Advances in Online Learning

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Center on Innovations in Learning

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The fundamental idea of distance education can be traced to the emergence of cuneiform and pictographic records that transmitted ideas across distance and time from one person to another, often instructing them on how to proceed with a task. Perhaps the origin of modern distance education is best traced to the University of Chicago, which offered mail correspondence courses for college credit beginning in 1892. The University of Iowa pioneered television broadcast courses in 1933, and at the same time, various efforts were begun in Australia to reach remote outback schools and in England to reach those that were unable to attend college classes.[1]

In 1971, the Advanced Research Projects Agency Network made possible the speedy electronic transmission of data—the origin of the global Internet, which was further opened to increasingly more users by IBM's personal computer for use in homes, schools, and offices. Not long after, universities began offering courses online. Heralded as one of the most significant trends in higher education in decades, online course offerings experienced meteoric growth in the 1990s and 2000s. While the rate of new online courses offered has leveled off to around 10% a year over the past decade, online education has made significant inroads in institutions of all types (Allen & Seaman, 2011). For example, the University of Phoenix, probably the best-known online university, enrolled 380,000 students in 2010 and had the highest student enrollment of any postsecondary institution in the U.S. (National Center for Education Statistics, 2011). In the last few years, Harvard, MIT, Stanford, and other universities have begun offering free, nondegree online courses taught by top professors to interested students

[1] For the history and older findings and principles described in this chapter, see Ely and Plomp's comprehensive *International Encyclopedia of Educational Technology* (1996).

anywhere in the world with Internet access, and many colleges today offer some courses online.

Advances in Online Education

This capsule history suggests the potential of online education to make high-quality education readily and cheaply available to vast numbers of students anywhere in the world—"24/7/365." Online courses (those delivered digitally) may be delivered with the teacher in the room or thousands of miles away. The advent, quick adoption, and now widespread prevalence of Internet-connected mobile devices, the ubiquity of high-speed Wi-Fi connections, the availability of video- and screen-capturing, and the explosion of digital content have fueled the growth of online courses. If a course is to be used by tens or hundreds of thousands or even millions of students, it is worthwhile to prepare it thoroughly in terms of the currency and accuracy of the content, the best means of instruction, the optimal use of media—auditory and visual—and the selective use of interaction among students and course leaders. Teams of specialists in these areas can far exceed the knowledge and skills of even the greatest teachers working alone.[2] The course materials and procedures can be tried out and critically evaluated by the team and, preferably, by others who have not participated in its development, thereby lending objectivity and additional perspectives. Modern technologies allow data collection on student responses, learning patterns, content access, and a myriad of information on learning effects. On the basis of what is gleaned, the course may be revised and improved, then used repeatedly, perhaps even for a decade, for skills and subjects that do not change rapidly such as algebra, ancient history, second language learning, and grammar and spelling.

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Courses may be assembled from preexisting modules or discrete lessons, and courses may be planned as a series of modules. These may be used in a fixed sequence, which is more necessary in some subjects, for example, in algebra. Alternatively, curriculum consultants, teachers, and students can assemble a variety of multiyear programs of study from modules, courses, and experiences, depending on state and local curriculum requirements. Along with the subject matter and skills acquired in online learning, students gain exposure to modern technology skills such as advanced Internet searching, information curating, and social networking that are becoming essential in modern life, including occupations and professions. Of course, many students below the age of 18 have had

[2]For empirical evidence on the accomplishments, further potential, and criticism of online learning, see Casey & Lorenzen, 2010; Dickey, 2005; and Oblinger, 2000.

considerable experience with online technology and have far greater speed and skill than many older adults, including most traditional educators, making young students more comfortable with online learning.

Remote high schools in sparsely settled areas can offer courses to a few advanced students who would otherwise be denied such courses as calculus, differential equations, and animal husbandry. Since online education can be delivered day and night in many nonconventional school settings, it offers the possibility of great savings in the cost of erecting and maintaining traditional school buildings and the waste of student travel time.

