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The Implications of Information and Communications Technologies for Distance Education: Looking Toward the Future

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EXECUTIVE SUMMARY

Distance education is the provision of educational materials, content, and instruction between teachers and students who are separate in place or time. Distance education can take many forms, but its hallmark is the use of technology, media, and materials to facilitate teacher-student interaction from afar. A component of both U.S. and international education systems, distance education has provided an alternative to traditional face-to-face educational programs and courses for many years — typically for non-traditional students.

Distance education is becoming an increasingly important element of the education landscape. The range of distance education opportunities is broadening locally, nationally, and internationally. People are drawing increasingly on distance education courses and programs for both their primary and supplementary educational needs, whether as stand-alone or supplementary to a general education curriculum.

One salient factor increasing interest in distance education is advancement in information and communications technologies (ICTs). In particular, digital and networked technologies have had a wide range of effects on the educational materials, practices, and institutions involved in education, notably by improving time- and cost-efficient delivery. Although correspondence, telephone, television, and teleconferencing have all been effective delivery methods for distance education, the Internet has been a particularly important development in making it possible for teachers and students to access a wealth of information and each other quickly, easily, and interactively in both face-to-face and remote education settings.

Thus, it is crucial that interested stakeholders continue to track new technological, educational, and cultural developments in order to actively plan for their integrated use and management in distance education now and in the future. Such tracking requires that we keep our minds open and that we do not assume that the ICTs and distance education technologies of today are the ones that will sustain us in the future. As this report will argue, the future will be an increasingly complex space in which success will consist of embodying and addressing such complexity gracefully. As of now, we are still not sure what kinds of technical, conceptual, institutional, and organizational configurations will be needed as we move into the next generation. However, by exploring the implications of ICTs for distance education with an open mind, we can begin to learn.

Purpose, Scope, and Analytic Approach

The purpose of this report is to identify and review current literature to explore the implications of information, communications, and computer technologies (ICCTs) for distance education. The review is not intended to be exhaustive but, rather, a point of departure for discussion. The information and implications outlined within are intended for all readers with interest in the topic including, but not limited to, researchers, analysts, and the public.

Within the report, distance education is broadly defined as the provision of educational materials, content, and instruction between teachers and students who are separate in place or time. Information and communications technologies (ICTs) are defined as technologies that utilize a combination of information technologies (such as computers or databases) and communications technologies (such as wired or wireless networks).

Only distance education efforts using ICTs in "traditional" public and private elementary, secondary, and higher educational institutions in the United States are considered in this report. Traditional institutions provide formal instructional activity in public or private preschools, elementary schools, secondary schools, 2-year and community colleges, 4-year colleges and undergraduate universities, and graduate schools. At the postsecondary level, these institutions typically grant associate, bachelor's, master's, and doctoral degrees. For the purpose of this report, traditional institutions are further categorized as "K through 12" institutions and "postsecondary" institutions.

While there is some discussion of career/training activities, international distance education endeavors, and the economics of distance education, such discussion is limited because the depth required for each topic goes beyond the scope of the report. Informal, non-traditional, and leisure-based educational activities through museums, libraries, home schools, or self-directed programs were also judged to be outside of the report's scope, as were scholarship on the cultural and social construction of technology and non-distance education-focused work in the fields of education, communications, and sociology. It is suggested that these topics form the basis of future research endeavors.

The following research questions are explored:

- What is distance education, how is it organized and supported, and how prevalent is it?
- What are the impacts of distance education? What effects is it having on learning and teaching?
- What are ICTs? What trends are we seeing in technology and information transfer? How are ICTs being used to deliver distance education?
- What important gaps are there in our knowledge of ICTs and distance education?
- Ultimately, what are the implications of ICTs for distance education?

The Implications of Information and Communications Technologies for Distance Education: Looking Toward the Future draws primarily on government, industry, scholarly, and organizational reports and articles published between 1999 and 2003. Most sources underwent a peer review process instituted for either refereed journals or books and research reports. Only the following types of research documents were included as sources:

- Research reviews and meta-analyses
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A number of themes emerge from a review of the literature. These themes underpin the question of what implications ICTs have for distance education and, following on this, what kind of research agenda should be pursued:

- Innovations in information and communications technologies will come in waves.
- ICT developments favor learners and give them more power.
- Detailed research about distance education structures and offerings is still needed for all educational sectors, especially for K–12 (and for elementary and middle school in particular).
- Information about the implications of ICT for distance education is fragmented by terminology and disciplinary and sector boundaries.
- Private information outpaces public research on ICTs in distance education.
- ICTs are facilitating the convergence of distance and other forms of education into a fully rethought “next-generation education” where learners are driving the markets.
- Regulations, funding mechanisms, and technical standards can influence how education is conceived of and configured.
- ICTs should support educational goals.
- Much more research is needed on how faculty are being trained and how technology, content, materials and resources, and instructional methods are addressed.
- The actual costs of education that integrally uses information technologies are unclear.

According to Wilson (2002, p. 5), “The e-learning revolution is not over. It is just entering a more intelligent and less self-indulgent phase.” This may indeed be the case as educators, policymakers, industry professionals, and others seek to integrate a world of active technological advancement with worlds that, in many cases, find it difficult to advance at the same pace. What is certain is that ICTs, educational governance and administration, and educational goals of general and distance education are converging toward a more integrated purpose in the education of the future. It is our duty to ensure that human thought and purpose — and not the technology itself — drive those activities.

