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ABSTRACT
                This five-part report synthesizes current theory and
research on the adult as learner and generates implications for design and
delivery of learning systems, particularly those involving computer-mediated
technology and related software. "Adult Learning in Context" (Sean Courtney,
Jiali Luo) examines the current situation of the adult learner, with special
attention on increased computer use by the adult learning population.
"Characteristics of Adults as Learners" (Courtney, Luo) focuses on these six
major dimensions that constitute learning: knowledge construction and
conceptual change; prior knowledge and experience; motivation, self, and
community; metacognition; authentic tasks and environments; and collaboration
and self direction. "How Technology Impacts the Learning Process" (Courtney,
Luo) focuses on computer-mediated communications systems. "Summary and
Conclusions" (Courtney, Luo) presents two sets of implications for
technology-based learning system design: those based on characteristics of
the learning process and those based on user experiences. "Web Access for
Adult Learners with Special Needs" (Stanley Vasa, Virginia Muggy) shares
knowledge of adult learners with special needs and characteristics associated
with disability categories and related Web design considerations. (Appendixes
include 175 references; papers on the learner-centered principle and user
interface design for older adults; and descriptions of 10 web sites used in
synthesis of recommended Web design guidelines.) (YLB)

Characteristics of Adults as Learners And Implications for Computer-Based Systems for Information and Instruction

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PART 1 Adult Learning in Context
Sean Courtney, Ed.D., and Jiali Luo

Overview

Lifelong learning has become a major, even permanent, reality for most Americans. This among others was a central finding of a study conducted by Washington State University, and reported in 1995 (Dillman, Christenson, Salant, & Warner, 1995). Perhaps the greatest reason for all of this educational activity, apart from the growing credentialing of American society, has to do with the transformation of the economy from a manufacturing base to one where knowledge is the driving force for success and profit. At the same time, according to the survey, what the potential adult learners want from public education are courses that are more accessible and packaged in ways that make it easier for them to learn. The public also believes that technology has advanced to where more and more learning can and should be offered at a distance. As the study reports, "people who are most likely to seek additional education have relatively greater access to home and work computers" (Dillman et. al., 1995, p.3).

In the light of this and other studies which report the changing needs and requirements of adults as learners, this report examines the phenomenon of adult learning, the characteristics of adults as learners, and the factors, including technology, which facilitate or inhibit the learning process.

Changing Times and Societal Demands

Unlike many other industrial countries, mass participation in adult education has long been a phenomenon of considerable significance in this country. What is different about the phenomenon today is the apparently sudden acceleration in numbers. While the rate of increase from the late 1960s to the early '80s had been somewhat modest, rising from around 10% in 1969 to 15% in 1984, the latest federal surveys suggest a dramatic change in the rate of involvement. Thus, in 1991, the National Household Education Survey (NHES, 1991) pegged the rate at 33%, double what it had been seven years earlier, while in 1995, the same survey reported the rate of participation at 44%, or about 84 million adult men and women.[1] Even allowing for the

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[1] Based on NHES definition of what constitutes participation in adult education; this includes "classes taken for a degree or certificate as well as those educational activities that are job-related and those taken for personal enjoyment or recreation." (NHES, October 1991, Technical Brief)

Introduction

The purpose of this report is to provide a synthesis of the most up-to-date theory and research on the adult as learner and from this base to generate a set of coherent and workable implications from that research for the design and delivery of learning systems, particularly those involving computer-mediated technology and related software.

Structure of Report

- This report is in five parts.
- **Part One** provides an overview of the current situation with respect to the adult learner in the U.S., paying particular attention to the increasing use of the computer by the adult learning population.
- **Part Two** describes the characteristics of the adult as learner, focusing on the six major dimensions that constitute the experience of learning.
- **Part Three** examines the impact of technology, particularly computer-mediated communication systems, on the learning process.
- **Part Four** presents a number of the more important implications for system design that reflect the synthesis of theory and research.
- **Part Five** shares knowledge of adult learners with special needs and the characteristics that are associated with disability categories and related web design considerations.

possibility of overestimation,[2] adult learning is a phenomenon of widespread and growing social and economic significance.

Nowhere is this more evident than in institutions of higher education (Patterson, 1996). Whereas the proportion of those aged 35 and over constituted about 1% of all fall enrollments in institutions of higher education back in 1970, by 1994, that figure had risen to 21%. At the same time, how adults participate in higher education has changed the nature of the campus landscape. The National Center for Education Statistics, for example, projects that by 1998, of all higher education students, a striking 72% will be part-time adult learners.

Though the phenomenon of participation in adult education is widespread, successful adult learners appear to be concentrated in very well defined segments of the total market. This is reflected in the statistical profile of the adult learner (first documented by Johnstone and Rivera back in 1963) which has remained fairly constant over the past thirty years, with one or two significant exceptions. Taken, as statistical whole, adult learners tend to be:

- Slightly more female than male (46% vs. 43%)[3]

- Younger rather than older (Close to 70% of all those in the youngest age group, 17-24 participate in adult education vs. 25% for those over 55).

- Much more highly educated (more than 60% of those with colleges degrees are involved in continuing education vs. 11% of those with less than a high school diploma)

- Of a higher income (50% or more of those with income of $40,000 or more per annum vs. 30% for those with $10,000 or less)

- Single rather than currently married (59% vs. 45%), and

- Inside rather than outside the labor force (54% vs. 25%).

The two exceptions are race and region, where the numbers in respective categories are similar. Thus, for example, while whites continue to dominate the adult education population when compared with blacks, Hispanics and others, the rate *within* the particular racial-ethnic group was about the same during 1991 and 1995.

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[2]   Sampling procedures have become more complex than in earlier surveys. Currently, using a process of random-digit-dialing, researchers undersample some populations, e.g. whites, and oversample other households. e.g. Hispanics and Blacks. in order to "produce reliable estimates for subdomains by race and ethnicity" (NHES. May 1997. Technical Report). There are some suggestions that these procedures may be overestimating the numbers of participants.

[3]   Calculated as the rate of participation for that particular group. So. for example, the rate for all men (and women) regardless of age. ethnicity. income. etc. is 43%. The comparable figure for women is 46%.

On the whole, then, American society seems eminently organized to respond to the learning needs of the more advantaged stratum and much less well-organized to respond to those who for a variety of reasons do not appear able or willing to take advantage of educational opportunity. Our assumption is that an underlying premise of the work of the ALX project is to find ways of responding to the needs of this under served group, particularly relying on technologies that make access to learning opportunities easier and more evenly distributed.

Finally, with respect to motivation, despite the tremendous diversity in the field of adult education as a whole (it encompasses everything from job training to the pursuit of leisure and personal growth), adults have pursued learning for a remarkably constant set of reasons down through the years. Since the early 1980s, the dominant motivation for learning has been work-related, either the preparation for a new career or connected with skills upgrading. In recent years, more of the work-related participation has been linked to relicensure and credentialing. Nevertheless, the adult as learner remains a complex entity.

Adult Learners and Technology

The development of technology has changed not only the way we live but also the way we think, teach and learn. As technology is increasingly used in education and literacy programs as well as in the workplace, computer literacy has become a necessity, not an option for adult learners (Timmermann, 1998). Individuals who want to look for work or stay competitive in the job market must learn to use computers. As Timmermann notes:

> Knowledge of the computer and the Internet is an empowering experience for the older adults, for it keeps them connected to today's society and the future as well. Adult educators who expose those older adults who are isolated, poor, disabled, or less educated to computer technologies will help to enhance their lives.
> (Timmermann, 1998, p. 69)

But as Morris (1994) notes, observing that the proportion of older adults (typically 60 and older) in the population is expected to rise considerably over the next decade: "little attention has been devoted to understanding, organizing, and accommodating [their] needs with respect o interaction with computers." (p. 374). In a superb treatment of the subject, Morris goes into considerable detail as to how older adults needs on the computer can be accommodated by designers of software and hardware. (Because of the detail provided by the author, the tables in

which age-related deficiencies are listed along with recommendations for how these can be accommodated are attached to this report in the Appendix, with permission of the author.)

There are a number of reasons for older adults to use computers and go online. The first is that they want to try something new (Third Age Media and the Excite Network, 1997). A case in point is that when adults over 50 years old were asked, "Why did you go online in the first place?" Sixty-seven percent said they wanted to try something new. The second important motivational factor is to make intergenerational connections via e-mail. Many older adults who live far away from their adult children and grandchildren want to meet their children online and get involved in the lives of their children (Timmermann, 1998). The third reason is that the workplace requires computer literacy. If older adults want to keep their jobs or seek new positions, having computer technology skills is a prerequisite for employment. This is especially true for older adults who want to hold clerical or administrative positions. They have no other choice but learning to use computers. Otherwise, they will be compelled to settle for unskilled and low-paying service jobs (Timmermann, 1998).

As many older people are self-directed learners, they might choose to think about taking courses on CD-ROM or online. In spite of this, one should realize that "learning in a classroom setting is a social as well as a growth experience for many older learners" (Timmermann, 1998, p. 67). One of the chief reasons for older adults to take courses is to meet others who share their interests. As noted by Timmermann (1998), learning at home can be an isolating experience if learners are not highly motivated.

There is a growing body of research on computer use by older adults, a picture that is in constant motion (Meyer & Talbot, 1998). At the same time, in terms of demographics, computer use, like adult education in general, mirrors the general population of those who are educationally active. For example, the Current Population Survey (U.S. Bureau of the Census, 1993) shows that 8.4% of the population age 65 years and over use computers at home compared with 25.3% of adults 25 to 34 years, 25.4% of adults 22 to 24, and 30.4% of adults 18 to 21 years of age. Gender-wise, 27.1 % of men and 24.3% of women use computers at home. In addition, more educated adults (undergraduate college degree or more--63.4%) use computers at home compared with less educated adults (high school graduates--25.1%; 9th to 11th grade--8%). A recent study by Poon and Meyer (1997) reported that young adults had significantly more favorable attitudes toward computers than did older adults as measured on a scale of attitudes

toward computers developed by Krauss and Hoyer (1984). The results of the study also showed that older adults used computers less frequently than young adults did. Age differences were found present in the use of computers in reading research that used computer versus paper presentation: Young adults showed more efficient reading comprehension when reading from a computer, whereas older adults showed better performance on the printed page (Poon & Meyer, 1997).

Generally speaking, older adults need extra practice with computers to show equal training gains as young adults. Studies show that older adults whose ages range from 55-75 years could learn word processing, but they differed from young adults (18-30 years) in that they took more time to select and carry out procedures and required more training (Hartley, Heartley, & Johnson, 1984; Elias, Elias, Robbins, & Gage, 1987). Krauss, Florini, and Bellos (1985 as cited in Elias et al., 1987), who studied computer use at home for older adults, noted the older adults' extensive need for assistance, consultation, and trouble shooting. Additionally, Schumann, and Boritz (1992) have noted problems older adults experience in learning word-processing procedures. All of these studies show older adults requiring more time and more trainer assistance to become competent users of word-processing tools. At the same time, they also show that older adults can clearly learn to use new office technology given optimal support for learning (Meyer & Poon, 1998)

Clearly, computers are on their way to becoming 'embedded,' and thus unconscious, parts of our everyday culture. Increasingly, as they are tied more and more to learning tasks and environments they will begin to define what these tasks and environments should be. This evolution promises profound change for our schools. Already, we see this change occurring. For example, between 1983 and 1988, the ratio of computers to students increased from one computer per 100 students to one computer per 30 students (Office of Technology Assessment [OTA], 1988). Currently, the ratio of computers to students is one computer per ten students, and the number of computers continues to increase steadily (OTA, 1995). In spite of access to computer technology in their classrooms; however, less than a half of all teachers have actually integrated computer use into the curriculum (Bracey, 1994; OTA, 1995).

PART 2 Characteristics of Adults as Learners

Sean Courtney, Ed.D., and Jiali Luo

Overview

Projects aimed at facilitating the learning processes of adults, including the design of environments, experiences, and technologies for learning, have all, in some way, benefited from the outpouring of work on the nature of learning since the turn of the century and particularly in the last two to three decades. A robust picture of the learning process and the factors that mediate it has emerged from very disparate research programs and bodies of related literature, supplemented by more confident reflections on the nature of practice.

Understanding how adults learn means relying on two very unequal bodies of knowledge. The largest of these, stemming from the field of educational psychology, attempts to provide an overall perspective on how learning happens, building an empirical picture of the learning process by drawing inferences from studies of children, adolescents, and college students. Only recently have psychological researchers and educators been concerned with adults as learners; so, empirically based work in this area is really in its infancy (e.g. Smith & Purchot, 1998). The second body of literature is particular to adult education as a field of study. Since the late 1950s (e.g. Brunner, Wilder, Kirchner & Newberry, 1959) a small and varyingly sophisticated body of work has been developed by practitioners and researchers of adult education focusing on the processes of and motives for adult learning (e.g. Brookfield, 1986; Merriam & Caffarella, 1991; Courtney, 1992). If we compare both bodies of works we are compelled to conclude that our understanding of how and why adults learn must be based mainly on inferences from the larger and more developed sets of theories and constructs drawn from the field of educational research in general. Nevertheless, both bodies of work are needed to present a comprehensive picture of the adult as learner.

Before proceeding, a note needs to be made of the phrase, "characteristics of adult learners." Though the literature on this topic is prolific, suggesting that much work has been done already in this area, in reality the term acts more as a convenient code for small number of factors identified by adult educators and thought to be important when adult learning but generally

unexamined for their empirical validity.[4] Typically, by characteristics of adults as learners is meant one or more of the following: Factors that appear to distinguish adults from children as learners, learning style, and demographics associated with the phenomenon of participation (such as those enumerated in Part 1 of this report).[5]

The biggest claim concerning adults as learners is that they are distinct from children as learners and thus warrant a different approach to teaching and instructional design. This position, originally staked out by Malcolm Knowles (1980) and later somewhat abandoned by him (Knowles, 1990), argued in favor of a distinct adult education philosophy—termed *andragogy*. It has been criticized extensively (e.g. Tennant; 1986; see several issues of the journal *Adult Education Quarterly* during the 1970s) and appears to be empirically unsustainable. Nevertheless, it is a good starting place for the study of adult learning because through it we can see the issues that have come to dominate the field of adult learning for the past half century and how these issues play out today against the general backdrop of what researchers and educators have convinced themselves about the nature of the learning process.

In what is still among the most cited statements on the subject (Zemke & Zemke, 1981), Malcolm Knowles (1980) proposed the concept of *andragogy* to characterize what he felt were fundamental differences between the child and the adult as a learner. Knowles's five characteristics still form the basis for many of the workshops and academic courses that educators conduct around the "principles of adult learning." These characteristics while generally unproven can be found woven into the modern view of the learning process, as it will be described below. According to the recently deceased author, adults are distinct as learners in terms of

- _ *Self-direction*, which implies that they want more control over and responsibility for their own learning;

- _ *Experience*, that unlike children, adults have a great deal of experience which they are eager to use in any new learning situation;

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[4] Abstracts in the ERIC data base with that title on its own or linked to other topics number in the hundreds. Few if any of these abstracts are summaries of empirical work. however.

[5] As an example. a book titled. *How Adults Learn: Instructional Guidelines for Sales Training*, authored by Franklin Spikes of Kansas State University. contains a chapter on adult learning characteristics. It consists of a summary of a paper published close to 20 years ago. itself a summary of then current theories. beliefs. and research on how adults learn; a summary of Houle's typology of learning orientations; reference to some general statistics on participation (such as were addressed in Part I of this report); material on learning styles; and a discussion of stages of the adult life cycle.

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      _ *Readiness to learn*, which is dictated by life cycle roles and responsibilities rather than any intrinsic interest in any particular subject matter as such.

This leads them to have a

      _ *Problem- rather than academic orientation* to the subject matter of learning, suggesting that hands-on and how-to courses are more desirable than those which detail theory.

Yet, despite this their

      _ *Motivation to learn* is intrinsic rather than extrinsic, suggesting a willingness to come to grips with learning for its own sake.

According to this scenario, an adult learner seeks out self-managed opportunities to learn and desires independence in formal learning environments. Such an adult brings a rich set of life experiences or prior knowledge to most learning situations and enters such situations desiring that this experience and knowledge be validated and somehow used. At the same time and partly because of his or her immersion in such experiences, s/he would seek out an education that would help him or her to solve problems, mostly those associated with life roles: at home, at work, in the community and, perhaps, on larger sets, such as national politics. Finally, such an adult would possess an orientation to the tasks of learning which made these tasks interesting or enjoyable in their own right, and while desiring applicability, would be ready to entertain learning for its own intrinsic value.

Basic Assumptions: Learning as Acquisition and Participation

Learning, according to the German psychologist, Kurt Lewin, can be understood as a change in

      _ *Cognitive structure*, which he equated with "knowledge" acquisition

      _ *Motivation*, e.g. liking and disliking someone or something;

      _ *Group belongingness or ideology*, which he identified with socialization, and,

      _ *Voluntary body control*, as in the acquiring of physical skills such as riding a bicycle.

