

Using Technology to Adapt Older Workers to New Worlds: Theoretical Framework for an Optimal Approach

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Abstract

Electronic technology and the WorldWide Web now make it possible to shift the introduction and conveyance of knowledge from the classroom to the home and/or workplace, freeing class time for interactions between instructors and learners that probe, reinforce, and internalize knowledge. The first element of this process, the movement of lecture-based knowledge transfer from the classroom to external environments is to a large extent already enabled by existing web and course/learning management system (C/LMS) technology. However, before plunging headlong into the application of these technologies based simply on their availability via one tool or another, does there exist verified, research-based guidance on the content and type of interaction that has been shown to be optimal in suiting the ways adult learners actually learn? This paper examines prior research and relies on it to provide specific recommendations and an example of how contemporary technologies can optimally be deployed to support adult learner training and retraining.

Striking extremes become apparent if we juxtapose the characteristics of aging human bodies and those of maturing electronic technologies. As our bodies age we experience the gradual loss of muscle tone and coordination, endurance, mental agility and flexibility of movement, among other negative effects, and an increase in the types and expense of medical attention required to sustain a desirable quality of life.¹ With electronic technology, however—at least until it is replaced by a radically newer technology—we see the opposite occur: speed, flexibility, and accessibility dramatically increase while cost declines with the economies of mass production and the improvement of the efficiency of manufacturing processes.² The positive effects of the latter are often applied to counterbalance the negative effects of the former, to wit: devices are developed to assist human senses as they diminish, “intelligent” prosthetics restore mobility to damaged limbs, and complex drugs mitigate or overcome the effects of bodily deterioration and disease.³ Existing electronic technology can also be used to support redirection of the human contribution to the economic enterprise by providing the basis for more effective learning of new skills and knowledge. It can optimally accomplish this by recognizing that individuals in different age groups learn in different ways and by employing a new pedagogical paradigm rather than using technology to “cement in place” the paradigm of the past. How we can accomplish this is the subject we consider here.

Computer support for education has existed for decades. The first computer-based training environments were evolved in the 1970's using mainframe technology.⁴ These were followed in the 1980s with software products that provided one or another form of interactivity and engagement with learning materials, self-assessment tools, and facilities for the provision of electronically-based reading materials including sound and animation.⁵ With the invention of the

internet and then the WorldWide Web in the 1990s the first proprietary web-based course learning and management support systems (C/LMS) became commercially available,⁶ followed by open-source equivalents such as Sakai and Moodle.⁷ These developments make it possible for institutions to deliver electronically-based learning materials to a wider audience, with more geographical and time flexibility, at lower cost, and for individuals to interact with these materials and to seek and locate knowledge resources immensely faster than ever before.

An amusing analogy of “innovation”

In the specific way that technology is integrated with pedagogy, and pedagogy itself, it seems we often find a situation analogous to this slightly humorous hypothetical example. Suppose it's 1859 (yes, just before the American Civil War!) and you're called in as an “innovation consultant” with a new venture that has installed horses and relay stations across the American west, from St. Joseph, Missouri to San Francisco. Riders carry mail in saddle bags and leave from St. Joe every day, heading west for about 20 miles until their mount tires out. The rider then changes to a fresh horse and heads west again, and repeats the process four more times, covering about 100 miles before handing off to a new rider with a fresh horse. The mail travels from St. Joe to the west coast in “only” three days on this Pony Express instead of six months as it had on wagon trains. Your assignment: improve the efficiency of the process. Altering history just a bit, suppose that the automobile was invented about 40 years earlier than it actually was, and is now, in 1860, available. You confidently recommend replacing the horses with Jeeps and leaving intact the basic concept of relay stations (spaced farther apart) and the physical delivery of messages.

The outcome? You would have failed miserably as an agent of innovation! The electrical telegraph had actually already been invented 20 years earlier, in 1839. Why not recommend scrapping the idea of physically carrying messages and instead propose conveying them electrically over a pair of wires strung between the origin and destination points? Seen in this light, the idea of replacing horses with Jeeps to improve the Pony Express seems as short-sighted as it indeed would have been.