CHAPTER 1: INTRODUCTION

Distance education is the provision of educational materials, content, and instruction between teachers and students who are separate in place or time. Distance education can take many forms, but its hallmark is the use of technology, media, and materials to facilitate teacher-student interaction from afar. A component of both U.S. and international education systems, distance education has provided an alternative to traditional face-to-face educational programs and courses for many years — typically for non-traditional students.

Distance education is becoming an increasingly important element of the education landscape. The range of distance education opportunities is broadening locally, nationally, and internationally. People are drawing increasingly on distance education courses and programs for both their primary and supplementary educational needs, whether as stand-alone or supplementary to a general education curriculum. In the United States, 56% of all 2- and 4-year public higher educational institutions offered distance education courses in 2000–2001, compared with 34% in 1997–1998 (National Center for Education Statistics, 2003a). Roughly 35% of districts and 40% of schools serving grades 10–12 have adopted online courses (Interactive Educational Systems Design, 2002, p. 2). For some time, distance education's importance has been broadly acclaimed. As early as 1996, Dhanarajan noted that "in three major reports published recently by UNESCO, the World Bank, and the OECD, distance education is being predicted as perhaps the most important mode of educational delivery for learning throughout life and for life in the coming decade" (p. 2).

Distance education has the potential to reach more people, narrowly address their specific educational needs and desires, do so in an economical fashion, and provide educational technological experiences in the process. Although distance education has been stigmatized in the past for offering an educational experience that is lower in quality than one at a traditional educational institution, improved quality control and accreditation bodies and procedures are working to ensure that such concerns are unfounded. In fact, in recent years, institutional and individual interest in distance education has been on the rise.

One salient factor increasing interest in distance education is advancement in information and communications technologies (ICTs). Digital and networked technologies, in particular, have had a wide range of effects on the educational materials, practices, and institutions involved in education, notably by improving time- and cost-efficient delivery. Although correspondence, telephone, television, and teleconferencing have all been effective delivery methods for distance education, the Internet has been a particularly important development in making it possible for teachers and students to access a wealth of information and each other quickly, easily, and interactively in both face-to-face and remote education settings.

Distance education has always called certain technical, practical, and policy issues into question. It is often argued that the more transferable the content of distance education courses, the more accessible, user-friendly, and, in many cases, cost-effective such courses and course modules may be. Thus, computer and application platforms, technical standards, and interoperable technologies are important considerations. Educational institutions also require accreditation and certified faculty in order to be legitimate. Thus, regulatory jurisdictions for course content, teacher credentialing, and institutional accreditation and evaluation are important to consider along with matters of funding, assessment, quality materials and curricula, student/teacher ratio, quality student-teacher interactions, professional development, and intellectual property, to name just a few. These are issues with which multiple stakeholders continue to grapple. Now, with technological advancements on the horizon — next-generation technologies such as integrated multimedia content, broadband and wireless networks, and immersion/simulation applications — it is necessary to consider their next-generation technical, practical, and policy implications.

Unfortunately, technology has been moving so rapidly that it is difficult to know what to expect next, let alone what practical and policy contexts it will require. New electronic and wireless technologies and delivery systems are changing how information is conceived, packaged, and transmitted. The concepts and transmissions of knowledge and education are likewise being affected by these developments. Technology is moving so quickly that trying to keep abreast of the wave from a planning and policy perspective is challenging. However, to make good on the promises of technology and education for the future, keep abreast we must.

Thus, it is crucial that interested stakeholders continue to track new technological, educational, and cultural developments in order to actively plan for their integrated use and management in distance education now and in the future. Such tracking requires that we keep our minds open and that we do not assume that the ICTs and distance education technologies of today are the ones that will sustain us in the future. As this report will argue, the future will be an increasingly complex space in which success will consist of embodying and addressing such complexity gracefully. As of now, we are still not sure what kinds of technical, conceptual, institutional, and organizational configurations will be needed as we move into the next generation. However, by exploring the implications of ICTs for distance education with an open mind, we can begin to learn.

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CHAPTER 2: DISTANCE EDUCATION TO DATE

The term *distance education* has grown to encompass a full range of new technologies, pedagogies, learning styles and skills, and environments that have, over the years, developed out of efforts to offer educational content for learning inside and outside of traditional educational settings. As a result, distance education has now been joined by a host of other concepts and practices that have arisen as a result of new technological and social developments. Thus, the distance education of 2003 is quite different from what it was 10, or even 5, years ago. Trying to name the ways it has grown and changed is crucial for rethinking it as a concept, a term, and a set of practices against the backdrop of recent and current developments in the fields of education, technology, and skills acquisition.

Distance Education and ICTs Defined

A traditional definition of distance education contains at least four components: education (teaching and learning), geographic or temporal divergence, a medium of transmission (technology), and information or communication content. The Western Cooperative for Educational Telecommunications (2003) defines distance education as "instruction that occurs when the instructor and student are separated by distance or time, or both." Moore and Kearsley (1996, p. 2) suggest this "distance" necessitates curricular and instructional approaches that are unique to the distanced education scenario: "As a result [of place/time differences, distance education] requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as special organizational and administrative arrangements." This conception of distance education as a unique and distinct educational experience occurring outside traditional educational experiences or institutions has grown.