Accommodating the Individual Student

Students need not take online courses only in school, and such courses can serve equally well a variety of students in highly varied circumstances, regardless of sociometric status, residence area, gender, ethnicity, race, and age. Children with disabilities or those who are ill can take courses at home or in hospitals and other institutions. Few traditional elementary school students have access to the study of Latin or Swahili, but these might be offered online, as can a multitude of other subjects and topics.

A careful selection of lessons, modules or units, and courses to suit individual learners in online programs can far better accommodate such student diversity than can traditional schools. In addition, online education programs are increasingly incorporating what is analogous to tutoring in traditional education but which has been seldom used for most students because of its cost. Advanced online programs can continuously track each individual's responses to elements of the lessons. In the event of an error, the programs can provide repetition of the lesson's element or a new way of presenting it such that the student avoids practicing errors and the probability of his or her mastery is greatly increased, particularly for lessons, topics, and courses that are inherently sequential. When instruction is delivered online, it can be customized and its user's achievement instantly measured, all resulting in a greater personalized learning experience.

Unwarranted Criticism of Online Programs

Though usually lacking scientific evidence and often concerned about competition and job security, traditional educators have leveled much criticism of online learning. They usually cite the lack of stimulation elicited by stirring lectures, insights prompted by the give-and-take of class discussion, and the opportunity to respond to students' questions. Traditional lectures (of the "sage on the stage") are a one-way means of transmitting knowledge and understanding. For one-way transmission, however, reading is hard to beat. By the middle grades, students can typically read 3 times faster than adults, including teachers, ordinarily can speak. Moreover, fluent readers can suit the pace of the reading to what they need; they may skip over parts they already know, and they may spend far more time than others on the parts that are difficult for them to

master. In addition, if lectures are preferred, perhaps on the grounds that they are especially motivating, they may easily be (and often are) incorporated into online education, as in the short, stimulating TED lectures by outstanding, well-prepared performers. In addition, professionally prepared illustrative graphics and short films teachers may find difficult to prepare can be incorporated into online programs.

The other frequent claim against online education is that it lacks the superior socialization of traditional schools and the stimulation of classroom discussion, much less the excitement of out-of-school life. More than a half century ago, James Coleman (1961) pointed out the intensity of the adolescent society often in opposition to responsible adults and how preoccupations with cars, clothes, and dating undermine education. Perhaps today's intense involvement with sports, unconstructive Internet surfing, and walking the shopping malls have added to the adolescent distractions from learning. Similar to the problem of lecturing, instruction geared to, say, the middle of the class may be too difficult for the slower learners and already known and comprehended well by advanced learners, thus wasting the time and adding to the boredom of both. Student questions and comments typically have the same problem of suiting the level of the lesson to learners with varying interests, abilities, prior knowledge, and speeds of learning.

Perhaps a warranted criticism of online instruction, however, may be that many of today's instructors are unfamiliar or untrained in the use of online instructional tools and online pedagogy. A particular skill set and understanding of how online learning opportunities can be created and enhanced are required to make an effective education course. Designers and instructors of online education courses not only need to be well versed in the traditional skills—such as knowledge of the subject matter, proficiency in designing instruction, and active student learning with clear expectations and timely feedback—they also must be proficient in the tools of technology and expectations that come with online learning. Learning management systems, chat or discussion boards, and other social networking tools, shared online (increasingly "cloud"-based) repositories, planning synchronous (simultaneous) as well as asynchronous learning experiences, and the awareness of accessibility standards are just a few of the skills needed to successfully teach an online course. This need is beginning to be addressed through the use of online communities, informal and formal professional development, training (free or paid) offered by content or system providers, and even certificate programs in e-learning.

