

Digital Transformation Of Education And Sustainability-Review Based Study

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Abstract: Digital transformation, however, is broader than just the digitization of existing processes. Digital transformation entails considering how products, processes and organizations can be changed through the use of new, digital technologies. A 2019 review proposes a definition of digital transformation as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies."

Key words: Digitization; Analog; Digital Converter; Digital Transformation; Communication;

Introduction

In a 2021 survey, 55% of European companies stated the COVID-19 pandemic has increased the demand for digitalization, and 46% of companies reported that they have grown more digital. Half of these companies anticipate an increase in the usage of digital technologies in the future, with a greater proportion being companies that have previously used digital technology. A lack of digital infrastructure was viewed as a key barrier to investment by 16% of EU businesses, compared to 5% in the US. In a survey conducted in 2021, 89% of African banks polled claimed that the COVID-19 pandemic has hastened the digital transformation of their internal operations. Digital transformation gives enterprises new vitality. Now, economic consequences are a major concern for digital transformation. In 2022, 53% of businesses reported taking action or making investments in becoming more digital. 71% of companies in the US reported using at least one advanced digital technology, similar to the average usage of 69% across EU organizations. However, since there are no comprehensive data sets on the digital transformation at the macro level, the overall effect of digital transformation is still too early to comment.

Educational technology

It (commonly abbreviated as **edutech**, or **edtech**) is the combined use of computer hardware, software, and educational theory and practice to facilitate learning. When referred to with its abbreviation, edtech, it often refers to the industry of companies that create educational technology. In addition to the practical educational experience, educational technology is based on theoretical knowledge from various disciplines such as communication, education, psychology, sociology, artificial intelligence, and computer science. It encompasses

several domains including learning theory, computer-based training, online learning, and m-learning where mobile technologies are used.

Definition

The Association for Educational Communications and Technology (AECT) has defined educational technology as "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources". It denotes instructional technology as "the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning". As such, educational technology refers to all valid and reliable applied education sciences, such as equipment, as well as processes and procedures that are derived from scientific research, and in a given context may refer to theoretical, algorithmic or heuristic processes: it does not necessarily imply physical technology. Educational technology is the process of integrating technology into education in a positive manner that promotes a more diverse learning environment and a way for students to learn how to use technology as well as their common assignments. Accordingly, there are several discrete aspects to describing the intellectual and technical development of educational technology:

- Educational technology as the theory and practice of educational approaches to learning.
- Educational technology as technological tools and media, for instance massive online courses, that assist in the communication of knowledge, and its development and exchange. This is usually what people are referring to when they use the term "edtech".
- Educational technology for learning management systems (LMS), such as tools for

student and curriculum management, and education management information systems (EMIS).

- Educational technology as back-office management, such as training management systems for logistics and budget management, and Learning Record Store (LRS) for learning data storage and analysis.
- Educational technology itself as an educational subject; such courses may be called "computer studies" or "information and communications technology (ICT)".

Educational technology is an inclusive term for both the material tools and processes, and the theoretical foundations for supporting learning and teaching. Educational technology is not restricted to high technology but is anything that enhances classroom learning in the utilization of blended, face-to-face, or online learning. An educational technologist is someone who is trained in the field of educational technology. Educational technologists try to analyze, design, develop, implement, and evaluate processes and tools to enhance learning. While the term educational technologist is used primarily in the United States, learning technologist is synonymous term used in the UK as well as Canada.

Modern electronic educational technology is an important part of society today. Educational technology encompasses e-learning, instructional technology, information and communication technology (ICT) in education, edtech, learning technology, multimedia learning, technology-enhanced learning (TEL), computer-based instruction (CBI), computer managed instruction, computer-based training (CBT), computer-assisted instruction or computer-aided instruction (CAI), internet-based training (IBT), flexible learning, web-based training (WBT), online education, digital educational collaboration, distributed learning, computer-mediated communication, cyber-learning, and multi-modal instruction, virtual education, personal learning environments, networked learning, virtual learning environments (VLE) (which are also called learning platforms), m-learning, ubiquitous learning and digital education. Each of these numerous terms has had its advocates, who point up potential distinctive features. However, many terms and concepts in educational technology have been defined nebulously; for example, Fiedler's review of the literature found a complete lack of agreement about the components of a personal learning environment. Moreover, Moore saw these terminologies as emphasizing particular features such as digitization approaches, components, or

