Refocusing learning on pedagogy in a connected world

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Abstract *Advances in technology provide valuable opportunities for furthering the goals and methods of education. In this paper, we argue that, unfortunately, many of these opportunities are not seized because of restrictive conceptions of education that constrain teachers to viewing the educational mission primarily in terms of providing instruction. Adopting a pedagogical stance on this issue leads us to a fundamental rethink of how technology can and should be used. From this reconsideration, we conclude that using technology predominantly to provide access to learning content is a misguided use of technology. Technology is rendered more powerful for learning objectives when it is used to support learning-by-doing. Technological advancement on its own does not lead to better education. Pedagogical guidance is vital if technology is to be productive for human learning.*

Introduction

The idea of using technology to advance the goal of education is not new. History reveals how various technological inventions markedly influenced teaching practices. From the early blackboard-based teaching approach of "chalk-and-talk'', we have witnessed the impact of television, the overhead projector, computer-based slide projection, multimedia CD-ROMs and, most recently, the Internet on the myriad ways in which education is practised. Some of these teaching approaches, for example, the use of educational television, have gone out of fashion completely. Other technology-based approaches, such as the use of Microsoft® PowerPoint slide projections, remain very much with us. Most of the current excitement, however, revolves around the technology and connectivity of the Internet as it has become increasingly pervasive and ubiquitous. We can also think beyond such now "mundane'' technologies to more sophisticated instances such as point-to-point video and rich media conferencing that require broadband satellite-based links and to mobile devices with wireless connectivity. From an educator's point of view, the pertinent questions are: What does technology advancement portend for education? Will education automatically be more readily available to all? Will the quality of student learning, with the benefit of technology, be automatically enhanced?

In order to answer questions of this nature, we need first to critically examine current practices related to technology adoption. We shall do this in the next section of this paper. In subsequent sections, we shall highlight the problems related to current practice and seek to understand the causal underpinnings of these problems. To this end, we shall consider the nature of human learning to better understand how learning can be supported effectively. We shall argue for a need to refocus learning on pedagogy rather than on technology. We shall then consider design implications for technology-based learning and suggest what might motivate change in the desired direction before we conclude the paper.

Current practices of technology adoption

As Weigel (2000) notes, the most widely adopted approach to technology adoption is simply that of porting the classroom to the Internet. University faculty do this extensively by making all lecture notes and lecture slides

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available to students for download via the Internet. More adventurous faculty in institutions with good technology infrastructure often get their lectures videotaped and placed on a streaming server to provide students with anytime, anywhere access to the lectures. Some faculty members also have their lectures Web-cast "live".

Why do faculty members adopt these approaches? There are two principal reasons. First, these approaches conform to the comfortable existing practice of disseminating information. In the past, faculty members distributed information and learning materials using paper, but they now distribute the same information and learning materials via the Web. There is minimal perturbation of existing practices. Second, these approaches to technology adoption entail minimal cost to faculty members. They only have to master Internet technology to the level necessary to mount their materials on a course Web site. Given that this is not very difficult to do, especially with the availability of ever more user-friendly software tools, this is precisely what gets done.

There is another version of "putting lectures on the Web" that sometimes gets adopted. This version is more sophisticated and entails considerably more work. Using this approach, faculty make use of multimedia tools to pre-record their lectures. They then make these lectures available on-demand to students either via file download or via a streaming server. Various software tools, such as Microsoft® PowerPoint, either on its own or used in conjunction with Lotus® ScreenCam, can be harnessed for this purpose. With PowerPoint, it is also possible to create, with the aid of a backend server, a video-recorded "talking head" version of a lecture that proceeds in tandem with the PowerPoint slide being displayed. While these technologies may be wonderful in that they allow instructors to make use of audio narration and rich media, they continue to adhere to viewing the teaching role in terms of disseminating information.