Although a history of distance education is beyond the scope of this report, early distance education efforts relied on the technology of mail correspondence and, later, on radio and television (Nasseh, 1997; Distance Education Clearinghouse, 2003). Recent distance education efforts are relying more and more on Internet and other ICTs that the International ICT Literacy Panel (2002) says "reflect the convergence between computer and communications technologies and can be viewed as a set of activities and technologies that fall into the union of IT and telecommunications (p. 2).

The electric and electronic hardware and software necessary for creating both stand-alone and networked electronic communications devices, such as radios, televisions, computers, cell phones, and personal digital assistants (PDAs), are of great interest to those interested in distance education. Yet, the complexity and dynamic nature of the intersecting technologies, fields, institutions, activities, and resources makes analyses of current or imminent technological models, systems, and impacts difficult (Collins, 1997; Harley, 2002).

Consider, for example, the fact that there are a host of terms and concepts used to describe intersections of technology and education. Remote education, distance learning, e-learning, online learning, Web-based learning, virtual learning, instructional telecommunications, cyber-learning, and distributed learning — all of these terms describe education that is technologically-mediated but that may or may not comprise distance education specifically. Online, cyber-, and Web-based learning all refer primarily to learning that takes place through the Internet. E-learning refers to any type of learning using electronic means of any kind (TV, radio, CD-ROM, DVD, cell phone, personal organizer, Internet, etc.). Virtual learning refers to immersive or simulated learning scenarios where the learner participates as an actor (Dillenbourg, 2000). These educational forms can be utilized for learning at a distance but are not necessarily synonymous with it.

Confusion or differences in terms can be partly attributed to disciplinary and sector distinctions (e.g., education vs. business sector; K–12 vs. postsecondary), temporal conventions (e.g., distance learning in the 1970s and 1980s and e-learning in the 1990s and 2000s), and technological distinctions (e.g., e-learning for learning from all things electronic and cyber-learning from, primarily, the Internet).

Although some scholars believe that there is conceptual conflation and confusion about distance education (Moore, 2000; McIssaac and Gunawardena, 1996), others argue that current trends toward “distributed” and “blended” educational experiences may make the matter moot (Dede, 1995; Oblinger, Barone, & Hawkins, 2001). Distributed and blended educational models require a new instructional and pedagogical paradigm based on “shifts in what learners need to be prepared for the future and on new capabilities in the repertoire of teachers” (Dede, 2002, p. 2). In these models, distance-based knowledge webs, virtual interactions, synthetic experiences, and sensory immersion are seen as complements to real-time or face-to-face activities and relationships in the regular classroom. However, although education delivery models are blending distance and face-to-face approaches that use a variety of technology-based curricular and pedagogical approaches, distinct distance education models currently exist and are worth consideration.

Why Distance Education?

Distance education has been pursued as an educational delivery model for many reasons. First and foremost, distance education has filled an important demographic niche. Distance education students have typically been non-traditional students — those who are older, employed, married or with children, and living in circumstances such as far-off rural or unsafe urban areas that make it difficult for them to physically attend an educational institution (Ashby, 2002). According to a study by the American Association of University Women (2001), women are increasingly pursuing online education because of the flexibility of time it allows. Many individuals with disabilities find that distance education courses improve their access to teacher-class interactions and coursework by making in-person contact less necessary. The most compelling demographic argument, however, and a point that will be discussed in greater detail below, is that the students (and increasingly the teachers) of today expect their educational experiences to incorporate and reflect their rather extensive experiences with digital ICTs.

A second reason distance education has been pursued is that it fills an important content niche. States, districts, schools, and other educational institutions unable to provide certain educational offerings because of economic, staff, or other logistical limitations can turn to outside resources. Thus, for example, high school students needing advanced placement (AP) physics or a course in Japanese language can engage in such study rather than forfeit the experience.

Following this example, a third reason to pursue distance education as an education delivery model has been its robust and profitable economies of scale, scope, and return on investment. This will continue to be the case as remote education methods, systems, materials, and regulations become more established and as "libraries" of educational content are developed and used in multiple venues.

Finally, distance education's use of technologies results in course content and pedagogical experiences that are already integrated with technology. Students are not only exposed to new technologies within content contexts; they are learning to use these technologies while simultaneously developing 21st century information and communication skills.

Theories of Distance Education

A number of theories underpin the design, development, and delivery of distance education. However, the literature reflects concern that these theories have not continued to evolve with new educational goals, technologies, organizational structures, interpersonal relations, and teaching and learning practices. The result is not only conceptual confusion (McIssaac and Gunawardena, 1996; Garrison in McIssaac and Gunawardena, 1996, p. 406; DuMont, 2002), but also practical limits when those who conceptualize, develop, and deliver systems for distance education continue to follow the models available to them (Szabo & Rourke, 2002; Wisher et al., 1999). Thus, new theoretical models are necessary, would broaden and enrich the field, and would help guide the development and delivery of distance education in its increasingly varied forms.

Whether a discipline unto itself (Holmberg, 1986) or a field of education (Keegan, 1996; Devlin, 1989; Garrison, 1989; Rumble, 1988), distance education is an educational transaction based on the transmission of information through content and pedagogic means to enhance student learning. Thus, the primary goals of distance education are educational goals and outcomes. A secondary goal is developing ways to transmit and deliver information between a teacher (broadly defined) and student(s) so that the student(s) can learn effectively and can demonstrate learning gains.