delivery methods rather than being fundamentally dissimilar in concept or principle. For example, m-learning emphasizes mobility, which allows for altered timing, location, accessibility, and context of learning; nevertheless, its purpose and conceptual principles are those of educational technology. In practice, as technology has advanced, the particular "narrowly defined" terminological aspect that was initially emphasized by name has blended into the general field of educational technology. Initially, "virtual learning" as narrowly defined in a semantic sense implied entering an environmental simulation within a virtual world, for example in treating posttraumatic stress disorder (PTSD). In practice, a "virtual education course" refers to any instructional course in which all, or at least a significant portion, is delivered by the Internet. "Virtual" is used in that broader way to describe a course that is not taught in a classroom face-to-face but through a substitute mode that can conceptually be associated "virtually" with classroom teaching, which means that people do not have to go to the physical classroom to learn. Accordingly, virtual education refers to a form of distance learning in which course content is delivered by various methods such as course management applications, multimedia resources, and videoconferencing. Virtual education and simulated learning opportunities, such as games or dissections, offer opportunities for students to connect classroom content to authentic situations. Educational content, pervasively embedded in objects, is all around the learner, who may not even be conscious of the learning process. The combination of adaptive learning, using an individualized interface and materials, which accommodate to an individual, who thus receives personally differentiated instruction, with ubiquitous access to digital resources and learning opportunities in a range of places and at various times, has been termed smart learning. Smart learning is a component of the smart city concept.

History

Helping people and children learn in ways that are easier, faster, more accurate, or less expensive can be traced back to the emergence of very early tools, such as paintings on cave walls. Various types of abacus have been used. Writing slates and blackboards have been used for at least a millennium. From their introduction, books and pamphlets have held a prominent role in education. From the early twentieth century, duplicating machines such as the mimeograph and Gestetner stencil devices were used to produce short copy runs (typically 10–50 copies) for classroom or home use. The use of media for instructional

purposes is generally traced back to the first decade of the 20th century with the introduction of educational films (the 1900s) and Sidney Pressey's mechanical teaching machines (1920s). The first all multiple choice, large-scale assessment was the Army Alpha, used to assess the intelligence and, more specifically, the aptitudes of World War I military recruits. Further large-scale use of technologies was employed in training soldiers during and after WWII using films and other mediated materials, such as overhead projectors. The concept of hypertext is traced to the description of memex by Vannevar Bush in 1945. Slide projectors were widely used during the 1950s in educational institutional settings. Cuisenaire rods were devised in the 1920s and saw widespread use from the late 1950s.

In the mid-1960s, Stanford University psychology professors, Patrick Suppes and Richard C. Atkinson, experimented with using computers to teach arithmetic and spelling via Teletypes to elementary school students in the Palo Alto Unified School District in California. Stanford's Education Program for Gifted Youth is descended from those early experiments. Online education originated from the University of Illinois in 1960. Although the internet would not be created for another decade, students were able to access class information with linked computer terminals. Online learning emerged in 1982 when the Western Behavioral Sciences Institute in La Jolla, California, opened its School of Management and Strategic Studies. The school employed computer conferencing through the New Jersey Institute of Technology's Electronic Information Exchange System (EIES) to deliver a distance education program to business executives. Starting in 1985, Connected Education offered the first totally online master's degree in media studies, through The New School in New York City, also via the EIES computer conferencing system. Subsequent courses were offered in 1986 by the Electronic University Network for DOS and Commodore 64 computers. In 2002, MIT began providing online classes free of charge. As of 2009, approximately 5.5 million students were taking at least one class online. Currently, one out of three college students takes at least one online course while in college. At DeVry University, out of all students that are earning a bachelor's degree, 80% earn two-thirds of their requirements online. Also, in 2014, 2.85 million students out of 5.8 million students that took courses online, took all of their courses online. From this information, it can be concluded that the number of students taking classes online is on a steady increase.