Network connectivity has spawned one other significant type of technology use: that of synchronized geographically dispersed classrooms. Through the use of broadband satellite links, two physical classrooms can be connected via audio and video so that they share a common teacher. Students can also communicate with one another, in the presence of the teacher, via the audio-video link-up. While use of advanced technology in this manner can enable useful teaching possibilities, the teacher-centric model of instruction is nevertheless retained.

Key problems

There are two key problems related to popular approaches to technology use as described in the preceding section. First, a porting-the-classroom-to-the-Internet approach implicitly subscribes to education via the instruction paradigm, not the learning paradigm (Barr and Tagg, 1995). Second, research studies strongly indicate that the introduction of new technology does not, on its own, improve learning. We shall elaborate on these issues.

Schooling, and university education for that matter, have never been about learning so much as about instruction and certification. This is regrettable. From the perspective of the instruction paradigm (Barr and Tagg, 1995), universities and colleges exist to provide instruction by transferring knowledge from faculty members to students. Thus, these institutions offer courses and programs. They seek to improve the quality of instruction provided and to achieve access to education for a diverse range of students, including minorities and the under-privileged. Criteria for success of the institution's mission include factors such as enrolment, the quality of entering students, and curriculum development. Teaching structures are time-based, involving 50-minute lecture durations, fixed class start and end times, and accumulated credit hours. Instruction is teacher-centered, with an emphasis on covering material. The focus is initially atomistic, proceeding from an exposition of parts to a presentation of the whole. Learning is assessment driven, making use of continual as well as end-of-course assessment. The implicit learning theory guiding instruction presupposes that knowledge exists as a thing "out there", that it can be conveniently decomposed into bite-sized chunks and delivered by instructors, and that the learning process is cumulative and linear. In short, learning proceeds according to the storehouse metaphor of accumulating knowledge. In the instruction paradigm, faculty are primarily lecturers. Faculty and students act independently and largely in isolation of each other. The role of the teacher is to classify and sort students for the purpose of certification and accreditation. All this must sound terribly familiar to anyone who has been through college or university.

What kinds of outcomes arise from adhering to tenets of the instruction paradigm? How do students respond to an instruction paradigm institution? How much student learning actually occurs? To what extent can the instruction provided be credited with the learning that does occur? Indeed, what kind of learning occurs? Are students satisfied with the outcomes of their education experience? As Schank (2002, p. 253) observes, in an instruction-oriented environment where learning is driven by grading and testing, students "cheat, they compete, they wrangle their way around, they argue for grades, they whine and complain to teachers about their grades, they stress out, they cram and then forget what they crammed. They do everything but love learning". And as every university teacher knows, students often tune out at lectures. They also turn off when they learn that they are not responsible for any particular class assignment. Clearly, something is wrong. Can things not be better?

Indeed, much is problematic with the status quo. And when technology use is introduced into an instructional setting that is intrinsically problematic to begin with, it cannot help to improve matters. A fundamental re-look and re-think are needed to identify the root causes of problems prevalent in traditional education environments.

What do we understand today concerning the impact of introducing new technology on learning? The impact of one type of new technology – media – on learning is fairly extensive and well-documented, and we can learn a useful lesson from this. Each wave of new technology that comes along seems to inspire unbridled optimism and confidence that it will revolutionize the practice of education and solve the world's education problems. The implicit suggestion has always been that adoption of the new technology would directly result in an improvement in educational outcomes. Clark (1983), in his review of the effect of media use on learning outcomes, argued that the medium is not the message: media use does not influence learning outcome under any conditions. Some ten years later, the journal *Educational Technology Research & Development* revisited this topic and published a special debate issue on this topic (see Clark, 1994; Kozma, 1994). In that issue, Kozma critiqued two media-based projects and argued for the need to consider the capabilities of media and the methods that employ them, as these methods interact with both the cognitive and social processes by which knowledge is constructed. From these studies and others, it is generally accepted today that media in particular, and new technology in general, do not, indeed cannot, directly cause learning outcomes. Rather, what matters is finding a good match between the selected media or new technology and the way in which they are used. A good fit offers the best prospect for achieving improved learning outcomes. Media on their own, or technology in general, are much too generic as instructional artefacts. Hence, they are too flexible in terms of their possible application for educational purposes. By themselves, they lack adequate causal power to directly and systematically affect learning outcomes. The manner in which they are used and the goodness of fit between the technology selected and the manner in which it is used are the factors that really matter. In short, pedagogical wisdom with respect to technology application is what counts.