Yet we face essentially the same situation in regard to the approach many educators take with electronic technology. The “traditional” form of instruction involves the class lecture, in which a person with knowledge (the instructor) dispenses it in oral form to an audience of people presumably in need of that knowledge (students). This form of instruction originated in the days of the medieval university before printing made books readily available. This form of instruction continued even after the invention of movable type printing, when each student could readily have their own copy of learning materials. And it persists even to the present day with the use of slides by lecturers. In its worst contemporary form it consists of a lecturer reading monotonous, word-filled slides to an audience that has already read them by the time the speaker utters his or her first few phrases. In this situation electronic technology has been (mis)used simply to perpetuate and enshrine a form of pedagogy that originated a thousand years not because it was effective but because it was the only way then available to disseminate information. Making better (read that as “more colorful”, “more noisy”, “more clipart-laden”) Powerpoint slides is just like replacing the Pony Express horses with Jeeps!

Desirable learning outcomes

Readily available electronic technology now allows us to distribute information (like slides) along with audio narration in ways that do not demand the viewer to have any particular software

(such as Powerpoint or Word). The web is capable of rapidly conveying textual, graphic, audio and even video files. In addition, many people, especially mature, already-employed workers are now facing time demands that mean they may have study time available at unusual hours during the week or weekend. In this environment it is critical to use available contact time with learners as wisely and as productively as possible. This does not mean perpetuating unproductive one-way transfers of information orally, which can readily be accomplished via the web. It does mean making as productive use of class contact time to apply knowledge and further internalize it by interacting with it dynamically. Thus the task before us is two-fold:

- to develop and document ways to shift lecture-like activities from the classroom to the web, in ways that impose as little specific time, equipment, and software hurdles and demands as possible
- to develop ways to apply and interact with knowledge in the classroom so as to maximize the benefit of the time a learner spends with a knowledgeable guide in the person of the instructor.

A partial list of some of the ways in which these things can be implemented include:

- Slides posted so as to minimize device and communication requirements for viewing
- For software training, slides which are full-screen illustrations of the software in use, with annotations that concisely describe actions or their effects
- Audio narration for slides playable on a student's computer or portable sound playing device, matched to or independent of the slides themselves
- Scripts for the audio content of a course provided in readily accessed written form
- Video "shorts" of techniques or topics embedded in the C/LMS
- Using online "tests" as exercises, letting students do them within a window of time consisting of a days or longer, including feedback for incorrect responses and suggestions for overcoming deficiencies in present knowledge.

All of the above let instructor turn a class inside-out, doing lectures outside of the classroom and/or at a distance, making it possible to use class time for exercises, discussions, field trips, experiments, and other activities that apply the knowledge gained. By using available technology to accommodate different learning styles, times, and locations, learners of all ages and with various times demands and schedules can be provided with the resources to facilitate knowledge and skills acquisition.

However, in connection with any specific age group, the application of new technologies to learning should not be driven simply by the technology itself. This is a trap into which many technical personnel, as well as many educators, often fall. When driven from this side of the equation technically available options all too often can become solutions in search of problems. Instead, it is more beneficial to achieving intended learning outcomes if the nature of the learning process specific to the intended audience is identified and appropriate technologies and techniques then be chosen to implement learning approaches that have been confirmed to be suited for that audience's learning. It is on this aspect of pedagogical actions that we focus here, with the intended audience specifically identified as adult learners.

Characteristics of Effective Learning Materials for Adults

According to Williamson,

Adult learning and development researchers tell us that adults prefer instruction that is self-directed, reflexive, experiential, relevant, solution-oriented, and transformative (learner's biases and assumptions are challenged). Training must also activate, affirm and build upon prior knowledge and real-world experience and have immediate and practical application.⁸

This sums up perhaps better than any other single statement the essence of effective professional development training.