The recent article, "Shift happens: online education as a new paradigm in learning", Linda Harasim covers an overview of the history of online education as well as a framework for understanding the type of need it addresses, the concept of distance learning has already been invented for many centuries. The value of online education is not found in its ability to have established a method for distance learning, but rather in its power to make this type of learning process more efficient by providing a medium in which the instructor and their students can virtually interact with one another in real-time. The topic of online education started primarily in the late 1900s when institutions and businesses started to make products to assist students' learning. These groups desired a need to further develop educational services across the globe, primarily to developing countries. In 1960, the University of Illinois created a system of linked computer terminals, known as the Intranet, to give students access to recorded lectures and course materials that they could watch or use in their free time. This type of concept, called PLATO (programmed logic for automatic teaching operations), was rapidly introduced throughout the globe. Many institutions adopted this similar technique while the internet was in its developmental phase.

In 1971, Ivan Illich published a hugely influential book, *Deschooling Society*, in which he envisioned "learning webs" as a model for people to network the learning they needed. The 1970s and 1980s saw notable contributions in computer-based learning by Murray Turoff and Starr Roxanne Hiltz at the New Jersey Institute of Technology as well as developments at the University of Guelph in Canada. In the UK, the Council for Educational Technology supported the use of educational technology, in particular administering the government's National Development Programme in Computer Aided Learning (1973–1977) and the Microelectronics Education Programme (1980–1986). By the mid-1980s, accessing course content became possible at many college libraries. In computer-based training (CBT) or computer-based learning (CBL), the learning interaction was between the student and computer drills or micro-world simulations. Digitized communication and networking in education started in the mid-1980s. Educational institutions began to take advantage of the new medium by offering distance learning courses using computer networking for information. Early e-learning systems, based on computer-based learning/training often replicated autocratic teaching styles whereby the role of the e-learning system was assumed to be for transferring knowledge, as opposed to systems developed later based on computer-supported collaborative

learning (CSCL), which encouraged the shared development of knowledge. Videoconferencing was an important forerunner to the educational technologies known today. This work was especially popular with museum education. Even in recent years, videoconferencing has risen in popularity to reach over 20,000 students across the United States and Canada in 2008–2009. Disadvantages of this form of educational technology are readily apparent: image and sound quality are often grainy or pixelated; videoconferencing requires setting up a type of mini-television studio within the museum for broadcast, space becomes an issue, and specialized equipment is required for both the provider and the participant.

The Open University in Britain and the University of British Columbia (where Web CT, now incorporated into Blackboard Inc., was first developed) began a revolution of using the Internet to deliver learning, making heavy use of web-based training, online distance learning, and online discussion between students. Practitioners such as Harasim (1995) put heavy emphasis on the use of learning networks. With the advent of World Wide Web in the 1990s, teachers embarked on the method of using emerging technologies to employ multi-object oriented sites, which are text-based online virtual reality systems, to create course websites along with simple sets of instructions for their students. By 1994, the first online high school had been founded. In 1997, Graziadei described criteria for evaluating products and developing technology-based courses that include being portable, replicable, scalable, affordable, and having a high probability of long-term cost-effectiveness. Improved Internet functionality enabled new schemes of communication with multimedia or webcams. The National Center for Education Statistics estimates the number of K 12 students enrolled in online distance learning programs increased by 65% from 2002 to 2005, with greater flexibility, ease of communication between teacher and student, and quick lecture and assignment feedback. According to a 2008 study conducted by the U.S Department of Education, during the 2006–2007 academic year about 66% of postsecondary public and private schools participating in student financial aid programs offered some distance learning courses; records show 77% of enrollment in for-credit courses with an online component. In 2008, the Council of Europe passed a statement endorsing e-learning's potential to drive equality and education improvements across the EU.