In short, disappointment is inevitable if one places one's hopes on advanced technology to solve problems related to education and training. It is not that technology does not matter. Indeed, it does, because new technologies create new opportunities and affordances for educational use. But, on its own, and especially when used with an instructional purpose, technology merely increases the efficiency with which traditional, ineffective teaching practices are conducted. Unimaginative use of technology side-steps the challenges presented by new technologies and fails to appreciate the opportunities inherent in them. As Weigel (2000, p. 12) notes, "if institutions were truly concerned with using distance education to enrich collegiate learning experiences, Internet-based learning ... would look much different from what we've seen thus far".

Understanding the problem

In light of the above, let us attempt to understand the roots of the above problems with a view to assessing whether technology can be better harnessed in service of education.

As a tool, technology is neutral. It can be used, misused, and even abused. Pedagogical wisdom is needed to guide productive use. Biased by a blind, and often unconscious, adherence to the instruction paradigm, instructors instinctively use advanced computing technologies to further the traditional goal of knowledge dissemination. Networking and communications technologies are particularly suited to and powerful for supporting knowledge dissemination. While technology-facilitated knowledge dissemination is clearly important because it helps to extend the reach of education, viewed critically, we quickly realize that it merely places learning content (e.g. course materials framed in HTML, Word document files, PowerPoint slides, "talking head" courseware) in the hands of learners. Having 24×7 access to such educational content is a big boon, and we do not wish to under-value this. In today's Web-enabled world, it has become the norm for students to expect direct, on-demand access to such content. There is nothing wrong with all this. The problem is that it does not go far enough.

We know that a country with a library (or a network of libraries) doth not an educated citizenry make. Access to educational and learning resources is a necessary condition for learning, but it is clearly not a sufficient criterion. Weigel (2000) frames this issue in terms of a trade-off between reach and richness, these terms being borrowed from the business literature. We prefer to use the terms access and learning. Access refers to harnessing technology to achieve the goal of universal accessibility to learning content (see, for example, Chee, 1998). Learning refers to a particular quality of that content: the extent to which the content is capable of facilitating human learning. In an instruction paradigm world, what matters most is accessibility to information (or knowledge), memorizing that information, then regurgitating that information in content-oriented examinations or in response to simplistic multiple choice questions. The underlying goal of assessment is to answer the question: has the student got the facts? What if a student has got the facts? If so, one can conclude that the student has acquired mastery of the factual content of a course that they learned from the teacher, from the PowerPoint slides, and so on. But how useful is this outcome, both to the student and to society at large? Can the knowledge gleaned be applied by the student and productively used? Can the student do anything useful with what he or she has learned? Sadly, the widespread answer is "no". Why is this?

To any person schooled in the cognitive sciences, the answer is simple. It lies in understanding the difference between declarative and procedural knowledge. Learning by being told at best allows a student who has learned well to tell back. Many learning assessments evaluate just this.

When students do well in these assessments, they are led to believe that they know the subject-matter and have achieved subject mastery. But all that they have really mastered is the recall of declarative knowledge. For such knowledge to be useful, however, it must be transformed into procedural knowledge: an ability to execute pertinent procedures manifested by an ability to do or act by using the knowledge learned. The transformation of declarative knowledge to procedural knowledge is a cognitively demanding process and requires considerable effort to master. Sadly, many courses and study modules never go beyond the knowledge level, resulting in learning that is not useful.

