---|---|---|
| characteristics | problem is given by the teacher or the systems; learning supported from the supply side; adult-run education; prescriptive | problem is based on the learner's needs and interest; learning supported from the demand side; child-run education; permissive |
| strengths | organized body of knowledge; pedagogically and cognitively structured | real interests, personally meaningful tasks, high motivation |
| weaknesses | limited relevancy to the interests of the learner or the task at hand | coverage of important concepts may be missing; unstructured learning episodes; lack of coherence; short term interests might not coincide with long term interests |
| primary role of teachers | sage on the stage — presents what they know and are prepared for | guide on the side – confronted with unfamiliar problems, providing resources for students' problem solving |
| planning versus situated responses | anticipating and planning of the learning goals and content | learning needs arise from the situational context |
| distribution over lifetime | *decreasing* in importance from school to university to lifelong learning | *increasing* in importance from school to university to lifelong learning |
| assessment | "standard" assessment instruments are applicable | "innovative" assessment instruments are needed |
| unique research challenges | presentation of an organized body of knowledge (basic skills) | task identification; context awareness; coping with unknown problems |



### *Beyond the Fallacy of the "Big Switch": Creating Mindsets in Support of Lifelong Learning*

Young people growing up in our societies spend a substantial number of years in educational institutions. In addition to learning about a variety of subjects, they will form *mindsets* what learning is all about which will have consequences for the rest of their lives. Instruction, access to existing information, solving given problems, individual performance, and tool-free environments are themes that determine many "school cultures" in today's world. The components of these mindsets are different from what citizens are confronted with in their lives after school that require problem framing, active participation, collaboration,

and learning on demand in support of interest-driven learning. A one-sided focus of schools on tools for learning will leave students unprepared for a world in which tools for living are of critical importance (see section 3.3).

Figure 1 illustrates the consequences of this approach assuming that after years of exposure to current school-based practices, students miraculously at some point of time will acquire and practice learning behaviors as required for the demands of lifelong learning in the digital age. Having taught many courses at universities and interacted with many students at the undergraduate and graduate level provided us with overwhelming evidence that the "Big Switch" model represents a fallacy.

