Transformative Technology and the Classroom

Joseph Phillips

[Keywords] Technology, Digital Technology, Education, Computer Assisted Language Learning, Computers, Networks, Wi-Fi, Cloud Storage

Abstract

This paper examines the claim that digital technology is truly transformative for education. It describes the historical context of technology as it applies to education in general and computer assisted language learning in particular. It distinguishes between educational technology that is facilitative and that which is transformative and sets out requirements for the latter.

Introduction

For a hundred years or more there have been predictions that technological innovation was about to transform education. Although aspects of the classroom have changed, for the most part, these predictions have largely rung hollow. Indeed, despite the great promise of technology, a teacher from the nineteenth century would clearly recognize the present classroom of the twenty-first. The details have changed of course, tablets have replaced slates, whiteboards have to some extent taken over from chalkboards, and movies and PowerPoint presentations have taken the place of magic lanterns. But a Victorian teacher would at once feel comfortable at the front of a twenty-first century row of desks as sleepy students take notes. In the nineteen twenties, commentators suggested that radio heralded an imminent revolution in education, and following the Second World War, similar predictions were made about television. For the most part, the predictions of these commentators failed in large to bear fruit, and actual changes were superficial. Over the last three decades, similar predictions have been made about digital technology, and it is reasonable to wonder if this latest excitement is just an echo of the excitement that accompanied the early days of radio and television. One critic writing as early as 1986 describes each new educational technology as following a cycle involving five stages: initial enthusiasm; validation by studies; disappointment due to lack of adoption by teachers; and blame leveled against teachers for failing to utilize fully the new technology.¹ The latter stage reflects a general distinction in attitude toward technology in the classroom between educators and teachers. Educators
are often enthusiasts who see technology as somehow guaranteeing pedagogical success. Teachers, on the other hand, are dubious of claims for technology that fail to consider sufficiently the practical challenges that teachers face in the classroom.

So is new digital technology about to herald a transformation in education, or is it a reprise of the initial enthusiasm that accompanied radio, television and other technologies in the past? Is there anything fundamentally different about digital technology that will make its influence on education more profound than that of previous technologies? The following discussion will explore these questions by examining current technological trends that are beginning to combine in ways that are significant for education. These trends largely rely upon technologies that were unavailable or in their infancy until the end of the last century. Obvious among them are powerful executive technologies that are already appearing in school curriculums. They consist of three main components: computers (including tablets and smartphones), fast wireless Internet access, and cloud data storage, all three of which are now available at price points that are making them ubiquitous in developed countries. They are becoming normalized in the terminology of Bax. Less obvious are diagnostic technologies that facilitate research into the way the brain processes information. Neurologists are using technologies such as functional magnetic resonance imaging and positron emission tomography to examine the pathways of learning in the brain. Implementation of these diagnostic technologies has led to insights about how educators can create more effective and efficient learning methodologies for students. The adoption of various combinations of these technologies, both executive and diagnostic, is making possible a transformation in the approach to formal education.

Cynics will argue that we are at the initial enthusiasm stage described above. However, it can be argued that a tipping point has been reached, for also driving the adoption of digital technologies in education are powerful economic pressures that will require educational institutions to implement them. Increasingly, quality education, and especially higher education, is becoming unaffordable, and it has become incumbent on education providers to create efficiencies. Partly as a result of this, we can already see digital technologies emerging in schools and universities at an accelerating pace. This paper will provide an overview of important components of these new technologies and how they are already beginning to impact education. In the following discussion, the English as a foreign language classroom will provide the context for some of the ways in which these new technologies can be implemented, but it should be noted that this is not to suggest this as a limitation to their application.

Before proceeding, it is necessary to define terms. The term “education” is used in the
narrow sense of providing or receiving instruction in the context of an institution such as a school or university. By contrast, “technology” is defined broadly. “Technology” covers anything from the pencil to an array of fiber-optic connected servers. A further constraint on the following discussion is geographical; the educational contexts referred to are primarily those in the United Kingdom and North America.

The paper will be divided into two parts. The first will cover the history of technology as it applies to education over the last 100 years. This discussion will mainly focus on technology used by teachers and students in conjunction with a syllabus designed by an institution but will also include technologies used by neurologists that provide insight on brain function that is relevant to educators and students. The second part will consider the application of recent technologies in the form of computers, wireless Internet access and cloud data storage as they apply in the context of what is known as computer assisted language learning (CALL) and will suggest ways in which such technologies can be incorporated into an English as a foreign language (EFL) curriculum. While the specific context of the discussion in the second part is the EFL curriculum, it will be obvious that many of the components mentioned will have application to education in general.