To elaborate, consider the example of a student learning to swim. There is clearly a vast difference between learning to swim and learning about swimming. The former entails acquiring procedural knowledge while the latter entails acquiring only declarative knowledge. So while a student who has mugged a book about swimming will likely do well on a test about swimming, we do not expect him or her to be able to actually swim. The problem with traditional education is that too much of learning is declaratively oriented. Hence, students may "know" a lot, at least for a short period of time, but they are unable to make use of what they know. There is nothing wrong with knowing a lot. However, on its own, it is not empowering and is inadequate for real world purposes. Matters are made worse by the fact that declarative encodings of knowledge that students do not find personally meaningful or relevant to themselves are very quickly forgotten. Seen in this light, what little might have been gained by acquiring knowledge and remembering information is also all too soon lost. This is a rather sorry outcome for students who have expended considerable effort memorizing knowledge.

What then might be needed? We argue that what is needful is learning for understanding rather than learning for knowledge. We should perhaps be explicit about our intended meaning of the terms knowledge and understanding as these terms are often used with multiple or ambiguous meanings. When a student answers a question correctly (for example, "What is the capital city of France? Answer: Paris"), we are prepared to grant that the student knows the capital city of France. Knowledge is thus demonstrated behaviorally by saying or by writing the correct answer. In similar vein, when Polly the parrot says (or screeches) that "Daddy is home!" we might be prepared to impute to it the knowledge that Daddy has arrived home. Behaviorally, it satisfies the given criterion of "knowing". But what of understanding? Would we accept that Polly understands the real world event of Daddy arriving home? In all likelihood, we would not. Why? The imputation of understanding is predicated on possession of a rich web of interconnected cause-and-effect relationships that underlie the ability to act intelligently, given the possession of knowledge. Clearly, the extent to which Polly might be able to leverage what it is deemed to know is very limited. Because of this, we regard Polly as lacking real understanding.

An instruction-oriented curriculum breeds knowledge acquisition, not understanding. However, the value of education lies not in training people to become "walking encyclopaedias" or mobile storehouses of knowledge. Students must go beyond acquiring knowledge to acquiring understanding. How can this be achieved? By students beginning to learn by doing. People learn how to do something only through trying to do that thing. The case of swimming makes this point evident. We argue that the appropriate pedagogy for subject mastery with understanding is the method of learning-by-doing.

If this argument is accepted, then the implications for technology use in support of learning are quite profound. Before setting out prescriptions for technology-based learning, however, we shall first examine in greater detail the nature of human learning so as to understand what is needed to achieve the goodness of fit between technology and pedagogy that will produce quality learning.

The nature of human learning

Our discussion thus far can be summed up in terms of the following equation:

$$\text{Content} + \text{Delivery} = \text{Learning}$$

It should be fairly evident now that

$$\text{Content} + \text{Delivery} = \text{Delivered Content}$$

and delivered content, on its own, does not carry us far toward the goal of achieving learning. So, if content plus delivery are inadequate, what is needed? As previously indicated, we shall argue that learning by doing is needed. Indeed, all deep, meaningful learning takes place via doing (Schank, 2002), and the criterion of successful learning is knowing-in-application, not knowledge-in-the-head.

Presumably, we have all witnessed young children learning. As postulated by Donald (1991, 2000), early learning is mimetic in nature and involves a brain capacity that allows children to map elementary event perceptions to action, thus creating the possibility of action-metaphor, gesture, pantomime, re-enactive play, and self-reminding. "Inner" mental thought and language develop through inter-psychological events being turned inward, becoming internalised, and evolving to the intra-psychological plane of experience (Vygotsky, 1978, 1986). This outer-to-inner translation highlights the importance of experiential and socio-cultural dimensions of human learning that have their basis in human activity and behavior.