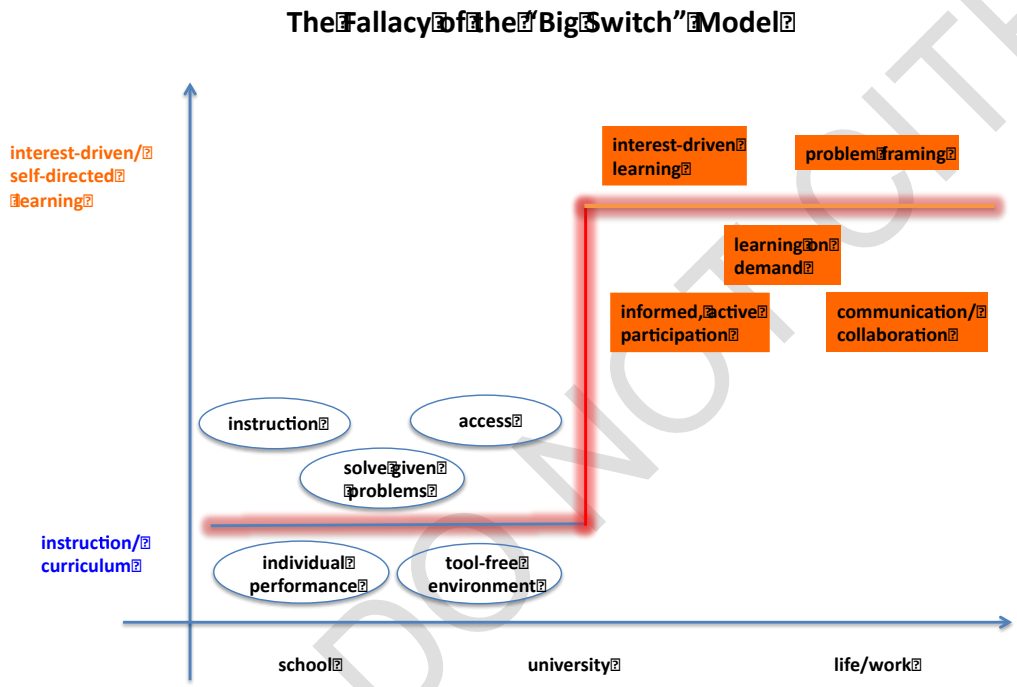


**Figure 1: The Fallacy of the "Big Switch" Model**

Figure 2 characterizes an approach that avoids the "Big Switch" fallacy by engaging students incrementally starting at an early age in interest-drive learning activities. While it is self-evident that students in elementary schools will have less knowledge to contribute than graduate students, they can and should be exposed to (1) skills and processes that support learning as a lifetime activity [Gardner, 1991], (2) that teachers do not always know the answers and that they should actively contribute to the framing and solving of problems [Bruner, 1996], and (3) that collaboration with others should not be considered as "cheating" [Norman, 2001]). One way of avoiding the fallacy of the Big Switch model is to develop models that bridge the gap between education in institutions and less formalized settings for learning. Allowing learners to "learn whenever they are curious and seamlessly switching between different contexts" [Wong & Looi, 2019].

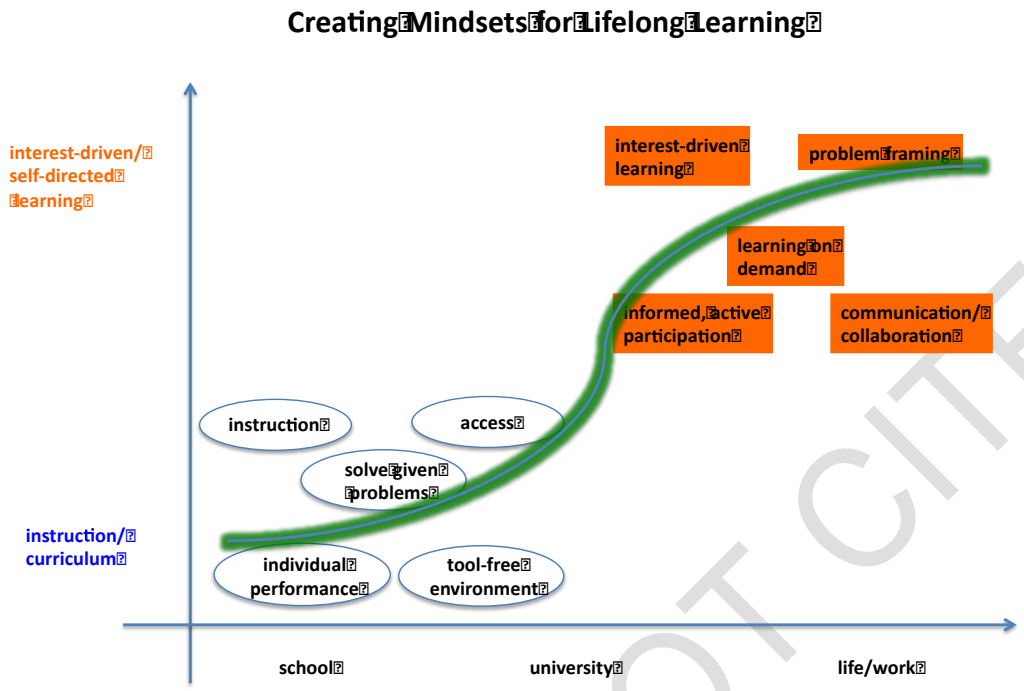


**Figure 2: Creating Mindsets for Lifelong Learning**

## *Beyond Learning Analytics: Measuring What We Value*

Learning Analytics research and approaches have enhanced learning in many different ways —particularly in online environments in which the interactions of learners can be easily tracked, analyzed, visualized and potentially also predicted. Learning Analytics [Larusson & White, 2014] examines the data captured about learners by looking for patterns and correlations that can provide insight how to improve the learning process. Collecting data is important for providing evidence instead of relying on beliefs, misconceptions, assumptions, and unsupported claims. But there are also pitfalls associated with current approaches in learning analytics [Muller, 2018] leading often to unintended, unnoticed, and undesirable side-effects, including: (1) influencing our behavior (e.g.: in curriculum design narrowing of what is taught to those things that can be easily measured with objective tests), (2) creating a potentially misleading impression of being "scientific" (by comparing numbers), (3) an obsession with data assuming that data is the best overall measure of any given situation, and (4) that data always produces valuable results.