Part 1: A Brief History of Technology in the Classroom

Compulsory education at the primary level was largely present in Europe and North America by the 1880s. The main technology utilized for education at that time until well into the twentieth century was the chalkboard and the writing slate. It was not until the end of the First World War that the manufacture of pencils and paper became cheap enough for them to replace the slate, and the chalkboard still stands at the front of many classrooms today. Following, in rough chronological order, are executive technologies that have had the greatest impact on education over the last century.

Film:

Film was the first modern technology to be taken up by educators. In a 1913 newspaper interview, Thomas Edison stated:

Books will soon be obsolete in the public schools. Scholars will be instructed through the eye. It is possible to teach every branch of human knowledge with the motion picture. Our school system will be completely changed inside of ten years.
Books, of course, did not become obsolete, but training films did find an important role in education, though initially, the lack of sound and the requirement of expensive and bulky projection equipment acted as a deterrent to their implementation. The Second World War created an environment in which large numbers of military personnel needed to be trained quickly, and service-training films were used extensively. During that war, the U.S. Army Air Force produced more than 400 training films and 600 filmstrips, and during a two-year period (from mid-1943 to mid-1945), it was estimated that there were over four million showings of training films to U.S. military personnel. Following the war, training films were taken up by both industry and education. Schools and universities employed 16mm movie projectors, but these were still large, expensive, and often difficult to set up. An alternative was the filmstrip, consisting of a spool of ordinary 35 mm film inserted vertically into a projector and able to show between 50 and 72 images. A 33-rpm record that contained audio prompts to the operator to turn to the next image originally accompanied the filmstrip. Film and filmstrips were made obsolete with the advent of videocassette recorders and had largely disappeared by the 1980s.

Radio

Radio promised to supply the sound missing from early film, and quickly became adopted for educational purposes in the United States, Canada and Australia. This is not surprising in that these countries had large geographically diverse rural populations. Almost with the start of commercial broadcasting in the 1920s, educational radio commenced. As early as 1921, universities in Utah, Wisconsin, and Minnesota obtained broadcasting licenses. By 1925 almost 200 broadcast licenses had been issued. Radio provided a way for schools and universities to supplement lessons and lectures with additional material. Theatrical and musical performances could for the first time augment the textbook. There were, however, limitations with radio as an educational medium. First, was an issue with scheduling; there was not yet a way to record broadcasts, so the broadcast and receiving radio had to be synchronized. As with film, equipment was expensive and bulky because of the vacuum tubes that made up the receivers, and with the beginning of the Second World War, production of these tubes was diverted to military use. During this period, faced with training a large number of people with diverse backgrounds quickly and efficiently, the United States military intensively utilized audio-visual media and devices. Among these were training films and filmstrips mentioned above, as well as the overhead and slide projector, and audio equipment for teaching foreign languages. All of these soon found application in schools and universities at the end of the war. But in the postwar period, it was television that was seen as offering the greatest potential for educators, and interest in radio waned. Interestingly, facilitated by new digital technology, radio has evolved and transformed into asynchronous forms such as
podcasts and audio-augmented websites such as Voice of America Learning English.⁶

Television

Soon after the end of the Second World War, television broadcasting in the US and Canada began in earnest, and again the educational potential was lauded. In 1957, in conjunction with New York University, the United States television network, CBS, began broadcasting *Sunrise Semester*,⁷ a series of university lectures on various fields in the humanities, so called because the broadcast time was at 6:00 a.m. However, with concerns about over commercialization and lack of active participation by students, especially young children, such enthusiasm began to wane in the 1960s. Perhaps to maintain momentum in learning through television, in Nov 1967 in the United States, the Public Broadcasting Act provided federal funding for non-profit stations, and this led to the creation of the Public Broadcasting Service and National Public Radio. The former soon began broadcasting children’s educational television programs in the form of *Sesame Street*. Prior to the commercialization of the videocassette recorder in the 1970s, use of broadcast media was restricted to the time of the broadcast. With this new technology and its successor digital video disk (DVD) this limitation was overcome, and live broadcast educational television has more recently been subsumed into websites such as that of *Sesame Street*.⁸

Overhead Projector

The overhead projector (OHP) was another device that was developed and used by the US military in the Second World War and that was soon adopted in educational institutions at its end. The device consists of a transparent sheet of approximately A4 size, which can be printed or written on using markers. The sheet sits on a base with a source of illumination and is projected onto a screen or wall through a Fresnel lens. The OHP performs a similar function to a chalkboard, but there are several advantages. Transparencies can be prepared in advance thus saving classroom time spent writing on a chalkboard. In addition, transparencies can be reused. The OHP base is at a convenient height for writing, and unlike with a chalkboard, the teacher can face the class. When a transparency is full, it can be either replaced with a new sheet or erased. For these reasons, and because of simplicity of operation and relatively inexpensive cost, OHPs were adopted extensively in education. They are still used today, but are rapidly being replaced by document cameras and video projectors.