Underlying these different forms are two fundamentally distinct ways of interpreting what it means to learn. On the one hand, to learn means to acquire knowledge, skills, attitudes, orientations, etc. The notion of **learning as acquisition** fits very well with our commonsense

notions of how and what we are learning. Students themselves say it,[6] and the literature for many years has stressed that idea that the action of learning is the action of obtaining or getting something—cognitively, affectively, and from a psychomotor standpoint. Mostly this 'getting' has been interpreted as an internal process, occurring in the brain, mind, head, and so forth.[7]

According to the second and distinct sense of the term that has gained credibility in recent years, learning has been construed as a fundamental aspect of 'social practice,' the myriad cohesive actions--some oriented to maintenance of various systems (personal, family, community, professional, and political), some oriented to change. This conception identifies **learning with participation**, the idea that when someone is learning they are involved with something, someone, some place, community, organization, etc. So the action of learning is the action of involvement or of being a member of some group or community. Much of the recent literature and research in this area stems from the work of Lave (1991), Lave and Wenger (1991) and Brown, Collins & Duguid (1989).

In one of most-cited works in this area, Brown, Collins & Duguid (1989) argue that too much of school-based learning leads to "inert" knowledge, bodies of terms, concepts, principles, and theories which can be dredged up from long-term memory in time for exams or similar artificial challenges but which do not serve in any real way to help the learner negotiate his or her environment. *Situated cognition*, as the authors describe it, is essentially bound up with the context of its use, involves social interactions and the use of tools, including material resources, e.g. the computer, that the culture has come to value.

In the following section, the exact mechanism by which learning occurs or the conditions under which it is optimal will be discussed.

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[6] A study by Courtney (1996) asked students to respond to a sets of definitional questions about the learning process. The results of a qualitative analysis of more than 100 responses (over a period of six years) suggest that adult learners mainly see learning as an acquisition process. which is sometimes *additive*—adding to already acquired knowledge. and sometimes *transformative*—meaning a whole new perspective is gained on a particular subject or problem.

[7] A recent text on the subject. Schunk (1996). captures the emphasis on knowledge. its transmission and storage. Learning according to the author means: "Acquisition and modification of knowledge. skills, strategies. beliefs. attitudes. and behaviors: [l]earning involves cognitive. linguistic, motor. and social skills. and can take many forms." (p. 2)

The Experience of Learning

According to a recent joint publication of American Psychological Association and the Mid-continent Regional Educational Laboratory, there are five basic factors and an assortment of principles associated with the learning process: meta-cognitive and cognitive, affective, developmental, and personal and social. To sum up the position of the group according to its first and most basic principle, "learning is a natural process of pursuing personally meaningful goals, and it is active, volitional, and internally mediated" (Appendix A).[8]

Extrapolating from these principles to the design of instruction and learning systems for adults, the following is a list of characteristics that describe what researchers believe learners are doing both when they are most active and cognitively engaged as learners.

- Adult learners are *active constructors* of their own knowledge as opposed to passive recipients of someone else's (**Knowledge Construction and Conceptual Change**).

- Adult learners come to the context of learning with *prior experience and knowledge* which frame one's encounter with the world, even one's sense of the world; learning is in very basic ways both a cumulative and transformative affair (**Prior Knowledge and Experience**).

- *Motivation to learn* is based on the individual's sense of self as a learner and his/her place in the community of learners (**Motivation, Self, and Community**).

- Adult learners have conscious access to the basis of their own learning, what is nowadays referred to as *metacognition* (**Metacognition**).

- Learning is most effective when embedded in *authentic activities, tasks and, environments*, environments optimally balanced between control by the designer and the learner (**Authentic Tasks and Environments**);

- The most successful learning involves a constant shifting between *collaboration* and *self-direction* (**Collaboration and Self-direction**)

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[8] See Appendix A for the MCREL list of basic learning principles.

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Contemporary theories of learning are for the most part accounts of how learning takes place as a cognitive process of acquiring knowledge. Chief among them is **conceptual change** theory (Strike & Posner, 1985), which derives, for the most part, from the study of how high school and university students acquire mathematical and scientific concepts. In this view, learning is the

> interaction that takes place between an individual's *experiences* and his or her
> current conceptions and ideas (i.e. *prior knowledge)*. These conceptions create a
> *framework* for understanding ...information gathered through experience.
> (Pintrich, Marx, & Boyle, 1993, p.170; emphasis added)

Current conceptions or prior knowledge create both a framework for interpreting new experiences and data, while at the same time creating *resistance* to the new learning. How much resistance is created really depends on the extent of prior knowledge. Psychologists use the term *assimilation* to describe how learning occurs when little is known about the subject in the first place. *Accommodation* describes the process of learning when a great deal appears to be already known of the subject. According to researchers,

> The processes of assimilation and accommodation are guided by the principle of
> equilibration whereby individuals seek a relatively stable homeostasis between
> internal conceptions and new information in the environment. (Pintrich et al.,
> 1993, p.170)

It might thus be expected that, in comparison with children, adults have acquired a great deal of prior knowledge, based on their experiences of relationships, work, community participation, and the like. (This, for example, as we saw above is one of the major components of Knowles's theory of andragogy) If this is the case, then it can be expected that adults will display more resistance to learning and that their learning will be more accommodation than assimilation. It might further be expected that such resistance would show up in the academic classroom when the weight of the adult learner's rich practical knowledge encounters the power of the teacher's expertise, which often assumes the total ignorance of the student as a starting point. What we do know suggests, paradoxically, that this is the case: adult learners desire their

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[9] Greg Kearsley's site on the Web lists 50 different theories or models.
(See http://gwis2.circ.gwu.edu/~kearsley/theories.html)

current and prior work and life experiences to count in the academic learning environment, though how it is to count in the teacher-driven curriculum is far from obvious (Tracy & Schutenburg, 1986).

Prior Knowledge and Experience

Prior knowledge and experience (see Knowles above) shapes how the learning task and environment is encountered. What does this knowledge and experience consist of? In a model made popular during the 1980s, David Kolb proposed that all learning involves a "cycle" of encounter with experience, involving experience, observation, theory, and experimentation (Kolb & Fry, 1984). The 'theory' the learner brings to bear upon the learning task consists of propositional or declarative knowledge, sometimes referred to as *knowing that* (facts, ideas, information, theories, events, etc.) and procedural or conditional knowledge, referred to as *knowing how* (being able to enact skilled performance in context, a reflection of expertise). How is that knowledge stored in memory? According to psychologists (e.g. Rumelhart & Norman, 1978), when someone learns one of three things may happen:

  - *Accretion*, according to which new information is made to fit into preexisting structures already laid down over time. Pratt (1991) has referred to this as additive knowledge;

  - *Restructuring*, whereby current schemata are changed because they are found to be unsatisfactory or because new knowledge cannot be accommodated within the framework of the old;

  - *Schema tuning*, whereby existing scheme and frames are adjusted to improve accuracy, generalizability, and specificity.

Learning involves more than the mere confirmation of experience. Experience has to be mediated and reconstructed (or transformed) by the student for learning to occur. A crucial issue is how and under what conditions people can reconstruct their experiences and thereby learn. It is very important then that ways be found to acknowledge learning in the design and conduct of instruction (Tennant, & Pogson, 1995). Experience on its own may be insufficient for learning to occur. Our everyday encounter with experience can result in non-learning, according to Jarvis (1987), who has proposed a typology of learning consisting of three categories—nonlearning, nonreflective learning, and reflective learning. When we do learn it may be nonreflectively, "preconsciously," or "incidentally" as part of some other ongoing activity (one of our assumptions

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above), or when we learn psychomotor skills, or when we are mainly engaged in memorization. Finally, according to Jarvis, at the highest level we may respond to the environment critically (Brookfield, 1987) or *reflectively,* through either *contemplation (*what we typically think of when we talk about 'reflection' or 'thinking'), *reflective skills learning* or reflective practice, which applies to many so-called professional jobs, or *experimental learning,* which attempts to describe how a scientist might behave. This also reflects the final steps in Kolb's cycle whereby the learner having thought and theorized about the causes of his experience is now ready to try something new to change the situation.

Motivation, Self, and Community

Adults who are motivated to learn may display some or all of the following characteristics: curiosity about and interest in learning activities; diligent, conscientious work; feelings of self-confidence; and commitment to the task and high performance (Pintrich & Schunk, 1996). According to the same authors, motivation may be defined as the "process whereby goal-directed activity is instigated and sustained" (p.4). In other words, for learning to occur, it is not sufficient that learners have appropriate amounts of prior knowledge or that they possess metacognitive self-awareness. Learning, in fact, is less a rational process of discarding some concepts in favor of others and more an emotion-laden experience in which the learner's *sense of self as a motivated learner* is important, as well as the learner's place in the larger *learning community,* either real, e.g. classroom, or imagined, e.g. a field of practice. To say that the individual adult has a sense of self as a motivated learner means that the following are salient to his or her orientation to learning: goals and expectations; interests and values; self-efficacy and control; and volition, persistence, and effort.

Goals. Recent research suggests that individuals who may otherwise be similar, e.g. in terms of intelligence, may perform differently on tasks because of the **goals** they bring to the environment. Dweck and Leggett (1988) found that when faced with challenge, some children demonstrated a maladaptive, or "helpless" response, according to which they gave up the task when it proved too hard, while others displayed a more "mastery-oriented" style, in which they seemed to relish the challenge and the set-backs in performance it provided. The researchers argued that similarly able learners behaved differently, because they saw the task differently.

Some learners have a "performance goal" orientation, the purpose of which is to gain a favorable response from others, e.g. the teacher, about one's performance. It also matters to these

learners that the ego not be threatened. By contrast, those with a "mastery orientation" are essentially concerned with learning and increasing competence and see cognitive challenge as a way of gaining new knowledge about the world. Of most significance to discussion here is the discovery that learning environments can be manipulated to induce performance rather than mastery orientation and that many formal learning environments are already loaded in favor of performance and "surface" learning as compared with mastery and "deep" learning (Dahlgren & Marton, 1978).

Interests and Values. While it seems that learning is more likely to occur if it is more interesting and is valued by the learner, researchers are now seeking to understand more about the phenomenon of interest and how it influences the processes of learning. For example, some learners may bring a natural interest to a subject area, while at the same time valuing its importance, e.g. for career aspirations (Pintrich et al, 1993). As a result, the same learning situation may elicit both mastery-orientation (natural interest giving rise to intrinsic motivation for learning tasks) and performance orientation (importance of subject generating concern for grades). Research by Pintrich and Garcia (1991) suggests, in fact, that both mastery and performance orientations can both operate at the same time in a learning situation.

Work by Hidi (1990), Schiefele (1991) and others make a further distinction between "personal" and "situational" interest. Based on the amount of experience and prior knowledge about a particular subject, learners bring a certain amount of personal interest and disinterest to the situation. This is not normally a contingency the instructor or designer of instruction can do much about. What s/he can influence is the variable of "situational" interest, features of the learning environment, which can be manipulated to elicit the learner's interest and involvement: elements such as the look of the text, the use of multi-media resources, stories, 'hooks', live drama, and so froth. Increasingly, and this may be a difference between younger and adult learners, learners come to learning environments with preferences for how they want material presented to them. This in part accounts for the success and popularity of the Web as a medium for learning (Owston, 1997).

Self-Efficacy and Control. Besides goals, interests and values, a further dimension of motivation is the learner's sense of the task and his/her ability to accomplish it, what Bandura (1986) termed "self-efficacy." Researchers distinguish two kinds of self-efficacy (Pintrich et al., 1993). One has to do with the amount of confidence a learner has in the value of his/her own

ideas with respect to a particular area of knowledge. Here the learner asks himself: Can I do this task? Why am I doing it? What do I know already about it? The higher the self-efficacy or confidence the more resistant the learner may be to receiving new information. In the context of conceptual change, discussed above, this leads to the phenomenon of "accomodation" whereby learning is paradoxically both easy and hard. It is easy because the learner already has a good deal of prior knowledge and so is not starting from scratch as it were, but hard because the structures of knowledge already formed may interfere with the learner's ability to acquire new information. The challenge for pedagogy and design is how to destabilize the learner's overconfidence in his own knowledge and lead him to new knowledge, without undermining his self-worth as a learner.

This brings us to the second sense of the term: the learners' confidence in their ability to "change their ideas [and] to use the cognitive tools necessary to integrate and synthesize divergent ideas" (Pintrich et al, 1993, p. 186). This point underscores the earlier theme of learning as situated, learning as participation. Learners are not mere holders of propositional knowledge; they are also tool-users, cognizers that function optimally in environments which permit them to also use their procedural knowledge in the solution of problems and assignments.

Lastly, with respect to control there is some research to suggest that learners prefer and are more productive in environments in which they can exercise a degree of control not evident in the traditional classroom environment (Jha & Courtney, 1994). But the evidence on this point is inconclusive in an intriguing manner. We already know that adult learners bring prior rich experiences to the learning encounter. Research in this area is, however, mixed. Some studies, for example, suggest a generation gap: adult learners, particularly order adults, appear to prefer learning environments which have a lot more structure and put the control of the class into the hands of the teacher (Tracy & Schutterberg, 1986).

<u>Volition. Commitment. and Effort</u>. Some researchers have argued that motivation on its own cannot account for long-term success as an adult learner. In this view, motivation accounts for an individual's *choice of goals* and the general enthusiasm or interest for learning. It takes volition, it is argued, to translate interest and enthusiasm into effective action. Volition is needed to explain *follow through and the ability to maintain intentionality* in the face of distracting and counter-motivational tendencies (Corno, 1993).

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Contemporary research in the area of motivation and volition encompasses both laboratory-type situations as well as "practical" investigations of areas such as weight loss, vocational choice, and binge eating (Lazarick, Fishbein, Loiellio, and Howard 1988). One of the more significant of these 'practice' areas is the application of volition-related constructs to classroom learning and academic achievement (Corno, 1992, 1993). To Julius Kuhl and his colleagues at the Max-Planck Institute in Munich can be attributed the rehabilitation and resurgence of interest in the importance of volitional processes to motivation and action. Kuhl bases his beliefs in the importance of volition on the fact that people in their normal lives distinguish between an "intention to do something and the ability to control the enactment of that intention" (Kuhl, 1984, p.100).

Applied to the study of adult learning, this might mean, first, a concern for the factors responsible for the adult's orientation to or interest in learning (motivation); second, his/her ability to follow through on intentions despite forces to the contrary (action), and third, the adult's persistence in task actions as well as the strategies enacted to enhance success as a learner (performance) (Courtney & Speck, 1994). Subsequent work appears to confirm the putative distinction between "weighing" and "willing", between "predecisional" or motivational conditions and "postdecisional" or volitional action states (Gollwitzer, Heckhausen, & Ratajcak,1990).

According to Corno, for example, citing the example of class assignments, students and teachers are, in a sense, engaged in a process of negotiation which sets the parameters of the various aspects of the task, taking into account the students' concerns. It is during this phase that the motivational_constructs are dominant: students establish expectations, assign values to the task, while at the same time expressing feelings about doing the assignment (Pintrich & DeGroot, 1990). Once, however, the commitment to the task has been made, students enter a new or postdecisional phase.

Designers of learning systems could also benefit from work on volition. Success in education for most adults is equated to how well they pay attention to developing educational goals and working toward them appropriately (Corno. 1993). Adult learning in environments such as computer-mediated instruction consists of a widespread maze of interrelated activities in which the process of learning is the major responsibility of the learner. often without direct help of a guide. instructor. or the system's designer.

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Social Context and Communities of Practice. The dominant view of motivation rests on the assumption that learning consists of the acquisition of knowledge and that the major concerns are about individuals acting in relative isolation from each other (with the exception of Bandura's social learning theory). Adopting the perspective of **learning as participation**, however, means not being able to separate motivation from the context in which it has its reality or from the actions of which it is an account. As was stated at the outset, there is no such thing as learning sui generis. Motivation is not just something that is *located* in the mind of an individual actor. It is part of the account of the significant actions and interactions which, together, constitute a given experience or imagined experience. This means that in giving an account of motivation we are also talking about learning and vice versa. And in giving an account of both, our account would be incomplete without the "whole story": without reference to the social and cultural contexts of which these entities are members (Lave & Wenger, 1991; Sivan, 1986).

Characteristics of the concept of motivation as a "situated" phenomenon include the impact of joint collaborative activity (or its absence); the role of social interactions; the influence of culturally-based knowledge and practices, including cultural technologies; the mediating role of signs and symbols--our cultural tools, as well as that of peers and competent others; etc (Rueda & Moll, 1994; Sivan, 1986).