A fundamental challenge facing Learning Analytics research is to develop methodologies whose main focus is to move from "value what we measure" to "measure what we value". To do so will avoid a tyranny of potentially irrelevant metrics that threatens the quality of learning by ignoring that much that is measurable is unimportant and not everything that is important is measurable. Examples for the "value what we measure" approach are (1) the International "Program for International Student Assessment (PISA)" and (2) the USA Program "No Child Left Behind (NCLB)" which both rely heavily on student performance on standardized tests. These movements favor quantifiable approaches (e.g.: instruction of facts and skills) rather than projects, discovery learning, creativity, and imaginative play [Resnick, 2017]. Most assessment technologies, that are employed in evaluating students, use multiple-choice, short answers to provide objective scoring. This form of testing requires that all students learn the same thing thereby suppressing approaches such as creativity, customization, and interest-driven learning. The argument here is not that we should not measure individual performance, but a sole focus on individual knowing, will regardless of intention, downplay the importance of creative and collective learning, to

teachers but maybe most problematic also to students. Besides aspects of measuring what we value, the very idea of continuous measurement has been critically discussed as it risks emphasizing completion of tests rather than developing critical thinking among students, and that it might create a sense of constant surveillance [Cerratto-Pargman & McGrath, 2021].

The "right kind" (not all of them) of data are of critical importance to understand *"how things are"*. A challenge of equal (if not more) importance is: how can data driven approaches provide insights and foundations for envisioning new educational designs (as indicated by the different "Beyond" themes of this article) to explore *"how things could or should be?"* [Robinson & Aronica, 2015]. There is New educational designs are not only influenced by data but also by problems, ideas, visions, and inspirational prototypes. The role of the teacher is also central to realize effective use of data for guiding instruction [Utterberg Modén et al., 2021]. Teachers are responsible for teaching in their classroom and if systems are part of creating unfair or unwanted conditions they are in many cases and should be able to choose not to include the systems. However, this is dependent on a certain level of transparency of the systems, allowing teachers to understand the foundation of suggestions that system makes. Given the difference between different classrooms it is unlikely that general predictions and algorithm-driven advice would create a fair and fruitful learning situation to all students, pointing to the importance of allowing humans in the loop not only in design, but also in design-in-use of such systems.

## Calls to action: Support Co-Evolution and Identify Design Trade-Offs

### *Co-Evolution of Learning, Media, and Learning Organizations*

The core argument of this paper is that learning in the digital age should not be envisioned as learning limited by how it is understood and practiced today, and merely *enriched* or *enhanced* by digital technologies, but instead our focus should rather be on supporting the *co-evolution* between learning, new media, and new ways of organizing learning by exploring opportunities for radically new conceptualizations and practices. Technological developments are necessary, but they are not sufficient (e.g.: distance learning supported by modern communication technologies should not be restricted to "classroom learning at a distance" but explore new opportunities for collaboration supported by modern communication technologies). Many current uses of technology to support life-long learning and distance learning are restricted to a *"gift wrapping"* approach [Fischer, 1998]: 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. This problem is visible in many comparative studies of the use of new technologies for learning. Here face-to-face is often used as baseline, restricting such studies from including tasks including functions that are only available in digital settings (e.g.: comparing memorization between students use pen or computer to take notes). Many digital educational tools, and digital tools in general have functionalities that have no comparable counterpart in face-to-face, or pen-and-paper activity.

Established frameworks, such as instructionism, fixed curriculum, memorization, decontextualized learning, etc., are not sustained or transformed by technology itself. This is true whether we use computer-based training, intelligent tutoring systems, multimedia presentations, or distance education approaches.

Co-evolution (grounded in the different "beyond" arguments of this paper) is grounded in descriptive and prescriptive goals such as: (1) learning should take place in the context of authentic, complex problems (because learners will refuse to quietly listen to someone else's answers to someone else's questions); (2) learning should be embedded in the pursuit of intrinsically rewarding activities; (3) learning-on-demand needs to be supported because change is inevitable, complete coverage is impossible, and obsolescence is unavoidable; (4) organizational and collaborative learning must be supported because the individual

human mind is limited; and (5) skills and processes that support learning as a lifetime habit must be developed.

