The Impact of Design Interaction on Learner Success in Online Learning

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Abstract

How users interact with software and course design plays a critical role in influencing learner success in e-learning. Design focus has primarily been upon student success in online environments without first considering the role of instructor success when interacting with software to design online coursework, and the resulting impact of instructor success on student success. These two facets of design interaction and learner success in e-learning environments are examined here: first with the instructor as learner of course software, then the student as learner of the resulting course. Criteria for evaluating learner-design interaction are presented, as well as a proposal for creating technology change by influencing design.

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I. INTRODUCTION

At some time in our lives, we have encountered frustration in learning and using new objects. The typical reaction is to blame ourselves and our inability for instant comprehension, and we feel intimidated or even stupid, put to shame by inanimate objects; rarely do we question the inadequacy of the object's design, opting rather to blame human shortcomings and error. When using computers, our frustration can accelerate dramatically, resulting in high cognitive friction – "the resistance encountered by a human intellect when it engages with a complex system of rules that change as the problem changes" (Cooper & Reimann, 2003, p. 19).

In online environments where learner and instructor are isolated from each other, this situation can be further exacerbated, and the resulting increase in transactional distance plays a critical role in learner success in the online classroom. Moore & Kearsley (1996) define transactional distance as "a distance of understanding and perceptions caused by the geographic distance, that have to be overcome by teachers, learners, and educational organizations if effective, deliberate, planned learning is to occur" (p. 200). Difficulties in using an online learning system can interfere with the learning process "causing frustration both for the students and the instructor" (Dabbagh, 2000, p. 40). If the online instructor also has difficulties using the system – for example in designing coursework – the resulting course design may also inhibit student learning.

Efforts to resolve the technology dilemma have focused primarily on circumventing or adapting to technology, for example, through extensive training programs, technology orientation sessions, and technology credit courses (Hillman, Willis, & Gunawardena, 1994). Thus the student and instructor spend a considerable amount of time learning a new system: four to six hours to feel comfortable with a new learning system, and eight to twelve hours to achieve some mastery in the system (Harasim, Hiltz, Teles, & Turoff, 1998). From the learner perspective, this time would be better utilized learning in the online course, as these activities do not relate to course content (Hillman et al, 1994).

Rather than engaging in discourse with online educators to determine their design needs, the software industry is forcing higher education to incorporate these "technology crutches." Not only that, software companies have convinced higher education that in order to succeed in online learning, it must implement these technology crutches – and that it is a normal and acceptable solution. Software designers have convinced course designers that it is the course designer's job to empower and teach learners in using the software designer's technology, which demonstrates that Tom Sawyer's approach to white-washing fences also works in higher education. Why has higher education bought into the "dancing bear software" phenomenon, even though their instructors and their students don't like the time and effort involved in learning and working with (and around) the software (Cooper, 2004)? And why is online education letting the technology industry determine how it will teach?

In the early 90's, efforts to impose learner-centeredness onto technology were spearheaded by design and technology professionals such as Donald Norman (1988), Alan Cooper (1996), Jakob Nielsen (2004), and Jeffrey Rubin (1994). Financial losses stemming from substantial training costs and increased time to performance (e.g. in learning new systems) gave corporations the incentive to support this movement and to begin demanding easy-to-use systems. It is a battle that continues to be fought. Computer software kingdoms, with programmers holding the keys to the technology gates, are the last bastions of knowledge as power in an information age characterized by freedom of information and learner-centeredness. Rather than dutifully accepting technology shortcomings, higher education must also rise with others within the technology fiefdom and assert its right to a design that works the way education expects and wants it to.

Project Contents

This project discusses the definition of design and the designers, and then examines the significance and influence of design interaction on learner success in online education environments. Design focus has primarily been on learner success in online environments without also considering the integral role of instructor success. Not only must instructors ensure that students learn in their online classrooms, but they themselves must first achieve success when interacting with the course software to design that online coursework; learner success then, also depends on the instructor's success in creating the course. This project examines the significance of design interaction and learner success in online education environments, first with the instructor as learner and designer, then with the student as learner.

This project will now proceed to review literature and research done on design interaction (often referred to as interface interaction) and its impact on learners and their success in

online education. Based on that research, I will define personas for the online education instructor and learner, and then identify criteria for evaluating software design for the effectiveness of its design interaction. Finally, I will provide recommendations for achieving successful learner-design interaction, imploring higher education to become more actively involved in defining the design of their online education environments.

II. WHAT IS DESIGN?

Papanek (as cited in Cooper & Reimann, 2003) defines design as the "conscious and intuitive effort to impose meaningful order" (p. 5). Cooper further expands on this definition by asserting the importance of understanding 1) user desires, needs, motivations, and contexts, and 2) business, technical, and domain requirements and constraints. The resulting design is a translation of this information "into plans for artifacts (or artifacts themselves) whose form, content, and behavior is useful, usable, and desirable, as well as economically viable and technically feasible" (p. 5).

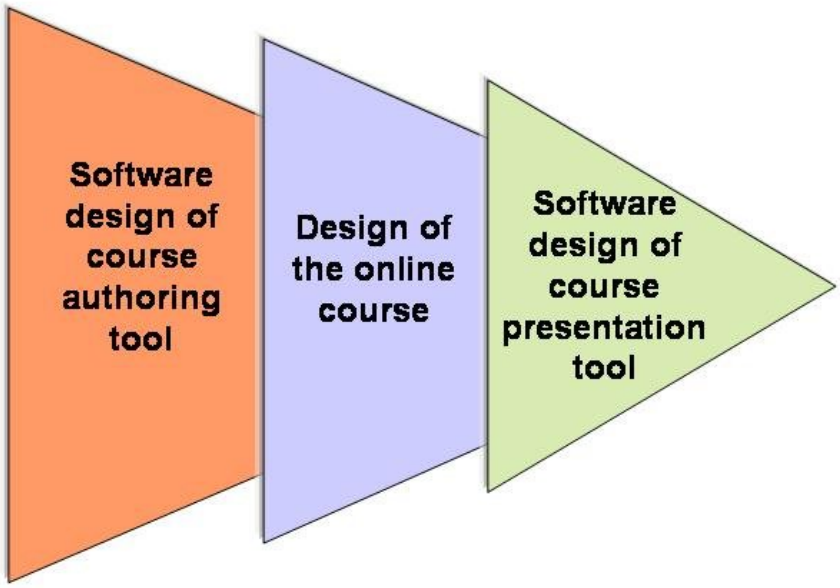
According to Norman (1988), design is the art of creating "a conceptual model that is appropriate for the user, that captures the important parts of the operation of the device, and that is understandable by the user" (p. 189). In Norman's ideal design scenario, the user model and design model are the same. Cooper & Reimann (2003) describe three distinct design models: the implementation model (reflecting technology), mental model (reflecting user's vision), and the represented model (the end result). To achieve the most effective level of design, designers must create a represented model that matches the mental model. Unfortunately, most software designs reflect implementation models. Norman's and Cooper's user-modeled approaches to design are similar to the user-centered design approach, defined by Rubin (1994) as "the techniques, processes, methods, and procedures for designing usable products and systems, but just as important, the philosophy that places the user at the center of the process" (p. 10). Cooper's assessment is simply that good design makes users more effective in achieving their goals.