Our review of the relevant literature, however, identified the work of several others that also has a direct bearing on the way in which software training materials can be developed for maximum learner benefit. Bannert explored the utility of minimizing the software feature set to which learners were initially exposed and also compared the effectiveness of instructor-led materials with self-instruction materials, and determined that in his experiments user satisfaction and acceptance of the various training approaches was identical, yet learners experiencing self-learning materials “achieved significantly better learning outcomes than students in the ‘human tutor’ group.”⁹ Bannert also found that while learners exposed to a subset of system functionality learned significantly faster, they did not—in contrast to the assumptions of Carroll, upon whose “training wheels” approach his work rested¹⁰—experience better learning outcomes. Leutner identified that focusing on a subset of software functionality first, and gradually expanding the focus, while at the same time beginning with heavy guidance and gradually relaxing it, were more effective as a strategy than any other combination and manipulation of these factors, and confirmed that ignoring these factors in the design of a training approach for software almost invariably was less effective.¹¹ Venkatesh and Davis determined that prior to hands-on experience with a new software system, a user's perception of the ease of use of the system is based primarily on the individual's own self-conception of their computer skills in general, but that an objective sense of system usability is gained after direct experience. Further, the nature of that sense of usability is tied intimately to the nature of the direct experience and the satisfaction, or lack of satisfaction, experienced by the person in that contact.¹² (Venkatesh and Davis, 1996). Yi and Davis accomplished an in-depth validation of and evolution of an observational learning model confirming that training in which a learner observes how a task is accomplished and then models the same behavior produces superior training outcomes to those of approaches relying more heavily on the theory behind an operation or recitation of the results of an action.¹³ Ricci et al. studied whether an approach to training in which new skills are taught as part of a game were as or more effective than traditional step-by-step (“test and text”) explanation and drill and determined that the game approach was superior in specific instances.¹⁴ Especially insightful is very explicit human-computer interface analysis of training materials provided by Carroll, Smith-Kerker, Ford, and Mazur-Rimetz in describing the design and formation of a “minimal manual” guide for the development of self-instruction materials, which combines the development of very specific notions of instructional material content and expression with focused experiments to evaluate the outcome of their use.¹⁵

The primary intent of the learning materials development for the adult audience, as guided by the identified research, should aim at the provision of materials that could serve the purpose of in-person teaching or training over a distance as mediated by technology, with the active

participation of an instructor. However it is also necessary to envision that the same materials must be useful to learners for self-instruction and reference purposes and their own “explorations” of the subject matter. The principles and beneficial practices derived from our literature search led directly to the design goals to be met by an optimal type of learning materials for the adult audience. The materials must:

- be concise—contain the minimum necessary verbiage to accomplish the purpose
- provide focused coverage of specific topics with work-related outcomes relevant to the audience
- provide coverage in context to incur the minimum necessary learner orientation to applicability
- be intuitive in nature and require no, or an absolute minimum, of additional explanation
- lend themselves to accurate, consistent, and rapid learner interpretation.

A concrete example suggests itself as a means of clarifying and giving substance to these goals. For this we chose the process by which adults such as faculty members are given training in using a new version of a software system such as Blackboard Version 8. It is evident that it is possible to satisfy many of these requirements with an implementation method that not only provides the desired product but also is substantially faster to implement than the traditional “user manual” approach stemming from the legacy of early technical writing. The user manual approach begins with the assumption that written materials are primarily that: words supported by focused illustrations. The approach developed to meet the identified design goals and practices reverses this and recognizes that when software training is the goal the object of focus is the entire screen viewed by the user. Words are secondary and their placement must reflect the primacy of this fact and the overwhelming importance of the context provided by the entire screens viewed by the user, which literally is the software system to the user. Figure 1 illustrates this type of learning materials in slide and print forms.

**To add a discussion forum,
first click Discussion Board and then click Forum.**

The screenshot shows the Blackboard interface for DePaul University. The left sidebar contains a menu with 'Discussion Board' highlighted. A red arrow labeled '1' points to this menu item. The main content area shows the 'Discussion Board' page with a 'Forum' link highlighted by a red arrow labeled '2'. Below the 'Forum' link is a table of existing forums:

Display Order	Forum	Total Posts	Unread Posts	Total Participants	Grade				
1	Chicago Olympics discussion	6	1	3		Modify	Manage	Remove	Copy
2	Economy discussion	1	1	1	-	Modify	Manage	Remove	Copy

The 'Economy discussion' forum has a description: "Discuss how you are handling your money at this time. What are you doing with your investments and how are you handling debt?"