Barriers to Online Education

There is a widespread but perhaps diminishing attitude among administrators and educators, especially at the K–12 level, that online or distance education courses are not as rigorous as traditional bricks and mortar programs. A 2011

Sloan Consortium report indicated that less than one third of chief academic officers say their faculty see the value and legitimacy of online education (Allen & Seaman, 2011). This may be a result of concern over a teacher's assumed ability to "directly" monitor the student during the learning process (i.e., while in the classroom) and instead having to resort to online testing, or products produced by the student, or other methods typically considered "indirect" measures of student learning. Proponents argue that online experiences provide much richer opportunities for learning and accessing a breadth of course material, and the evolving tools for monitoring and assuring student participation remove many of the causes of concern regarding independence of student work. The causal reasoning on both sides of this argument is speculative, but evidence cited below supports online methods with respect to achievement outcomes.

Another barrier at the K–12 level is the practice of reimbursing school districts for student "seat time," the amount of time students spend in the classroom, typically 180 days per year minimum. Schools are grappling with how to account for online or distance education within the seat time formula, with 36 states creating policies that take into account credit-for-performance in addition to or in lieu of physical time spent in class (Cavanagh, 2012). More guidance for states on how to accomplish this may be forth-coming, as the U.S. Department of Education also is deemphasizing seat time, stating: "Transitioning away from seat time, in favor of a structure that creates flexibility, allows students to progress as they demonstrate mastery of academic content, regardless of time, place, or pace of learning" (2013, para. 1). Increased standardization of digital content, program interface, and reporting systems may also need to occur before the effectiveness of online education becomes fully realized at scale. Currently, educators often need to learn several different tools with unique interfaces and differing operations. In addition, these independent (unconnected) learning systems may not provide the interoperability essential to build useful extensive data systems and networks of information to be used or shared by multiple teachers, schools, districts, or systems. As part of the digital education movement, both governmental programs (e.g., the State Educational Technology Directors Association) as well as private organizations (e.g., IMS Group; the Association of Educational Publishers) are promoting the use of common standards for digital materials, allowing digital products from any source to be readily integrated into a school's or college's learning management system.

> ***"Transitioning away from seat time, in favor of a structure that creates flexibility, allows students to progress as they demonstrate mastery of academic content, regardless of time, place, or pace of learning."***
>
> U.S. Department of Education, 2013

Online Education Principles Exemplified

Though hundreds of online programs could be cited and described, two seem particularly valuable to illustrate the benefits of digital education: the Khan Academy and the MimioSprout and MimioReading suite of products. Each of these programs offers the following features, which are representative of the best in online learning:

- personalization of learning and instruction;
- the potential to increase motivation;
- increased access across locations and times of the day;
- improved abilities to collect and evaluate data;
- increased resources for teacher training;
- the potential to streamline systems and processes; and
- the ability to generate learning analytics (see Twyman, 2013).

Khan Academy

As an outgrowth of his response to a young relative's need for school tutoring and instruction, Bangladeshi-American Salman Khan, a graduate of the Massachusetts Institute of Technology and the Harvard Business School, created his eponymous nonprofit academy in 2006. By 2012, it provided free, short online video tutorials in mathematics, physics, general and organic chemistry, biology, healthcare and medicine, macro- and microeconomics, finance, astronomy and cosmology, history, American civics, art history, and computer science.

Each tutorial is a complete, custom, self-paced learning tool. The system provides custom-tailored help for students with problems, and awards points and badges to measure and incentivize student progress. Coaches, parents, and teachers can view a student's progress in detail and analyze multiple students' progress for targeted interventions.

The aim of the Khan Academy is to provide tens of thousands of lessons to serve anyone, anywhere, anytime—a world-class education for the worlds of children, adolescents, and adults. By 2012, Khan Academy had served more than 200 million students and many uncounted more with philanthropically sponsored, offline versions for economically underdeveloped areas of Africa, Asia, and Latin America (see Khan Academy, 2013; Noer, 2012; Rasicot, 2011; Young, 2010).