Computer-mediated communication (CMC) is between learners and instructors, mediated by the

computer. In contrast, CBT/CBL usually means individualized (self-study) learning, while CMC involves educator/tutor facilitation and requires the scalarization of flexible learning activities. In addition, modern ICT provides education with tools for sustaining learning communities and associated knowledge management tasks. Students growing up in this digital age have extensive exposure to a variety of media. Major high-tech companies have funded schools to provide them with the ability to teach their students through technology. 2015 was the first year that private nonprofit organizations enrolled more online students than for-profits, although public universities still enrolled the highest number of online students. In the fall of 2015, more than 6 million students enrolled in at least one online course. In 2020, due to the COVID-19 pandemic, many schools across the world were forced to close, which left more and more grade-school students participating in online learning, and university-level students enrolling in online courses to enforce distance learning. Organizations such as Unesco have enlisted educational technology solutions to help schools facilitate distance education. The pandemic's extended lockdowns and focus on distance learning has attracted record-breaking amounts of venture capital to the ed-tech sector. In 2020, in the United States alone, ed-tech startups raised \$1.78 billion in venture capital spanning 265 deals, compared to \$1.32 billion in 2019.

Higher education

Online college course enrollment has seen a 29% increase in enrollment with nearly one-third of all college students, or an estimated 6.7 million students are currently enrolled in online classes. In 2009, 44% of post-secondary students in the USA were taking some or all of their courses online, which was projected to rise to 81% by 2014. Although a large proportion of for-profit higher education institutions now offer online classes, only about half of private, non-profit schools do so. Private institutions may become more involved with online presentations as the costs decrease. Properly trained staff must also be hired to work with students online. These staff members need to understand the content area, and also be highly trained in the use of the computer and Internet. Online education is rapidly increasing, and online doctoral programs have even developed at leading research universities. Although massive open online courses (MOOCs) may have limitations that preclude them from fully replacing college education, such programs have significantly expanded. MIT, Stanford and Princeton University offer classes to a global audience, but not for college credit. University-level programs, like edX

founded by Massachusetts Institute of Technology and Harvard University, offer a wide range of disciplines at no charge, while others permit students to audit a course at no charge but require a small fee for accreditation. MOOCs have not had a significant impact on higher education and declined after the initial expansion, but are expected to remain in some form. Lately, MOOCs are used by smaller universities to profile themselves with highly specialized courses for special-interest audiences, as for example in a course on technological privacy compliance. MOOCs have been observed to lose the majority of their initial course participants. In a study performed by Cornell and Stanford universities, student-drop-out rates from MOOCs have been attributed to student anonymity, the solitude of the learning experience, and to the lack of interaction with peers and with teachers. Effective student engagement measures that reduce drop-outs are forum interactions and virtual teacher or teaching assistant presence - measures which induce staff cost that grows with the number of participating students.

Corporate and professional

E-learning is being used by companies to deliver mandatory compliance training and updates for regulatory compliance, soft skills and IT skills training, continuing professional development (CPD), and other valuable workplace skills. Companies with spread out distribution chains use e-learning for delivering information about the latest product developments. Most corporate e-learning is asynchronous and delivered and managed via learning management systems. The big challenge in corporate e-learning is to engage the staff, especially on compliance topics for which periodic staff training is mandated by the law or regulations.

Government and public

There is an important need for recent, reliable, and high-quality health information to be made available to the public as well as in summarized form for public health providers. Providers have indicated the need for automatic notification of the latest research, a single searchable portal of information, and access to grey literature. The Maternal and Child Health (MCH) Library is funded by the U.S. Maternal and Child Health Bureau to screen the latest research and develop automatic notifications to providers through the MCH Alert. Another application in public health is the development of mHealth (use of mobile telecommunication and multimedia in global public health). MHealth has been used to promote prenatal and newborn services, with positive outcomes. In addition, "Health systems have implemented

mHealth programs to facilitate emergency medical responses, point-of-care support, health promotion, and data collection." In low and middle-income countries, mHealth is most frequently used as one-way text messages or phone reminders to promote treatment adherence and gather data.