Viewing motivation as a cognitive phenomenon implied a definition of learning which was also cognitive, as located in the head, and knowledge acquisition as something that reflects the structuring of the brain, the mind, memory schema, etc. Hence, a lot of the current research on motivation is comfortable with school-based inquiry--trying to find out how students respond to various types of classroom contexts. Schooling or formal education is in this view a legitimate given. It would not be possible, however, to talk about motivation-in-context in the absence of the latest shift in our thinking about learning: that it too is situated and reflects less something that goes on in the head and more something that is out there is the community of practice (Lave and Wenger, 1991).

Metacognition

Learners do not merely acquire knowledge (as in the acquisition paradigm). In doing so, they often pay attention to how they are learning, what they are doing right (e.g. how they are studying text), and what they are doing wrong (e.g. memorizing text instead of trying to

understand it at a 'deep processing' level). Researchers refer to this awareness as *metacognition* (Schraw, 1994; Bruning, Schraw, & Ronning, 1995; Schraw & Moshman, 1995).

Cognitive and metacognitive skills play an important role in the learning process. Research shows that successful learners use a variety of cognitive and metacognitive skills to enhance their learning (Garner & Alexander, 1989; Pressley, Borkowski, & Schneider, 1987). Research also indicates that high-achieving students generally possess more knowledge and regulate their learning more efficiently (Alexander, Carr & Schwanenflugel, 1995). This ability is also crucial to being self-directed as learners (see below). Adult metacognition is a multidimensional array of self-constructed, regulatory skills that span a variety of diverse cognitive domains, according to Schraw (1998). As such, as with other learning-related attributes, it may appear as a naturally unfolding dimension of the personality (i.e. individual difference) or as something that is taught. Metacognitive awareness may come from three resources: direct, peer-regulated, or autonomous learning environments (Schraw, 1998). Direct learning refers to environments in which individuals are given direct strategy instruction via a variety of instructional programs. Peer-regulated learning refers to strategy-training programs that involve some form of peer assisted instruction. Under the influence of Vygotsky's notion of the zone of proximal development, which assumes that optimal learning occurs beyond one's current level of independent functioning (Rogoff, 1990), students are believed to learn best from interacting with other slightly more advanced peers.

Like children, adults learn skills and acquire metacognitive knowledge from their peers typically through peer modeling and cooperative problem solving (Schraw, 1998). The former mechanism enables individuals to observe the proficient use of a skill and gain access to the regulatory strategies of experts. The latter refers to interactive peer problem solving, involving individual participation rather than mere observation. Both modeling and cooperative problem solving lead to increase in self-efficacy, strategy use and efficiency, conditional knowledge, and metacognitive regulation.

Direct, peer-directed, and autonomous learning environments all promote the construction of strategies and metacognitive knowledge. However, it remains to be seen whether one of these approaches is more effective than another, or whether their effectiveness interacts with age or current developmental level (Schraw, 1998). Because metacognitive knowledge is a

lifelong task, teachers are advised to teach at the current level of students and challenge students to move from a lower level to a higher level (Schraw, 1998).

Authentic Tasks and Environments

With the shift that is underway in our conceptions of learning and motivation from the mind to the social milieu, the questions we ask of instruction and design are different. Instead of asking "what kinds of cognitive processes and conceptual structures are involved [in learning, we] ask what kinds of social engagements provide the proper context for learning to take place" (Lave & Wenger, 1991, p.14). Instead of focusing on questions that cognitively oriented educators might ask (How do we get their attention? How do we keep up their interest? etc.), we are studying what is **authentic** or real about the learning environment in which (proposed) learning is taking place? How are communities of practice being established? How do we create a sense of membership in or ownership of the project, task, etc.? As has been noted,

> [learners] appear to be more motivated under authentic, meaningful task conditions, where they jointly construct meaning [in collaboration] with peers and teachers, and where activities are challenging yet within their reach or zone of proximal development....[Learning]...requires personal construction of meaning,...where [learners] have a sense of owning the task. (Rueda and Moll, 1994, p.131)

The ability to learn, to retain what was learned, and to recognize how that information or knowledge might be useful in a current context depends to a large extent on the meaningfulness of the connections made in the first place, something that psychologists have known for quite some time (e.g. Bartlett, 1967). What is more recent is the realization that meaningfulness in learning depends on authenticity in task or environment. Authentic environments are those in which learners are really or symbolically present at sites in which the relevant tasks or experiences are to be learned (Courtney, 1994). Authentic tasks, which may be performed at the site of origin or reproduced at a different location, are those performances that matter to the ongoing realization of a work section.

Authenticity in the learning environment has received added stimulus with the renewed interest in problem-based learning (PBL) (Stepien & Gallagher, 1993) and the belief that PBL is the best route to truly motivated and cognitively engaged learning (Blumenfeld, Soloway, Marx, Krajcik, Guzidal & Palincsar, 1991). PBL also reflects the realization that some subject matter areas. e.g. medicine. are inherently ill-defined and that the practice associated with them cannot

be algorithmically set out before hand (Koschman, 1996). Authentic learning environments are also the subject of computer-oriented learning designers who have been engaged in creating programs that simulate worlds and construct microworlds within which learners are free to engage in conditions which mimic real-life encounters under conditions which are safe from threat and injury.

Some educators look to a future of "computer-generated virutual reality" whose ultimate end may be the total transformation of life and learning (e.g. Tiffin & Rajasingham, 1995), while others are content for the moment to deal with more immediate educational challenges, such as improving the learning of math and science (Dede, Loftin, & Regian, 1994; Winn, 1995). Authenticity in task and learning environment has also caused a renewed interest in collaborative forms of learning and inquiry (Resnick, 1987).

Collaboration and Self-Direction in Learning

Collaboration requires learners who have the capacity for independent, critical judgement. To be effective as a partner in learning, one must also be effective in self-directed or self-regulated inquiry (Schunk & Zimmerman, 1994). One of the central tenets of Knowles's concept of andragogy is self-direction, the idea that learners desire degrees of freedom with respect to what they will learn, from whom or what they will acquire necessary information, and how they will know when they have reached their goals. Self-direction or self-regulation refers to "the ability to control all aspects of one's learning, from advance planning to how one evaluates performance afterward" (Bruning, Schraw, & Ronning, 1995, p.136). Self-directed reflection plays a decisive role in the construction of metacognitive knowledge and regulatory skills. This is because reflection leads to the restructuring of one's knowledge and enhances an increasingly theoretical understanding of one's own cognition.

Over time, the image of the self-directed learner, as with the emphasis on experience, has become central to the modern ideology of adult education. Nowadays, paralleling the concept of self-direction, and receiving increasing attention, is the concept of the "self-regulated learner." (Schunk & Zimmerman, 1994). There are two ways in which we can think about self-direction as it applies to learning. One is to focus on the qualities it takes to be become a self-directed learner and to assume that these are qualities which individual learners possess and which they bring with them to learning situations (Zimmerman, 1995). Another, and an equally compelling line of inquiry, is to assume that self-direction is a feature of learning environments and an aspect of

learner's strategies when faced with certain educational choices (Merriam & Caffarella, 1991; Pratt, 1991; Grow, 1991). The latter position stemming from the work of Allan Tough in the 1970s simply assumes at the minimum that most learning experiences are independent of institutions of learning and take place naturally and on an as-needed basis. They arise when the circumstance dictates and end just as quickly, or when the learner believes his particular goal has been reached (Spear & Mocker, 1984)

Theories of self-regulation include three core components: metacognitive awareness, strategy use, and motivational control or volition (Bruning, Schraw, and Ronning, 1995), strategy use refers to the means by which learners encode, represent, and retrieve information. Skilled learners, according to Zimmerman and Martinez-Pons (1990) "choose strategies selectively and monitor their effectiveness throughout the learning process." Strategies can also help learners maximize their limited resources.

Long (1996) has made an interesting distinction between self-directed and other directed learning, summarizing the differences between them as follo

Self-Directed Learning	Other Learning
Relatively independent	Relatively dependent
Values self-initiative	Values following directions
Positive self-efficacy	Limited self-efficacy
Metacognitively aware	Limited meta-cognitive awareness
Intrinsically motivated	Extrinsically motivated
Engages in deep processing	Engages in surface processing
Prioritizes mental focus	Mental focusing diffuse (p. 3)

Long (1996) has identified two major barriers that appear to interfere with the application of ways and means to facilitate self-directed learning. First, the connotation of *self-directed* often causes us to forget that even self-directed people search for clues and cues that assist them in their learning. In self-directed learning, there is often a place for a helper of some kind. A second barrier is about the issues of ownership and significance. It is easy to assume that whatever is learned is equally important. Viewed from the perspective of a social human community, this assumption is difficult to defend. As a member of the human community some of what we learn may be more important to ourselves than to others, and even some of what we learn may be of

less value to some in the human community than to others. In some instances our learning may be directly useful beyond ourselves, while in other instances it may not be.

As noted by Garrison (1991), sociological factors of adulthood have made adult education unique. Adults have to assume various roles and responsibilities. It is natural to assume that learning will be associated with these (Aslanian & Brickell, 1980). At the same time, changing times and societal demands have compelled a large proportion of the adult population to study at their own convenience and under their own direction. The question is, do we laud this enterprise and point to it as an example of what individual adult learners can do on their own or do we also criticize the tendency to ignore the underlying issues that increasingly give people fewer choices about their environments or the object of their learning. While adult roles and responsibilities have an impact on the methodology of organizing adult education, according to Garrison, the constraints of adult life do not inherently argue for greater independence and self-direction in learning.

Foucher (1996) notes the importance of motivation in a self-directed context. In learning contexts where fewer of the normal educational structures are available, e.g. computer-mediated learning, the ability to determine one's goals for learning is especially crucial. As suggested by Carre (1992), one way to prompt autonomous initiatives is to establish a learner-friendly culture: "Autonomous learning refers to environments in which individuals spontaneously construct strategies and knowledge with only limited external support" (Schraw, 1998, p. 99).

Summary and Conclusions

In this part of the report we examined the learning process and how it takes place. While there is yet much that we do not know, e.g. where and how learning is located in various parts of the brain's cognitive, affective and psychomotor domains, there has been a consensus forming around the major dimensions of what learning is and how it takes place. That consensus was presented here.

To summarize, the modern view is that the learner is an *active constructor* of his or her own knowledge and not a mere passive recipient of someone else's (e.g. Chan, 1997; DeGrave, 1996). Or to paint the picture somewhat in reverse, if the intent of instruction or curriculum design is to make of the adult learner a passive receiver of objective, outside knowledge, there are good empirical as well as theoretical reasons for believing that s/he will resist (actively or passively) that intrusion into his/her consciousness. It follows from this view that if information

is presented to a potential learner in the form of 'direct instruction' the learner will end up taking from that information what fits with prior knowledge and current conceptions and 'discard'—forget—the rest. In this view, therefore, to teach a student means to facilitate or enable the learning process rather than to transmit knowledge directly. In some quarters this has been specified to mean conducting a 'dialogue' with the learner in such a way as to elicit from her or him their current conceptions and misconceptions of the subject matter so as to engage and 'repair' them (Laurillard, 1994).

Second, with respect to the impact of prior knowledge and experience, instructors and designers of learning systems should link their explanations and illustrations to what the learner already knows, building a bridge from the known to the unknown. They can do this by creating authentic tasks and experiences such as simulations, games, and role plays, from which learning will flow as a result of the active participation of the learners (Courtney, no date). Such activities establish a common experience base for the students, who can then construct meaning through personal reflection and group discussion. Finally, experience can be used as the primary source for learning. Typically the meanings that learners attach to their experiences are subjected to critical scrutiny through the medium of the group. The adult educator may consciously set out to disrupt the learner's world view and stimulate uncertainty, ambiguity, and doubt about previously taken-for-granted interpretations of experience—new interpretations emerging from this exercise (Mezirow, 1991; Cranton, 1994).

Finally, and an important bridging point between this part of the report and the next, learners bring with them not merely different conceptions or prior knowledge of a particular subject; they 'see' the subject and orient themselves to learning it through the conceptions they hold of the learning process itself, e.g. that all learning is about acquiring knowledge in environment such as classrooms, etc. (Courtney, 1996). Changing the learner's orientation towards the subject, working on his or her self-efficacy, means also working on the prejudices and biases that learners bring to the learning situation as to what is permissible as a learning exchange. sentiments that are actively encouraged by a tradition-bound teaching profession (Jaffee, 1998). There may be no greater challenge facing educators as we move into the 21st century. especially with the likelihood that learning technologies will become part and parcel of our everyday practice. than that which requires all of us to change how we think about the learning process.

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We turn now to examining the experience of learning from a different perspective: that of teachers, curriculum specialists, and others who have been involved in working with various technologies to enhance and create opportunities for learning.

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PART 3 How Technology Impacts the Learning Process
Sean Courtney, Ed.D., and Jiali Luo

Overview

The adult learner of today enters a world of learning bewilderingly different from the world he or she had encountered even a decade ago. That change can be summed up in the singular instrumentality of the computer. Less than two decades ago, the first personal computers had no hard drives and a mere 64K of working memory. Every data carrying disk was 5 1/4" floppy. Today, it needs hardly to be said, personal computers have not only vastly increased their speed and power but are capable of sophisticated multi-tasking, in movable and remote locations, while being networked together in ways that until the late 1960s were not even thought about. This networking and its potential to connect people over vast distances to bodies of knowledge is now, possibly for the first time since the invention of movable type, threatening to change forever the way we think and learn, work, and teach.

Adult learners encounter the new technologies of learning with some mix of anticipation and anxiety. On the one hand, more than ever before they would like to be able to access learning opportunities whenever and wherever they choose (Dillman et al., 1995). They have access to personal computers and would like to use them to attend classes, take degrees, and otherwise keep up with the fast pace world of change. On the other hand, many adults do not own computers, rarely use them except perhaps at their local library, and certainly never think of them as vehicles for learning or spaces on which to create and express ideas, while being linked to vast cyber-cognitive resources across the world.

Teaching and Learning New Technology

To learn to use new technology, according to Russell (1995), learners have to pass through six stages: 1) awareness, 2) learning the process, 3) understanding and application of the process, 4) familiarity and confidence, 5) adaptation to other contexts, and 6) creative application in new contexts. An understanding of these six stages on the part of teachers and students plays a significant role in facilitating the learning process.

At the first stage learners have knowledge about the existence of the technology, but they have not used it yet. At the second stage the technology is intrusive, giving rise to frustration. Learners at this stage do not understand the operating system of the technology; they get

frustrated and therefore lack confidence in themselves. The need at this stage is for extensive
support from experienced users. At the third stage learners begin to understand what the
processes mean and how they can be applied to a specific task. Learners at this stage acquire a
sense of achievement, for they no longer need constant support. At the fourth stage learners
become familiar with the processes and exercise certain control of them. Learners achieve a
sense of confidence, for they can solve problems through the hindsight of experience. At the fifth
stage the technology is becoming invisible. Learners at this stage are no longer concerned about
technology. What they focus on at this stage are possibilities for other applications of the "tool."
At the sixth stage learners apply technology to purposes other than the one used for learning the
process.

Literacy is by no means equal to competency in a field (Hunter, 1992). When learners
become technologically competent, they have just reached stage four. In order to reach stage six,
learners have to acquire competence that provides them with additional abilities to cope with
changing technology and innovation. At Stage Six technology is no longer intrusive. It has
become an invisible tool. Only when the computer as a tool or machine becomes invisible can
learners make creative applications of technology (Russell, 1995).

Computer Anxiety

In the initial encounter with the computer, as with any new technology, the reaction may
be one of anxiety leading to resistance. What is the nature of this fear and how can it be
managed? A model of computer anxiety developed by McInerney, McInerney, and Roche (1994)
consists of four parts. Part A consists of four first-order factors--learning about the basic
functions of computers, performance/competence with computers, handling computer equipment,
and receiving feedback on computer competence--and one second-order factor-- general anxiety
in gaining initial computing skills. Part B consists of sense of control, which can be either
positive or negative. Part C consists of one factor--computer self-concept. Part D consists of four
first-order factors --worry, distractibility, and happiness, physiological symptoms--and one
second-order factor--general state of anxiety in computing situations.

How can learners get over computer anxiety? First, learners should know why computer
skills are vital to complete the task at hand. Research, supported by the conclusions discussed in
the previous section of the report, shows that when students use computers for a real purpose and
when what they learn is relevant to their lives, they are more likely to overcome computer

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anxiety faster. And what's more, they are likely to have a more positive attitude towards computer learning (Marker & Ehman, 1989; Jones & Petre, 1994). Second, learners should know that a positive, anxiety free attitude toward computing is a prerequisite for computer literacy (Simonson, Maurer, Montag-Rorardi, & Whitaker, 1987). Third, local support personnel must be readily available to the naive user (Romiszowski & Haas, 1989; Marker & Ehman, 1989). Because early successful encounters with the technology will feed enthusiasm and build confidence in the naive user, providing technical and psychological support is vital to the learning process (Russell, 1995). Once they have mastered the basic skills learners will stop "being busy" with the keystrokes. They will then have the mental time to concentrate on creative applications of the new computer or program (Russell, 1995).