Figure 1 – Example in a series of training slides developed to meet the research-derived criteria

The method developed to satisfy our requirements relies on the ready ability to capture an entire screen as a graphic image. A simple keystroke carries this into the “memory clipboard” from which it can be inserted directly into a Powerpoint slide.¹⁶ In addition to the top of screen instructional verbiage, stand-out block arrows, heavy circle borders, or inset text boxes in a distinctive color can be used on the screen image itself to call attention to items. The intention with these is to provide the kind of attention-drawing visualization analogous to that which would occur if an instructor were standing next to the learner, looking over his or her shoulder, and physically pointing out the item and identifying and explaining important points about it. The intention of using full-screen images in all cases is to avoid the kind of “out of context” learner confusion that often ensues when only a fragment of a screen is illustrated, which is almost always the case if training materials are viewed as traditional “user manuals” or ordinary technical writing.

Suggested Method

Implementation of the research-derived basis for productive adult learning materials suggests the following step-by-step process.

1. Identify the end products or things learners will know by taking the training—the specific products, analyses, or factual knowledge they will be enabled to create or possess, not the steps or functions or facts to which they will be exposed; see Carroll’s “Minimal Manual” admonition on page 129.¹⁷
2. Sequence the topics to be covered within a course and develop a hands-on exercise for each. Break a complete exercise into steps that can be expressed in a few lines.
3. Perform the step-by-step sequence of operations needed to accomplish each exercise and capture each screen, creating a slide in the pattern illustrated in Figure 1. Explanatory words (if needed) are carefully chosen and edited so that they are concise and not verbose, so that they always fit within the top border area and within a supplementary annotation box with 24 point type.
4. Sequence the slides and perform a copy edit on the entire set, adjusting wording to insure consistency between slides and exercises sheets.
5. Pilot test the training with a small initial group. Refine the slides and exercises as dictated by this experience before placing them into widespread use.

Conclusions

A clear emphasis on the results of prior research into the nature and needs of adult learners can inform pedagogy and lead to optimal learning outcomes. The results of such research indicate that changes in pedagogy are highly desirable to modify the traditional format of lecture-based instruction. Shaping the application of technology to pedagogy, as informed by research, can avoid the type of “solution-seeking-a-problem” that has characterized some attempts to improve higher education processes. While this approach has obvious implications for adult training in such things as software usage, it has relevance also to any form of knowledge transfer in which the learner is an adult.

Endnotes

¹ A concise and informed article on the effects of aging on the human body and various reasons proposed as to why these changes are thought to occur see http://longevity.about.com/od/longevity101/a/why_we_age.htm.

² As Boar has noted, "The physics of computing has had only one impact on its price/performance for the past 30 years, and the exact same impact is anticipated for the foreseeable future—its cost will continue to dramatically decline. This cost efficiency is critical because it enables computing to become ubiquitous and available with sufficient power at an enabling and attractive price point." Boar, Bernard H. *The Art of Strategic Planning for Information Technology*, 2nd edition. New York: John Wiley and Sons, 2000; p. 48.

³ For an informative overview of the types of these computer-based aids see Sears, Andrew, and Jonathan Lazar, Ant Ozok, and Gabriele Meiselwitz. "Defining an Agenda for Human-Centered Computing." *HFES Bulletin*, Volume 51, Number 2, February 2008, accessed February 14, 2009 at <http://www.hfes.org/web/BulletinPdf/0208bulletin.pdf>.