Within systems design, Banathy (1992) describes a design vision of education systems, where design is as an ongoing process in pursuit of the ideal: "a decision oriented disciplined inquiry, aimed at defining what should be and producing a description of the model of the system that has the organizational capacity and collective human capability to bring about what was defined as the 'should'" (p. 33). Banathy's approach also draws upon the user's model, as it calls for the creation of user-design teams responsible for envisioning and realizing the design of systems.

Design within online education consists of three different perspectives (Figure 1):

- Software design of the course authoring tool
- Design of the online course (using the course authoring tool)
- Software design of the course presentation tool

Figure 1: Perspectives of Design in Online Education



A domino effect of design occurs in this process: the software design of the course authoring tool influences course design, which then affects how the course is presented to the learner. Combined with the course design, the software design of the presentation tool can have a powerful impact (both negative and positive) on learner success. All facets of these design perspectives must be taken into consideration when evaluating the success of design.

What Is Design Interaction?

Moore (1989) identifies three forms of interaction that occur in the distance education classroom: learner-content interaction, learner-instructor interaction, and learner-learner interaction. Hillman et al. (1994) expanded upon Moore's three types of interaction with a new type: learner-interface interaction. The authors argue that instructional designers must address learner-interface interaction, particularly when technology plays an influential role in the learning process, as the learner must also interact with the technology and its interface in order to learn. The authors present three means for improving learner-interface interaction: instructional activities, orientation sessions, and courses for using the technology – thereby catering to technology's shortcomings. Swan (2004) elaborates on the interface-interaction definition further by describing the interaction as one that permeates all of Moore's interaction types; she defines interface as the "specific technologies, platforms, applications, and course templates students must use to interact with course content, instructors and classmates" (p. 144).

Interface-interaction is also included in the Bates' (1995) ACTIONS model for reviewing and evaluating technology. He stresses the importance of interface in determining how learners and teachers interact with a technology, emphasizing the needs for 1) active learning,

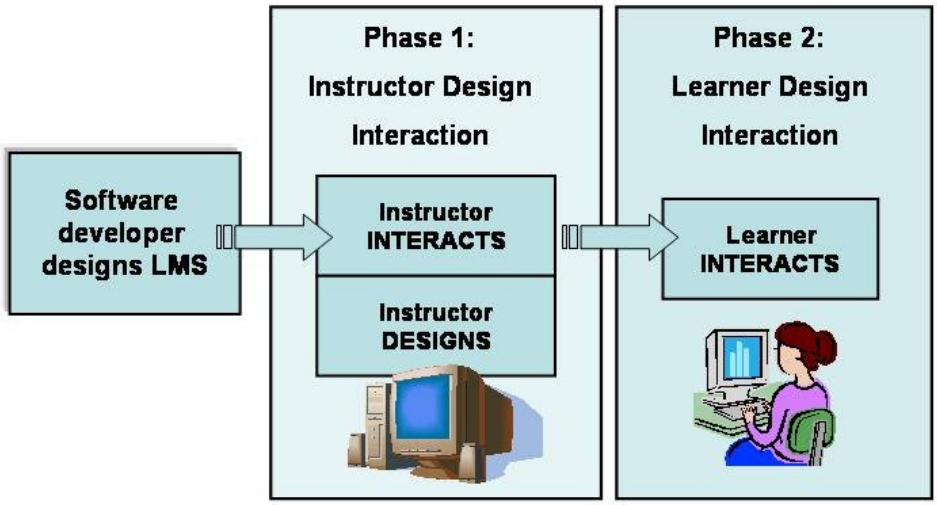
2) an easy-to-use or "transparent" technology, and 3) teacher and student control over teaching and learning activities (p. 51). Northrup (2002) presents still another perspective of interaction in the online classroom, identifying five interaction attributes: interaction with content, collaboration, conversation, intrapersonal interaction, and performance support. Van de Veer (1995) analyzes interface interaction along the dimensions of interaction style, user communication style, and system representation.

Using terminology such as interface interaction, however, does not fully address the design interaction aspect of software. Cooper (2004) makes a stark differentiation between interface interaction and *design interaction*, stating that by isolating design to the interface, we allow programmers to "slap on" an interface at the end of programming when it is too late to make design changes. He compares the occurrence to "putting an Armani suit on Attila the Hun" – he looks good, but he's still a pretty terrible guy (p. 23). To resolve this inconsistency, Cooper recommends defining design interaction *before* software developers begin programming.

Most design discussion about online education software centers on interface design, a term often used interchangeably with interaction design (as defined by Cooper & Reimann, 2003). Van de Veer (1995) defines interface design as the "design of the whole user virtual machine, including both the functionality, the interaction, and the metacommunication [helping users use the system]" (p. 148). This project takes a holistic approach, enfolding interface design into the interaction design definition.

Design interaction within online education occurs in two distinct phases: 1) instructor design interaction, as the instructor interacts with the design of the course authoring software, and 2) learner design interaction, as the learner interacts with the course design, as well as the software for presenting the courses (Figure 2). It is this combination of design interaction which ultimately determines how software design will affect learning.

Figure 2: Phases of Design Interaction in Online Education



Who Are the Designers?

There are usually two prominent designers within online education: the software programmer and the instructor. The software programmer designs the course authoring and presentation software, and the instructor designs the online course. The reality of software design is that software developers design technology, instructors then use their technology to design their courses, and learners must wallow through the end results. Designers are usually not typical users, and little effort is made to interact and study users who will use the end design (Norman, 1988); "designers often become expert with the device they are designing. Users are often expert at the *task* they are trying to perform with the device" (p. 156).

Programmers, the primary designers of software, tend not to have the necessary understanding of the needs of those for whom they are designing; their primary focus is to demonstrate technology's power and features (Norman, 1993). Cooper (2004) attributes this to the programmer's need to be in control, and he argues that *technologists* (programmers) dehumanize users – it is not the technology that dehumanizes users. While users are compelled by goals, programmers are compelled by features. "Enlightened" software designers may express concern about user-centered design, but often have a distorted view of the user. Some programmers may be programming for the wrong user, or, even worse, programming for every user, thereby drastically increasing functionality (Cooper, 2004).

Not enough is being done to cross the chasm between designer realities and user realities, and "little effort has gone toward devising the languages of interaction" (Norman, 1988, p. 180). My experience within the MDE program has been that instructors did not feel responsible for influencing, much less driving software design. Instead, instructors took a

more passive stance, with one instructor stating that software design was the software programmer's responsibility and *not* the instructor's – the instructor should only be responsible for designing courses. This approach however, is disempowering for the instructor. The instructor knows what she needs to teach a class; but yet, the software programmer decides how to design the software, usually with little or no idea of what the instructor really needs.