Document Camera

Developed in the 1980s and increasing adopted by schools from the 1990s, document cameras are similar to OHPs, but instead of projecting a two-dimensional image written or
printed on a transparency, they digitize a two or three-dimensional image, which can then be projected using a video projector. They have an advantage over OHPs in that any object that is small enough can be displayed. This can include notes, books and even objects. The visual resolution is also typically much higher than that of OHPs.

Teaching Machines

A universal challenge faced by educators is maximizing the effect of instruction. Students, as individuals, come to class with different backgrounds, abilities, learning styles and expectations. Students do not all learn at the same pace and have different needs during the learning process. The idea of enhancing the learning process by using programmed instruction through a teaching machine came out of the field of behaviorist psychology and the theories of B. F. Skinner. Skinner's teaching machine was a mechanical device that through a series of questions provided instruction to a student at an appropriate level. Teaching machines appeared in the 1960s but were supplanted by increasingly capable electronic computers from that time forth.

Phonographs, Tape Recorders, Audiocassette Recorders and Compact Disks (CDs)

Phonograph recording technology was developed in the late 19th century and used in language classrooms from the 1920s. It had the advantage over radio in that it was asynchronous. In addition a particular part of the recording could be conveniently selected and reselected again and again – something that was essential for aural and oral language practice. Phonograph recordings continued to be extensively used well into the 1960s, when they were largely replaced by tape recordings.

Developed in Germany during the Second World War, audio recording on magnetic tape was commercialized in the US following the war and became available to consumers in the late 1950s and early 1960s. Tape recorder/players soon found wide application in schools and were extensively used for language instruction. The more convenient form of audiocassette was first sold in the 1960s and soon replaced larger reel-to-reel players. Cassettes became the dominant format following the introduction of the Sony Walkman in 1979, but were in turn replaced by CDs, the first true, commercially available digital medium, which had the advantage of instant access to specific content.

Video Cassette, Laser Disk, and Digital Video Disk (VCR, LD, and DVD)

Beginning in the 1970s, videocassette recorders became widely available and cheap enough to make it possible to record television programs for playback in the classroom. Soon after, prerecorded videocassettes containing movies, documentaries and educational
material also became available. In 1978 laser disks became commercially available. These were prerecorded with similar content to that of videocassettes but were of higher video resolution and had the advantage that any part of the recording was immediately accessible; no forward winding or rewinding was necessary. In 1982, the first audio compact disks were sold. They quickly found application in educational settings, especially in language education. In the late 1990s video CDs (VCD) containing movies became briefly popular, but were soon largely replaced by DVDs, which appeared at the same time. DVDs were of higher resolution, and unlike VCDs contained digital rights management encryption that prevented copying. By 2003, sales of DVDs topped sales of videocassettes. CDs and DVDs also had read-only-memory forms (CD-ROM/DVD-ROM) that replaced floppy disks and were the main form of software distribution prior to ubiquitous fast network speeds.

**Computers**

Beginning in the early 1980s, reductions in cost and size and increased processing capacity saw the beginning of computer-aided instruction in schools and universities. By the end of this decade, computers were in almost all school districts in the United States, and computers began to replace or augment the technologies outlined above. More recently, fast wireless Internet access and cloud data storage are impacting education in significant ways. This impact will be discussed below in detail in the context of computer-assisted language learning, but prior to that discussion, it is necessary to consider diagnostic technologies that are providing information on the neurological basis of learning.

**Learning and the Brain**

No discussion of education can be complete without considering the organ through which education takes place, namely, the brain. Further, a useful way to view the brain is as an organ that like any other has evolved and adapted to fit the environment it finds itself in. Putting a discussion of the brain in this context makes sense of some of the challenges that educators face and can perhaps provide insight into what might and might not be effective in a classroom context.