Extant theories of distance education have typically focused on elements of the enterprise: teaching, learning, and the systems and materials — typically technology-based — involved in doing this at a distance. Of course, new constructs are required to describe the new emerging conceptions of teaching, learning, and support. Keegan (1996) classified distance education theories into three groups:

(a) Theories of autonomy and independence of the learner (see Wedemeyer's (1981) 10 characteristics of learner independence, and Moore's (1996) theory of transactional distance)
(b) Theories of the industrialization of teaching (see Peters (1971) and Rumble (1986) on the three modes of distance education's institutional operation)
(c) Theories of interaction and communication using systems and technology (see Holmberg's (1986) theory of "meaningful learning"; Short, Williams, and Christie's (1976) notion of "social presence"; and Perraton's (1985) integration of distance education theory with educational philosophy).

Moore (1973) and Wedemeyer (1981) suggested that technology could be used to support "independent study" that allowed both students and teachers more autonomy and control of their teaching/learning relationship via a technology-facilitated distance arrangement. Rumble (1988) advanced that the physical separation between student and teacher defined the essence of distance education.

Drawing from general educational theorists such as Dewey (1938) and Vygotsky (1978), Moore's systems theory of distance education and his notion of transactional distance have been particularly influential for explaining the pedagogical interactions that take place in distance education. It is the pedagogical relationships that influence the nature and quality of distance education experiences, Moore suggests. Because teaching activity and learning activity take place at different times and in different places, it is important to maximize the teacher-student dialogue, ensure a responsive course structure, and bolster the autonomy of learners to "make decisions regarding their own learning and construct their own knowledge based on their own experience" (Moore, 1996, p. 4).

Moore (1973) conceived of his theory of distance education as being embodied in and exemplified by the type of distance education program that resulted: "autonomous" (learner-determined) or "nonautonomous" (teacher-determined). Autonomous, learner-determined programs are more desirable, he argued, because of their dialogic, student-responsive nature. They result in three types of interaction: learner-instructor, learner-content, and learner-learner (Moore, 1996).

For explaining the institutional or organizational structure of distance education, Peters (1971) is most well known for his comparison of distance education with the mass production of industrialization. Although an apt analysis, particularly in terms of the influence of Marxist and neo-Marxist analytics at that point in time, Peters himself has suggested that a model appropriate to postindustrial society is necessary even if distance education is a product of industrial society (Peters, 1993).[1] Holmberg (1986) advocates interactive studies of distance education institutions and operating systems to help determine what distinguishes distance education from traditional and non-traditional educational approaches and how this difference is addressed in its delivery.[2]

Technological and organizational advances affecting the design and delivery of distance education are necessarily affecting the field's underlying theories. The advances encourage both enhancements and modifications to established theories and the development of new theories. An example of modifications to existing theory is the ADDIE advanced planning model (Saba, 2001). This "general-purpose, systematic, problem-solving heuristic modified for educational technology" and based on operationalizations of Moore's theory of transactional distance offers five learning-centered planning steps (p. 7): (1) analyzing needs of the learner; (2) designing instruction based on the learner's needs; (3) developing instructional materials; (4) implementing instructional sessions; and (5) evaluating the results systematically. The model assumes the centrality of learning. It also assumes the importance of a situated, integrated, educational response that requires specific materials and practices that must be continually evaluated and adjusted. This approach holds that there is no fixed type or model of distance education. Rather, the approach and form it takes will be different for each type of learner and learning situation.[3]

In the case of new theoretical development, different disciplines and practitioner camps are bringing their particular concepts, terms, and approaches to an increasingly converged distance education table. One trend is to move away from thinking of distance education as a distinct and unique educational endeavor. Instead, distance education is thought of as an educational approach that offers particular tools and affordances that address distinct educational needs. From this perspective, distance education is deemed "dead" or "not for everyone," and "distributed learning" that takes place situationally in different types of learning environments is the educational tool that should be employed when feasible and desirable. Such developments challenge basic educational assumptions that teacher and learner separation should take place throughout an entire educational experience for it to truly be a distance educational experience. The literature supports the notion that traditional ideas of distance education are either waning or wholly inappropriate to the new contexts of teaching, learning, and technology (Vrasidas & Glass, 2002; Oblinger, Barone, & Hawkins, 2001). As Vrasidas and Glass (2002, p. 46) note, "What the field needs is frameworks and

[1] The point is that distance education of today is something different from what it was before. Perhaps the new integration of "distance" into general education practice is the postindustrial influence rendering obsolete the silo, stand-alone approach to distance education.
[2] See also Simonson et al. (2000), Jeffries (n.d.), and Wang and Liu (2003).
[3] Vrasidas and Glass (2002) suggest that transactional distance theory is "fundamentally flawed." Although modifications to the theory are in order, its basic notions do provide points of departure for further theoretical consideration.

models that attempt to describe, explain, and help us understand the complexities of learning at a distance when interactions are heavily mediated by technology," not "grand theories to control and predict human behavior."

Attempts to rethink distance education as "distributed" or "blended" learning are indicative of the recent theoretical shift that no longer sees education as something undertaken either "in school" or "at a distance." Rather, teaching and learning are blended between these locations (including non-school locations) among the "next-generation," "21st century," or "information-age" students, teachers, materials, tools, and systems necessary for their success. As Dede (2002, p. 7) notes, "Distributed learning is not traditional distance education, but instead involves educational experiences that combine the use of face-to-face teaching with synchronous and asynchronous mediated interaction. This instructional strategy distributes learning across a variety of geographic settings, across time, and across various interactive media."