The dominant trend within distance education is the utilization of teams of specialists to design distance education courses, primarily due to the wide range of skills needed to design a course (Moore & Kearsley, 1996). The ideal design situation for higher education is that presented by Banathy (1991): design as a shared, collective responsibility not belonging solely to technology experts. On his design team, Banathy includes policy-makers, public and private leaders, community members, educational professionals, and students. He uses the term "user designers" to describe design team members – the people who serve, use, and are affected by systems. Banathy's proposal incorporates the "everyman" into a realm customarily ruled by technology lords, empowering design by empowering participation (Banathy, 1992, p. 34).

III. IMPACT OF TECHNOLOGY DESIGN ON LEARNER SUCCESS

"Now turn to the computer, an area where all the major difficulties of design can be found in profusion." (Donald Norman, 1988, p. 177)

Within distance education, discussion about the relationship between media and learning has often been charged and contentious. Opinions about the role of technology in education range from the extreme optimist who embraces technology with a passion, to those who believe media will never influence learning (Clark, 1994). Norton (1992) takes a more pragmatic approach, arguing that technology structure has the potential to shape learner activities. Jonassen, Campbell, & Davidson (1994) acknowledge the role of media in learning, presenting the media role as one of facilitation rather than simply as a conveyor of learning. Still others such as Kozma (1994) believe that a relationship between media and learning does not exist because educators have chosen not to establish one. This project is not about this technology debate. Instead, it supports the theory that technology *does* influence the learning experience and explores how intelligent design of technology can positively influence learner experience and ultimately learner success.

Consider the following fictional scenario:

At International Online University (IOU), administrators implemented a learning management system (LMS) for developing and delivering courses. To prepare instructors for using the LMS, IOU provided training and tutorials, as well as a help desk to answer questions. Professor Smith was tasked with creating an online English literature course, in addition to his face-to-face courses. Professor Smith was familiar with computers and e-mail, but had never created an online course using an LMS. He participated in the training and began designing his course a few days after attending the training.

Professor Smith immediately encountered problems. Now alone in his office, Professor Smith began to feel intimidated and inadequate as he interacted with the software; he encountered error messages that didn't make sense and had difficulties in getting the software to work as he wanted. It had seemed so simple to use in the classroom environment! Not only that, the software just didn't do what he needed it to do. Unsure of himself, Professor Smith was embarrassed to call a help desk staffed by undergraduate students, some of whom were in his classes. Faced with a pressing deadline, he persisted in learning enough of the software to upload the course syllabus and a list of textbook requirements. Relieved at being able to realize at least the minimal requirements for his online course, Professor Smith then settled into teaching online…where he encountered more design interaction problems. He found the process for posting comments to be cumbersome and soon became overwhelmed in replying to student posts. Not comfortable with using the complicated posting procedure and not having the time to master the functionality, Professor Smith has decided to directly e-mail students with comments and answers to questions.

Jill Wagner, a 32-year old working mother of two children, is taking her first online class. Jill has a laptop for her studies, but does not consider herself a technology guru. Jill has logged onto the IOU online course system to access her English literature class. The logon process is time-consuming, and when she finally reaches the class, she must execute a lengthy procedure to print the course syllabus. The process for posting comments is also complicated, and Jill finds it difficult to find specific posts. She e-mails Professor Smith with questions about posting her comments, and he advises her to contact the help desk. Unfortunately, the help desk is only staffed during business hours, and Jill's primary study time is after 9:00 p.m. (after her children are asleep). So Jill e-mails the help desk with her questions. After a few days with no response, Jill becomes frustrated with the response time of the help desk, and she still hasn't figured out how to find a post to which she planned to respond. She feels as if she has spent more time trying to use the online course technology than learning about English literature. After a week of muddling through the course software, Jill decides to drop the class.

Although this is not an actual scenario, it is one that could easily transpire when learners and their instructors are confronted with poor technology design in distance learning. In this case, technology is driving not only the learning process, but also the course design process. In addition, the technology design is intimidating and embarrassing for both learners and instructors. Professor Smith is intimidated by the LMS he uses to design his course, and as a result, only uses LMS functionality to a minimum – enough to get his job done, then abandoning the rest of the functionality (Cooper & Reimann, 2003). Jill Wagner becomes frustrated with the software design (e.g., printing out the course syllabus and posting comments) and can't get the support she needs to get her work done; ultimately, she decides that the course technology isn't worth the frustration and drops the class. Within IOU's distance education program, dropout rates are high. Rather than faulting the software design, however, management concludes that the IOU student body isn't ready for online education, prompting IOU to cancel the program, much to the relief of Professor Smith and other faculty members.

Domain knowledge – knowledge of principles for which a person has been educated or trained – should be enough for users to succeed when using software, and they should not have to become computer literate in order to do their jobs (Cooper, 2004). The same principle can be applied in higher education: instructors who design and deliver online courses should not need to attend extensive training to teach online; if the instructor knows his course topic and how to design his course, then he shouldn't have to be computer literate to successfully do his job. Cooper (1996, p. 481). writes: "…learning to use software should be as easy as learning the way around a new office. A little benign exploration, a couple of interesting side trips, a fortuitous meeting in the hallway; this is how we get oriented in real life. We should expect nothing less from our software." Norman (1988) describes the best software design as that "in which the computer itself 'disappears,' in which you work directly on the problem without having to be aware of the computer" (p. 180).

Unfortunately, the ideal is not the reality in environments that use technology. Learners, both instructors and students, become inhibited and less actively involved when they cannot successfully interact with technology (Hillman et al., 1994). In addition, learners will avoid using the technology (Cooper, 2004). While working on online collaborative projects within the Master of Distance Education (MDE), I found that students often chose not to use the collaborative software provided by WebTycho, the University of Maryland University College's proprietary software for delivering distance education courses. This recurring phenomenon resulted in numerous workarounds using technology *outside* of WebTycho: Microsoft Word (for tracking changes and inserting changes) and e-mail (for distributing updates). In another example within the MDE program, I worked on an online project with a major corporation; this organization asked us to use their online education system to prepare a proposal for an upcoming conference. All of the participants had extreme difficulties using the system, which hindered us tremendously from accomplishing work online; our frustration accelerated to the point that all communication was done using e-mail, completely avoiding use of the company's education software.

If software technology is easy-to-use, understandable, and helps learners achieve their purposes, then learners will not reject it, but instead they will embrace the technology. One example of technology that has dramatically changed student lifestyles has been the word processor. When I completed my undergraduate work, all term papers were completed on a manual typewriter; I spent numerous hours writing and rewriting papers by hand, then typing and retyping them. Last minute revisions, such as an additional footnote, were unheard of. Now I can easily and quickly make changes to my term papers. Word processing is an example of technology and design that has helped learners become more efficient in their work as students.