Young children also learn by doing and by repeated failure at doing. Over time, however, they learn to succeed through sustained practice. Schank (2002, p. 81) argues that "[l]earning is the same for everyone – failure causes the rewriting of the rules that failed". He states bluntly that "[c]ontrary to common belief, people don't have different learning styles" (Schank, 2002, p. 80). Rather, they have different personality types that give rise to different preferences in learning approach. But everyone learns by failure and by correcting mistakes.

As outlined by Schank (2002), expectation failure is vital for human learning to progress and eventually succeed. A lack of expectation failure leaves existing knowledge structures unchanged because these structures withstand the demands of lived experience. However, when expectations fail, emotions are triggered, and people feel an inner need to rationalize and to explain the cause of failure. This need, in turn, sets off thinking processes that catalyze learning. In such a discordant mental state, people are receptive to information provided and to explanations that will help them explain the expectation failure and rationalize the outcome that they experienced. Just-in-time information is thus especially valuable and effective for learning. Memory is activated when learning experiences engender high emotional impact. Motivation for learning is enhanced when the learning situation is personalized, socialized, and made relevant and engaging.

A content delivery approach to education fails to make contact with the principles of human learning described above. When learning is not centered on doing, there can be no expectation failure to create the cognitive dissonance that triggers learning. Emotions remain unengaged, memory is not reorganized, and motivation is not aroused. In short, nothing significant happens. Hence, no lasting changes occur. The end result is the oft lamented outcome associated with traditional education: poor retention and lack of learning transfer.

A remedy for the above outcome can be found in the principles articulated by the learning paradigm (Barr and Tagg, 1995). From the perspective of the learning paradigm, the goal of teaching is to produce student learning, not instruction. Such learning is achieved by the creation of powerful learning environments that elicit student discovery and knowledge construction. Teaching structures are holistic, moving from whole to parts. This approach provides the needed context for meaning making and meaningful problem solving. Teachers design learning experiences that facilitate students' knowledge construction. Learning experiences are active, mentally and possibly also physically, with learning being student-centered and student-controlled. Often, such learning environments require cooperation and collaboration with peers in a socialized setting.

A learning paradigm mindset fits a learning-by-doing approach to education and training. What implications arise from the adoption of this mindset and from an understanding of the nature of human learning for how we might use technology to promote learning rather than instruction? We discuss this topic in the next section of the paper.

Designing successful e-learning

We have already argued that students learn most effectively when they learn by doing. Learning-by-doing sets up the context for meaningful and motivated learning. Schank (2001) highlights the possibility of using the computer to revolutionize traditional classroom courses by using its ability to create simulations in the subject domains that students are trying to master. As a general computing device, computers have the wonderful potential of supporting an interactive learning process that responds to students' actions. They need not simply be bearers of content. Courses that are naturally doing-centered, such as computer programming, are good candidates for simulation-based learning. As suggested by Schank, authentic programming skills can be learned by creating realistic situations in a simulated workplace supported by interactions with one or more online mentors who evaluate successive program approximations submitted by students until the mentors are satisfied that the job has been done well.

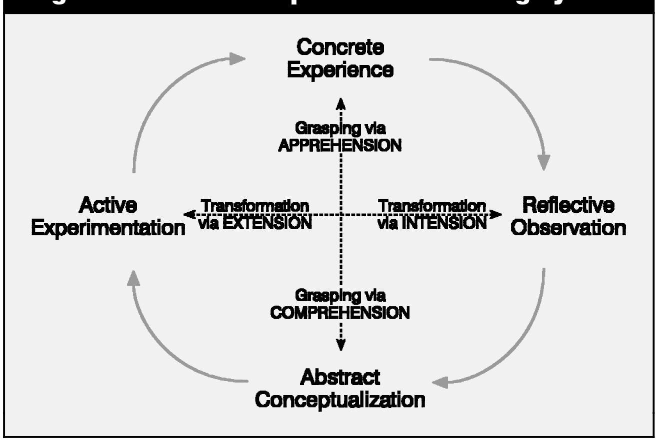
In his later book, Schank (2002) advocates seven criteria for assessing the effectiveness of e-learning courses. He refers to these criteria as the FREEDOM criteria where each letter of the acronym FREEDOM stands in turn for *f*ailure, *r*easoning, *e*motionality, *e*xploration, *d*oing, *o*bservation, and *m*otivation.