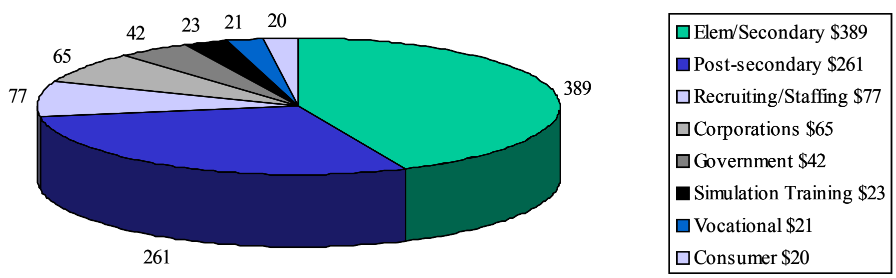
It is important to remember that what exists in theory does not always exist in practice. According to the literature, distance education is only beginning to be executed as a *range* of educational activities both integrated with and independent of other types of schooling. Even so, while online distance education is fast becoming the primary mode of delivery, many distance education programs and courses currently rely on older technologies, such as mail correspondence, telephone and fax interaction, or telephony-based videoconferencing — alone, in conjunction with one another, or in conjunction with the Internet. Although the promise of online distance education has been great, and in many cases has been realized, technological and cost limits continue to limit the parameters of its delivery (e.g., networked telecommunications systems still are limited to primarily text and small file/packet transmission). As a result, distance education continues to take the form of a primarily text-based activity that favors the skills and competencies of those with higher-level literacy skills — particularly English literacy skills. Yet, as the following section on distance education's prevalence and supports by sector illustrates, current models reflect increasingly diverse organizational, service, and demand drivers that are consistent with a more decentered and technologically-advanced approach.

This decentering of distance education as a distinct educational activity makes up distance education's most recent theoretical shift. The literature clearly shows that new and emerging technologies, new organizational and institutional arrangements, and new forms of communication are all converging to require new — and more complex — conceptions and practices.

Prevalence of Distance Education

Distance education seems to be on the rise — and the education market is significantly larger than the other markets combined. That being said, data collection for some sectors is weaker or less established than for others, and terms and classifications are not standardized. Thus, the emerging picture of distance education is limited to the aggregate of multiple perspectives and, for some sectors or subsectors, not particularly reliable.

Figure 1 – U.S. Greater Learning Industry Market, 2001 in Billions



Brandon-hall.com in Galvin (2002).

K–12 Education

In the world of K–12 education, the prevalence and growth of distance education are hard to track. Unlike national efforts to monitor basic aspects of postsecondary distance education (i.e., NCES Postsecondary Education Quick Information System), there are no such specific efforts at the K–12 level (Clark, 2001) except data forthcoming from the NCES Fast Response Survey System (D. Levin, personal communication, January 9, 2003). There are various estimates. However, the variety in baseline assumptions on which they are measured makes comparability difficult. A further complication is that distance education statistics are reported for grades K through 12 as if the courses are offered equally across all 13 grades. In fact, distance education currently occurs primarily in high schools, with emerging prevalence in elementary and middle schools. Finally, it is often unclear whether reports of Internet delivery of course content refer specifically to distance educational activities or in-class online activities.

Even with these caveats, there are numbers to suggest that states, districts, schools, and private firms are all increasing their blended and distance education program and course offerings. According to the National School Boards Association (2002), 20% of K–12 students will receive at least one-third of their instruction over the Internet in the next 3 years, and a majority of high school students will have had an online course before graduating by 2006 (Rose, 2001). Clark (2001) estimated that 40,000 to 50,000 K–12 students would enroll in an online course during the 2001–2002 year.

Just over 35% of districts and 40% of schools "responsible for grades 10–12" have adopted online high school courses (Interactive Educational Systems Design, 2002, p. 2). Numbers that point specifically to distance education initiatives are those dealing with virtual schools. Growth in this sector is notable. At least 14 states have or have planned state-level virtual schools (Clark, 2001). The 40 leading virtual schools with a total enrollment of 85,500 students was projected to grow to 88 virtual school programs with more than 275,000 students in the 2001–2002 year (Peak Group, 2002). In addition, enrollment does not comprise just domestic students. In the Florida Virtual High School, more than 1,900 students from 17 countries registered in the spring of 2000.

For-profit entities offering distance education are also growing. CLASS.com, through the University of Nebraska Independent Study High School Online Diploma Program, served 15,000 students from 6,500 high schools in 1999–2000 (Levin & Tinkler, 2001, p. 3). Cyber charter schools are also on the rise. In Pennsylvania, for example, 84% of the state's districts reported and nearly 80% had students enrolled in cyber charter schools in 2001–2002 (Pennsylvania School Boards Association, 2001, p. 4). Although these statistics suggest that distance education is most certainly growing in the K–12 sector, much more systematic and specific data are needed. For example, distance education initiatives at the elementary and middle school levels are currently taking place (e.g., K12 Virtual Academies, Star Schools, and Apex Learning), but data about the prevalence and effectiveness of these efforts are not yet available.