A prevailing discussion within distance education has centered upon the challenges of implementing technology for creating and delivering online courses. Bates (2000) discusses the issue of instructor resistance to the change that often comes with implementing new technology. Viewing this issue from a *design* perspective, instructor resistance could be a learned resistance to technology resulting from years of working with poorly designed technology (e.g., programming a video cassette recorder). If the design of the technology would actually *help* instructors achieve their goals and purposes without hindering them from doing their jobs, resistance could be greatly reduced.

According to Norman (1988), computers break all the design rules: they make things invisible, are arbitrary, are inconsistent, make operations unintelligible and dangerous, and are impolite. Anyone who has worked with computer software will probably agree with

Norman's assessment at some level. The repercussions of poor technology design are numerous: feelings of isolation, panic, frustration, and anger; high learner drop out rates; rejection of distance education as a legitimate form of learning; and learners interpreting technology unfriendliness as unfriendliness of the teaching institution (Dinevski, 2004; Hara & Kling, 1999). Palloff & Pratt (1999) report physiological problems that can occur when the learner is confronted with poor hardware and software design: eyestrain, back problems, headaches, and stress. General feelings of frustration and unhappiness with the online learning experience are a secondary side effect.

Fear is the most common reaction to new technology, regardless of the learner's proficiency level (Hillman et al., 1994). For faculty, the result of this fear is often resistance to change and anger at the planned changes; explicit faculty concerns include losing tenure, being replaced by a machine, not being able to use technology effectively, increased teaching load (and less time for research), and elimination of the classroom as the fundamental center of teaching (Bates, 2000; Bates, 1995; Jaffee, 1998). For students, fears include not being able to post messages in the online classroom and concern about how their messages will be interpreted by classmates (Palloff & Pratt, 1999; Harasim et al., 1998). A side effect of high anxiety levels is a reduced capacity for working memory (Hara & Kling, 1999).

Frustration and embarrassment is another common reaction to computer technology, feelings that users are often forced to submerge when the software makes them feel stupid (Cooper, 2004, p. 34). If learners become frustrated early in the learning experience, they can become demotivated and less involved in the online classroom (Palloff & Pratt, 1999; Hara & Kling, 1999). If too intimidated by computer technology, students may drop out of a course, particularly if there is no on-site support (Roberts et al., 1998). Unfortunately, little research has been done on learner frustrations with technology; Hara & Kling (1999) attribute this to 1) researchers being biased toward technology, 2) little qualitative data, 3) no opportunity for students to provide feedback about their frustrations, and 4) studies only being done on experienced distance education instructors. Learners feel guilty that they cannot use software, rather than (rightfully) placing the blame on the software designers (Norman, 1988). Poorly designed software can also result in people disliking their jobs (Cooper, 2004); for learners, this could translate to a dislike of learning.

Software design is often inconsistent. Since learners yearn to be in control of their learning, this inconsistency can lead to disorientation and disempowerment of learners (Nielsen, 2004). A learner must be able to form a conceptual understanding of the system's information structures, relying on her mental models, in order to trust the system enough to interact with it effectively (Van der Veer, 1995). Interaction with the computer design must meet learner expectations; if their expectations are not met, learners may feel oppressed and may resent the technology and ultimately the online course (Nielsen, 2004).

Within distance education environments, technology design can also influence transactional distance. When there is increased structure and decreased teacher-learner dialog in distance education course, there is increased transactional distance. When there is decreased structure and increased teacher-learner dialog, transactional distance decreases (Moore & Kearsley, 1996). To be successful in reducing transactional distance then, design must support decreased structure and increased dialog. This can be achieved by providing a flexible, constructivist learning environment and appropriate tools that are easy-to-use and *promote* dialog, thereby reducing transactional distance. By incorporating Cooper & Reimann's (2003) concept of cognitive friction, one could deduce that design impacts transactional distance at all levels:

⇑ poor design = ⇑ cognitive friction = ⇑ transactional distance

⇑ good design = ⇓ cognitive friction = ⇓ transactional distance

In the best of all worlds, software should operate in the background, so transparent that learners do not even realize it is there; it should be so easy to use that learners can adapt to it quickly and can then focus on course content (Palloff & Pratt, 1999). However, learners often have difficulties in interacting with the software, for example in accessing and working with the network, setting up the modem, importing text, and uploading messages; learners can also encounter navigation problems, giving them a sense of information overload and being lost in cyberspace (Harasim et al., 1998). Users of computers make mistakes with the software. Much like children working with computers, adults will also click on icons until the screen freezes (Plowman & Stephen, 2003). Moore & Kearsley (1996) find that distance learners are anxious at the beginning of the course about being able to meet expectations, which can impair learning.

Screen display is another aspect of design interaction that influences learner success, and is often “the most neglected aspect of the instructional design process” (Morrison, Ross, O’Dell, Schultz, and Higginbotham-Wheat, 1989, p. 167). Screen display has been shown to impact learners in the following ways (Table 1).

Table 1: Impact of Screen Display on Learners

Design aspect	Impact on learners
Text density	Low text density can reduce reading times, while high density text can increase performance error rates (Morrison et al, 1989).
Message spacing	Extra space between lines can contribute to legibility, and using brief, self-contained messages per line speeds information processing (Aspillaga, 1991a).
Margins	Ragged margins allow learners to benefit from "premonitions of meaning," while standard, justified margins interrupt normal eye movements, making reading more work for the reader (Aspillaga, 1991a, p. 56).
Location of text for graphics	When text for graphics appears in a consistent location, the transfer of information is better facilitated, and learning is enhanced (Aspillaga, 1991a; Aspillaga, 1991b).
Links	Fewer links can improve learning task performance and create a more positive attitude toward the system, while numerous links disrupt the reading process and decrease ability of learners to process information (Zhu, 1999).
Hypermedia structure	A clear hypermedia structure helps in knowledge acquisition and retention; an unclear hypermedia structure increases disorientation (Zhu, 1999).
Integrated object displays	Resists the degrading effects of time, stress, and temporal separation (Effken & Doyle, 2001).

Content presentation in courses is also critical to learner success in online environments. Course structures should be consistent, transparent, and simple, so that learners can easily adapt to the online course environment (Swan, 2004). According to Kozma (1994), "media and their attributes have important influences on the cost or speed of learning but only the use of adequate instructional methods will influence learning" (p. 27). He goes on further to state that well-designed media allow us to take advantage of a medium's capabilities and to influence learning.

How technology is used in the classroom also influences learner satisfaction. A recent study by the Educause Center for Applied Research found that students believed that online quizzes and other interactive quizzes helped them learn (Young, August 2004, para. 9). One student quoted in the study stated that faculty often use technology poorly and are often embarrassed because their students know more about the technology than they do. Only 12.7 percent of students found that improved learning was the greatest benefit of technology, with 3.7 percent stating that technology brought no benefits to the classroom.