For most of the course of human evolution, humans were hunter-gatherers. If all of human history is condensed to a single day, the adoption of agriculture began very late at 11:54 p.m. Given the long period in which we were hunter-gatherers, it is reasonable to suggest that the human brain has evolved to adapt to that way of life. We know something of the hunter-gatherer lifestyle because it survived until relatively recently. Fieldwork conducted by anthropologists over the last century describes hunter-gatherer societies as consisting of
small, nomadic, extended family groups comprised of fifty or so individuals, who survived by foraging and hunting. Literacy was nonexistent and numeracy in the modern sense was at a basic level. Formal education of children was also nonexistent. In fact, education in the form of direct instruction from a teacher seems to have been rare in such societies. Instead, anthropologists who have conducted fieldwork on hunter-gatherers report that education seems to be self-directed and often in the form of play. Notable is the absence of direct teaching, and learning takes place by observation. Notable also is the fact that the children themselves decide what to devote their attention to based on interest. It is informative to contrast this with the modern classroom in which what to study is determined by teachers and curriculum designers.

Another obvious difference is the absence of literacy at any level in pre-agricultural societies. In fact, in most of the world, literacy has only become widespread in the last 150 years. Whereas there is likely to be a genetic component to human language - provided there is input, all healthy humans learn to process spoken language - reading and writing, by contrast, have not existed long enough for the brain to evolve an innate facility for literacy.

What does this tell us about formal education in general? According to evolutionary psychologist, Peter Gray:

From an evolutionary perspective, school is an abnormal environment. Nothing like it ever existed in the long course of evolution during which we acquired our human nature. School is a place where children are expected to spend most of their time sitting quietly in chairs, listening to a teacher talk about things that don't particularly interest them, reading what they are told to read, writing what they are told to write, and feeding memorized information back on tests. As I have detailed in previous essays, during the entire course of human history until very recently, children were in charge of their own education. They learned by following their own inner, instinctive guides, which led them to ask countless questions (their own questions, not someone else's), to converse with others as equal partners, to explore their world actively, and to practice the skills crucial to their culture through self-directed play in age-mixed groups.

Given these possible educational constraints that are imposed by our history, how are we to proceed with a rational approach to what teachers do in class in order to be effective? Until relatively recently, the operation of the brain was poorly understood, and in fact, our knowledge of the brain was often derived from the results of injury or pathology. Recent
advances in the science of neurology have enabled researchers to obtain detailed information about the way the brain processes information, and contained in this information are perhaps hints on what might be successful teaching strategies. Beginning in the 1990s, functional magnetic resonance imaging has been used to accurately map blood flow in the brain as it happens, and since blood flow is closely correlated with neural activity, this provides a window on the functioning brain. Such research can not only potentially support hypotheses that arise from the field of evolutionary psychology, but also have relevance to the way we teach. Theories of learning are finding support in such research.

One such theory is the monitor theory of second language acquisition proposed by Stephen Krashen, which suggests that in language teaching practice, “The best methods are therefore those that supply "comprehensible input" in low anxiety situations, containing messages that students really want to hear.” The theory consists of five hypotheses and relevant to this suggestion on teaching practice is the affective filter hypothesis, which states that affective variables relate to success in second language acquisition. The affective filter works to allow or prevent comprehensible input from being used for language acquisition. Krashen places affective variables in three categories as follows:

1. Motivation. Performers with high motivation generally do better in second language acquisition.
2. Self-confidence. Performers with self-confidence and a good self-image tend to do better in second language acquisition.
3. Anxiety. Low anxiety appears to be conducive to second language acquisition, whether measured as personal or classroom anxiety.

Although developed in the context of language acquisition, the affective filter hypothesis would appear to have wider application to learning in general. The hypothesis is consistent with research into the brain that suggests that such a filter resides within the limbic system. Neuroimaging studies demonstrate that stress can prevent information from entering the brain's areas of higher cognitive memory consolidation and storage. Stress in the form of over correction, anxiety, and boredom will act to raise the filter. Conversely, motivation, interest, and confidence will lower it. Teaching activities should be designed with this in mind, and an evaluation system based on effort and progress rather than criteria-based outcomes is likely to be more effective in lowering the affective filter.

Neuroimaging studies also suggest strategies that promote learning. Patterning activities
appear to do this. For example, in learning new vocabulary, linking the new word with a previously created category correlated with metabolic activity in the prefrontal and hippocampal regions of the brain. Uncategorized vocabulary failed to show such activity.\textsuperscript{18} Merely providing students with definitions of vocabulary words fails to take advantage of the brain’s potential to reinforce learning by pattern association.