Benefits

Effective technology use deploys multiple evidence-based strategies concurrently (e.g. adaptive content, frequent testing, immediate feedback, etc.), as do effective teachers. Using computers or other forms of technology can give students practice on core content and skills while the teacher can work with others, conduct assessments, or perform other tasks. Through the use of educational technology, education is able to be individualized for each student allowing for better differentiation and allowing students to work for mastery at their own pace. Modern educational technology can improve access to education, including full degree programs. It enables better integration for non-full-time students, particularly in continuing education, and improved interactions between students and instructors. Learning material can be used for long-distance learning and are accessible to a wider audience. Course materials are easy to access. In 2010, 70.3% of American family households had access to the internet. In 2013, according to Canadian Radio-Television and Telecommunications Commission Canada, 79% of homes have access to the internet. Students can access and engage with numerous online resources at home. Using online resources can help students spend more time on specific aspects of what they may be learning in school but at home. Schools like the Massachusetts Institute of Technology (MIT) have made certain course materials free online. Although some aspects of a classroom setting are missed by using these resources, they are helpful tools to add additional support to the educational system. The necessity to pay for transport to the educational facility is removed. Students appreciate the convenience of e-learning, but report greater engagement in face-to-face learning environments. Colleges and universities are working towards combating this issue by utilizing WEB 2.0 technologies as well as incorporating more mentorships between students and faculty members. According to James Kulik, who studies the effectiveness of computers used for instruction, students usually learn more in less time when receiving computer-based instruction, and they like classes more and develop more positive attitudes toward computers in computer-based classes. Students can independently solve problems. There are no intrinsic age-based restrictions on difficulty level, i.e. students can go at their own pace.

Students editing their written work on word processors improve the quality of their writing. According to some studies, the students are better at critiquing and editing written work that is exchanged over a computer network with students they know. Studies completed in "computer intensive" settings found increases in student-centric, cooperative, and higher-order learning, writing skills, problem-solving, and using technology. In addition, attitudes toward technology as a learning tool by parents, students, and teachers are also improved.

Employers' acceptance of online education has risen over time. More than 50% of human resource managers SHRM surveyed for an August 2010 report said that if two candidates with the same level of experience were applying for a job, it would not have any kind of effect whether the candidate's obtained degree was acquired through an online or a traditional school. Seventy-nine percent said they had employed a candidate with an online degree in the past 12 months. However, 66% said candidates who get degrees online were not seen as positively as job applicants with traditional degrees. The use of educational apps generally has a positive effect on learning. Pre- and post-tests have revealed that the use of educational apps on mobile devices reduces the achievement gap between struggling and average students. Some educational apps improve group work by allowing students to receive feedback on answers and promoting collaboration in solving problems. The benefits of app-assisted learning have been exhibited in all age groups. Kindergarten students that use iPads show much higher rates of literacy than non-users. Medical students at the University of California Irvine that utilized iPad academically have been reported to score 23% higher on national exams than in previous classes that did not.

Disadvantages

Globally, factors like change management, technology obsolescence, and vendor-developer partnership are major restraints that are hindering the growth of the Educational technology market. In the US, state and federal government increased funding, as well as private venture capital, has been flowing into the education sector. However, as of 2013, none were looking at technology return on investment (ROI) to connect expenditures on technology with improved student outcomes. New technologies are frequently accompanied by unrealistic hype and promise regarding their transformative power to change education for the better or in allowing better educational opportunities to reach the masses. Examples include silent film, broadcast radio, and television,

none of which have maintained much of a foothold in the daily practices of mainstream, formal education. Technology, in and of itself, does not necessarily result in fundamental improvements to educational practice. The focus needs to be on the learner's interaction with technology—not the technology itself. It needs to be recognized as "ecological" rather than "additive" or "subtractive". In this ecological change, one significant change will create total change. According to Branford et al., "technology does not guarantee effective learning", and inappropriate use of technology can even hinder it. A University of Washington study of infant vocabulary shows that it is slipping due to educational baby DVDs. Published in the Journal of Pediatrics, a 2007 University of Washington study on the vocabulary of babies surveyed over 1,000 parents in Washington and Minnesota. The study found that for every hour that babies 8–16 months of age watched DVDs and Videos, they knew 6-8 fewer of 90 common baby words than the babies that did not watch them. Andrew Meltzoff, a surveyor in this study, states that the result makes sense, that if the baby's "alert time" is spent in front of DVDs and TV, instead of with people speaking, the babies are not going to get the same linguistic experience. Dr. Dimitri Chistakis, another surveyor reported that the evidence is mounting that baby DVDs are of no value and may be harmful. Adaptive instructional materials tailor questions to each student's ability and calculate their scores, but this encourages students to work individually rather than socially or collaboratively (Kruse, 2013). Social relationships are important, but high-tech environments may compromise the balance of trust, care, and respect between teacher and student.