Computer Aversion

Computer aversion is a term used to describe negative attitudes towards computers (Meter, 1985). It is a major obstacle to using instructional technology and may or may not be anxiety-based (Larner & Timberlake, 1995). For example, lack of expertise or experience with the computer may be another primary reason for such negative attitudes. Computer aversion has been found to differ according to academic discipline (Raub, 1982). Mathematics and science majors have the lowest levels of computer aversion, whereas humanities and social science majors have the highest levels. Social science, education, and humanities students have more computer anxiety and less positive attitudes than mathematics, science, and business students (Liu, Reed, & Phillips, 1990; Rosen, Sears, & Well, 1987).

Is computer aversion related to age? Older persons are assumed to have more computer aversion than younger persons. This assumption, however, is not supported by research (Hunt & Bohlin, 1991; Igbaria & Chakrabarti, 1990; Ray & Minch, 1990). Rosen et al. (1987) reported a complex and unclear relationship between age and computer attitudes.

Is computer aversion related to gender? In their review of literature, Hadfield, Maddux, and Love (1997) have found that gender is unrelated to any measure of computer aversion (Busch, 1995; Dyck & Smither, 1994; Edelbrock, 1990; Kernan & Howard, 1990; Leite, 1994; Okinaka, 1992). A few studies show men display a significantly lower level of computer aversion than women, but the differences found have been so small that they have been of little practical significance (Badagliacco, 1990; Okebukola, 1993; Shashaani, 1994). In their meta-analysis of

empirical studies, Rosen and Maguire (1990) concluded that the differences in computer aversion between the sexes were neither strong nor consistent.

Is computer aversion related to race? Research concerning ethnicity differences in computer aversion is rare. A study by Rosen et al. (1987) reports that nonwhites have less computer anxiety, but whites have more positive attitudes with respect to personal use of computers.

The study by Hadfield et al. (1997) also examined computer aversion among preservice teachers. The results show that computer aversion is significantly related to seven variables: 1) prior computer experience; 2) ownership of a personal computer; 3) critical thinking skills; 4) technical teaching field; 5) anticipated teaching level; 6) gender; and 7) ethnic minority membership. Why are preservice teachers found aversive to computers in general? In conversations with subjects, many indicated they owned a computer only because another family member had one in the house. Male preservice teachers are lower in computer aversion than are female preservice teachers. Perhaps female preservice teachers still view working with computers as a male activity. Critical thinking skills are negatively related to computer aversion. The improvement of critical thinking skills could reduce computer aversion.

Computer-Based Learning Systems and Their Impact on Teaching and Learning

The traditional norm and organizational form for teaching and learning is the synchronous classroom milieu, usually a single site in a fixed plant such as a community college or university, with teachers and students who meet each other once or twice a week. The traditional norm for instruction is the teacher-driven curriculum, a teacher-organized construction of knowledge and skills, which is 'transmitted' to the learner using time-honored methods of communication, such as the lecture. While there is yet much resistance to the changes being brought about by the new learning technologies (Jaffee, 1998), it is clear that they are here and may be here to stay.

Technology-based learning systems take a variety of forms. Despite this variety, however, a basic distinction can be made between synchronous and asynchronous forms. The primary exemplar of a synchronous learning milieu is the classroom where the 'learning' is confined to a particular space and time. Distance learning technologies, typically, extend the space but not the time element. Asynchronous forms do both: teaching and learning are not confined to a physical plant and 'class meetings' (as in the Lotus Notes system, e.g. Seagren & .Stick, 1998) are

'distributed' over dates and times. We now examine the learning associated with both of these major forms.

Distance Learning

Distance education is a product of need and autonomy. Ever since its appearance, it has provided easy and convenient access to numerous learners. It is also a world populated more by adults than the traditional younger learner. These adults share the following characteristic: They study part-time while maintaining work, family, and social commitments. Why do adults choose to have distance education? There are two chief reasons. One is that no suitable courses are available where they live, and the other reason is that distance education provides learners with freedom as to when and where they study. Some adults choose to study by distance education instead of taking face-to-face courses because they find it works best for their lifestyle even if face-to-face education is available in cities where they live (Kember, Lai, Murphy, Siaw, & Yuen, 1994).

From an institutional perspective, distance learning aims at increasing learner access to instruction and maximal use of institutional resources. The purpose is to provide learners with well-designed instruction and enable learners to accomplish their specified learning objectives (Gibson & Gibson, 1995). Technology applications in distance learning programs lead to an increasing access to information. However, technology applications themselves are not distance learning per se. "Internet accessible databases, computer bulletin boards, and public radio and television are not distance learning unless they become part of a larger system" (Gibson & Gibson, 1995, p. 15).

Distant learning/telecourses have these advantages:

- They are an effective way to deliver instruction to students who do have convenient access to the face-to-face course (McNabb, 1994).
- They impose a discipline and organizational rigor on both instructors and students that is not usually required in more loosely structured conventional classroom (McNabb, 1994).
- They provide accessibility (McNabb, 1994).
- The increase in self-discipline imposed by distance learning/telecourses results in more student learning (McNabb. 1994).

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- Learner interaction with the content and the institution is high (McNabb, 1994).

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Distance learning/telecourses also have some disadvantages.

_ They lack the kind of teacher-learner dialogue frequently found in face-to-face classes (McNabb, 1994; Moore, 1993).

_ The electronic system may highlight an instructors' weaknesses, making instructors who tend to speak in a monotonous voice, for example, even less attractive than they otherwise might sound.

When we think about the structure of distance learning, we have to pay particular attention to two interrelated factors. One is the sophisticated system of technology itself; the other concerns the human factors that support faculty and learner needs. When making investment in distance learning, one must be aware of the fact that the success of the distance education system relies on the two factors mentioned above. To build a sophisticated technology system is important, but equally important are the human factors. It is important to get dollars to build the technology and maintain the human infrastructure. "You are doomed to failure if you only get the dollars to build the technology" (Gibson & Gibson, 1995, p. 15).

Interactivity is important to the distant education program. It is because student involvement is an important factor that generates effective mediated learning (Hackman & Walker, 1990). In fact, interactivity should be a desired learning outcome, for learners have been found more satisfied with instruction when the level of interaction is perceived to be high (Fulford & Zhang, 1993).

Computer-Mediated Communication

What do we mean by computer-mediated communication (CMC)? According to Ebbelink (1998), CMC is the "exchange of information between persons via computer networks." Using tools such as email and computer conferencing, CMC allows learners and teachers to engage in tasks in flexible ways (Steeples et al., 1996). While it permits multiple uses, CMC is mainly used to exchange information in the way of asking questions, exchanging opinions, and staying in touch (Rice & Case, 1983).

Why do adults engage in CMC and related forms of asynchronous education? First, as noted by Eastmond (1998), rapidly changing societal and work environments demand continuous learning. Second, the demographic data show that nontraditional students (over twenty-five, part-time, working, residing off campus) are the new majority. They are pursuing education for career

development, job security, upward mobility, recareering, and other professional and personal reasons (Eastmond, 1998). All these factors have driven learners online.

The following benefits are associated with CMC:

- *Flexibility*. The major benefit CMC provides is flexibility. It offers flexibility to both learners and instructors (Steeples et al., 1996). Freeing people from the constraints of timing and location, CMC opens up opportunities for many students. Such students include including people with a disability that restricts their regular attendance on campus and women who have caring or family responsibilities. CMC enables disabled people and women to tailor their study around restraints upon their time and mobility.

- *A large audience*. CMC promotes an active exchange of information among a large number of individuals (Hilitz, 1990).

- *Interaction*. CMC can supplement and significantly improve the quality and frequency of interactions between instructors and students (Downing, Schooley, Matz, Nelson, & Martinez, 1988).

- *Quality*. In CMC discourse, students are reported to ask more challenging questions, and instructors are reported to provide high quality responses to students' inquiries (Downing, Schooley, Matz, Nelson, & Martinez, 1988).

- *Privacy*. CMC differs from either face-to-face communication or communication by paper in that it offers a private channel of communication (Koschmann, Kelson, Feltovich, & Barrows, 1996). In CMC discourse, students do not have to listen to compulsive talkers, for message from compulsive talkers can be skipped or ignored without breaking the rules of social interaction (Smith, 1988). Moreover, immediate feedback which enables learners to see the results of their work without embarrassment and in privacy.

- *Equality*. The nature of CMC environments promotes a democratizing effect (Dubrovsky, Kiesler, & Sethner, 1991). Equal access enables participants to have more confidence in themselves. It greatly benefits women participants. As noted by Dubrovsky, Kiesler, and Sethner (1991), in face-to-face interactions, women are often forced into a facilitation role and many times

lose turns to speak in conversations. Conversely, in CMC discourse, women are able to express themselves more easily and fully, without interruption. Furthermore, CMC learning environments can be geared to positively capitalize upon women's team-playing and cooperative skills.

_ *Responsibility.* CMC tend to increase student responsibility for learning through greater individual and group instructional strategies.

_ *Skills.* CMC leads to the development of keyboarding skills which may assist adults in acquiring a basic employment skill.

_ *Visual format.* CMC can present complex instructional material in concrete visual formats which depict social events or scientific phenomenon.

_ *Addressing individual needs.* CMC has the potential to accommodate different instructional needs and learning styles of adults.

CMC also has some disadvantages.

_ *Slow communication.* CMC is a typed communication, requiring people to write on the computer screen. Compared with oral communication, it can be very slow (Koschmann et al, 1996).

_ *Lack of cues.* Although CMC is a private channel, it is just a narrow channel. Unlike spoken discourse, CMC does not provide any tonal or gestural cues (Koschmann et al, 1996; Chapanis, 1988).

_ *Source of distraction.* When multi-media is corporated into a learning project, video displays can serve as a powerful distraction, luring participants from the real task at hand (Koschmann, et al., 1996).

_ *Information overload.* The use of the Internet contributes to information overload (Gilbert, 1998).

The Effectiveness of Computer-Mediated Communication

A study by Grabowski, Suciati, & Push (1990) found that full-time students, doctoral students, students with an assistantship, with no children, a part-time job, consulting, or no job are the most likely users of electronic mail or CMC. Another finding was that more international students than nationals used electronic mail. One explanation is that international students who

have language difficulty may find it easier to communicate via written word. Another explanation is that international students may be more interested in the use of the technology.

The following factors are identified as encouraging use of CMC: easy access, no time/place limits, knowledge of computer, and ease of use. The following factors are identified as inhibitors: no need and no modem access. Convenience and technical skills are found not as important in their decision to use electronic mail.

The results of an experimental study by Schutte (1997) show that compared with students in a traditional classroom, virtual students communicated more with fellow students, spent more time on class work, were more likely to think they had more flexibility, showed a greater understanding of the material, and were more positive toward the subject of the course. In a word, virtual interaction produces better results. However, virtual students seemed more frustrated. Their frustration stemmed from the inability to ask questions of the professor in a face-to-face environment.

When, therefore, is mediated learning effective? The answer is that effective mediated learning occurs when students perceive that they are personally involved in the educational process (Holmberg, Schuemer, & Obermeier, 1982). In such cases, effective mediated education takes the form of a didactic conversation conducted between the teacher and the students. System design has great impact on the effectiveness of mediated learning, such as, for example, instructional TV (Hackman & Walker, 1990). One measure of the effectiveness of the delivery systems is to see how well the systems can meet instructional needs. Systems are considered most effective when they include the following three elements: 1) two-way communication capabilities, 2) high levels of interactivity, and 3) user control (Ellis & Mathis, 1985; Hough, 1984; Kozma, 1986).

Another important factor that has great impact on the effectiveness of mediated transmission is the degree of social presence that is conveyed in computer-mediated communication. By social presence, we mean the ability to approximate the characteristics of face-to-face interactions (Short, Williams, & Christie, 1976). As we know, face-to-face communication is very effective in dealing with relationship initiation, negotiation or conflict resolution (Rice, 1984). Compared with face-to-face communication, written communication is less effective in accomplishing these high social presence tasks.

One aspect of social presence is immediacy, which is defined by Mehrabian (1969) as behaviors that "enhance closeness to and nonverbal interaction with another" (p. 203). The study by Hackman and Walker (1990) also found that several teacher immediacy behaviors were closely related to perceived learning and satisfaction. These teacher immediacy behaviors include using personal examples, encouraging students to participate, using humor, addressing students by name, providing individual feedback, inviting student contact, praising students, smiling, avoiding tense body position, and using vocal variety. Provided with such teacher immediacy behaviors, students found it easier to ask questions or make comments in class. Moreover, "distant students were more likely to feel a sense of rapport or companionship with in-class students when the instructor smiled and encouraged those off campus to talk."

In short, the results of the study show that system design and teacher immediacy behaviors have tremendous impact on student learning and satisfaction in the televised classroom. Interactive systems are strongly correlated with perceived student learning and satisfaction. Students tend to consider instructors more favorably when they use strategies for enhancing social presence such as encouraging involvement, offering individual feedback and promoting a relationship with off-campus students. Instructors are rated most fair and effective when they manage to shorten the psychological distance between themselves and their distant students.

Implications of Computer-Mediated Communication for Educators

Like traditional classroom environments, CMC learning environments need ways to sustain interest and stimulate participation. Because of this, online instructors are confronted with many challenges. To effectively assume their online duties and responsibilities, instructors need to adopt proactive roles to stimulate continuing participation (Steeples et al, 1996).

The ways in which instructors can encourage active participation in online learning environments also has implications for those who design such systems in the first place. First, instructors can pose questions to learners and stimulate them to generate an active response. Second, they can help establish electronic communities, which can link geographically-dispersed people based on their common interests. Third, instructors can assign one or two dedicated individuals to coordinate and stimulate computer-mediated discussions. At the very beginning, instructors themselves have to take the lead in generating lively discussions; subsequently, leadership roles can be distributed as students can take turns to act as facilitators, the

phenomenon of "teacher decentering" (Courtney, 1997, 1998). Playing such roles can gain the respect and active support of their peers (Steeples et al, 1996).

Instructors should not allow the facility to be a distraction to students. They should place the computer monitors into the desktops so as to minimize interference with the lines of sight among classroom participants (Cornell, Luchetti, Mack, & Olson, 1989; Kay, 1991). Institutions and individual instructors should provide students with structured learning materials, optimal opportunity for quality dialogues between students and instructors (Moore, 1991).

Ultimately, instructors must devote time and effort to understanding the needs of learner populations. Based on the needs of their students, instructors must carefully design the content to be taught, determine the exact learning objectives, the type and frequency of learner exercises and activities and evaluation procedures, and the relationship between the learner and instructors (Moore, 1991). When technology is thoughtfully incorporated into a teaching program, it cannot only provide different ways for learning, but also help learners to build upon their strengths and extend their knowledge and abilities (Savini, 1995).

World Wide Web

According to constructivist learning theory, Web-based teaching has potential to produce superior results in several areas, including active learning, individualization, cooperative learning, critical thinking, contextual learning, and learning to learn (Bazillion & Braun, 1998). Web-based teaching can enhance learning in the following ways, taken directly from Bazillion and Braun:

- *Active learning.* Students no longer assume a passive role but actively construct knowledge by exploring Web sites, experimenting with search engines or new ways of seeking information, manipulating things, engaging in discussion of found Web sites, seeking out other Web sites that complement or contradict, or constructing a new knowledge base.

- *Individualization.* Students are able to explore other learning styles and find out what works best for their cognitive abilities.

- *Cooperative learning.* Through peer motivation, involvement, and approval, students gain skills in negotiation and team building, besides learning from each other.

_ *Critical thinking.* The WWW provides valuable examples of primary sources
and other resources that invite the learner to examine ideas critically and to put
them into the context of the topic under discussion.

_ *Contextual learning.* Opportunities for gaining better understanding, e.g.,
increasing the knowledge base can include many sites relating to specific
topics that can be examined and evaluated.

_ *Learning to learn.* Students go beyond traditional memorization of facts and
fundamentals to the acquisition of learning skills, e.g., electronic research skills,
that they can transfer to other courses and later on to their personal and
professional lives.

Designing Computer-Mediated Learning Environments

Many of the suggestions and much of the advice about how to design courses and
programs for the web and how to encourage online learning rest on the assumptions and findings
about learning and learners presented in Part 2 of this report. In order for online learning to
succeed, the design must assume the following: adult learners active in the construction of their
own knowledge, at times interacting with each other in collaborative or collective forms of
inquiry and at other times behaving as self-directed learners, around tasks that simulate real-
world areas of work and practice.

Koschmann, Kelson, Feltovich, and Barrows (1996) have identified four steps for theory-
based learning designs:

1) Articulate the desired instructional features of the planned innovation.

2) Analyze current practice in the light of the design goals.

3) Develop a specification based on both the instructional requirements of the setting and
the known capabilities of the proposed technology.

4) Produce an implementation that allows for adaptation to instructional practice.