Neuroscientists have also described the effects of the neurotransmitter dopamine on learning. Dopamine is associated with increased alertness and increased ability to store and recall information, and significantly, with addiction. It is also an important component of the reward system of the brain, and the activation of dopamine as a result of unexpected reward has been noted in the context of video game playing. This has implications for creating educational software that employs elements of video gaming - so called gamification. Gamification of educational programs may transform a mundane task into an addictive learning process.\textsuperscript{19} According to one researcher:

> Video games are largely just problem-solving spaces; if people could not learn them well and in an engaging fashion, the companies that make the games would go out of business. So it is, perhaps, not surprising that game designers have hit on—and even innovated on—many of the learning principles that contemporary research in the learning sciences has argued work for deep and effective human learning.\textsuperscript{20}

**Part 2: Computer Assisted Language Learning**

The history of Computer Assisted Language Learning (CALL) is well documented and can conveniently be divided into stages. Warschauer describes three: a structural stage, a communicative stage, and an integrative stage, and provides a chronology as follows:\textsuperscript{21}

- **Structural CALL:** 1970s to 1980s.
- **Communicative CALL:** 1980s to 1990s.
- **Integrative CALL:** 2000 onwards.

The beginning of the structural CALL stage coincided with a behaviorist approach to language learning. Materials were text based and largely consisted of stimulus-response drills. Programmed learning provided students with material appropriate to their level based on previous responses to the software. This functionality duplicated that of the teaching machine, and in fact, the flexibility, ease of use, and decreasing cost of computers over time led to the
demise of the teaching machine not long after its introduction in schools in the 1960s. The
behaviorist approach to language teaching fell out of favor in the 1980s and was replaced
by a communicative approach focusing on interaction, meaning, and the use of language.
Rather than drills, software focused on communicative tasks, and technological development
supported sound and simple animation. This stage also marked the beginning of the use of
computer game software that had not been created specifically for language learning. The
third stage, integrative CALL, marks the beginning of the use of multimedia in which the
computer becomes a facilitator to integrate disparate media. Bax generally agrees with these
stages but claims that integrative call has yet to be achieved, arguing that until the multimedia
technologies are ubiquitous (Bax uses the term “normalisation”), the third stage has not been
achieved.22

Whether or not normalization in Bax’s sense has been achieved, elements of the
technologies that make up the infrastructure of this third stage are becoming increasingly
commonplace. Chief among these technologies are computers (including tablets and
smartphones) fast wireless Internet access, and cloud data storage. What follows is an
overview of these CALL technologies and some of the ways they can be implemented. It
must be emphasized that although it is convenient to consider elements of CALL technology
separately, it is the synergy that exists when these technologies are used in combination that
makes them so powerful and potentially transformative.

Moore’s law is the observation that, over the history of computing hardware, the number
of transistors in a dense integrated circuit doubles approximately every two years. Since the
number of transistors correlates generally with processing power, this means that computers
are becoming exponentially more powerful over time.23 It is interesting to examine how this
processing power can translate into CALL functionality. The greatest impact in this area is
and will be in speech synthesis and speech analysis software. Already there exists text-to-
speech software (TTS) that uses text-to-phoneme conversion and comes close to native like
pronunciation for single words. Sentence level intonation is not yet completely natural, and
in this regard, one major problem is determining the illocutionary intent of an utterance.
Another is the number of homographs in languages such as English. Corpus linguistics can
provide probability data on vocabulary collocation and thereby achieve a high degree of
appropriate matching between the homograph and intended meaning, but this process is not
perfect. A third difficulty with TTS is acronyms. Sometimes they are spelled out such as in the
country name “USA”; sometimes they are pronounced as a word as in “NATO”. TTS software
will probably never provide perfect pronunciation and intonation. However, it does not have
to be perfect. Many language teachers are not native speakers of the target language and are not able to provide a perfect pronunciation model. Furthermore, comprehensibility rather than native-like pronunciation can form a reasonable goal for learners, and TTS software does provide comprehensible speech that can approach that of native speakers.

TTS is built into some operating systems and can also be installed as a standalone application for computers, smartphones and tablets. This software typically has several useful functions for the language learner. Text can be highlighted as it is read, and reading speed can be changed without changing pitch. A learner can practice reading by shadow reading a text and incrementally increase reading speed. Shadow reading is also effective practice for comprehension. Another function of TTS is as a pronunciation guide: A learner can select individual words in a text to hear their pronunciation. This is a useful adjunct to an online or software dictionary that is missing this function. A learner can also listen to an assigned or favorite text, effectively turning the text into an audiobook.