Implications for Design Interaction

There are substantial drawbacks for organizations that choose to accept poor design interaction in their course software. For example:

- Burgeoning technical support costs to resolve learner problems and to answer their questions
- Ongoing development and maintenance cost of learner training (both students and instructors)
- Frustrated faculty who reject the technology altogether, or worse, utilize it half-heartedly – ultimately further frustrating students
- Frustrated learners, leading to higher dropout rates and a disregard for online distance education as a feasible form of study

When students interact with course content and course software or when instructors interact with online courses, they are usually confronted with some of the influencing factors described here: fear, anxiety, isolation, or loss of control. In order to empower instructors and students in the learning (and designing) process, we must address the learner needs and return control to the instructor and to the student (Norman, 1993).

Kozma (1994) calls on instructors to reevaluate ideas of design and "to view the design process as a dynamic creative interaction…between the designer, the situation, and the medium…The emergent design will be influenced by the goals, beliefs, and knowledge of the users, as well as the interaction of the designer, as embedded in the design object" (p. 17). Jonassen et al. (1994) recommend first examining the learning process, then the context in which the learning occurs and the cognitive tools needed to support learning: "only then should we consider the affordances of media for creating those environments or providing those tools" (p. 38). Naidu's (2003) approach to designing instruction for e-learning environments is to first identify models and approaches to learning and then design accordingly, i.e., one designs based on the learner goal, and then designs the interface to support the learner in his/her learning goals. Learner models/approaches include: distributed problem-based learning, critical incident-based computer supported collaborative learning, goal-based learning, learning by designing, and web-based role-play simulation.

Dinevski (2004) believes personalization of technology will be a key motivating factor for learners, creating more intimacy with the computer, for example, via a portal offering all the functionality that the learner needs to complete the tasks to accomplish his/her goals. Such an integrated interface of tools would be a tremendous support to the success of online learning networks (Harasim et al., 1998). Jaffee (1998) predicts that the key to overcoming faculty resistance to technology is to acknowledge the gap between technology innovators and the mainstream, create an alliance between the two, deflate the claims of technology as the answer to all pedagogical challenges, and give faculty a reason to buy into a new technology.

Each of these proposals addresses at least some aspect of the design process: meeting learner needs (e.g., through personalization and portals), forming interdisciplinary specialist design teams, defining learning processes and then the tools to support them, and building bridges of communication. New approaches to course design and the course design process are only part of the solution, however. To achieve long-term success, we must address software design at its roots by realizing a new approach to the design of educational software, one based on designing for learner (student and instructor) interactions.

Many scholars have researched and written about the effective use of technology in distance education courses, debating the question of which technology is best for which purpose (Bates, 1995, 2000; Moore & Kearsley, 1996; Haughey & Anderson, 1998; Roberts, Brindley, & Spronk, 1998). However, this approach continues to support technology in driving distance education rather than vice versa. Distance education would be better served

by *first* determining instructor and learner needs and purposes, then taking those needs and purposes to the technologists, who must *then* address the question of how technology can assist instructors and learners in fulfilling their purposes.

IV. DESIGN SPECIFICATIONS

This section discusses design principles, defines the process for defining design interaction, defines personas for the distance education instructor and student, and establishes criteria for evaluating design interaction.

Principles of Design

Norman (1988) identifies seven fundamental principles of user-centered design. Although not specific to online education, Norman's design principles can also be methodologically applied to online learning environments, in both software design and course design (pp. 188-189):

1) *Use world and head knowledge while designing interactions*: Distance learners usually have extensive experience and knowledge, which they bring with them into the classroom. To support design interaction, this experience and knowledge must be integrated into the design.
2) *Simplify task structures for instructors and students.* Tasks should have a simple structure, and the technology and its design should serve to simplify tasks even further.
3) *Make design visible to learners*: Norman (1988) recommends accomplishing this by making the system explorable and something to easily experiment with. For a system to be explorable, 1) the learner can see and do allowable actions, 2) the learner sees and understands the effect of an action, and 3) the learner does not suffer from an action, particularly financially.
4) *Utilize natural mappings*. To do this, the system state needs to be easy to interpret and perceive – and should match learner expectations.
5) *Exploit constraints*. Design so that the learner believes there is only one right way to use the system.
6) *Plan and design for error*. A good design plans for a wide range of possible errors, helps users avoid errors, and also supports users in easily recovering from errors.
7) *If that doesn't work, standardize*. Create a standard, use it consistently, and train learners in the standard.

The Design Interaction Process

The design interaction process determines how we can realize interaction design both in the software and the resulting course. Cooper (2004) recommends the approach shown in Table 2 (p. 84).

Table 2: Design Interaction Process

	Step	Description
1.	**Identify all key users and other stakeholders.**	Key users are those who will interact with the product, including "fringe" users. To design software for these users, you need to know them with precision. This is a major part of the design process, and studies should be done on how the product will be used – with the intended users (Norman, 1988).
2.	**Write profiles for each.**	In this step, personas are defined. Personas are fictitious, but are based on real users. The persona tool allows us to create a "cast of characters" and to select the primary persona for whom we will be designing. (See the following section, "Defining Personas".) Gather information for defining personas by observing users, conducting user interviews, and conducting research and prototype audits (Cooper & Reimann, 2003).
3.	**Develop statements of persona goals.**	In defining goals, we must understand what the learner wants to achieve (Norman, 1988). Goals help designers decide on the functionality of the product and include *life goals* (e.g., be the best at what I do, get the promotion, learn all there is to know in a field), *experience goals* (e.g., don't feel stupid or make mistakes, feel confident and competent, not be bored), and *end goals* (e.g., find the best price, finalize the press release, process the customer's order) (Cooper & Reimann, 2003). Not all goals must be achieved at once; however, it is essential that goals are not violated (Cooper, 2004).
4.	**Describe tasks to be done to accomplish the goals.**	The next step is to translate goals into design, which is done using scenarios: "a method of design problem solving by concretization" (Carroll, 2001, as cited in Cooper & Reimann, 2003, p. 75). These persona-based scenarios are the tools for incorporating tasks and describe the ways one or more personas use a product to realize their goals. Types of scenarios include *daily-use* (done everyday), *necessary* (not done everyday, but required), and *edge-case* (hardly ever done or done only by a select group of users) (Cooper, 2004).
5.	**Come up with proposed visual representations of key objects and interaction behaviors.**	During this step, requirements and framework definitions for the scenarios are completed. The *requirements definition* involves creating problem and vision statements, brainstorming, identifying persona expectations, constructing the context scenario, and identifying needs. The *interaction framework definition* includes defining form factor and input methods, views, and functional and data elements, determining functional groups and hierarchy, sketching the interaction framework, and constructing key path scenarios (Cooper & Reimann, 2003).
6.	**Build it.**	Refine and realize the design: draft the look and feel of the system, build scenarios to validate the design interaction, and finalize the design (Cooper & Reimann, 2003).