MimioSprout and MimioReading

Two pioneer programs, Headsprout Early Reading and Reading Comprehension, provided online individualized instruction that employed engaging animation and colorful graphics and was highly refined with psychological principles as well as formative and summative evidence on effects. Now known as MimioSprout and MimioReading (see Mimio, 2013), these products were built and released in the early 2000s, just as parents and educators were beginning to

realize the power of the Internet in providing quality instruction as a supplement to or replacement for teacher-delivered, classroom-based instruction. A review of the features of these programs clearly illustrates the utility and power of online education.

Both Internet-based reading programs developed their content and teaching interactions from current evidence and known best practice. Headsprout Early Reading/MimioSprout teaches the research-based fundamental skills identified by the National Reading Panel (National Institute of Child Health and Human Development, 2000) as critical to reading success. The content of Headsprout Reading Comprehension/MimioReading is based not only on a scientific analysis of what it means to comprehend text (e.g., Goldiamond & Dyrud, 1966), but also on a systematic review of how comprehension is taught and what works in schools. The development method included formative evaluation (see Layng, Stikeleather, & Twyman, 2006) and a nonlinear, behavior-analytic design process. This development process involved initial testing with hundreds of children, producing over 250 million data points, to refine the program and its instruction (see Twyman, Layng, Stikeleather, & Hobbins, 2004).

The resulting products individualize teaching for each student; the programs automatically and continuously track each learner's performance and immediately adjust instruction and branching based on the analysis of individual responses, patterns of errors, and correct responses. Hallmarks of good instruction, including frequent opportunities to respond (Gettinger & Seibert, 2002), relevant feedback (Cossairt, Hall, & Hopkins, 1973), reduced error learning (Touchette & Howard, 1984), visual displays of progress (Fuchs, 1986), mastery before moving on (Kulik, Kulik, & Bangert-Drowns, 1990), direct practice (Hall, Delquadri, Greenwood, & Thurston, 1982), and meaningful application are embedded into the programs. Tens of thousands of learners from all over the world have used the programs, including students in public schools, private and charter schools, virtual schools, homeschools, and even those in hospitals and orphanages. Independent summative evaluations (see Clarfield & Stoner, 2005; Huffstetter, King, Onwuegbuzie, Schneider, & Powell-Smith, 2010) validate not only the instructional outcome of learning to read but also the power of online learning.

Other Online Programs

This new learning paradigm is further exemplified by the for-profit company, K12 (http://www.k12.com/), which provides à la carte online courses and full-time online schooling programs to parents and schools in 28 states and 36 countries. K12 students engage in independent online study, with supporting teachers available by email and by phone. Monitoring and assessment occurs either online, in person in blended settings, or using other technologies (e.g., phone and video).

Many districts and schools have adopted a blended model, one in which students learn partially through the online delivery of content and instruction and partially via a supervised brick-and-mortar location other than the home. The blend may be for a single course of study or for a combination of courses. In a private or public–private partnership, programs such as Achievement First (see Achievement First, 2013) or the Knowledge is Power Program (http://www.kipp.org/results) charter school network have shown an increase in student attendance and participation and improvement in both standardized and competency-based test scores.

Education technology entrepreneurs are rapidly expanding the kind of adaptive software and "cloud ware" available. They concentrate not only on content alone but also on classroom and behavior management tools. Launched in 2011, for example, ClassDojo (http://www.classdojo.com/) is an online program that allows teachers to continually track and manage student behavior in class, awarding points for specific good behavior like attentiveness and politeness and subtracting them for poor behavior such as being disruptive or not turning in homework. Teachers can choose to make students' points visible to the class throughout the day. While the principles of behavior at work are similar to those in the Good Behavior Game (see Embry, 2002), the automatic public visibility of Class Dojo may provide even greater motivation to students to behave well.