"Developers of instructional software should try to accommodate variability across
classrooms by designing their systems to be sufficiently flexible to support differences in local
pattern of use" (pp. 117-118).

Based on the findings of his study of naive email users, Russell (1996) makes four
recommendations for instructional designers of courses:

- Use a novel relevant real-life task to encourage the student to jump the hurdle of the processes in order to become involved in the task (see Part 2 under authentic tasks and environments)

- Introduce the six stages for learning a new technology to students before they commence a computer course (reflects the importance of prior knowledge, as discussed in Part 2).

- Provide a nonthreatening environment with extensive technical and moral support during Stages two and three when self-esteem can be low and problems are not easily solved by a naive learner. McInerney, McInerny, & Sinclair, (1994) suggest that students will develop confidence if the learning environment is non-threatening. (See above under "motivation—control and self efficacy.")

- Encourage students to articulate their *metacognitive* experiences in relation to the six stages. When students verbalize their learning, they can identify where they have come from, where they are now, and the vision of success. The act of interacting with the six stages in order to clarify their own learning situation objectifies their learning and may remove negative subjective thoughts.

To make good use of the computer technology, learners have to acquire sophisticated Internet skills. As described by Cahoon (1998), Internet skills refer to the ability to use a variety of Internet client software, particularly Web browsers, e-mail programs, news readers, and FTP (file transfer protocol) clients. A skillful Internet user is expected to be able to send and reply to e-mail, search for archives, and participate in Web-based conferences or newsgroups. Successful application of these skills to real-world situations requires conceptual understanding as well as the memorization of step-by-step procedures (Cahoon, 1998).

Creating Online Learning Communities

There are three major challenges for the designers of an online educational environment, according to Wiesenberg and Hutton (1996):

- increased time for delivery of the course (two or three times what is necessary for a traditional course),

- creating an online community,

encouraging students to become independent learners (See above under "self-direction").

Benefits of Online Courses

Online learners report attitudes of greater control and responsibility toward their learning; students also find that online writing, because it is the major form of communication with the instructor (Courtney, 1997), demands greater reflection than speaking (Harasim, 1990; Rohfeld & Hiemstra, 1994).

Studies show that online components of traditional courses substantially increase the communication between the teacher and the students and among the students, when compared to similar writing classes without computer communication (Hartman et al., 1991; Hiltz, 1990; Schrum, 1998; Schrum & Lamb, 1996).

Electronic communication appears to foster collaboration and group interactions. (Schrum, 1998).

Disadvantages of Online Courses

Online forums lack many of the cues that govern ordinary social interaction, such as eye contact, body language, facial expressions, and voice tone. Facilitating online learning is a great challenge for instructors and involves many responsibilities:

Creating the environment, guiding the process, providing points of departure, moderating the process, managing the content, and creating community, strategies for creating a sense of community include establishing ground rules and expectations, using introductions and icebreakers, suggesting ways for connecting participants off-line, and involving participants directly in the process of community creation by inviting participants directly in the process of community creation by inviting their ideas on ways to make this happen. (Holt, Kleiber, Swenson, Rees, & Milton, 1998, p. 48).

In order to create online learning communities, instructors and designers must consider the nature of the interaction that may occur and the type of interaction that is to be reinforced. Schrum (1998), for example, has identified three types of potential interaction: Learners can interact with the content, the instructor, and the other learners. In traditional courses, there is great variability in the amount of interactivity. Because many traditional courses are delivered via

lectures and students are busy taking notes, there is only limited interaction. With students being online, online opens up great possibilities for broadening interaction (Schrum, 1998).

First, students can interact with the content in various ways. As shown by research literatue, self-regulation and active participation play a vital role in the process of learning. In light of this, instructors might explore a wide range of possibilities to stimulate content interaction. They may require students to post comments on readings, provide links to previously evaluated Internet resources, or allow students to access instructors' personal notes and pertinent questions. Instructors can also ask students to post other products of their work, such as essays, scanned images, and Web pages (Schrum, 1998).

In terms of the interaction between instructors and students, Laurillard (1993) has identified four ways of supporting such interaction in an electronic environment. The four ways are: 1) using discursive language to understand each other's conceptions, 2) enhancing adaptiveness, 3) conducting frequent activities for students to demonstrate their understandings, and 4) reflecting frequently on the students' work (Schrum, 1998).

In addition, instructors can design collaborative student work. Group activities can take various forms. These forms include solving a problem, creating a simulation for others, designing a product, or completing a task. What's more, groups can be created via self-selection based on the type of project students would like to do and their work styles. Groups can also be created heterogeneously to simulate a work situation (Schrum, 1998).

Finally, student interactions may occur synchronously or asynchronously. Instructors have to decide which type of interaction is appropriate for student activities. The asynchronous model, for instance, may work better for tasks that require thought and reflection than the synchronous model. On the other hand, "synchronous activities require careful structures, advance organizers, and monitoring" (Schrum, 1998, p. 57).

Designing Courses for Online Instruction

In the process of designing online instruction, as noted by Schrum (1998), people have to pay attention to a number of pedagogical and organizational concerns.

Pedagogical Concerns.

Pedagogical issues include the identification of learning goals. philosophical changes in teaching and learning, reconceptualization of the teacher's role. evaluation of student and instructor, and the stimulation of interactivity (Schrum. 1998). Before designing the course,

designers should ask the following questions: What is purpose of this course? What are the instructional and personal goals of this course? (Schrum, 1998).

In terms of design, there are two options for course designers. They may choose to redesign an existing course or create a new course. Whatever they do, they have to remember it is unwise to simply transfer an old course to a new medium. Course designers have take the following into consideration: the structure of the course, the planning for educational and personal needs, and the teacher's role. Designers will have to make decisions as to what actions lead to the promotion of the active and independent learning characteristic of successful online courses. Designers also have to consider relevant materials and negotiated assignments that stimulate participation, involvement, and action (Schrum, 1998). Assignments that work well in a traditional classroom may be used as a starting point. As online courses are different from traditional classes, instructors must consider how these assignments could work as an online experience (Schrum, 1998).

Online teaching requires a different type of evaluation.

"Evaluation must be ongoing and continual; relying on one midterm and a final paper would put students at a disadvantage. It may be wise to plan several points during the term when students will provide anonymous feedback about the course. Some faculty include one question each week that requires students to discuss aspects of the content, interactions, and effective qualities of their online experience" (Schrum, 1998, pp. 56-57).

Organizational Issues.

There are four organizational issues concerning online instruction. First, instructors have to decide how much of the course will be online. Second, instructors have to think about the timing of the course. They should make it known to learners when to start and when to finish the course. Third, instructors have to determine what types of assignments and interactions that are to be included. As group size may influence communications patterns and affect the workload of instructors, a group of fifteen to twenty students has been suggested to be a manageable group for interaction and for instructors. Finally, instructors should specify the prerequisite computer skills expected of the students. It is of particular importance to give students a list of assignments, readings. expectations, and rules for 'netiquette' from the very start (Schrum, 1998).

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PART 4. Summary and Conclusions: Implications for the Design and Delivery of Technology-Based Learning Systems

Sean Courtney, Ed.D., and Jiali Luo

Overview

What we have attempted to do in this report is, first, to describe the characteristics of adults as learners, particularly those that empirical research has demonstrated to be central to the learning process; second, to suggest how technology, particularly computer-mediated forms, are impacting the learning process; and finally, to offer recommendations to technology users for ways to improve learning experiences online. In this, the final part of the report, we gather these recommendations together under two headings: implications for design based on characteristics of the learning process and implications for design based on user experiences. Again, we take this opportunity to note Morris's (1994) contribution to this topic, in the exceptionally detailed analysis and recommendations he makes concerning use of computers by older adults. The following set of implications is intended to complement his work.

The basic model for designing programs to help groups and individual learners reach their goals derives from traditional instructional design theory (Andrews & Goodson, 1980). This assumes a teacher, facilitator, or guide who designs the system and in doing so has access to information on learners and their background characteristics. Instructional design assumes further that someone–a live instructor–will interact with the learner to ensure that the educational program will meet its objectives. Over time, this model has been found to contain essential inadequacies, particularly in its inability to capture "situated" or contextual demands that live users of the model inevitably encounter as they seek to put the models into practice (Streibel, 1989; Suchman, 1987). That being the case, learning systems of the future will likely need to operate within two basic parameters:

- Individual learners acting in self-directed manner, defining their own goals, designing the methods and approaches best guaranteed to reach them and evaluating how and when they have achieved them; and

- Self-directed groups or teams of learners acting in collective or collaborative fashion to reach group or organizational goals.

Both groups will rely with increasing need and confidence on computer-mediated and related technologies to help them achieve their goals. At the same time, future learners will be engaged in a dual task: mastery of a particular content related to the task at hand and mastery of a learning process. In other words, learners will be learning as they go on two fronts. And designers of learning systems will have to consider how to build in learning supports to facilitate that process. While computer-mediated learning is still in its infancy, system designers can begin to draw inferences from what is currently known about adults as learners in their efforts to facilitate the learning process.

Principles of Design Based on Characteristics of Adults as Learners

1. *Active Construction and Prior Knowledge:* Adults actively build up new conceptions and misconceptions of subject matters, in the process of which the structure of prior knowledge plays a key role.

Implication: In order to be effective, computer based learning designs (CBLD) must provide for ways in which current conceptions can be interrogated to discover their errors, faults, and limitations. This requires designs which are interactive.

2. *Metacognitive Awareness or Learning to Learn:* Learners will be more successful the more they know about how to learn–metacognition; especially that the customary ways of doing things are not natural but learned responses to intellectual challenges and practical tasks.

Implication: *CBLD* should experiment with systems that provide metacognitive 'scaffolding' *to help* learners teach themselves even while learning the content. The more a system is 'self-regulating' in terms of its inbuilt generativity as a learning system the more useful it will be in the long run.

3. *Authenticity and Experience:* Adult learners benefit most from learning situations and contexts that are *situated* and mirror the reality of daily life.

Implication: *CBLD* which include 'microworlds' and simulations of real environments and task situations are more attractive to learners and likely to be more successful in the long run.

4. *Motivation and Self-Confidence:* Adults motivate or demotivate themselves depending on the stories they tell themselves and how they perceive themselves as learners.

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Implication: While designers cannot take account of the natural levels of self-efficacy that learners bring with them to the task of learning, CBLD should strike a balance between systems which contains too much challenge and those which contain too little.

5. *Motivation and Community:* Adults derive significant dimensions of their motivation to learn from the communities of practice in which they are embedded. Through these communities of mainly work-based practice, learning tasks derive their authenticity and significance.

Implication: CBLD should find ways to link learners together either physically, where possible, or symbolically, where not. This is especially critical for those populations who appear to lack such communities, e.g. disadvantaged marginalized groups.

6. *Motivation and Self-Direction:* Being self-directed for many adults means having all or some control over the goals, methods, and outcomes of the learning process.

Implication: CBLD need to create systems that respect this desire for independence and self-direction, that contain open 'spaces' in which learners can create their own parameters for learning, including 'stop out' points when learning tasks can be naturally abandoned for short or long periods of time.

7. *Learning Style:* While the evidence for the various distinctions is at best equivocal, it appears that learners approach learning tasks from a variety of basic cognitive stances, some of which favor concrete experience, others of which favor analytic theorizing.

Implication: Combining this information with what we already know about the need for realism and authenticity in tasks suggests that CBLD can play it safe on this question of styles with designs which, where appropriate, build three-dimensional color and sound into basic linguistic structure of the text.

Principles of Design based on Experience with Computer-Mediated Teaching and Learning.

8. We live in an age when more and more technologies are being designed to be 'friendly': to be capable of operation within minimum of prior training. Gas stations are a good example. The gas station of today invites the consumer (potential learner) to pump her own gas and even pay for it 'on site' without a transaction with the service provider. The success of the enterprise depends on

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the consumer's willingness to "learn" the system (a premise which is at the heart of the learning-as-participation paradigm) and on the company's provision of 'job aids'–the guides on the pump provide to ensure that the learner will experience successful 'practice.' There is little room for 'error'; if the learner experiences frustration using the system he will quickly abandon it.

Implications: Similarly, CBLD systems should be seen as advanced, sophisticated versions of the gas station; they must provide 'job aids' and build in lots of support in order to guide the learner through problem-solving exercises, to a successful exchange with the system and the goal of competent performance, all with a minimum of error.

9. Anxiety and resistance associated with learning using CBLD has much to do with the strangeness of the computer as a tool for learning and the computer environment as a learning space, though that fear is lessening daily. At the same time anxiety is produced the more abstract is the task and the less it has to do with current work or life considerations.

Implications: Designers need to find ways to make computer use as familiar as the current use of everyday tools, e.g. the toaster, the copy machine. At some level, the system must be designed not only to be interactional (a point made earlier) but to be capable of 'speaking' with the learner (see, e.g. Suchman's [1987] work with users of Xerox copiers). Ultimately, the learner must see the computer almost as a 'humanoid': still a machine but capable of helping him or her solve practical problems in a human way.

10. Research on the effectiveness of computer-mediated instructional systems suggest the form may be more successful than the synchronous classroom, but that some of the success has to do with the interactivity among learners, partly because the instructor is less available.

Implications: CBLD need to consider the establishment of 'support networks'—"social presence"—to make it less likely that learners will drop out of the system when problems are encountered and to deal with ongoing issues of motivation and volition.

As we prepare for the 21st century, there are forces at work which make it likely that computer-mediated learning and instruction will become an everyday reality for the ordinary citizen.

Issues of Access: First, more and more adults express a desire to participate in learning and education at times and sites that are convenient to them. Increasing familiarity with the computer and the Web make it likely that computer based asychronous learning systems will become increasingly the educational option of choice when compared with traditional synchronous forms such as the school or university. At the same time, there is the danger of the computer haves and the computer have-nots. The history of adult education in the U.S. is one which suggests that those who appear to be the greatest beneficiary of the official educational system are also those who to continue to use it to fulfil personal aspirations and organizational mandates (Courtney, 1992). How then do we attract to systems of 'learning on demand' those who have been alienated from the learning enterprise in general and do not associate it with the fulfillment of needs or personal ambition?

Institutional Demand: Postsecondary institutions around the country appear to be looking increasingly to technology as a way to solve problems of falling roles and rising costs. While the possibilities for curriculum reform presented by the new technologies are exciting, there is a bottom line that administrations is increasingly attune to. Rising overhead and huge fixed cost per student make it likely that American universities will look overseas at the success of the 'mega'universities in Asia and Australia as models for future provision.

New Technologies: Even while administrators, educators and learners struggle to keep up with the current systems new and more spectacular systems appear ready to come 'online'. Mastering these various forms is perhaps one of the greatest challenges facing the field of postsecondary education into the next century.

New Cultures of Learning: In conjunction with the arrival of the new interactive distributive multimedia (Pea, 1996), educators are increasingly questioning the old ways of doing business and the continuing utility of the twin pedagogical "isomorphisms" (Jaffee. 1998): the teacher-centered curriculum and the classroom-based learning milieu. Moving from an

instructional delivery paradigm to a facilitation-of-learning paradigm will be among the most significant of the upheavals that institutions of higher education are likely to experience over the next decade or so.

In short, these and others are forces at work which guarantee that new generations of learning technologies will emerge and be needed to meet the increasing challenges of life and learning in the 21st century.

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PART 5 Web Access for Adult Learners with Special Needs

Stanley Vasa, Ed.D., and Virginia Muggy

Overview

The intent of this report is to share knowledge of adult learners with special needs and the characteristics that are associated with disability categories in order to provide this population the same opportunities as other adult learners in using computer-based systems for information and instruction. In presenting this information, it is hoped that an awareness of and sensitivity to accessibility issues will be fostered. Numerous general and specific design suggestions are supplied to meet the needs of adult learners with special needs. In addition, design implementation is scaffolded through provision of additional resources for accessible computer-based systems of information and instruction.

Characteristics of Adult Learners with Special Needs

A subset of the population of all adult learners is adult learners with special needs. These individuals are members of a heterogeneous group with ample capabilities who also acquire at birth or through accident or illness, a disability. The adult learner with special needs is an individual with a disability who benefits from environmental accommodations. Recognizing and providing accommodations to compensate for individual differences, allows the adult learner with special needs to have the same opportunities as other adult learners. To reduce environmental barriers, accommodations are designed to maximize the individual's strengths and minimize the limitations inherent with a disability. For example, individuals with corrective vision have a special need for eyeglasses in order to perform the same functions as those without glasses. In fact, eyeglasses compensate so well for so many that individuals with corrective eyewear are typically no longer disabled.

Frequently, individuals with a disability face challenges because physical and social circumstances are imposed that ignore their special needs (Andrew, 1994; U.S. Department of Commerce, 1994; Vanderheiden, 1990; Weisgerber, Dahl, & Appleby, 1981). In order to perform the myriad of activities that constitute daily living, working, and learning, three critical skills emerge. These life performance skills include the ability to 1) communicate, 2) process and retrieve information, and 3) perform physical movements. For adult learners with special needs varying degrees of environmental accommodations, from simple to intensive, are necessary to

perform these life skills with maximum independence and self-reliance (Weisgerber, Dahl, Appleby, 1981).