Doing, observation, reasoning, and exploration are student independent criteria that a learning designer needs to build into the simulation constructed to support learning-by-doing. A good course encourages practice in doing. The simulation must require continuous doing as "[d]oing is what learning is all about" (Schank, 2002, p. 221). Most traditional courses attempt to prepare students for a kind of doing that never takes place. As an example, this is evident in a typical university first course in management. A good course also allows students to observe things for themselves. Observation promotes memorability. It can also trigger the process of mental analysis. Technology can be harnessed to make observations media-rich, thereby enhancing memorability when used judiciously. A good course encourages practice in reasoning. A course is not effective if it fails to engage higher-order mental faculties. Simulations present rich and complex cases that require higher-order reasoning skills. A good course also promotes exploration and enables inquiry. Students naturally inquire when they experience failure and are in a confused state of mind. They need to know the reason for the experienced failure. Technology can be effectively utilized to provide the just-in-time information that students need when they need it most. One approach is for the needed information to be provided in the form of a dialog between the student and a mentor. Engaging in such a dialog facilitates learning because conversation (articulation of thoughts and ideas and receiving a response to one's articulation) reifies mental processes that are otherwise tacit. Technology can be used to create a learning situation with simulated mentors and peers. In this context, dialogic learning takes place naturally.

The criteria – motivation, emotion, and failure – are student dependent criteria. A good course must motivate students to want to learn about the subject domain. To this end, students must be persuaded of the relevance of what teachers want them to learn. Intelligent and creative learning design are required to construct learning simulations that demonstrate and persuade students of the relevance (to themselves) of what they are learning. Motivation is an integral part of human memory. Motivated learning helps to create the conditions for meaningful learning that gets remembered. A good course must incite an emotional response in students. Emotional engagement in learning gives rise to the creation of episodic memory, not just semantic memory, that gets indexed on the basis of experienced learning cases. People remember what they care about. Learning designers must seek to get the emotive dimension of meaningful learning coupled to the subject content in some way. Finally, a good course must enable failures that surprise students. Engaged learning involves event prediction and expectation creation. When events unfold according to prediction, we learn nothing. However, expectation failure creates immediate emotional arousal that demands finding a plausible explanation for the experienced expectation failure. Working through the process of finding causal explanations for failure leads to reorganization of memory and hence to learning. Technology must create learning environments in which it is safe for students to fail. They should not have to be devastated or embarrassed by failure. The technology must also provide resources for recovery from failure in the learning environment.

At a higher level of description, learning simulations must support two important transformational processes. The first is transformation from apprehension to comprehension (or experience to intellect); the second is from extension to intension (or from "outside" to "inside"). These processes are neatly encapsulated in the framework of Kolb's (1984) experiential learning cycle (see Figure 1). The framework emphasizes the importance of experience in learning. Experience provides the real-world grounding for thoughts and ideas, thereby rendering them meaningful. This emphasis is consistent with Schank's focus on learning-by-doing. The extension-to-intension dimension of Kolb's framework mirrors directly the process of internalization articulated by Vygotksy (1978). (Cf. Donald's (2000) "Outside-inside" principle.) Viewed as a whole, we see that active experimentation yields concrete experience, providing the basis for reflective observation which, over multiple instances, leads to generalization and abstract conceptualization. This process iterates as an ongoing cycle. By this means, students' understandings are transformed extensionally and intensionally, and comprehension is grounded in apprehension. Some of our work, for example, Chee and Hooi (2002), makes explicit use of these learning principles.