Criteria for Evaluating Design Interaction

"Don't make the user feel stupid" (Cooper & Reimann, 2003, p. 67)

This is the most important of all design guidelines and should be the guiding principle of all design activities. Another important guideline is that the user is able to figure out what to do and that he can tell what is going on with the system (Norman, 1988). Criteria for evaluating the successful design interaction of software include:

Table 3: Learner-Design Interaction Criteria and Education Software

Criteria	**Attributes**
Learner-controlled	Promotes self-pacing and exploration of the system Does not violate learner goals
Feedback processes	Provides feedback to learner on self-progress and self-monitoring Provides cues about learner choices in the system
Transparent	Does not intrude upon the learner's attention to learning Presents functionality and structure clearly
Flexible	Is easy to interact with Encourages exploration
Accessible	Shows ease of accessibility of information – in the order learners want
Interactive	Engages learner's attention and imagination Supports backtracking and is easy to navigate
Consistent	Is easy to navigate – and predictable Presents information consistently on the screen
Reliable	Performs as expected and intended by the learner

(Bates, 1995; Norman, 1988; Laszlo & Castro, 1995; Vrasidas, 2002; Nielsen, 2004; Cooper & Reimann, 2003)

In addition, design interaction should be ethical, purposeful, pragmatic, and elegant (Cooper & Reimann, 2003). Cooper and Reimann's design rules support the overriding adage that users want to be effective. Within learning environments, this translates to learners want to learn – and to be effective in pursuing learning goals. Detailed guidelines for designing design interaction elements such as menus and pushbuttons, error messages, dialog boxes, and tool boxes, can be found in Cooper & Reimann; guidelines for creating usable interfaces can be found at Nielsen's (2004) website and in Mehlenbacher (2002).

General principles for designing online content include: has logically structured lessons, clear objectives, and small units; incorporates planned participation and repetition; complete; includes a means for specific and prompt feedback and continuous evaluation; is interactive, with a nonlinear, easy-to-use graphic user interface; effectively uses multimedia; gives attention to educational and technical details; supports learner-controlled interaction; is easy to navigate; and uses concept maps and advance organizers to help learners conceptualize information structures (Moore & Kearsley, 1996; Driscoll, 1988; Palloff & Pratt, 1999;Vrasidas, 2002). Instruction must start with the learner, and be designed to meet learner

needs and to promote active engagement, communication, and interaction (Ansorge & Cooley, 2001; Palloff & Pratt, 1999).

Norman (1993) writes that the learning environment should be one conducive to optimal experience and should:

> "provide a high intensity of interaction and feedback; have specific goals and established procedures; motivate; provide a continual feeling of challenge, one that is neither so difficult as to create a sense of hopelessness and frustration nor so easy as to produce boredom; provide a sense of direct engagement, producing the feeling of directly experiencing the environment, directly working on the task; provide appropriate tools that fit the user and task so well that they aid and do not distract; avoid distractions and disruptions that intervene and destroy the subjective experience." (pp. 34-35)

Technology should be accessible and not be the driving factor in design interaction, but rather fade into the background as the learner and content moves to the forefront (Palloff & Pratt, 1999; Mehlenbacher, 2002). Cooper's design principle of knowing the user is also integral, and instructors should integrate different learning styles into the design of course material (McLoughlin, 1999). Instructors should not attempt to address the learning styles of *every* learner type, however, as this will have a similar effect of "creeping featurism" – this time in the courseware rather than the software. Instead, instructors should also utilize personas during the design process and integrate learning styles of the primary personas. (Norman (1988) defines creeping featurism as "the tendency to add to the number of the features that a device can do, often extending the number beyond all reason…each new set of features adds immeasurably to the size and complexity of the system" (p. 173).)

Learners need to be able to find the information they need. Within knowledge management circles, the general three-click rule is almost always recommended (i.e., the learner gives up looking for information after three mouse clicks) (van Rennes & Collis, 1998); however, recent research by Porter (2003) dismisses this rule, stating that it is not the *number* of clicks that is important, but instead whether user can find what they are looking for. Zhu's (1999) research, mentioned earlier, recommends using fewer links to improve learning task performance.

Designing for the web is not the same as designing with other media. Research by van Rennes & Collis (1998) shows that students prefer reading printouts rather than reading online; appreciate a consistent design, screen layout, and navigation; are sensitive to text formatting, preferring a restful contrast of colors; are not interested in logos and images; need to tell the difference between course pages and pages called up from links; prefer scrolling instead of internal links within a page; and want to know immediately what is new and where it is. Extensive guidelines for designing web-based content can be found in McCormack & Jones (1997), Vrasidas (2002), and Henke (2001).

A consistent design process, for example an instructional design process (ISD) such as ADDIE (analysis, design, development, implementation, and evaluation) should be implemented to guide the course development (Seels & Glasgow, 1998). Such a process makes the planning process objective, consistent, and orderly, improves the quality of planning, is replicable and can maximize economies of scale. Instructional plans should address learner background and knowledge, learner tasks, social dynamics, instructional objectives, and learning environment and tools (Mehlenbacher, 2002).

Defining Personas

One of the most critical tasks in specifying design interaction is to define the user persona. *Personas* are a design tool used to direct the design and development of software and web solutions; personas are fictitious, but are based on research and knowledge of actual users (Calabria, 2004). Organizations can use personas in variety of ways. For example, personas can be used to determine the best user interface for users, communicate corporate visions of product development, and assist in task development and scenario definition (Calabria, 2004).

The benefits of using personas are plentiful. Personas:

- Focus design on user goals and needs, designing for a realistic group of personas who represent what most users need
- Support other user-centered design activities, such as usability testing, and course and documentation design and development
- Keep development teams from implementing everything that users request, an occurrence Norman (1988) refers to as "creeping featurism"
- Help design teams prioritize, articulate, and evaluate design plans
- Assist in problem resolution (e.g., which features would this persona really need and want?)

(Cooper & Reimann, 2003)

Personas are not the same as other user-centered design tools. *User models*, which specify user classes and their corresponding problems, are an abstraction of personas (Calabria, 2004). *Market segmentation* defines markets, but not the actual product, and focus groups gauge the market's initial reaction to a product form; *usability* and *user testing* test the final product, which can only happen once the product has been designed (Cooper & Reimann, 2003).