A total of forty-nine million people with disabilities reside in the United States (U.S. Department of Commerce, 1994). There are many ways of grouping these individuals. For the purposes of this report, disabilities are grouped to reflect four primary categories: vision impairments, cognitive disabilities, hearing impairments, and movement disabilities. Although categories and labels are not indicative of an individual's capabilities, they do provide some understanding of functional challenges common to individuals with a particular disability. Life performance challenges and general characteristics of adult learners with special needs that may be associated with each of the four disability categories are described.

Vision Impairments

Adult learners with visual impairments have varying degrees of life performance challenges in communication and movement. For these individuals, vision challenges persist even with correction (e.g., glasses, contacts). This disability category is comprised of individuals with no vision, low or limited vision, and color blindness.

A multitude of information is gained through sight. One's visual acuity and field of vision influence the use of sight as an efficient means of obtaining information. Visual acuity indicates how well a person can see at various distances. Normal visual acuity is described as 20/20. For example, an individual whose vision is 20/20 sees an image accurately 20 feet in the distance, whereas the individual whose vision is measured at 20/40 sees at 20 feet what others who do not need visual correction see clearly at 40 feet. Field of vision, measured in degrees, is the ability to perceive objects in a wide area. Typically, most individuals have a central field of vision greater than 20 degrees as well as peripheral vision, the ability to perceive objects outside the central line of vision.

No Vision. An individual with no functional use of sight must use other sensory mediums such as touch and hearing in order to learn. The terms "totally blind" and "legally blind" describe the inability to distinguish sizes, shapes, distances, and motion (Andrew, 1994). The term "legally blind" indicates that an individual's central visual acuity with the best correction in the better eye is less than 20/200 or the individual's field of vision is less than 20 degrees at its widest point.

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Low or Limited Vision. An individual with low or limited vision may use some sight to learn and perform tasks. However, even with corrective eye wear, these individuals continue to have serious difficulties with either peripheral vision, focusing, seeing at a distance, or at close range. Typically, individuals with visual acuity measuring 20/70 to 20/200 in the better eye with correction are considered to have low vision. Individuals with limited vision (e.g. tunnel vision) have a significantly restricted visual field.

Color Blindness. Individuals with color blindness cannot distinguish between some colors. For example, an estimated nine percent of all adults cannot distinguish between the colors blue and yellow or the colors red and green (Vanderheiden, 1990). In addition, these individuals may have difficulties with contrast.

Characteristics of individuals with vision impairments include but are not limited to restricted use of graphic or pictorial materials; restricted use of written or printed information; difficulties with contrast, spatial orientation and mobility, and an inability to distinguish colors.

Cognitive Disabilities

Adult learners with cognitive disabilities have varying degrees of life performance challenges with communication, cognition, and/or movement. This disability category includes individuals with a specific learning disability, mild mental retardation, traumatic brain injury, and attention deficit disorder.

Unlike vision and hearing impairments that indicate a sensory deficit, cognitive disabilities indicate a processing deficit. The ability to conceive and retrieve information and knowledge are basic functions of the central nervous system which includes the brain and spinal cord (Andrew, 1994). Central nervous system or neurological dysfunction ranges from mild to severe and has many presumed causes both documented and inconclusive.

Specific Learning Disability (SLD or LD). SLD is typically identified during the school years (Andrew, 1994). An individual with a specific learning disability has average or above average intelligence but does not learn in the same way or as efficiently as peers in all subjects. The discrepancy between ability and performance typically occurs in one or two areas but not all areas which include spoken language (listening or speaking), written language (reading, writing, spelling), arithmetic (calculating, conceptualizing), and reasoning (organizing and integrating thoughts). This difference cannot be explained by or attributed to a mental, visual, hearing, or

motor impairment. SLD includes the terms *dyslexia* (reading), *dyscalculia* (math) and *developmental aphasia* (language).

Mild Mental Retardation (MMR). Mild mental retardation refers to below average intelligence with an associated mild impairment in family, social, or vocational functioning. Individuals with mild mental retardation learn, but do so at a developmentally slower pace than their peers. As adults, most function within the community, are gainfully employed, and live successful lives (Andrew, 1994).

Traumatic Brain Injury (TBI). This disability is characterized by an acquired external injury to the brain that results in the individual experiencing reduced cognitive functioning, limited attention, impulsivity, confusion, and/or disorganization. Injury to the brain may be diffuse or confined to a specific domain which results in varied levels of cognitive functioning. TBI includes the term *acquired aphasia*.

Attention Deficit Disorder (ADD). ADD indicates a persistent pattern of inattention and/or impulsivity. A portion of these individuals also experience hyperactivity. The individual identified with ADD has such an extreme degree of inattention and/or impulsivity that cognitive functioning is impaired.

Individuals with cognitive disabilities typically exhibit one or more of the following characteristics: difficulties with reading and comprehending what is read; limitations in writing and mathematical calculations; poor motor coordination and fine motor skills; and/or deficits with memory, attention, generalization, inference, problem solving strategies, planning and/or organization.

Hearing Impairments

Adult learners with hearing impairments have varying degrees of life performance challenges in communication. This disability category includes individuals who are deaf and hard of hearing. For these individuals, hearing difficulties persist even with a hearing aid to amplify sound.

Like sight, much information is gained through the sensory medium of hearing. The use of hearing as an efficient means of obtaining information is influenced by two factors--the degree of hearing loss and the age of the individual when hearing loss occurs.

Hearing is measured by using hertz (Hz) and decibels (dB). Hertz measures frequency or the number of vibrations per second which is perceived as high and low pitches. High pitches

have high frequencies/numbers and low tones have low frequencies/numbers. Decibels measure intensity or loudness with 0 dB representing the softest sound that is normally heard. Typically, most individuals hear sounds that range from 20 to 20,000 Hz and can hear decibel levels occurring from 0 to 120 dB. Speech, for example, measures from 250 to 4,000 Hz and 10 to 60 dB. Sounds measured at 85 dB and greater are considered hazardous to one's hearing health.

As important as the degree of hearing loss is the age of the individual when hearing loss occurs. Individuals who are born or become deaf before they learn to speak and understand language have different needs than those individuals who lose the ability to hear after developing language.

Deaf. Individuals who are deaf cannot use hearing as their primary way to gain information. A hearing loss of 60 dB, the equivalent to normal conversation, is considered severe.

Hard of Hearing. Individuals who are hard of hearing may use some sound, with the help of a hearing aid, to obtain information, perform tasks and communicate. Individuals with hearing losses from 20 to 60 dB are considered hard of hearing.

Common characteristics of adult learners with hearing impairments are limitations in speech production and reception, difficulties with balance and motor coordination, and in many cases limited language development resulting in reading and writing skill challenges.

Movement Disabilities

Adult learners with movement disabilities have varying degrees of life performance challenges with movement. This disability category includes individuals with cerebral palsy, spina bifida, muscular dystrophy, and multiple sclerosis as well as individuals who are temporarily or permanently without the use of a limb either congenitally or as a result of injury. Also included in this disability category are individuals who have other health impairments (e.g., arthritis) that result in limited strength.

Individuals with movement disabilities experience various motor limitations including paralysis, extreme weakness, and total or partial inability to voluntarily coordinate muscular movements. Movement disabilities range from mild to severe with associated accommodations ranging from simple to intensive. For example, an individual with cerebral palsy may require multiple accommodations as compared to the individual with a casted hand.

Cerebral Palsy (CP). CP is nonprogressive, congenital disorder of movement and posture characterized by limited control of muscle groups which control motor functioning. The three main types of cerebral palsy are spastic, stiff and exaggerated motions with involuntary muscle contractions; athetoid, involuntary and uncontrolled movement; and ataxic, inability to coordinate movement producing difficulties with balance and depth perception. CP may be associated with a number of other disabilities (Andrew, 1994).

Spina Bifida. Spina Bifida, an incomplete closure of tissue surrounding the spinal cord, results in movement disabilities ranging from paralysis to muscle weakness.

Muscular Dystrophy. Muscular Dystrophy is an exceptionally rare and progressive disease that weakens and then destroys the affected muscles of the individual.

Multiple Sclerosis (MS). MS is a chronic disease of the central nervous system with a typical onset between the ages of twenty and forty. MS begins as a weakness in one or more of the extremities followed by a variety of greater functional limitations as the disease progresses through the years.

Overall characteristics of individuals with movement disabilities include but are not limited to limitations in mobility, manipulation, and coordination.

Models of Instruction for Adult Learners with Special Needs

Instructional models for adult learners with special needs mirrors the general population. Like all adult learners, individuals with special needs have had unique life experiences and pursue opportunities to learn in order to satisfy interests and assimilate and manage life changes (Davis & McCallon, 1974). Additionally, all adult learners need to be physically and psychologically comfortable for learning to occur (Davis & McCallon, 1974). One emerging and powerful information resource and instructional model is computer-based systems. The World Wide Web (WWW) is an example of such a system.

Computer-based systems offer unlimited diversity, adaptability, and immediacy as a model for information and instruction. The primary benefit of web use is the potential ease in which multiple sources of up-to-date information from public and private industries, organizations, and institutions can be searched, accessed, downloaded, and responded to interactively (Boone & Higgins, 1998). As of January 1998, a total of five million web sites exist (Wissick & Gardener, 1998).

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The features that make the web appealing for all adult learners are the same features that benefit the population of adult learners with special needs (Peters-Walters, 1998). For example, individuals interested in vision impairments may access a single address (http://www.yuri.org/webable/search.html) to find an additional 200 web site links on vision impairments. Additionally, for adult learners with special needs, the WWW potentially presents the ability to participate in our information-oriented society more effectively than ever before from one's home and in one's preferred modality (U.S. Department of Commerce, 1994).

Implications and Recommendations

As an instructional model for adults with special needs, gaining competencies in using computers in general and utilizing the World Wide Web specifically shows promise. According to Edyburn (1998), there are four levels of web proficiency. The first level is awareness, followed by basic, intermediate, and advanced skills. At the awareness level, learners know of the existence of the World Wide Web and where it is available. Basic skills include the abilities to locate and initiate a browser, enter a WWW address, and navigate within that web site. Intermediate skills include understanding how to conduct a search and knowledge of steps to save or print selected information. Individuals that create web sites and teach others how to use the Web are at the advanced skill level. Additionally, Wissick & Gardner (1998) suggest that familiarity with web terminology and the ability to evaluate the quality of web-based information are critical competencies.

A major hurdle for individuals with disabilities is access to this computer-based information infrastructure. Currently, most web page designs present multiple challenges for adult learners with special needs (Diversity Management Directorate, 1998; Gunderson, 1998; Horner, 1998; Jacobs, 1998; Letourneau, 1998; National Center for Accessible Media, 1998; Paciello, 1998; Peters-Walters, 1998; U.S. Department of Commerce, 1998; Vanderheiden & Chisholm, 1998). As a result of the *reasonable accommodation* mandate of the Americans with Disabilities Act of 1990 (ADA) and Section 508 of the Rehabilitation Act amended in 1992, protecting the rights of individuals with disabilities to access all telecommunication systems including computer-based systems for information and instruction (e.g., WWW) is considered to be a "national responsibility" (U.S. Department of Commerce, 1994). Provision of accessible information and instruction that is designed, developed, and tailored to maximize individual

strengths and minimize limitations for this population is needed and requires a "conscious, concentrated effort" (Kaplan & DeWitt, 1998).

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Access to the WWW by everyone regardless of disability is feasible and is the focus of several web site designers (Center for Applied Special Technology, 1998; Diversity Management Directorate, 1998; Gunderson, 1998; Horner, 1998; Jacobs, 1998; Letourneau, 1998; National Center for Accessible Media, 1998; Paciello, 1998; U.S. Department of Commerce, 1998; Vanderheiden & Chisholm, 1998). Accessible means that an individual with a disability can use the same resource to carry out the same task to acquire the same information with "the same ease, in the same time, and at the same cost" as an individual without a disability (Telecommunications Advisory Committee, 1997).

Developing and refining accessibility has been and continues to be an interactive, "evolutionary process" reflecting continual advancement in computer technology and computer-based systems for information and instruction (Boone & Higgins, 1998; Center for Applied Special Technology. 1998). When computer-based systems are developed and designed with an awareness of potential difficulties and available accommodations for all users, differences equalize between learners with and without disabilities (Stacy-Peters, 1998). Paciello (1998) maintains that once an awareness has been established, creating accessible information becomes a "mindset" and a matter of "routine".

To assist in creating both an awareness and a resource document for sharing web site design considerations to meet the needs of 49-million adults with special needs, a synthesis of both general and specific design considerations was compiled. Ten representative web sites on web design considerations were utilized. A description of individual web sites used for the synthesis is located in the appendix. Implementing these design suggestions for accessibility assures web authors that their information and instruction will reach the widest potential audience without sacrificing design elements (Center for Applied Special Technology. 1998; Letourneau, 1998; Paciello, 1998).

General Web Design Guidelines

General guidelines may be applied for developing well-designed web sites that are helpful to all learners. A well-designed web site enhances the user's ease in navigating and obtaining information. The following guidelines assist in creating an easy to understand, friendly environment.

1. Use simple language and straightforward displays by providing a clear description of the site's content and general layout.

2. Maintain consistent layout elements for all web pages within a web site. For example, navigation bars should be placed in the same location on each page. Choose a standard format for a template and duplicate the same HTML tags, headers, and logos, etc. for subsequent pages or utilize cascading style sheets that format pages simultaneously for screen, print, and synthesized-voice computers.

3. Include on each page, a meaningful title, a link to the site's home page, previous page, next page, and table of contents, if one is provided.

4. Nest headings properly.

5. Avoid the use of the phrase *click here* for links. It provides no useful information, instead present navigational links in both graphic and text formats.

6. Use vertical descriptive text for each link and vertical graphic links to increase distinctiveness and understanding.

7. Avoid browser specific HTML tags. To ensure a minimum level of accessibility, write in standard HTML version 2.0.

8. Avoid compressed formats that make files or programs difficult to download.

9. Use plain backgrounds instead of textured "wallpaper" backgrounds.

10. Use full text for dates. Days, months, and years have interchangeable positions dependent upon the native language or preference of the web designer. (For example, use August 19, 1998, instead of 8-19-98 or 19-8-1998).

Specific Web Design Guidelines for Adult Learners with Special Needs

Specific considerations for improved web accessibility for adult learners with special needs are presented by disability. It is important to note, as you read the following considerations, that an accommodation for individuals with one disability category may constitute a hindrance for individuals with another disability. For example, use of graphics creates a barrier for the individual who cannot see the page, but those same graphics may serve to clarify a concept for someone who struggles to understand the information.

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In keeping with the evolutionary refinement process of appropriate web design for all, these guidelines and considerations are not all inclusive. They are presented here with the understanding that they represent the recommended best practices to date in design considerations.

Visual Impairments

Of the four disability categories (vision, cognitive, hearing, and movement), adult learners with visual impairments and adult learners with cognitive disabilities, face the greatest barriers in gaining access to information using the WWW (Paciello, 1996). The highly visual properties of computer-based systems for information and instruction and the resulting imposed barriers are apparent. Typical environmental accommodations for these individuals are to use screen magnification software or a screen reader. Screen magnification software allows the user to enlarge all or a portion of highlighted graphics and text. A screen reader is another software program that translates the printed text on the screen to a synthesized voiced text. The reader, moving from left to right, vocalizes exactly what is printed with no interpretation. Individuals using screen readers may significantly improve their understanding of web pages when specific web page design considerations are implemented. Additionally, individuals with color blindness, who fail to distinguish between colors, are also impacted by web site design considerations. See Figure 1 for addressing web page designs for the special needs of adult learners with vision impairments.

Figure 1: Web Design Considerations for Adult Learners with Visual Impairments

Characteristics of Adult Learners with Visual Impairment	Web Design Considerations	Examples and Elaboration
restricted use of graphic or pictorial materials	Use separate descriptive text for all images and graphic information.	Examples: image maps, video files, tables, graphs, and photos. Some authors identify picture descriptions by placing a capital letter "D" near the image that is linked to the alternative text tag (ALT-tag). Include a brief description of what "D" represents and why.
	Use separate descriptive text for graphic navigational links or image submit buttons.	To judge the clarity of descriptive text, turn off browser's image downloading or use Lynx, a text-based browser.
	Include explanatory text on first screen.	Assists in identifying/describing home page so user may decide if web site is the one desired.
	Provide alternative text for each APPLET.	Describe the function of the application. If an applet gathers information provide an alternative.
	Avoid ASII art. Replace it with an image and alternative text.	Ask, Does this image convey information beyond what is in the alternative text description? Take the purpose of the image into account so that the provided text explains the intent of the image fully.
	Provide a link at the top of each page to allow user to move back and forth between text only pages and graphic pages.	Hopping back and forth between text only and graphic pages may be difficult and time consuming.
	Avoid functions that require a response within a specified amount of time.	User may not be able to locate control for response in allotted time.