Massively open online courses (MOOCs), although quite popular in discussions of technology and education in developed countries (more so in the US), are not a major concern in most developing or low-income countries. One of the stated goals of MOOCs is to provide less fortunate populations (i.e., in developing countries) an opportunity to experience courses with US-style content and structure. However, research shows only 3% of the registrants are from low-income countries, and although many courses have thousands of registered students only 5-10% of them complete the course. This can be attributed to lack of staff support, course difficulty, and low levels of engagement with peers. MOOCs also implies that certain curriculum and teaching methods are superior, and this could eventually wash over (or possibly washing out) local educational institutions, cultural norms, and educational traditions. With the Internet and social media, using educational apps makes students highly susceptible to distraction and sidetracking. Even though proper use has been

shown to increase student performance, being distracted would be detrimental. Another disadvantage is an increased potential for cheating. One method is done by creating multiple accounts to survey questions and gather information which can be assimilated so that the master account is able to fill in the correct answers. Smartphones can be very easy to hide and use inconspicuously, especially if their use is normalized in the classroom. These disadvantages can be managed with strict rules and regulations on mobile phone use. A disadvantage of e-learning is that it can cause depression, according to a study made during the 2021 COVID-19 quarantines.

Over-stimulation

Electronic devices such as cell phones and computers facilitate rapid access to a stream of sources, each of which may receive cursory attention. Michel Rich, an associate professor at Harvard Medical School and executive director of the center on Media and Child Health in Boston, said of the digital generation, "Their brains are rewarded not for staying on task, but for jumping to the next thing. The worry is we're raising a generation of kids in front of screens whose brains are going to be wired differently." Students have always faced distractions; computers and cell phones are a particular challenge because the stream of data can interfere with focusing and learning. Although these technologies affect adults too, young people may be more influenced by it as their developing brains can easily become habituated to switching tasks and become unaccustomed to sustaining attention. Too much information, coming too rapidly, can overwhelm thinking. Technology is "rapidly and profoundly altering our brains." High exposure levels stimulate brain cell alteration and release neurotransmitters, which causes the strengthening of some neural pathways and the weakening of others. This leads to heightened stress levels on the brain that, at first, boost energy levels, but, over time, actually augment memory, impair cognition, lead to depression, and alter the neural circuitry of the hippocampus, amygdala and prefrontal cortex. These are the brain regions that control mood and thought. If unchecked, the underlying structure of the brain could be altered. Overstimulation due to technology may begin too young. When children are exposed before the age of seven, important developmental tasks may be delayed, and bad learning habits might develop, which "deprives children of the exploration and play that they need to develop." Media psychology is an emerging specialty field that embraces electronic devices and the sensory behaviors occurring from the use of educational technology in learning.

Socio-cultural criticism

According to Lai, "the learning environment is a complex system where the interplay and interactions of many things impact the outcome of learning." When technology is brought into an educational setting, the pedagogical setting changes in that technology-driven teaching can change the entire meaning of an activity without adequate research validation. If technology monopolizes an activity, students can begin to develop the sense that "life would scarcely be thinkable without technology." Leo Marx considered the word "technology" itself as problematic, susceptible to reification and "phantom objectivity", which conceals its fundamental nature as something that is only valuable insofar as it benefits the human condition. Technology ultimately comes down to affecting the relations between people, but this notion is obfuscated when technology is treated as an abstract notion devoid of good and evil. Langdon Winner makes a similar point by arguing that the underdevelopment of the philosophy of technology leaves us with an overly simplistic reduction in our discourse to the supposedly dichotomous notions of the "making" versus the "uses" of new technologies and that a narrow focus on "use" leads us to believe that all technologies are neutral in moral standing. These critiques would have us ask not, "How do we maximize the role or advancement of technology in education?", but, rather, "What are the social and human consequences of adopting any particular technology?"