A correlate of TTS software is that which can analyze elements of a learner’s pronunciation and intonation and provide feedback on its accuracy. A learner’s speech can be analyzed in real time to provide visual feedback in the form of pitch contours or flashing lights. Typically, a learner will read a text or repeat a spoken sentence and the software will analyze the learner’s pronunciation. Software can also be developed to assess intelligibility of student utterances. For example, a learner reads aloud a sentence displayed by an automated Reading Tutor. When he or she stumbles over a difficult word, the system highlights the word, and a voice reads the word aloud. The learner repeats the sentence - this time correctly - and the system responds by displaying the next sentence. Websites also exist in which learners can obtain feedback in the form of points while modeling the pronunciation in online videos. Finally, speech recognition software, although designed for other uses, can be used with caution in a CALL setting. Other CALL applications, although less processor intensive, can be profitably incorporated in a language-learning curriculum:

Flashcards: Unlike paper flashcards, digital flashcards are not limited to two sides, and can incorporate text, audio and even video. There are numerous free or low cost digital flashcard applications available, and many of these allow users, learners or teachers, to create customized flashcard sets. Most flashcard software incorporates a spaced-repetition (SRS) system in which a vocabulary item is reviewed just before it is likely to be forgotten. Smartphone applications of this sort are convenient in that vocabulary can be practiced virtually anywhere and anytime a learner has a moment of free time, and there is evidence
that these digital flashcards are more effective than traditional paper flashcards.\textsuperscript{31}

Dictionaries: Electronic dictionary software can be more efficient than a paper dictionary and contain links to audio files that provide examples of pronunciation. These dictionaries can also contain concordances of example sentences so that target words can be seen in context.

Grammar and spellcheckers: Although originally developed for native speakers, grammar and spellcheckers can be adapted for target learners.\textsuperscript{32}

Subtitled video is available on websites and can be manipulated to slow down the rate of speech to match a learner’s ability, and vocabulary words contained in the video can be clicked on to provide a definition or manipulated to create personalized wordlists that can form a SRS flashcard set.\textsuperscript{33}

Course Management systems: A course management system (CMS) consists of computer software that:

- supports the placement of course materials online,
- associates students with courses,
- tracks student performance,
- stores student submissions,
- mediates communication between students and between student and instructor,
- provides a way for teachers and school administrators to manage classes and individual students.\textsuperscript{34}

Perhaps most importantly, a CMS allows teachers to closely monitor the progress of individual students, and this enables assignment of homework or classwork that is targeted more precisely to a particular student’s level. Students are able to track their own progress, and this can be a motivating factor in their learning.

Online Courses: In the last decade, the availability of fast computer networks has enabled lectures and other instructional video and audio to be available online. In 2007, Apple Corporation initiated iTunesU,\textsuperscript{35} which hosts video and audio university, college, high school and grade school lectures and other educational materials uploaded by participating institutions. Participating universities include Stanford, Yale, MIT, Oxford, the University of Tokyo and many others. Access to courses is free, and courses cover a wide range of content. Khan Academy is another example of educational materials available for free online.\textsuperscript{36}
Massive Open Online Courses (MOOCs): Online courses offer a way to audit a university course at a distance, but typically do not allow people to do more than this. MOOCs are different in that they enable learners at a distance to participate in courses beyond passively viewing lectures and course materials. Typically, as well as viewing lectures, learners can download course materials, participate in chat sessions with teaching assistants and other learners, take quizzes and tests and submit assignments for peer review. At the present time, US universities offer approximately 1000 MOOCs. Most are free but offer no credit other than a certificate of completion (for which there is usually a small charge). However, beginning in January 2013, the first MOOCs for credit were offered by San Jose State University, and later that year, Georgia Institute of Technology offered the first MOOC-based masters degree. Participating US universities include Harvard University, Stanford University, Massachusetts Institute of Technology and many others, and MOOCs are now offered in several other countries.

It is obvious that MOOCs cannot in most cases replace a conventional university education. There are challenges with regard to individual tuition, grading and assessment, and it is debatable whether online chat sessions can adequately replace the face-to-face interaction provided in a seminar. Universities also function as research institutions as well as providing courses, and MOOCs cannot replace this function. However, MOOCs can augment existing courses to a significant extent by providing access to educational resources that would not normally be available.