Postsecondary Education

The data on distance education enrollments and offerings for postsecondary or higher education institutions are better and show continuous substantial growth. In 2000, the Web Based Education Commission reported that the number of online postsecondary courses and enrollments nearly doubled over 3 years. The National Center for Education Statistics (NCES) indicated that in 2000–2001, 34% of 2- and 4-year postsecondary institutions offered a distance education course. This constitutes approximately 5,010 institutions, of which 62% are public 2-year institutions, 78% are public 4-year institutions, 5% are private 2-year institutions, and 19% are private 4-year institutions. "56 percent of all 2-year and 4-year Title IV-eligible, degree-granting institutions offered distance education courses for any level or audience, representing about 2,320 institutions" in 2000–2001 (p. iii). NCES also reported that 90% of public 2-year institutions, 89% of public 4-year institutions, 16% of 2-year private institutions, and 40% of 4-year private institutions offered distance education courses. This amounted to a total of 3,077,000 enrollments. According to a Government Accounting Office (GAO) report, the Department of Education estimated that "84 percent of four-year institutions will offer distance education courses in 2002" (Ashby, 2002, p. 4). Statistics from the Sloan Foundation indicate that 16% of public and for-profit and non-profit higher education institutions offered only online courses (Allen and Seaman, 2003).

Enrollment and market numbers support these reports of increased postsecondary distance education course offerings. In the 1999–2000 academic year, 7.6% of all undergraduate students at postsecondary institutions participated in distance education classes (National Center for Education Statistics, 2002). Students enrolled in 2.9 million distance education courses in 2000–2001 — double the 1997–1998 enrollment in such courses (National Center for Education Statistics, 2003a). Ashby

(2002, p. 4) reported that roughly 1.5 million of 19 million postsecondary students would take at least one distance education course in 1999–2000. Gallagher and Newman (2002) estimated that approximately 350,000 postsecondary students were enrolled in U.S. “fully online” distance learning programs in 2002.

Career Training

Reports show that technology-based training is also on the rise in the corporate training arena; however, whether this is all distance-based is unclear. According to Fulton (2002, p. 7), “Business and industry have been the largest users of online learning, recognizing its value for expediting and advancing corporate training.” In 1998, corporations spent $550 million for Web-based learning — an amount expected to increase to $11.4 billion by 2003 (Moe & Blodgett, 2000, p. 229). Galvin (2002, p. 25) reported that in 2001 — before September 11 (9/11) — “training professionals planned to spend $56.8 billion by that year’s end. In 2002, $54.2 billion was spent on workforce development programs — a 5 percent drop.” The Department of Defense (DoD) spends more than $17 billion annually for nearly 30,000 training courses for almost 3 million military personnel and DoD civilians using advanced distributed learning (ADL) programs (Distance-Educator.com, 2003).

While the unique effects of 9/11 warrant caution in comparing 2000 data and data for subsequent years (Galvin, 2002, p. 25), the data do show an increase in technology-based (not necessarily distance-based) training. According to Thompson, Koon, Woodwell, and Beauvais (2002), the share of such training increased from about 8.8% of all training in 2000 to 10.5% in 2001. At the same time, the percentage of training time via classrooms declined from 79.4% in 2000 to 77.1% in 2001. Instructor-led distance delivery of training from a remote location has grown only 1% from the 2000–2001 average (7% total), with 48% of the training through self-paced Web courses (Galvin, 2002, pp. 68–69). Thus, although career/training distance education seems to be more sensitive to gross social events and markets (e.g., reduction in services post-9/11), there is growth in this sector.

The information in this section suggests that what is known about online and distance education is limited in a number of ways. Not only are there disparities in research among educational sectors, but many studies have not distinguished between online and distance education. Where there is evidence, it is clear that technology-based education is on the rise and that distance education does comprise a growth sector. However, more targeted research on the prevalence of distance education is needed.

Distance Education Drivers, Models, and Barriers

Although a quasi-comprehensive history of distance education models to identify persistent and transient constructs and concerns is an essential element of a far-reaching research agenda, the effort is beyond the scope of this report. It is useful, however, to point out factors that either drive or impede distance education's use or adoption, and to outline some of the models and characteristics of distance education institutions, programs, and courses that have been advanced in the literature. This information can be used as a baseline as well as a point of departure for thinking about distance education's future.

Drivers

The demand for distance education is driven by different sectors and interests. Educational goals, policies and regulations, consumer markets and funding, and technology all affect why distance education is pursued as a form of educational delivery and how such pursuit takes place.

There can be no doubt that laws and policies are drivers of individual and institutional behavior. Barron (2002), for example, suggests that sector needs and policies regarding educational goals — such as technology adoption, training, and certification and licensure — are major drivers of distance education in both domestic and international contexts. While not intended as an incentive for distance education specifically, both the No Child Left Behind Act (NCLB) and the Higher Education Act (HEA) support technological capacity building that may translate into distance education offerings.

NCLB requires states to license K-8 educational facilities and develop teacher and administrator technology standards for learning and teaching. When supported by funds, policies like the Enhancing Education Through Technology program (25% of federal technology dollars for staff development) can support blended and distance education activities (Ansell & Park, 2003). HEA contains two rules that shape the way distance education can be conceived and delivered. The 12-hour rule holds that a minimum of 12 hours a week of coursework must be offered if an institution does not operate using a standard semester, trimester, or quarter system. The 50% rule holds that institutions may not provide student financial aid if more than 50% of their course offerings are distance delivered (Carnevale, 2003a).[4] Legislation to fund technology connectivity such as the E-rate for K–8 educational institutions and the proposed NTIA Digital Network Technology Act to fund the same for minority-serving institutions have provided important support for capacity building of the technical infrastructure that institutions need to offer blended and distance education to their students. Finally, the Technology, Education, and Copyright Act (TEACH Act), which was signed into law in

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[4] Bill H.R. 1992, which proposes to eliminate these two rules as part of an upgrade of the nation's workforce investment and adult education systems, was introduced in the 108th Congress and referred to the House Subcommittee on 21st Century Competitiveness on 6/20/2003.

late 2002, made it possible for distance educators to use copyrighted materials for distance education purposes without permission and without paying royalties (Crews, 2002). These are all incentives to encourage distance education's adoption and use.