Goalbook (https://goalbookapp.com/) is another program for students with special needs. It allows all of a child's teachers and assistants to update his or her individualized education plan simultaneously, if they like, thus keeping everyone on track with the child's education without requiring constant conversations and paperwork. This program allows teachers to set personal learning goals for each child—say, reading a third-grade-level book or mastering the 9-times multiplication tables—and track learner progress. The system also allows for instant reports and data gathering of the child's progress on each measure. Another resource, Edmodo (https://www.edmodo.com/), offers free Internet-based software aimed at schools, students, and teachers. It functions somewhat like Facebook, only tailored to education. Once teachers and their students sign up to use Edmodo, they can exchange assignments, view the class calendar, and start and respond to online discussions. Teachers can post polls and quizzes and immediately track student progress through such assignments on any device that accesses the Internet. Goalbook looks like and acts similarly to Edmodo but provides goals and assessments for special needs students, such as those with various psychological handicaps.

Adaptive technology can be successful even without expert teachers. In one program, for example, high school students were recruited to teach Head Start preschoolers to read using a computer program called Funnix (http://www.funnix.com/) in a low-income, half-minority Georgia community. The students were much more successful in teaching reading than the regular teaching

staff, who used conventional methods. Funnix uses a step-by-step, sequential approach to teaching phonics that is highly scripted but also personalized through the computer program. The Funnix group was better at skills like naming letters, identifying the initial sounds of words, and reading nonsense words halfway through the year and reached reading levels of about a year ahead of the control group (Stockard, 2009).

MOOCs

Perhaps one of the most innovative recent trends in education is the arrival of massive, open, online classes (MOOCs), currently offered at the university level but with the potential to be adapted to secondary school instruction. MOOCs offer (mostly) free online college-level classes taught by noted lecturers to anyone who wants to enroll, anywhere in the world. They are revolutionary in both the openness of access and in the typically high quality of instruction offered. The original MOOC was a University of Manitoba course titled "Connectivism and Connective Knowledge," co-taught by George Siemens and Stephen Downes to 25 tuition-paying students and over 2,000 nonpaying students from around the world (Siemens, 2012). Perhaps the most notable MOOC has been an artificial intelligence course offered in 2011 by Stanford professor Sebastian Thrun and Google colleague Peter Norvig; it enrolled 160,000 students across 190 nations (DeSantis, 2012). Seeing the potential of MOOCs, Thrun went on to found Udacity, which—along with other new companies (both for- and not-for-profit), such as Coursera, Udemy, and edX (a joint venture of Harvard and the Massachusetts Institute of Technology)—are targeting the hundreds of thousands of students now enrolled in hundreds of online courses available worldwide.

MOOCs herald an unbundling or decentralization of higher education. In this new context, students are studying and taking exams when they want and where they want. Time to learn is not necessarily dictated by the traditional model of set class time, lab time, and office hours, thus changing the rate at which students learn. Western Governors University, an entirely online degree program, reports the average time for a student to complete a bachelor's degree is under 2½ years. Opportunities for students promise to grow as universities begin to offer or accept online course credits from other universities, thereby providing a virtual smorgasbord of instructional options, potentially allowing students to craft an individualized program of the best of the best or a uniquely personal program rounded out by courses not commonly offered by mainstream campuses.

The programs mentioned in this section exemplify the variety and usefulness of new online programs. Undoubtedly, many more creative programs will emerge in the next several decades. The key question now—"Do they make a difference in learning?"—is what the next section addresses.

Research Synthesis of Online Courses

American school achievement hasn't changed much in the last century, but the progress in technology in most realms has been astonishing, as can be seen in online instruction. A meta-analysis of 125 experimental and quasi-experimental studies revealed that students enrolled in online education courses through 2010 achieved better academically than students enrolled in traditional classroom instruction (Shachar & Neumann, 2010). Seventy percent of all 125 studies showed online education superior, and those after 2002 showed even more consistent results, with 84% superiority.