Figure 1 — Kolb's experiential learning cycle



This section of the paper on the design of e-learning highlights the critical importance of learning design. Considerable intelligence and creativity are needed to invent learning simulations that will satisfy the criteria outlined above to yield meaningful and impactful learning. While there is an established field of instructional design, it has focused, understandably, on principles for designing instruction. However, with the shift from the instruction paradigm to the learning paradigm, it becomes vital for teachers to correspondingly shift their attention to learning design. As articulated by Spence (2001, p. 18), "We won't meet the needs for more and better higher education until professors become designers of learning experiences and not teachers" (where, by the use of the term "teachers", Spence intends the meaning of the term "instructors"). Given that "[t]he business of education is learning" (Weigel, 2000, p. 15) and not teaching, we ought to pay special attention to the nature of human learning and designing for learning when we attempt to harness technology for educational purposes.

Motivating change

Given the political, historical, structural, and cost constraints under which universities operate, there are enormous pressures for them to retain the status quo. At best, changes in practice will be gradual and evolutionary in nature. For different institutional and pragmatic reasons (see Schank, 2002), it seems unlikely that universities will be drivers of the learning-by-doing approach to technology-based learning, at least on a significant scale.

Are educational reforms of the type contemplated by Schank a lost cause? Schank does not think so. He points to efforts by General Electric and even Columbia University and the Harvard Business School that have led to the creation and deployment of innovative education and training of the type he advocates. Schank envisages that the real threat to staid university education comes from corporate training and from the global need for lifelong education. Unfettered by the constraints of universities, organizations that choose to fill the training and learning needs of the masses will be more likely to succeed in developing and deploying learning-by-doing courseware that addresses both technical and general education. Being oriented toward a mass market, the up-front investment and development cost will earn substantial payback in the mid- to long-term.

There are already corporate "universities" in existence today. One such university is Motorola University. Other corporations have a training and certification arm that provides these services without going as far as calling themselves universities. Regardless of what they call themselves, most of these training organizations offer short, on-site training programs for executive and technical staff. Others have online training programs, but access is restricted to the corporation's own staff. Schank is of the opinion that corporations that have developed successful training courseware will begin to license it for use by people external to the organization. There is no reason not to do so.

Macromedia University, set up by the company Element K and accessible via the Web, offers commercial online training on Macromedia software products. It is unclear whether the company is officially affiliated with Macromedia, Inc. Whatever the case, this instance portends the possibility of online education squeezing out or at least eating into the turf of traditional university education over time. Schank seems to think that this will happen and that universities are at risk of losing their stranglehold on higher education. Will this happen? And to what extent? Time will tell. However, if this is a serious threat, universities must respond swiftly by improving the quality of their learning offerings.

Conclusion

In this paper, we have critically reviewed the typical ways in which teachers and organizations use or have used technology to achieve educational purposes. We have argued that much of typical use conforms to the mindset of the instruction paradigm with its concomitant emphasis on instruction, not student learning. This uncritical approach to technology use improves education only to the extent that it improves access to learning without necessarily improving learning itself. This represents a lost opportunity and constitutes an unsatisfactory state of affairs. To consider ways of using technology in support of learning, we turned to the learning paradigm for guidance on how technology might be used. We considered the nature of human learning and elaborated on how a good fit between technology and human learning needs can be achieved. We argued that the key to the development of effective technology-enhanced learning lay in carefully thought out learning design. Providing access to instructional content is not sufficient. With the aid of technology, we must provide opportunities for deep experiential learning. We must promote learning that "sticks," and learning that makes a difference.

Whether as educators or administrators of education, we want the benefits of both access and learning. We want both richness and reach. By careful consideration of the opportunities afforded by technology, we must be intelligent and creative in how we harness technology in service of education. We should aim to achieve the dual goals of access and learning for our students. They deserve nothing less. ■

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