Dirr (1999) draws attention to the fact that technology itself is a driver of distance education. He argues that new technologies that facilitate the delivery of educational programs become more sophisticated and require additional and more powerful technologies as they progress.

Learners and educational institutions, too, drive how education is delivered. Not only do learners form markets based on their needs (Barron, 2002), but they also form markets based on the types of learners they are and their relationships to various instructors or instructional settings (Oblinger et al., 2001; Dirr, 1999). Whether it be corporate, professional enhancement, degree completion adult, college experience, pre-college (K–12), recreational, test prep, or remediation, learners and their educational needs dictate whether or not distance education is pursued as an educational option. Finally, Dirr (1999) and Fisher (2001) posit educational institutional or program goals as drivers that, depending upon the types, levels, and constraints of funding and the cost-effectiveness of distance education programs or enhancements, also affect whether distance education appears in an institution's program (Jung & Rha, 2000; Cavalluzzo & Higgins, 2001; Thomas, n.d.; Adkins, 2002; Lane, 2000).[5]

According to Kriger (2001), market forces are one of distance education's most significant drivers. Merrill Lynch projects that the distance education market for traditional institutions will reach $7 billion by 2003, with a combined education and training distance education market of upwards of $25 billion by the same year. Gartner Research's projections are that the global market for Web-based learning will grow from $2.1 billion in 2002 to $33.6 billion in 2005. NCES reported that the total enterprise of education and training puts more than $700 billion a year into the U.S. economy and that distance education will be "grabbing an increasing slice of the pie" (Kriger, 2001, p. 5). Brandon-Hall.com reported that the "greater learning market" is worth more than $900 billion, with the postsecondary and elementary and secondary sectors making $261 billion and $389 billion of annual revenue, respectively (Adkins, 2002; see Figure 1). And, on the basis of estimates from 2000, Moe and Blodgett (2000, p. 171) suggested that the postsecondary distance education market would grow from $1.2 billion in 2000 to $7 billion by 2003.

While these types of financial returns from distance education are no doubt compelling, so is the argument that distance education can reduce the increasing costs of traditional educational delivery. Indeed, this has driven the adoption of ICTs for distance and blended learning. However, investments in information and communications do not seem to have stemmed rising educational costs — a matter that

[5] See the Andrew W. Mellon Foundation's Cost-Effective Uses of Technology in Teaching (CEUTT) projects as further sources for information on most aspects of distance education programs and initiatives, including funding supports and cost-effectiveness. Available at http://www.ceutt.org/L2WebBib.htm.

warrants further sustained investigation. Conversely, it can also be argued that it costs more to capture and transmit a thought via electronic and other distance means than via traditional education delivery methods. This is particularly the case if one considers the expense of increased communication time when kinesthetic cues or facial expressions and hand gestures are missing. Exactly what the costs are of the use of technology for distance or blended education is still under investigation. Through the work of projects like the Costs of Supporting Technology Services at Hamilton College (http://www.costsproject.org/default.htm), detailed empirical information is currently being gathered. Until that time, however, research on economic models can join empirical studies to paint a clearer picture of the economic structures and impacts of ICTs on distance and other forms of education.[6]

Models: Structures and Characteristics

All of these forces interact and work simultaneously to drive the prevalence, form, and content of distance education. Patterns of how and why they interact and the relative import and impact of these forces are detailed in different models. Table 1 offers a selective overview of literature that offers models and characteristics of distance education by sector.

In the case of organizing or operating structures of distance education institutions or programs, the dominant approaches discussed are organizing either by type of program (i.e., a full curriculum or a supplement to an established curriculum) or by institution or sponsor (see Table 1). Some have chosen to focus on the characteristics of distance education programs, courses, and services as touchstones for comparison and evaluation or as bases for models, rather than use organizing or operating structure as the defining characteristic of distance education models. There are also other approaches, such as that of Rumble (1986), which is based on the structure of content development. While each model type has its particular uses, other models or categories are both possible and available. The point here, however, is to give a general sense of the current discourse on distance education's organization and components through some of the more recent literature.

Both the K–12 and postsecondary sectors offer distance education options, through the full-curriculum and supplemental approach that are either developed in-house or by an outside profit or non-profit vendor. States, universities, and consortia of "equivalent" institutions sponsor initiatives in both sectors, as do for-profit entities. Another set of useful operating approaches for both the K–12 and postsecondary sectors is non-profit and for-profit organizational partnerships with other institutions, including outsourcing to vendors.

[6] See, for example, Berg (2000), Castells (2000), and Center for Studies in Higher Education (2001).