> ***A U.S. Department of Education-funded meta-analysis and literature review of 51 studies comparing both online and blended learning environments to the face-to-face learning environment found that "on average, students in online learning conditions performed better than those receiving face-to-face instruction"***
>
> U.S. Department of Education, 2010

Undoubtedly because technology tends to improve, studies after 2002 showed not only consistent but a very large average effect of 0.403, corresponding roughly to what is learned in four tenths of a school year, which would put typical online education students at the 66th percentile, meaning they would exceed 66% of students conventionally taught. Moreover, most of the studies reviewed in the Shachar and Neumann (2010) meta-analysis concerned effects of a unit or at most a year of study, which could be multiplied over 12 years of schooling. The cumulative effect would suffice to rank American students first rather than as low as 32nd among countries in international achievement surveys.

Nearly all the studies were conducted before or shortly after the Internet became such a widespread means of communicating across the world. It can be imagined that the Internet will gain greater speeds and that online programs will continue to improve. More and more students will have access to and use online instruction. Today, for example, nearly all U.S. families have access to online computers, if only in neighborhood libraries and schools, allowing more and more opportunities to learn online.

Most of the comparative studies of online education concerned high school and college mathematics and science courses. No similarly extensive analysis has been made of younger students, but the What Works Clearinghouse (2009) found and reported on a rigorous reading study (a randomized field trial) of 4-year-olds. The study contrasted the computer-based Headsprout early reading program, discussed above, with more conventional programs. The computer-tutored children exceeded 81% of untutored, conventionally taught children. This gave them about the same sized achievement advantage over their same-age peers as much older step-tutored students had over their same-age peers.

A U.S. Department of Education-funded meta-analysis and literature review of 51 studies comparing both online and blended learning environments to the face-to-face learning environment found that "on average, students in online learning conditions performed modestly better than those receiving face-to-face instruction" (U.S. Department of Education, 2010, p. ix). Studies specifically focusing on blended environments found blended instruction to be more effective than face-to-face alone (U.S. Department of Education, 2010).

Online technology has the additional advantage of building mastery of Internet, digital devices, and other skills necessary for further learning in subsequent grades, in college, and on the job. A survey of 300 professionals, for example, showed they spend 40% of their time in online communities interacting with others, and twice that percentage participate in online groups to help others by sharing information, ideas, and experiences (Valsiner & van der Veer, 2000). In addition, as documented in this chapter, either by itself or "blended" with traditional classroom teaching, online technology continues to build an excellent record in raising student achievement more than traditional methods.

These studies demonstrate the effectiveness of online education and distance learning, particularly in instances where support for the online experience is provided. As noted by the International Association for K–12 Online Learning, "Larger-scale studies are needed to show the correlations between program models, instructional models, technologies, conditions, and practices for effective online learning" (Patrick & Powell, 2009, p. 9). In the meantime, available evidence supports some action principles that can be taken at the state, local, or school level to facilitate online and distance learning outcomes. These are described below.

Action Principles

State Education Agency

a. Compare the coverage of state curriculum requirements in candidate online and distance programs.
b. Survey current online and distance programs in terms of effectiveness and state applicability.
c. Compare the effectiveness and efficiency of available and state and locally grown online and distance programs.
d. Analyze and make known the cost (in money and resources) of creating an online course or program.

Local Education Agency

a. Assist school authorities in understanding state online and distance requirements, research, and services.
b. Help school-level authorities choose, adapt, or develop the best online and distance programs uniquely suited for each school.

c. Offer explicit support for school administrators, teachers, and other school staff members in gaining knowledge of the effort required to develop, offer, conduct, and participate in an online or distance course.

Schools

a. Analyze state and local authorities' requirements and recommendations for online and distance education programs.
b. Choose the program best suited to the school for which they are responsible.
c. Cooperate with state and local authorities in mounting and enacting staff development and implementation activities.

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