Language exchange: Increased computer power and network bandwidth allows processing of video and audio in real time and this allows for language exchange to take place at a distance. Non-native speaker students in one country are able to engage in conversation with native speakers in another through voice-over-internet-protocol (VOIP) services such as Skype.37

Fast Wireless Internet Access and Cloud Storage: All of the above language learning activities can take place in a system of computers that are wired together in a network. However, the power and potential of these activities is greatly enhanced by enabling them on a fast wireless network. In such a case, learners do not have to be in a specific location, usually a classroom, in order to practice activities. They can study anywhere there is wireless network access and proceed at their own pace, more in step with their own particular level and learning style. Cloud storage is a model of data storage in which data is stored on servers remote from the computer at hand. Data storage in the present context would include all student files and course management information as well as information made available by the teacher and
school. In addition application software can also be stored in and accessed from these remote servers. In this scenario the computer at hand can be quite basic, becoming in effect a “thin client”. It also means that administrators do not have the burden of maintaining software, which is maintained at the remote server. Teachers can customize courses by making software resources available to students, thereby including the following benefits:\textsuperscript{38}

(1) multimodal practice with feedback
(2) individualization in a large class
(3) pair and small group work on projects, either collaboratively or competitively
(4) the fun factor
(5) variety in the resources available and learning styles used
(6) exploratory learning with large amounts of language data
(7) real-life skill-building in computer use

The above survey of CALL functionality is not exhaustive, but generally describes the palette of language learning activities that are available to a curriculum designer or learner. Emphasis is perhaps appropriately placed on the latter because increasingly, self-directed learning is facilitated by new CALL functionality. Emphasis is shifting from a teacher and classroom centered approach that attempts a one-size-fits-all approach to one that is centered on a particular learner. The wisdom of this approach is borne out by investigation of the neural processes behind the way we learn outlined above.

Conclusion

At the beginning of this discussion, the following questions were posed:

Is new digital technology about to herald a transformation in education, or is it a reprise of the initial enthusiasm that accompanied radio, television and other technologies in the past?

Is there anything fundamentally different about digital technology that will make its influence on education more profound than that of previous technologies?

I believe both questions can be answered in the affirmative. Previous, non-digital technologies have been convenient and have achieved efficiencies for both teachers and learners. There is no doubt that, for example, in a language learning class where the aim is to teach the spoken target language, listening to an audiotape of a dialog is a useful addition to a printed transcript of the dialog. No doubt, too, watching video of that dialog will enhance the learner experience even further. Over the course of the last century, successive technologies have served to
enhance the learner experience and create efficiencies. Teachers have also taken advantage of these technologies to make classes more interesting and informative and teaching more effective. However, notwithstanding this, and despite predictions to the contrary, these non-digital technologies are facilitative rather than transformative. More often than not, the classroom is centered on the teacher rather than the learner. I would argue that truly transformative educational technologies are qualitatively different and their implementation must conform to the following five requirements:

1. They must be essentially universally available and not dependent on constraints of time and space. In effect this means that learners, teachers and institutions should share network access to data at all times and in all locations.
2. They must be secure. User data must be protected by robust security that protects user privacy.
3. They must be affordable. The cost to learners should be no more expensive than the cost of traditional components of courses such as textbooks. The cost to schools should also be comparable to the administrative costs of traditional, non-transformative courses.
4. They must be interactive and adaptive. Learners should be able to connect and communicate with other learners and teachers, and teachers should be able to monitor and assess student progress at all times. Course content should be customizable and optimized for a particular learner.
5. They must support learner autonomy. Learners should to a significant extent be able to choose learning goals and the pace at which they achieve those goals.

Transformative technologies will make possible blended learning in which a significant proportion of curriculum content takes place online. In such a case the role of the teacher will change. The teacher becomes a facilitator or guide rather than the main source of instruction. Traditionally, the classroom is a venue for lectures and testing; in a blended learning situation, the teacher can assign video lectures or other media for homework, and the classroom becomes a place for discussion and problem solving. Learners can help each other and the teacher can provide individual instruction to learners as needed. The classroom becomes effectively flipped, lectures become homework, and problem solving takes place in the classroom, which becomes much more centered upon the individual learner rather than the teacher. In this situation, unlike the traditional classroom, learners are more able to proceed at their own pace, assigning more or less time to video lectures and assignments as required. They will have time to consider the content of lectures and repeat parts that they do not
understand. They will also have time to carefully formulate questions to ask or discuss during the next classroom meeting. Proceeding in this manner will reduce stress. Learners will also have time to pursue particular topics that they are interested in, again lowering the affective filter and promoting learning.