In defining personas, the following guidelines are recommended:

- Make pretend users and design for them
- Define personas by the goals they want to achieve (goals not tasks)
- Refer to a specific persona/user (not a general one), as this reduces product "bells and whistles"
- Give your persona a title and a name to personalize him/her
- Focus on defining the persona in detail not on defining the perfect user
- Use stereotypes if it makes defining the persona easier
- Be sure the persona is the actual user – and not the buyer (e.g., college administrator)
- Initially, describe the persona in a list of bulleted points (not a narrative)
- Identify all necessary personas – a "cast of characters" – but specify only one primary persona

(Cooper, 2004; Calabria, 2004)

When defining design interaction for online environments, we need to design systems that will support learner success. Our first task is to design the personas for both phases of the design interaction (Figure 2), and to truly define effective teaching and learning systems in distance education, we must focus first on those for whom we are designing: the distance learner and the distance instructor.

The Distance Learner Persona

Extensive research has been conducted on the needs of the distance education learner. These needs include:

- System accessibility
- Ability to communicate interactively, to move information around, and to collaborate
- Independent decision-making, self-management, self-sufficiency, and self-pacing
- Learning that is meaningful, and content that is relevant, useful, and interesting
- Clear directions
- Feedback
- Way to draw attention to individual concerns
- Using learning and life experience to solve problems
- Means to monitor progress
- Recognition of responsibilities outside of the classroom
- Complementary balance between training and information

(Bates, 2000; Rosenberg, 2001; Moore & Kearsley, 1996; Driscoll, 1998; Thompson, 1998; Moore, 1998; Salmon & Giles, 1998)

Learners have both personal and work-related goals in pursuing distance education. Their goals tend to be more instrumental than developmental for example, work-related goals such as advanced professional qualification, learning about new professional perspectives, gaining specialized knowledge, keeping jobs, and immediate or future job/career advancement, and personal goals such as increased knowledge on a topic, learning to be more effective, self-improvement (Thompson, 1998).

Based on this research, a persona definition for a distance learner could look something like this:

Working Mother: Jill Wagner is 32 years old, married, and has two children, Jerritt (12), and Jane (10). She has been working as a data processor for the last eight years at New Waves, Inc., and she would love to get the manager job opening up soon in her department. Unfortunately, the position requires that Jill has a bachelor's degree. Jill has two years of college and has decided to return to school to get her degree. She likes to garden in her spare time, because it helps her focus her thoughts. Jill owns a laptop and knows how to use the basic functions and considers herself pretty good at trouble-shooting.

Despite this, she is still anxious about starting to learn online. Jill lives in the city suburbs and has ISDN. Her husband is a computer software programmer at Data Fun, Inc., and when she has system problems, she will ask him, but she prefers to try and figure out the problems for herself. She often feels overwhelmed by everything on her plate: working 9

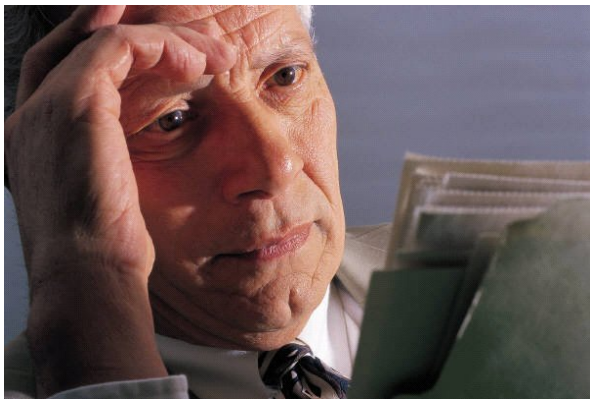
to 5, running the kids to soccer tournaments and piano lessons, helping them with their homework, and providing a warm and safe family environment. Jill is concerned that going back to school will be too much additional work and will cause too much unrest and stress for her family, which she wants to avoid. Jill is a member of the Parent-Teachers Association (PTA) and helps coach her daughter's soccer team on Saturday mornings.

Goals:

- Get the management job
- Balance her career, home life, and a new life as a student
- Find more time for her kids and husband

The Distance Education Instructor Persona

Little research has been done on the needs of the distance educator instructor within online environments. Cooper (2004) found that instructors need feedback on their performance in order to offset feelings of isolation. According to Jaffee (1998), one of the primary needs of faculty in online classrooms is to be able to maintain power and control within the classroom. This need of "sage-on-the-stage" instructors conflicts, however, with the guiding distance education constructivist principle of instructing students as "guides-on-the-side"; this conflict must be resolved in order for instructors to be comfortable in online teaching environments, for example, by designing software that gives the instructor a sense of control. Instructor needs include: ability to understand and use technology in courses, not be replaced by technology, keep or attain tenure, not be replaced by technology, a reasonable teaching load, and not be embarrassed or feel stupid. The following is a potential distanced education instructor persona:



Professor of English Literature: John Smith is 59 years old, married with three children, two grandchildren, and an Irish Setter named Fritz. John has been an English literature professor at IOU for the last 25 years. John loves to teach and to watch the lights in his students' eyes as they embrace literature for the first time. His greatest highs come from when he is an actor on the stage, reciting the great works of the masters before him. John obtained tenure ten years ago, and he feels a lot of pressure to keep up with the winds of change at the university, in particular with the recent shift to online education.

John does the crossword puzzle in the *New York Times* daily. He uses his computer to check on his stock portfolio, conduct research, and to send e-mail to his children, but he often feels overwhelmed by the numerous features available on his PC. He is sometimes embarrassed that he doesn't intuitively understand how the computer works and will often call his son, Chad, a network administrator, for help in fixing computer problems. In his spare time, John likes to try out Italian recipes on his wife and children, and to hike in the backwoods near their country home, 50 miles out of the city. Only dial-up Internet access is available in John's community. On Saturday mornings, John leads children's reading

hour at the local library. John drives a 1978 silver BMW, which he loves to tinker with, and he does the grocery shopping for the family. John's wife is a real estate broker.

Goals:

- Not lose tenure
- Not embarrass himself by his lack of technology savvy
- Work in a comfortable environment and provide a comfortable environment for his students to learn
- Maintain control of his classroom

The Digitalization Era and Persona Definition

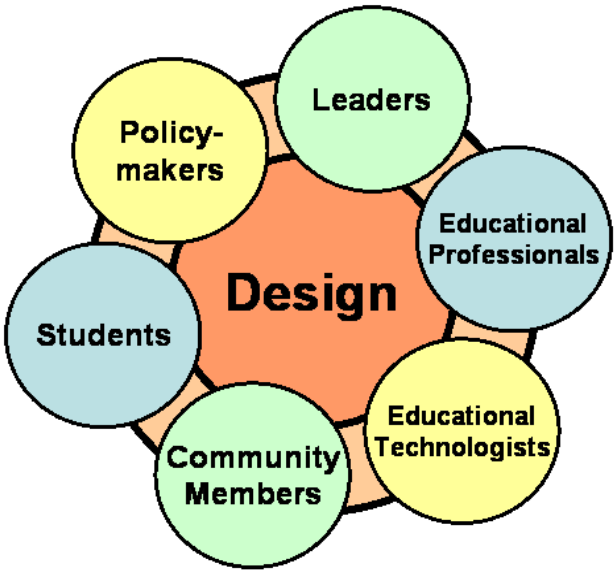
A growing phenomenon within education in general is the digital divide developing across the generations, or as Prensky (2004) describes it, the phenomena of digital natives and digital immigrants. Digital natives are those who have grown up with and are relaxed with technology, are under 30 years old, are eager for more information, embrace new technology, like to multi-task and parallel process, prefer random access to information, and thrive on instant and frequent gratification; as a result, these students think and process information differently than their instructors (Prensky, 2001). Digital immigrants on the other hand didn't grow up with technology, and are over 30, have a basic "fear" of technology (using it and/or being replaced by it), complain of information overload, and tend to be resistant to the change that technology brings.