Figure 1: Continued

Characteristics of Adult Learners with Visual Impairment	Web Design Considerations	Examples and Elaboration
restricted use of printed information and uses a screen reader to access printed text	Use style sheets to format document.	Style sheets are designed to simultaneously format a document for screen, print, and computer-synthesized voice ensuring accessibility.
	Do not use column formats or frames.	Screen readers may not recognize columns and will read the entire line in each column from left to right instead of down each column. Use a style sheet to eliminate the need to use frames and tables to format documents.
	Avoid long pages of unbroken text.	Screen readers translate text evenly without pauses or breaks unless open space is provided.
	Provide appropriate punctuation.	Screen readers pause when they detect periods, question marks, and exclamation points.
	Do not use blinking text tags.	Screen readers may not detect blinking tags.
	Avoid scrolling text.	Screen readers may not read at same rate as scroll feature.
	Avoid use of bullets. Use manually set numbers instead.	Screen readers do not detect bullets or numbered tag lists. Introduce lists with the number of items the list contains (e.g., There are five considerations.)
	Provide multiple formats for downloadable documents that are accessible to screen readers.	Example: Acrobat Reader.
	Avoid acronyms and abbreviations.	Screen readers may not recognize an acronym and pronounce it as a word. Or the acronym may stand for more than one title. If a web site must have an acronym or abbreviation. Use the ABBR and ACRONYM elements to denote.
	Do not bury links within a sentence.	Non-visual users are not able to detect links by color coding or underlining.

Figure 1: Continued

Characteristics of Adult Learners with Visual Impairments	Web Design Considerations	Examples and Elaboration
difficulties with contrast : background color or patterns may not be easily distinguished from text	Adjust control panel to monitor 256 shades of gray.	Assists in judging the ease of reading through discrimination between lightness and darkness.
	Design graphics with only 16 colors.	Ensures that colors do not change platforms.
	Use solid color backgrounds and avoid use of "wallpaper" backgrounds	Assists in providing clarity and discrimination between background images and text to be read.
difficulties with spatial orientation and fine motor skills	Keep screen uncluttered.	Leave space around all items to promote greater clarity and discrimination between elements.
	Use e-mail addresses or e-mail links instead of forms to be completed.	Boxes in fill-in-the-blank forms may be difficult to distinguish.
	Use vertical lists of links, instead of horizontal links.	Vertical lists improve discrimination between links.
ability to read with larger font size	Use legible fonts.	Some font styles are easier to read than others. For example, "Helvetica" with straight lines is easier to read than a flowery "Gothic" style.
	Allow for re-sizable fonts using relative sizing and positioning.	Screen magnification software to enlarge fonts and graphics for easier viewing may be used.
inability to distinguish between the colors blue and yellow and the colors red and green	Do not use background and print combinations of blue/yellow and red/green.	Users may not be able to distinguish.
	Provide site links in colors other than blue, yellow, red, or green.	Users may not be able to distinguish.
	Do not use color as the only means of conveying important information.	Users with color perception difficulties would not be aware of means to share information.

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Cognitive Disabilities

In addition to individuals with visual impairments, the other group of adults whose disability presents the greatest obstacle in gaining access to information using the WWW are individuals with cognitive disabilities (Paciello, 1996). Using the WWW is not an intuitive process (Peters-Walters, 1998). Currently, most browsers and web sites are predominantly presented in a text format for reading with little directions for navigating. Non-cluttered pages with clear, step-by-step directions for procedures and operation are important considerations for these learners. See Figure 2 for addressing web page designs for the special needs of adult learners with cognitive disabilities.

Figure 2: Cognitive Disabilities

Characteristics of Adult Learners with Cognitive Disabilities	Web Design Considerations	Examples and Elaboration
reading challenges	Reduce amount of reading.	Use graphics, graphic links, and image maps.
	Accommodate greater range of reading levels.	Simplify language. Use readability level checks available on some software.
	Do not use scrolling text.	User may not read at same rate as scrolling feature.
	Create an audio file.	Utilizes hearing as the means to obtain information rather than reading.
	Avoid functions that require a response within a specified amount of time.	User may not be able to read as quickly as allotted time.
	Follow design considerations for individuals with visual impairments who use a screen reader.	Screen readers may also be used by individuals with reading challenges.

Figure 2: Continued

Characteristics of Adult Learners with Cognitive Disabilities	Web Design Considerations	Examples and Elaboration
difficulties with comprehending what is read	Avoid long pages of unbroken text.	Use headers for outlining content and to aid in skimming.
	"Chunk" similar information together.	Grouping things together that work together improves clarity.
	Provide definitions of terms and lingo.	Some words have multiple meanings or are specific to computer-based information and instruction.
	Provide examples.	Examples help to explain by linking prior experiences with new information.
	Provide concrete instead of abstract navigation buttons. Select icons carefully.	Examples are to use a home icon for the home page and question mark for help link. Consider all possible interpretations of icon before selecting one.
	Provide a site map.	Assists in visualizing information and navigating the web site.
limitations in writing	Reduce need for keyboarding/composing.	Provide choices to select from instead of requiring keyboarding to respond.
	Accommodate greater range of skill levels and preferences.	One example is to offer keywords for search terms as well as providing choices.
	Avoid functions that require a response within a specified amount of time.	User may not be able to respond in allotted time.
deficits in memory (holding bits of information at the same time)	Utilize site maps and/or provide step-by-step instructions.	Eliminates assumptions that user will know what to do. Using cues assists user through process.
	Give each page a meaningful title.	Users will be able to more easily identify a bookmark page.
easily distracted, deficits in attention	Use headers.	Aids in focusing.
	Use graphics.	Images help to break up monotony.
	Limit length of animation or flashing text.	Limits distraction.
	Provide an *undo* or *back* function.	Allows user to easily correct mistakes made in impulse.

Hearing Impairments

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Currently, adult learners with hearing impairments have not experienced the same degree of challenge in utilizing the WWW as other adult learners with special needs. However, web site design may also reflect accommodations for these learners. American Sign Language (ASL) is the primary language of the Deaf community. ASL, a manual communication system has its own grammar, syntax, and idioms and is *not* a translation of English. The term finger spelling is used to indicate manual communication that designates a sign for each letter of the alphabet. Deaf individuals who use ASL and write in English (or any other language), encounter communication challenges of two languages. In addition to providing signing or text, the implementation of some of the considerations outlined for cognitive disabilities may also assist this population as shown in Figure 3.

Figure 3: Hearing Impairments

Characteristics of Adult Learners with Hearing Impairments	Web Design Considerations	Examples and Elaboration
inability to hear audio clips or the audio for video clips	Provide a link for complete text on audio clips. Provide text or signing for video clips.	Ask: Do all audio files have transcripts? Tie text transcripts to audio clips using the REL attribute. With Macintosh's "QuickTime" web authors can select as few or as many tracks as desired.
inability to hear or distinguish warning sounds or tones	Provide both visual and auditory warnings. Avoid functions that require a response within a specified amount of time.	Both types of warning may also assist other users as well. User with sensory deficit may not be able to respond in allotted time.

Figure 3: Continued

Characteristics of Adult Learners with Hearing Impairments	Web Design Considerations	Examples and Elaboration
limited language development	Provide definitions of terms and lingo.	Some words have multiple meanings or are specific to computer-based information and instruction.
	Reduce amount of reading.	Use graphics, graphic links, and image maps.
	Accommodate greater range of reading levels.	Simplify language. Use readability level checks available on some software.
	Avoid long pages of unbroken text	Use headers for outlining content and to aid in skimming.
	Provide concrete instead of abstract navigation buttons.	Examples are to use a home icon for the home page and a question mark for help link.
	Provide a site map.	Assists in visualizing information and navigating the web site.
writing challenges	Reduce need for keyboarding/composing.	Provide choices to select from instead of requiring keyboarding to respond.
	Accommodate greater range of skill levels and preferences.	Offer keywords for search terms as well as provide choices.
	Avoid functions that require a response within a specified amount of time.	User may not be able to respond in allotted time.

Movement Disabilities

For adult learners with movement disabilities, the keyboard and mouse, as well as manipulating computer-related materials (e.g., discs and printouts), present the greatest challenges. Alternative computer input mechanisms to replace the keyboard and mouse are available such the as sip-and-puff Morse code mouthstick, voice recognition software, and eye-gaze keyboards. Discussion of these adaptive mechanisms are not the intent of this paper, however, web page design considerations can provide necessary accommodations for these users

and others with movement challenges. Typically web site designers may provide accommodations for the area of fine motor skills that are needed for web navigation and responses (e.g. limited spacing, boxes, etc.). These considerations are addressed in Figure 4.

Figure 4: Movement Disabilities

Characteristics of Adult Learners with Movement Disabilities	Web Design Considerations	Examples and Elaboration
limitations in mobility	Furnish keyboard commands.	A recommendation for browser developers is to supply a toolbar of keyboard commands to replace mouse commands for individuals using alternative input mechanisms.
	Avoid any design element that may prevent keyboard operation.	This recommendation is for web authors.
limitations in manipulation and coordination	Increase size of graphic links to .5 x .5-inch square.	Assists in ability to use mouse effectively.
	Double space between lists of vertical links.	Assists in ability to use mouse effectively.
	Avoid use of forms with small boxes or provide e-mail address, e-mail link, postal address, or fax number for submitting information.	Provides alternative methods of response without needing precise movement.
	Avoid functions that require a response within a specified amount of time.	User may not be able to operate control quickly.

Self-Evaluation of Web Design Accessibility

The computer-based design considerations offered here for adult learners with special needs encompasses recommended web design practices for all. Adults with special needs can do little to change site designs to meet their needs, thereby, adults with special needs must rely upon web page authors to make needed accommodations (Gunderson, 1998; Paciello, 1998; Peters-Walters. 1998). To see the results of design choices, it is suggested to review web pages using a number of different browsers. Test the site using a text only browser (e.g., Lynx), a self-voicing browser (e.g., PWWebspeak), and multiple graphic browsers using sounds and graphics, graphics not loaded, sounds not loaded, and no mouse.

For a step-by-step accessible design evaluation of a specific web site, access "Bobby" at http://www.cast.org/bobby (Center for Applied Special Technology, 1998). "Bobby" will ask for the address of the site to be validated and will provide immediate on-screen feedback as to problem areas, line-by-line accessibility recommendations, accessibility tips, browser compatibility, and download time. Authors of this web site caution that Bobby is "only one step in the process of making a web site accessible to as many individuals as possible" since some aspects of web design cannot be tested automatically. In addition, "Bobby" suggests that web authors ask web site visitors for feedback in order to continually improve upon web site design. If a web site is "Bobby" approved, the web author may use the "Bobby" icon on the approved web site to indicate that the site has been accessible tested. While "Bobby" notes some HTML elements, "Bobby" is not designed to be a HTML validation resource. However, several HTML validation researches are available on the WWW. One HTML validation site, sponsored by the World Wide Web Consortium (W3C) authors of the Web Accessibility Initiative (WAI) is available at http://validator.w3.org/ (Oskoboiny, 1998).

A universal accessibility symbol has also been adopted for use by web sites that follow accessible design features. The image is available at http://www.wgbh.org/wgbh/pages/ncam/symbolwinner.html. Use of this image is self-assigned and -monitored with no charge for symbol use (Diversity Management Directorate, 1998; National Center for Accessible Media, 1998). Use of the symbol should also be accompanied by the description "A globe, marked with a grid, tilts at an angle. A keyhole is cut into its surface." The alt-text tag is "Web Access Symbol (for people with disabilities)". Currently, 150 known sites are using the symbol out of a possible five million existing web sites (National Center for Accessible Media, 1998).

Summary

Adult learners with special needs are individuals with ample capabilities who also have a disability. A total of 49-million people with vision impairments, cognitive disabilities, hearing impairments, or movement disabilities reside in the United States. Often times, these individuals face challenges in performing life activities that constitute living, working, and learning because physical or social circumstances are imposed that ignore environmental accommodations.

One powerful and emerging model of information and instruction for all adult learners are computer-based systems. For adult learners with special needs, the WWW potentially presents the ability to participate in our information-oriented society more effectively than ever before from one's home and one's preferred modality. Currently, most web page designs, however, present multiple challenges for adult learners with special needs.

Access to the WWW by everyone regardless of disability is feasible as demonstrated through the synthesis of recommended best practices in design considerations. Implementing these web design considerations for adult learners with special needs will produce two outcomes. Designers will reach the widest possible audience and users will gain access to more information.

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APPENDIX A The Learner-Centered Principles

Dr. Barbara McCombs

The Learner Centered Principles (LCP) Model was created and published as a result of a three year joint project between the American Psychological Association (APA) and the Mid-continent Regional Educational Laboratory (McREL). The purpose of this effort was to identify the key underlying factors which positively impact instruction through a comprehensive examination of the research base on learning, learners, and pedagogy.

Five factors with twelve underlying principles were identified as critical to effective learning. These are as follows:

Meta-cognitive and Cognitive Factors:

Principle 1: The nature of the learning process.

Learning is a natural process of pursuing personally meaningful goals, and it is active, volitional, and internally mediated.

Principle 2: Goals of the learning process.

The learner seeks to create meaningful, coherent representations of knowledge regardless of the quality of data available.

Principle 3: The construction of knowledge.

The learner links new information with existing and future-oriented knowledge in uniquely meaningful ways.

Principle 4: Higher order thinking.

Higher-order strategies for "thinking about thinking" - for overseeing and monitoring mental operation s-facilitate creative and critical thinking and the development of expertise.

Affective Factors:

Principle 5: Motivational influences on learning.

The depth and breadth of information processed, and what and how much is learned and remembered, are influenced by (a) beliefs about personal control; (b) saliency of personal values, interests, and goals; (c) personal expectations of success or failure; (d) affect, emotion, and general states of mind; and (e) the resulting motivation to learn.

Principle 6: Intrinsic motivation to learn.

Individuals are naturally curious and enjoy learning, but intense negative cognitions and emotions (e.g., feeling insecure, worrying about failure, etc.) thwart this enthusiasm.

Principle 7: Characteristics of motivation-enhancing learning tasks.

Curiosity, creativity, and higher-order thinking are stimulated by relevant, authentic learning tasks of optimal difficulty and novelty for each student.

Developmental Factors:

Principle 8: Developmental constraints and opportunities.

Individuals progress through stages of physical, intellectual, emotional, and social development that are a function of unique genetic and environmental factors.

Personal and Social Factors:

Principle 9: Social and cultural diversity.

Learning is facilitated by social interactions and communication with others in flexible, diverse (in age, culture, family background, etc.), and adaptive instructional settings.

Principle 10: Social acceptance, self-esteem, and learning.

Learning and self-esteem are heightened when individuals are in respectful and caring relationships with others who see their potential, genuinely appreciate their unique talents, and accept them as individuals.

Individual Differences:

Principle 11: Individual differences in learning.

Although basic principles of learning, motivation, and effective instruction apply to all learners (regardless of ethnicity, race, gender, physical ability, religion, or socioeconomic status), learners have different capabilities and preferences for learning mode and strategies.

Principle 12: Cognitive filters.

Personal beliefs, thoughts, and understandings result from prior learning and interpretations become the individual's basis for constructing reality and interpreting life experiences.

APPENDIX B User Interface Design for Older Adults

J. Morgan Morris

The percentage of older adults is expected to increase to unprecedented levels within the next decade. Little attention has been devoted to understanding, organizing, and accommodating the needs of older adults with respect to interaction with computers. Indeed, most usability studies have focused on the needs of younger adults, to the neglect of the elderly. As computerized products increasingly appeal to broader audiences, the needs of older adults will become a concern for designers. This review focuses on the organization and presentation of characteristics of older adult learners, along with recommendations based on those characteristics, with the hope that their accessibility will enhance designer intuition and provide suitable information to guide user testing.

Visual characteristics

Table 1. Visual characteristics

Visual component	Changes

Physical

- The cornea flattens, becomes irregular in structure, and may be prone to the occurrence of small deposits.
- The cornea yellows with age.
- The incidence of astigmatism increases with age.
- Pupil sizes may be smaller.
- The lens become more dense with age.
- The retina may atrophy.
- It is harder for an older subject to look upward.

Pathologies

- Cataracts are the leading cause of blindness for those over 65 (Corso, 1981); increase in glaucoma from age 60-85 (Anderson & Palmore, 1974; Kahn, et al., 1977); increase in several other pathologies.

Abilities

- Adaptation to dark decreases with age, especially after age 60.

- Sensitivity to glare increases with age, especially after 45.

- Loss of colour sensitivity after age 70. More pronounced for shorter wavelengths.

- Difficulty in tracking fast-moving objects, due to decreases in oculo-motor adjustment.