Not all courses will be able to easily incorporate this style of teaching and learning. Those that have strict criteria for credit in order to meet an external strictly assessed standard, might be less amenable than courses that are assessed upon internally peer or criterion-referenced standards. An example of the former might be a preparatory course for an externally administered test. But in the latter case, the criteria used for assessment could be based on individual progress or the submission of a portfolio of work.

Some teachers will feel at home with new technologies and blended learning. To others, adapting to a new way of teaching will be challenging. Teacher training in new methodologies will no doubt contribute to success.

Beyond the classroom new technologies point to further changes. MOOCs point to a potential for large numbers of people to participate in university level courses. At Harvard, more people have signed up for MOOCs in a single year than have attended the university in its entire 377-year history. With this emerging, new approach to education there are still many uncertainties, not the least of which is what the model for financing it will be. There are also questions arising with regard to credits. How will assessment take place and be paid for? However, in spite of these uncertainties, MOOCs are just one manifestation of transformations that point the way toward a future for education that is very different from that which has persisted for the last 100 years. The rate at which MOOCs have appeared over the last three years and the increasing number of participating universities support a suggestion that they represent more than mere “initial enthusiasm”. Moreover, MOOCs are evolving into different forms. Already some of the challenges with regard to assessment are being met with small private online courses, which unlike MOOCs limit enrollment to hundreds rather than thousands of participants and accordingly must implement some selection criteria. Another question for schools is the effect that online courses will have on their traditional courses. There is already increasing pressure to provide credit for online courses, and as we have seen, MOOCs command high enrollment (although the dropout rate is also high). If credit for online courses becomes common, it is reasonable to assume that many potential students will choose online courses over traditional ones. How this will affect the way that schools are financed is one of the uncertainties that suggest that the status quo in this regard is unlikely
to remain and that change is inevitable.

Digital technologies have disrupted traditional institutions that have existed essentially unchanged for many years. One example is newspapers. Weekday circulation of daily newspapers in the US was lower in 2007 than at any point since 1945. It is likely to be even lower today. Readers and advertisers have moved to the Internet. Recorded music provides another example of how distribution patterns can change relatively quickly. CD sales in retail stores in the US are 25 percent lower in August 2014 than they were a year earlier. Online retailing is yet another example of how the Internet is disrupting traditional marketplaces. In 2005 there were 1535 independent bookstores in the UK; in 2014 the number fell to below one thousand.

When it comes to the impact of digital technologies on education, it is likely that there is something more than “initial enthusiasm” taking place, and it is unlikely that the field of education will be immune from a transformative disruption.
Notes

1 Cuban, Teachers and Machines. p.5
2 Bax, S. (2003). Normalization in this context is discussed below in the section on computer assisted language learning.
3 New York Dramatic Mirror, July 1913
4 Reiser and Dempsey, Trends and Issues in Instructional Design and Technology. p.19
7 The Canadian TV network CTV ran a similar series of University lectures between 1966 and 1983. And the BBC in conjunction with the Open University broadcast lectures from 1971 until 2006.
11 And still does in some areas of the world.
12 Gray, “Children Educate Themselves III.”
14 Gray. ADHD and School: The Problem of Assessing Normalcy in an Abnormal Environment
15 Krashen, Principles and Practice in Second Language Acquisition. p.7
16 Krashen, Principles and Practice in Second Language Acquisition. p.31
17 Willis, Judy. The neuroscience of joyful education.
18 Coward, Pattern Thinking.
20 Gee, James Paul. New digital media and learning as an emerging area and “worked examples” as one way forward. P.11
23 In fact, because computer processor performance is also increasing along with transistor density, computer power is more than doubling every two years. Kanellos, M. "Moore’s Law to Roll on for Another Decade - CNET News."
28 http://www.englishcentral.com/videos
29 Wachowicz and Scott, “Software That Listens.”
30 Nakata, T. "English Vocabulary Learning with Word Lists, Word Cards and Computers.”
31 Basoglu and Akdemir, “A Comparison of Undergraduate Students’ English Vocabulary Learning.”
33 http://www.englishcentral.com/videos

https://itunes.apple.com/app/itunes-u/id490217893?mt=8&ls=1

https://www.khanacademy.org/

http://www.skype.com/en/


Meyer, The Vanishing Newspaper.


Singh, “Decline of the Independent Bookshop as UK Figures Fall below 1,000 for First Time.”

References