This phenomenon creates a fissure within the online education landscape. Technology savvy students (digital natives) will be at the mercy of technology-fearful instructors (digital immigrants) for at least the next ten years until they can become instructors themselves. The situation will probably not resolve itself until around 2030, if digital immigrant instructors take early retirement with 60. The struggle then for designers will be accommodating this trend by designing course software (and the course itself) for two such distinct groups. As Prensky (2001) puts it, we will need to learn "new ways to do old stuff" (para. 23). The primary persona for the distance education learner will probably remain a digital immigrant for some time to come, but eventually, design focus will need to shift to the needs of the digital native.

V. RECOMMENDATIONS

To achieve a learner-centered design solution that benefits learners (both instructors and students), we need to start with the learner. Banathy (1992) emphasizes the importance of user participation (policy-makers, public and private leaders, community members, educational professionals, and students) and introduces the role of educational technologists, who serve as the systems design evangelists within education; in order to sustain design, user designer participation is compulsory (Figure 3). These user design teams can serve at the departmental and organizational level, but to sustain the longevity of the design interaction process and to create a greater impact on the software industry, a higher-level consortium of user designers would need to be established.

Figure 3: User Design Teams



These teams must work together with the software programmers who develop education software, as well as *interaction designers,* who develop the blueprint of the design vision for programmers to implement (Cooper, 2004). Macdonald (2003) emphasizes the importance of including user input while designing, but does not believe that users should be the visionaries for future products and their design, a viewpoint also supported by Cooper (2004). However, user design teams *must* be part of the design process.

The most important principle when designing learner-centered courses is that instructors know their learners before beginning the design (Gibson, 1998). We should expect no less of the software programmers who design software for learners (instructors and students). Designers must consider the product, those who will use it, and how they will use it – *before* programming begins (Norman, 1988; Cooper, 2004). Education professionals must insinuate themselves into the product and its design, most importantly by becoming involved in design interaction, but also by becoming involved in other aspects of the software design and development process. For example, learners (not administrators, unless they are the learners) need to be involved in user focus groups, usability testing, and product testing.

The systems design process is an ongoing, never-ending journey (Banathy, 1992). We must take up the journey now if we are to create a vision of educational technology and influence the long-term design interaction of technology products. Bates (1995) writes:

> "That vision should take into account the potential of technology, but the vision should be driven by the needs of individuals and society at large, rather than by technological development per se. What technology *can* do – or what technology suppliers may suggest we do – may not be what we *want* it to do." (p. 230)

We must take a pragmatic approach to computer systems design, one that takes into consideration learner actions and consequences and use of technology in the human context (Coyne, 1995). Weiser (as cited by Coyne, 1995) states: "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are

indistinguishable from it." (p. 31) To realize Weiser's example, we must begin incorporating human factors and usability into the design of education products (Berg, 2000). Part of that process has begun here with a rough definition of primary personas. Additional personas need to be identified, until a representative cast of characters has been defined. Next, the scenarios and tasks for these personas must be developed in detail. Only then should educational technology products be built.

The reality is that we will not be able to implement design interaction immediately. The status quo (technology workarounds) will need to be maintained; however, it should not be supported indefinitely. Workarounds where learners receive support and guidance are a reasonable stop-gap, but are by no means a long term solution to technology design problems (Hillman et al., 1994; Palloff & Pratt, 1999). Software industry's focus on rushing products to market, the lack of good feedback mechanisms, and the designer's need for distinctive, unique design, all contribute to a distorted vision of what learners truly need. Software organizations need to refocus their efforts again on the learner, and start to see the benefits of design interaction: a more desirable product, increased customer loyalty and commitment to product, shorter development times, significant reduction of iterations, and reduced cost of development process (Cooper, 2004).

The reality is also that educational organizations aren't thrilled with the current industry standard in educational technology, a situation that currently feeds the growth of open source software development such as the SAKAI project, "a cooperative venture by several major universities to build free course-management software" (Young, July 2004, p. A27; Wheeler, 2004). Although open source systems allow for extensive customization and give design control back to instructors, other problematic issues are evident such as poor interface design, limited support, and a lack of direction (Robertson, 2004; Levesque, 2004).

Until now, educational software products have been telling learners to do what the technologists say (Banathy, 1991). By supporting design interaction, we create designs that meet the needs of learners, make them feel comfortable in their learning (or designing) environments, promote interaction and collaboration, make technology transparent, and puts learning in the foreground. By becoming involved in and *directing* design interaction, we can start influencing the future of educational technology.

VI. SUMMARY

Research on technology urges administrators to *manage* technology (Palloff & Pratt, 1999; Bates, 2000). For long-term, productive results to be achieved, however, we must refocus that viewpoint from one of managing to one of *driving* technology and technological change. How do we accomplish this?

First, we need to stop accepting poor design as the status quo. We must write to the product manufacturers, boycott poorly designed products, buy products with good designs, tell our vendors we aren't happy, and provide feedback on product design (Norman, 1988). As Norman so explicitly states:

> "Give mental prizes to those who practice good design: send flowers. Jeer those who don't: send weeds." (p. 217)

Next, we need to work together, through user design teams, to envision learning solutions that will sustain us through the information age. We must attempt to visualize the future so

that we can influence it (Tiffin & Rajasingham, 1995). We must learn to think abundantly about all that could be possible, rather than what is not possible (Cooper & Reimann, 2003). We need to focus on the learner and create learner-centered solutions: performance-centered web-based systems, electronic performance support, and embedded help (Raybould, 2002; Gery, 2002; Mobley, Knight, & Meserth, 2003). We need more research on student-centered and instructor-centered interaction with design if we are to build systems that espouse the principles of design interaction (Hara & Kling, 1999).

Finally, we must support programmers in their battles within their corporations to meet over-zealous deadlines and to implement a frenzy of mostly unnecessary functionality. We must help change the corporate viewpoint that software problems are simply technical problems and shift attention from feature-laden design and attrition-targeted development to one that meets user and customer needs (Cooper, 2004; Norman, 1988).

If design does not focus upon those whom it is serving, then it is destined to fail. If educational professionals do not become involved in influencing educational software design, they are destined to be forever managing technology rather than driving it.

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