⁴ <http://www.plato.com/About-Us/Our-Company/History.aspx> accessed January 14, 2009; this summarizes the history of the Plato™ Learning System and traces its evolution from mainframes to local area network environments and its changes of ownership

⁵ http://www.cilc.org/c/about/cilc_history.aspx accessed January 16, 2009; documents the history of the Center for Interactive Learning and Collaboration (formerly Corporation for Educational Communications) since its formation in July, 1994. See also http://www.digitalschool.net/edu/DL_history_mJeffries.html accessed February 3, 2009 for a broader and well-documented history of the use of audio and visual technologies in support of education. The slide set at http://www.ncsu.edu/student_affairs/detag/meetings/history020604.ppt#1 accessed February 1, 2009 provides an excellent and well-documented visual summary of developments in technology supporting distance learning in particular.

⁶ See AngelLearning product information accessed October 9, 2007, from <http://angelllearning.com/>; Annual Report for 2006 and Blackboard product information access October 13, 2007, from <http://www.blackboard.com/us/index>; Desire2Learn product information accessed October 12, 2007, from <http://www.desire2learn.com/>; WebCT product information accessed October 13, 2007, from <http://webct.com>.

⁷ Moodle product information. Retrieved October 8, 2007, from <http://moodle.org/>. See also Sakai product information. Retrieved October 8, 2007, from <http://sakaiproject.org/>

⁸ Williamson, Lisa. Training for Distance Learning Teachers. Unpublished paper summary contracted by Utah State Office of Education, Summer 2008, in which Williamson cites Merriam, Sharan B. "Andragogy and Self-Directed Learning: Pillars of Adult Learning Theory". *New Directions for Adult and Continuing Education*, no 89, Spring 2001, p3-11. Accessed on December 9, 2008 from <http://www.schools.utah.gov/edtech/ednet/pdf/Trainingpapers.pdf>

⁹ Bannert, M. The effects of training wheels and self-learning materials in software training. *Journal of Computer Assisted Learning* (2000) 16, 336-346.

¹⁰ Carroll, J.M. (1990) *The Nurnberg Funnel, Designing Minimalist Instruction for Practical Computer Skill*, MIT Press, Cambridge, MA.

¹¹ Leutner, D. Double-fading support—a training approach to complex software systems. *Journal of Computer Assisted Learning*; Dec 2000, Vol. 16 Issue 4, p347-357.

¹² Venkatesh, Viswanath; Davis, Fred D. A model of the antecedents of perceived ease of use: Development and test Decision Sciences; Summer 1996; 27, 3; ABI/INFORM Global, pg. 451.

¹³ Yi, Mun Y. and Davis, Fred D. Developing and Validating an Observational Learning Model of Computer Software Training and Skill Acquisition. *Information Systems Research*, Vol. 14, No. 2, June 2003, p146-169.

¹⁴ Ricci, Katrina E., Salas, Eduardo, and Cannon-Bowers, Janis A. Do Computer-Based Games Facilitate Knowledge Acquisition and Retention? (1996) *Military Psychology*, 8(4), 295-307.

¹⁵ Carroll, John M., Smith-Kerker, Penny L., Ford, James R. and Mazur-Rimetz, Sandra A. (1987) "The Minimal Manual", *Human-Computer Interaction*, 3:2, 123-153.

¹⁶ On a personal computer under Windows this function is accessed by holding down the Shift key and pressing the Print Scrn key. The image thus copied to the clipboard can be inserted into a slide by going into Powerpoint, creating a blank slide, and pressing ctrl/v to insert the image from memory. The image can be resized to fit the slide by grabbing a corner and moving it diagonally toward the center, then aligning a corner of the image to the corner of the slide and sizing it to completely fill the slide. In the case of web-based software accessed via a browser, the “crop” function of Powerpoint 2007 can be used to trim out the top part of the screen and the status line at the bottom to reduce visual clutter and provide room for a concise instructional message area at the top of the slide. (Alternatively, the screen image can be pasted into a photo editor and the cropping action done with the editor, and the image output as a .jpg file to be inserted into a slide. This method has the advantage of actually reducing the size of the graphic image, while the internal Powerpoint 2007 crop function leaves the image at its original storage space requirement.)

¹⁷ Carroll, John M., Smith-Kerker, Penny L., Ford, James R. and Mazur-Rimetz, Sandra A. (1987) “The Minimal Manual”, *Human-Computer Interaction*,3:2, 123-153.