Winner viewed technology as a "form of life" that not only aids human activity, but that also represents a powerful force in reshaping that activity and its meaning. For example, the use of robots in the industrial workplace may increase productivity, but they also radically change the process of production itself, thereby redefining what is meant by "work" in such a setting. In education, standardized testing has arguably redefined the notions of learning and assessment. We rarely explicitly reflect on how strange a notion it is that a number between, say, 0 and 100 could accurately reflect a person's knowledge about the world. According to Winner, the recurring patterns in everyday life tend to become an unconscious process that we learn to take for granted. Winner writes, By far, the greatest latitude of choice exists the very first time a particular instrument, system, or technique is introduced. Because choices tend to become strongly fixed in material equipment, economic investment, and social habit, the original flexibility vanishes for all practical purposes once the initial commitments are made. In that sense, technological innovations are similar to legislative

acts or political findings that establish a framework for public order that will endure over many generations. When adopting new technologies, there may be one best chance to "get it right". Seymour Paper points out a good example of a (bad) choice that has become strongly fixed in social habit and material equipment: our "choice" to use the QWERTY keyboard. The QWERTY arrangement of letters on the keyboard was originally chosen, not because it was the most efficient for typing, but because early typewriters were prone to jam when adjacent keys were struck in quick succession. Now that typing has become a digital process, this is no longer an issue, but the QWERTY arrangement lives on as a social habit, one that is very difficult to change. Neil Postman endorsed the notion that technology impacts human cultures, including the culture of classrooms, and that this is a consideration even more important than considering the efficiency of new technology as a tool for teaching. Regarding the computer's impact on education, Postman writes : What we need to consider about the computer has nothing to do with its efficiency as a teaching tool. We need to know in what ways it is altering our conception of learning, and how in conjunction with television, it undermines the old idea of school. There is an assumption that technology is inherently interesting so it must be helpful in education; based on research by Daniel Willingham, that is not always the case. He argues that it does not necessarily matter what the technological medium is, but whether or not the content is engaging and utilizes the medium in a beneficial way.

Data protection

According to a report by the Electronic Frontier Foundation, large amounts of personal data on children are collected by electronic devices that are distributed in schools in the United States. Often, far more information than necessary is collected, uploaded, and stored indefinitely. Aside from name and date of birth, this information can include the child's browsing history, search terms, location data, contact lists, as well as behavioral information. Parents are not informed or, if informed, have little choice. According to the report, this constant surveillance resulting from educational technology can "warp children's privacy expectations, lead them to self-censor, and limit their creativity". In a 2018 public service announcement, the FBI warned that widespread collection of student information by educational technologies, including web browsing history, academic progress, medical information, and biometrics, created the potential for privacy and safety threats if such data was compromised or exploited. The transition from in-person learning to

distance education in higher education due to the COVID-19 pandemic has led to enhanced extraction of student data enabled by complex data infrastructures. These infrastructures collect information such as learning management system logins, library metrics, impact measurements, teacher evaluation frameworks, assessment systems, learning analytic traces, longitudinal graduate outcomes, attendance records, social media activity, and so on. The copious amounts of information collected are quantified for the marketization of higher education, employing this data as a means to demonstrate and compare student performance across institutions to attract prospective students, mirroring the capitalistic notion of ensuring efficient market functioning and constant improvement through measurement. This desire of data has fueled the exploitation of higher education by platform companies and data service providers who are outsourced by institutions for their services. The monetization of student data in order to integrate corporate models of marketization further pushes higher education, widely regarded as a public good, into a privatized commercial sector.