### *Identifying the Best Possible Mixes with Design Trade-Offs*

Design is choice [Simon, 1996]. To gain a deep understanding of the potential and the transformations of innovative socio-technical environment for making learning a part of life requires a careful analysis of *design trade-offs* [Fischer, 2018] associated with different approaches. Because optimal solutions and simple "right" or "wrong" answers do not exist, identifying the best possible mixes represents a desirable objective and should contribute to the formation of mindsets.

*Personalization* of information (based on user and task models) can be used as an example to illustrate a specific design trade-off analysis. The concept is often used for promoting innovative learning environments and it can provide the following *desirable objectives*:

- customizing education to the particular needs and abilities of individual learners will reduce information overload with context-awareness by providing the "right information, at the right time, in the right place, in the right way, to the right person";
- supporting *interest-driven learning* by presenting and engaging people with topics that they *want* to learn rather then that they *have* to learn thereby allowing them to take responsibility for their own learning;
- providing *feedback* to learners about their own activities and problem-solving activities (e.g., with critiquing components).

Potential *pitfalls* associated with personalization are:

- it prohibits learners from being exposed to different views on issues thereby promoting *group-think* [Janis, 1972];
- it encapsulates learners in *filter bubbles* [Pariser, 2021] limiting learners to particular world views, never seeing things outside of them;
- it limits *serendipitous encounters* (e.g., encountering interesting ideas, things, events, and people by chance and volunteering information to learners that they consider relevant without asking) [Roberts, 1989];
- it provides the foundation for privacy intrusions [Mayer-Schönberger & Cukier, 2013].

Other design trade-offs were articulated in previous sections of the paper including:

- will *distributed cognition* (section 3.3) support the unaided human mind or will it lead to an overreliance on external tools thereby suppressing the acquisition of basic knowledge and skills (e.g.: navigation systems may have a negative impact on geographical knowledge);
- will approaches to *long tail learning* (section 3.6) facilitate interest-driven learning or will it lead to insufficient exposure to basic skills;
- will communication tools increase and widen the collaboration with other learners, or will it increase social isolation because individuals will be sitting at home in front of a computer and interacting less with other people;
- will digital technologies widen the *"digital divide*" or reduce it by making educational opportunities available to many more learners in all parts of the world (e.g. with Massively Open Online Courses (MOOCS) [DeCorte et al., 2016]).

The best possible mixes need to be situated and explored in specific settings. The revolution in education we see happening will have large effects on society. As with any innovation, the associated design trade-offs need to be analyzed to identify gains and losses Some pessimists see people becoming subservient to

their technologies and many people being left behind as technology comes to dominate our lives. Some optimists see a golden age of learning opening before us, where people will be able to find resources to pursue any education they may want.

## Conclusions

Universal schooling has formed the basis for our societies today. With the arguments articulated in this paper we do not want to deemphasize the values of schools but rather entice a discussion on reconceptualizing them from a lifelong learning perspective. Many aspects of traditional schools such as students (1) being supposed to sit still and passively listen to the talk of teachers, (2) memorize the information given them to by teachers or found in books, and (3) regurgitate that information back on tests (see section 4.8) worked relatively well in a world where change was not constant, where coverage of important topics was a feasible objective, and skills learned could be applied for a lifetime. Our argument is not that such activities are meaningless, but that we are lacking exploration, debate and investigation on whether they are sufficient.

The digital age greatly enhances the opportunities and supports the necessity for "making learning a part of life". But while the growth of technology is certain, the inevitability of any particular future is not. The impact of schooling goes beyond that new information about computers, the Internet, and social media are integrated into the schools of today. The transformation of schools needs to be informed by an understanding of the impact of mindset formation that will determine people's approach to learning for the rest of their lives. Our framework is focused on moving "beyond gift-wrapping" by not only fixing and existing systems but to change them and not only reforming but transforming them. We need creative practices to explore frameworks for technological imagination not only grounded in understanding new media and technologies in terms of productivity, efficiency, reliability, and from economic perspectives, but also in exploring innovative sociotechnical environments that contribute to human creativity, gratification, enjoyment, and quality of life.

It is our hope that this article will be of interest to many stakeholders (including learners, teachers, curriculum designers, technology experts, parents, and politicians) and provide a foundation for an ongoing debate and informed actions for "Making Learning a Part of Life" in the digital age.

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