- Field of vision shrinks after age 55.

- Uncorrected static visual acuity decreases with age.

- Dynamic visual acuity decreases with age.

- Depth perception begins to deteriorate between the age of 40 and 50.

- Older adults are more likely to have difficulties with stimulus persistence. This may begin early as age 45.

Visual tasks

- For visual search tasks, as the number of irrelevant items increase, the visual search time increases (Plude & Hoyer, 1985).

- Increased display set size has been found to lead to age-related decreases in card sorting tasks (Falduto & Baron, 1986).

- Well-practiced tasks do not pose the same difficulties as do unfamiliar tasks.

Computer tasks

- Eye-strain has been reported to be higher among older telephone operators (Hedman & Briem, 1984).

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- Older people will take longer to process visual information presented on a computer screen (Camisa & Schmidt, 1984).

- Older viewers need higher levels of lighting for visual tasks.

- As the visual field shrinks with age, normal-sized text may be difficult to identify.

- Bifocals may cause difficulties in viewing keyboards, displays, and reference documents in correct focus.

Visual recommendations

Font size. Provide multiple font sizes, and allow the user to select the best size for the task.

Text characteristics. Consider using high-quality, anti-aliased character fonts on displays with relatively high resolution. Also consider using negative contrast displays (dark characters on a light background.) (Gould et al., 1987)

Resolution. Maximize the displayed resolution of screen objects. (Czaja, 1988)

Display terminals. Use display terminals that tilt and swivel, so that users with bifocals can adjust displayed information to suit their needs. Also consider using larger displays than usual. (Czaja, 1988; Tobias, 1987)

Lighting. Ensure that the work area is brightly lit. (Czaja, 1988; Kelly and Kroemer, 1990)

Glare. Eliminate glare from the use environment. (Kline & Schieber, 1985; Czaja, 1988)

Colour:

Use colour combinations that are effective and do not burden the perceptual system. For example, avoid blue for thin lines and small shapes (Murch, 1987)

Avoid colour combinations that ask the viewer to distinguish between colours of shorter wavelengths, e.g., blues and greens. (Kline & Schieber, 1985; Murch, 1987)

Colour for text. Choose the colour for text and background carefully. Consider using white text on a blue background as a suitable colour combination for the display of text. (Other research (Gould, 1987) finds dark text on a light background to be readable.) (Murch, 1987; Tobias, 1987)

Brightness. Older viewers need higher brightness levels to distinguish colours. (This is taken verbatim from Murch (1984)

Object speed. Avoid fast-moving objects on the screen. (Czaja, 1988)

Scrolling speed. Avoid fast scrolling; allow the user to adjust the speed of scrolling to suit his/her own tastes. (Tobias, 1987)

Search item relevance. Keep items relevant in search tasks. For example, a good organization scheme is necessary for menu systems. (Plude & Hoyer, 1985)

Search set size. Keep set size small in unfamiliar search tasks. (Plude & Hoyer, 1985)

Multiple sensory modalities. Use more than one sensory modality to encode information. The more cues that are present, the more likely the person is to attend to them. (Kelly & Kroemer, 1990)

Multiple visual dimensions. Use more than one dimension of visual stimuli to encode information, e.g., size, shape, and colour. (Kelly & Kroemer, 1990)

Interaction style. Choose interaction styles that feature visual display of objects rather than featuring interaction dependent on text. For example, a graphical user interface may be favoured over command line interaction.

Special software. Consider using special software to display directories and other text in larger fonts, or to provide a software 'magnifying glass' to enlarge characters at will.

Highly visual impaired users. Consider using alternative interfaces for those who are blind or severely visually impaired. Use of special screen reading products, voice recognition, optical reader products, or speech synthesizers may be appropriate. (Vanderheiden et al., 1991; Mynatt & Edwards, 1992)

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Auditory characteristics

Table 2. Auditory characteristics

Auditory component	Changes

Physical

    —   Loss of hair cells in the ear.

    —   Tendency toward an excessive accumulation of ear wax.

    —   Higher frequency of collapsed auditory canals.

    —   Decline in elasticity of eardrum.

    —   Thinning and calcification of the ossicular joints.

Abilities

    —   Impairments in pure-tone thresholds, particularly for high frequencies.

    —   Impairments in frequency discrimination.

    —   Problems with auditory temporal discrimination and sound localization.

    —   Impairments in speech discrimination.

    —   Problems with understanding distorted speech.

    —   Problems with recall of long sentences.

Auditory recommendations

Arrangement. Arrange the use environment to provide direct contact with sources of sound. (Olsho et al., 1985)

Noise. Make the use environment free from unnecessary noise. (Olsho et al., 1985)

Task relevance. Avoid use of sounds that are not relevant to the task. (Nielsen & Schaefer, 1994)

Frequencies. Keep meaningful auditory tones in the range of 800-1000Hz. (Czaja, 1988)

Synthesized speech. Avoid use of synthesized speech if possible. (Czaja, 1988)

Dimensions. Use more than one dimention of any auditory stimuli to encode information, for

example, changes in both frequency and amplitude. (Kelly & Kroemer, 1990)

Highly hearing impaired users. Consider using special interaction devices for the deaf or

severely hearing impaired, especially for tasks involving verbal communication.

Physical characteristics

Table 3. Physical characteristics

Physical component	Changes
Physical	
_ Decrease in both standing and sitting height (Stoudt, 1981).	
_ Flexibilty of limbs is diminished (Stoudt, 1981).	
_ Increase in arthritis and neurological disorders with age.	
Abilities	
_ Functional reach of arms is diminished (Stoudt, 1981).	
_ Grip strength declines with age (Clement, 1974).	
_ Postural sway increases with age.	
_ Motor ability decreases with age.	
_ May become fatigued more easily.	
_ May maintain many well-practiced physical skills, e.g., typing (Salthouse, 1984).	

Physical recommendations

Interaction devices:

   Use interaction devices that do not fatigue non-skilled typists. For example, touch screens

      may be fatiguing for some tasks. (Czaja. 1988)

   Use interaction devices that do not require precise movements. This recommendation is most

      appropriate when the users have physical difficulties. (Hollander & Plummer. 1986)

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Menu structure. Use menu structures that display wide targets, and do not require a series of precise movements.

Documentation. Build help into the system, either in the form of an on-line manual or context-sensitive help. The user should not have to get up to get a user manual.

Experienced typists. For experienced typists without disabilities, consider the keyboard for data entry tasks. (Salthouse, 1984)

Use environment:

Provide flexibility in the ability to position documents, the display, and other materials in the use environment.

Allow frequent rest breaks for older computer users. (Czaja, 1988; Tobias, 1987)

Interaction devices. Consider speech recognition for elderly use. (Ogozalek & Praag, 1986; Czaja, 1988)

Special software or hardware. Consider using special software or hardware to assist physically impaired users with multiple keystrokes.

Highly physically impaired users. If hearing and speech are unaffected, many of the interaction techniques appropriate for the severely physically impaired. If hearing and speech are affected, consider the use of special switching devices to facilitate interaction with alternate keyboards, environmental controls, and electronic communication aids.

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Memory characteristics

Table 4. Memory characteristics

Memory component	Changes

Abilities

- Decrease in acquisition and retrieval of new information from long-term memory (Poon, 1985).

2 General cognitive slowing.

3 More affected by interference from tother items or tasks (Talland, 1965; Taub, 1968).

- Need more time to consolidate information.

- Spatial memory skills decline with age (Bruce & Herman, 1986).

Strategies

- May not use orh=ganizational and elaborative strategies without explicit instructions to do so (Hultsh, 1969).

- May not make use of mediational techniques unless instructed to do so (Hulicka & Grossman, 1967).

- May not take notes when necessary (Jerome, 1962; Young, 1966).

Memory recommendations

Visibility of objects. Display any items which otherwise must be visualized, since spatial skills deteriorate with age. (Kline & Shieber, 1985; Bruce & Herman, 1986)

Navigational aids. Provide navigational aids such as maps and fisheye views to orient the user. This is especially true in hypertext systems. where navigational abilities have been linked to spatial visualization skills. (Campagnoni & Ehrlich, 1989)

Interaction style. Use menus and other recognition strategies. Don't burden the older user's

memory with learning complex syntax if unnecessary. (Joyce, 1989)

Design for consistency. Remove inconsistencies in the user interface design. (Czaja, 1988;

Nielsen, 1989)

Instructions:

> If organization is required, provide explicit instructions for organization. (Hultsch, 1962)
>
> If a mediational technique is useful, provide explicit instructions for use of a technique
>
> (Hulicka & Grossman, 1967).

Learning. Avoid rote learning. (Chown et al., 1967; Czaja & Drury, 1981; Carroll et al., 1985)

Note-taking. If note-taking is beneficial, provide expilicit instructions to take notes. (Jerome,

1962; Young, 1966)

Task structure. Structure tasks to be independent and sequential; allow time after presentation for

learning. (Talland, 1965; Taub, 1968; Christensen, 1968)

Information presentation. Use multiple sensory modes for presentation of information.

(Arenbury, 1968)

User experience. Allow the older adult to make use of experience; for example, allow them to

use a keyboard if they are proficient. Realize that learning the computer keyboard may

provide interference, as there are many extra keys and differences in key locations

Attitudinal characteristics

Table 5. Attitudinal characteristics

Attitudinal component	Changes

General

Link in initial experience to attitude (Danowki & Sacks, 1980).

Mixed results across several studies regarding attitudes toward computers.

Computer experience can lead to positive changes in attitudes (Jay & Willins, 1992).

Current generation of elderly is prone to alienation from technology.

Many older adults are motivated to learn to use computers (Morris, 1992).

The elderly do not want to feel different from other groups.

Older adult learners are motivated, but want to learn information they can use today.

Many older adult learners may have met with failure in previous attempts at learning.

Attitudinal recommendations

Designer assumptions. Realize that many older adults may be enthusiastic computer users, and have positive attitudes toward computer use. (Ogozalek &Praag, 1986; Morris, 1992)

System messages. Use supportive, non-challenging instructions and messages. (Ross, 1968)

Wording:

Provide features that accommodate older adults, but do not mark them as being intended specially for senior citizens. (Bowe, 1988)

Avoid wording that makes seniors feel different. For example, avoid phrases such as "the elderly" and "disabilities." (Bowe, 1988)

Be sure that the user is in control rather than the system.

Error-free design. Use 'error-free' interaction, i.e. disable operations that are invalid.

Notification of interaction. If a system is on public display, such as information kiosks, be sure to communicate that it is intended for interactive use. (Baird et al., 1988)

Software training recommendations

Written materials:

Include a clear and fairly extensive explanation of the hardware and software. (Elias et al., 1987)

For word processing tasks, include q specific lesson on the differences between traditional manuscript preparation (typing) and word processing on a microcomputer. (Elias et al., 1987)

Provide take-home, printed study material for those areas that are especially difficult for the older trainee: cursor movements, scrolling, editing, tabbing, and block routines. (Elias et al., 1987)

Training session length. Keep all training sessions a maximum of two hours in length and provide additional sessions if necessary. (Elias et al., 1987)

Self-pacing. Allow for self-pacing, with no strict time limits. (Zandri & Charness, 1989)

Help. Provide easy access to assistance, both human and on-line. (Zandri & Charness, 1989)

Instructional technique. Consider the use of video modeling as an alternative to other on-line instructional techniques. (Gist et al., 1988)

Training strategy. Allow older adulters to train in pairs (Danowski & Sacks, 1980)

Avoid memorization. Do not rely on extensive memorization as part of the training. (See 'Memory' section.)

General design recommendations

Design for older users. Design for older users. Many features that benefit older users will also benefit younger users. (Bowe, 1988; Newell & Cairn, 1993)

Test using older users. Test using older users. because their characteristics can interact in many unpredictable ways.

Flexibility. Design for flexibility. Design so that a user does not "outgrow" the characteristics of the system as age-related changes accrue. (Kelly & Kroemer, 1990)

APPENDIX C Descriptions of Ten Selected Web Sites Used in Synthesis of Recommended Web Design Guidelines

Bobby
Center for Applied Special Technology
http://www.cast.org/bobby

Bobby, a web-based public service site developed by the Center for Applied Special Technology (CAST) in Peabody, Massachusetts, reads, analyzes, and either validates existing web pages as accessible or offers written suggestions for improved accessibility along with the time needed to download. Other links provided by the CAST organization from this site are teaching strategies and teaching tools. Teaching strategies shares how to find and use accessible curriculum materials for education, while teaching tools describes available software education programs that use accessible design features.

National Center for Accessible Media
WGBH Educational Foundation, Boston, MA
http://www.wgbh.org/wgbh/pages/ncam

The National Center for Accessible Media (NCAM), a research and development facility, works to make media accessible to underserved populations including minority language users and individuals with disabilities. NCAM has a history of pursuing accessibility issues starting with the creation of captioning for hearing impaired public television viewers 25 years ago. Today, NCAM has developed methods to provide captioning and audio description (QuickTime and MoviePlayer) for web page authors.

People with Disabilities and NII (National Information Infrastructure)
US. Department of Commerce, Technology Administration
http://www.itpolicy.gsa.gov/coca/SB_paper.htm

Historical and current evidence of benefits gained from the development of a National Information Infrastructure (NII) that is accessible to all are outlined. Additionally, objectives and goals for future policy development as envisioned by the American with Disabilities Act (ADA) as well as other national laws and policies are discussed. Examples of on-going NII access efforts by federal agencies and federally supported activities are cited.

Special Education Resources on the Internet (SERI)
Roseann Horner
Hood College, Frederick, Maryland
http://www.Hood.edu/seri/index.htm

In addition to web site design guidelines for web page authors, SERI supplies a collection of Internet links to find additional information on disabilities. Also included are links for assistive technology for special needs, guidelines for evaluating commercial products that are sold to enhance access to the WWW, and descriptions of associations and national organizations for individuals with disabilities.

Starling Access Services
Chuck Letourneau, owner/operator
http://www.igs.net/~starling/acc/acint.htm

Starling Access Services is a business that offers consulting services on web site design, adaptive computer technology, and workshops on access and accommodation issues. This web site provides guidelines and tips for accessible web design for learners with disabilities. In addition, this web site details how adherence to accessibility guidelines also provides benefits for users who do not have the latest browsers and equipment or live in rural or remote areas with limited access to the Internet.

Trace Research and Development Center, University of Wisconsin-Madison
Gregg C. Vanderheiden, Director
http://www.trace.wisc.edu/

Working with government and industry, personnel at the Trace Research and Development Center, University of Wisconsin-Madison address numerous functions and provide multiple products to augment and expand communication, computer, and information technologies for people with disabilities. This web site provides numerous materials for web designers, browser designers, assistive technology designers and suggestions for users. In addition, copies of government documents on disability, information on issues ensuring a National Information Infrastructure (NII), and a searchable resource database on additional electronic and publication references on disabilities are available.

WAI Accessibility Guidelines (Web Accessibility Initiative)
World Wide Web Consortium (W3C)
Ian Jacobs, Editor
http://www.w3.org/TR/WD-WAI-PAGEAUTH#Good

The World Wide Web Consortium (W3C) is an international organization hosted by the Massachusetts Institute of Technology Laboratory for Computer Science in the United States, the Institut National de Recherche en Informatique et en Automatique in Europe, and Keio University in Japan. W3C provides information about the WWW for developers and users and promotes global standards for its use. The W3C group also provides a HTML Validation Service at http://validator.w3.org/

Web Page Accessibility Self-Evaluation Test
Diversity Management Directorate, Public Service Commission, Government of Canada and the
Adaptive Technology Resource Center (ATRC) at the University of Toronto

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http://www.psc-cfp.gc.ca/dmd/access/testver1.htm#finding

A 27-item self-evaluation test is a highlight of this web site sponsored by the Government of Canada in cooperation with the University of Toronto. Additional links to other web sites regarding accessibility and the history of the universal web access icon are included.

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WebABLE
Yuri Rubinsky Insight Foundation
Mike Paciello
http://www.yuri.org/

A comprehensive and routinely revised database of over 500 disability and access related Internet resources are featured at this web site. Resources are searchable based upon disability, web site author (e.g., education, government, manufacturer, consultant, organization) and /or any combination of eight geographical regions.

World Wide Web Browser Access Recommendations
Jon Gunderson, Mosaic Accessibility Project
University of Illinois at Urbana/Champaign
http://www.staff.uiuc.edu/~jongund/access-browsers.html

This site emphasizes the need to improve the usability of browsers for individuals with movement and visual impairments. Suggestions for implementing keyboard commands and tool bar functions to replace mouse commands are offered along with examples of accessible dialog box controls.

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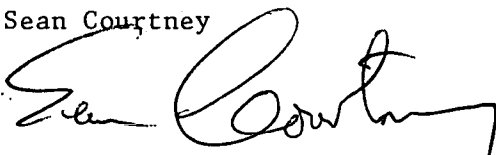
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