Parental participation

Cultural divides and deficit thinking creates mutual distrust between marginalized parents and schools which in turn creates barriers to active parental involvement of marginalized parents in the education of their children. Researches also show that parents of high socio-economic status play active and direct role in the education of their children and are more likely to influence school policies that affects their children's schooling whereas parents of low socio-economic status play indirect roles in the education of their children and are less likely to influence school policies that affects their children's schooling. The gap between parents' educational involvement among parents from higher socio-economic status and parents from lower socio-economic status results in a more personalized education that caters for the needs of children from higher socio-economic backgrounds and more alienating and generic education systems/policies for students from low socio-economic backgrounds. The following practices are necessary for parent and community participation in the education of their wards to be effective; students come to school healthy and ready to learn, parents assist schools with financial and or material support, there are frequent communications between parents and school authorities, parents have meaningful authorities in the schools and they also assist in the teaching of their children. Parents' home based educational involvement such as creating an enabling learning environment at home,

helping their children with their assignments, helping their children develop cognitive skills and other school skills and motivating their children to do well in school supports student success. Researches show that multimodal and effective migrant parental involvement in the education of their children increases the test scores of such students and also shows strong student success even after academic abilities and socio-economic status are taken into consideration.

Sustainability

It is a societal goal that broadly relates to the ability of people to safely co-exist on Earth over a long time. Specific definitions of sustainability are difficult to agree on and have varied in the literature and over time. The concept of sustainability can be used to guide decisions at the global, national, and individual levels (e.g. sustainable living). Sustainability is commonly described as having three dimensions (also called pillars): environmental, economic, and social. Many publications state that the environmental dimension (also called "planetary integrity" or "ecological integrity") is the most important, and, in everyday usage, "sustainability" is often focused on countering major environmental problems, such as climate change, loss of biodiversity, loss of ecosystem services, land degradation, and air and water pollution. Humanity is now exceeding several "planetary boundaries".

A closely related concept is that of sustainable development, and the terms are often used synonymously. However, UNESCO distinguishes the two thus: "Sustainability is often thought of as a long-term goal (i.e. a more sustainable world), while sustainable development refers to the many processes and pathways to achieve it." The concept of sustainability has been criticized for various reasons. One such criticism is that the concept is vague and merely a buzzword. Another is that sustainability as a goal might be impossible to reach; it has been pointed out that "no country is delivering what its citizens need without transgressing the biophysical planetary boundaries". How the economic dimension of sustainability should be addressed is controversial. Scholars have discussed this aspect under the concept of "weak and strong sustainability". For example, there will always be tension between the ideas of "welfare and prosperity for all" and environmental conservation. Therefore, trade-offs are required. Approaches that decouple economic growth from environmental deterioration would be desirable but are difficult to implement.

There are many barriers to achieving sustainability that must be addressed for a "sustainability

transition" to become possible. Some barriers arise from nature and its complexity. Other barriers are "extrinsic" to the concept of sustainability. A number of extrinsic sustainability barriers are related to the dominant institutional frameworks where market mechanisms often fail to create public goods. Some approaches humanity can take to transition to environmental sustainability include: maintaining ecosystem services, reducing food waste, promoting dietary shifts towards plant-based foods, reducing fertility rates and, thus, population growth, promoting new green technologies, and adopting renewable energy sources while phasing out subsidies to energy production through fossil fuels. Global issues are difficult to tackle as they require global solutions, and existing global organizations (such as the UN and WTO) are inefficient in enforcing current global regulations, for example due to the lack of suitable sanctioning.

"Sustainability can be defined as the capacity to maintain or improve the state and availability of desirable materials or conditions over the long term". "Sustainability is the long-term viability of a community, set of social institutions, or societal practice. In general, sustainability is understood as a form of intergenerational ethics in which the environmental and economic actions taken by present persons do not diminish the opportunities of future persons to enjoy similar levels of wealth, utility, or welfare." "Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and economic resources. Sustainability is not just environmentalism. Embedded in most definitions of sustainability we also find concerns for social equity and economic development."

Conclusions

Education for Sustainable Development allows every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future. Education for Sustainable Development means including key sustainable development issues into teaching and learning; for example, climate change, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption. Education for Sustainable Development requires far-reaching changes in the way education is often practised today.

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