Table 1 – Distance Education's Organization and Characteristics

Organizing or Operating Structure		
K–12	Clark (2001)	State-sanctioned, state-level, college- and university-based, consortium- and regionally-based, local education agency-based, virtual charter schools, private virtual schools, for-profit providers of curricula, content, tools, and infrastructure including commercially available delivery platforms such as Apex Learning, Blackboard, eCollege, and Class.com (see also Freedman et al., 2002)
	Lizardi (2002)	Consortia, statewide, university-administered (fee or no fee), choice for charter or virtual schools, private entities
	Fulton & Kober (2002)	States, districts or consortia, cyber charter schools, other online education providers

Postsecond-ary/Training	Rumble (1986)	Sole-responsibility, mixed mode, and consortium
	Trow (2000)	Elite, mass, and universal
	Hanna (1998)	Extended traditional universities, for-profit adult-centered universities, distance education and technology-based universities, corporate universities, university-industry strategic alliances, degree and certification competency-based universities, and global multinational universities
	Kriger (2001)	Existing higher education institutions with or developing distance education programs, corporate university joint ventures, full virtual universities, corporate university or training institutions
	Oblinger, Barone, & Hawkins (2001)	Extensions of traditional institutions, not-for-profit subsidiaries, for-profit subsidiaries, and virtual universities – many of which engage in partnerships
	Harley (2002)	For-profit, equity stakes in external companies, university consortia, licensing agreement, MIT OpenCourseWare initiative
	Gallagher & Newman (2002)	Course management system providers, consultancies, and full-service distance learning specialists
	DuMont (2002)	Competing and complementary forces of internal environment and external environment
	Barron (2002)	Vendor-global-consultant alliances, vendor-integrator alliances, and vendor-vendor alliances

Program, Course, or Service Characteristics		
K–12	Sherry (1996)	“Curriculum enrichment modules and ongoing telecommunications projects” (p. 5), programs funded for rural or underserved urban communities, courses to meet graduation requirements, AP, foreign language, or vocational classes, homebound and disabled students
	Clark (2000)	Technology, funding, curriculum, student services, professional development, access and equity, assessment, policy and administration, marketing and public relations (pp. ii–iii)
	Levin & Tinkler (2001)	Intrinsic (curriculum and instruction) and extrinsic (organizational) elements of online programs or courses. Intrinsic: aligned with standards, engaged in multiple learning styles and critical thinking, assessment, diversity, active engagement with students and teachers, appropriate delivery method and interface, support/detraction from instructional task, richness of communication experience. Extrinsic: accreditation, Internet access, faculty role, faculty compensation and support, mentoring for students (on-site coordinators for questions)
	Peak Group (2002)	Full curriculum, supplemental curriculum
	Fulton & Kober (2002)	Sponsorship, funding mechanisms, teacher requirements, course offerings, modes of delivering instruction, and other key features (synchronous and asynchronous, supplement and online alternative, standard semester and self-paced)
	Lizardi (2002)	Opportunities for students unable to attend regular schools (travel, medical condition, career, disability, suspension), courses school cannot offer, AP courses (contentious in California), choice for parents “who desire schools of a particular educational philosophy, theme, or pedagogy” (charter, private, and home schooling)
	Educational Partnerships and Learning Technologies & University of Washington (2002)	Content aligned with “lowest common bandwidth denominator,” accredited, required courses and some AP honors courses, certificated high school teachers, mostly full-time online enrollments, courses delivered by proprietary platform, 90% access VHS from school, initial funding from grants and corporate sponsorship with later shift to ongoing state support

Postsecond-ary/Training	McIssaac & Gunawardena (1996); Johansen et al. (1991)	Same time/same place, same time/different place, different time/same place, different time/different place, and the technologies (including traditional classroom interaction) that can be used for each
	Oblinger, Barone, & Hawkins (2001)	Partnership services include online applications, campus-based portals, online procurement, online course delivery, supplemental content providers, online libraries, online textbook distributors, and advising and tutoring (see p. 17)
	Porter & O'Connor (2001)	Technology assistance to learners via online assistance, telephone support, in-home assistance, on-site (at program), mail, special equipment (such as loaned computers), tutorial, hotline, study guides, advisement/counseling, peer counseling
	Green (2002)	Campus Web portals for services such as applications, course reserves, course registration, student transcripts, full online courses, and e-commerce/credit cards
	Gallagher & Newman (2002)	Set of direct (platform, student/faculty support) and indirect services (technology infrastructure and program administration): critical technology and academic services, technological and operational infrastructure
	Gallagher & Newman (2002)	Supplemental programs, hybrid or mixed-mode programs, fully online programs

To date, the range of organizing and operating structures for postsecondary education has been wider for the postsecondary sector than for K–12. Because the wide range of student and client consumers in postsecondary institutions has more distinct educational goals, more specialized institutions and supports are required. Based on the literature reflected in Table 1, universities and other adult educational institutions in this sector, including corporate training programs, adopt organizational approaches based primarily on demand drivers (e.g., the clientele to be served; the goals they seek to achieve; and the organizational, policy, and economic constraints of the institutions involved). Because the institution of distance education programs requires significant up-front investments for technical infrastructure, program and course content, and organizational support and staff development, trends seem to be leading toward providing some sort of distance education as part of an institution's educational offerings. In these cases, however, the unbundling and outsourcing of services through vendors and partnerships — most on a for-profit basis — is becoming more prevalent.

Identified characteristics of postsecondary programs, courses, and services can be fully online, hybrid, or supplemental, and tend to be organized around any or all of the following categories: instructional delivery mode, technology, or platform; student and faculty support services (e.g., academic services, online applications, technical support, advising and tutoring, course reserves, libraries); and accreditation.

In the K–12 sector, for example, a discrete full-curriculum virtual high school model has emerged alongside the more traditional and prevailing supplemental curriculum approach. In fact, state-run, full-curriculum virtual high schools, such as the Florida Virtual High School, the Kentucky Virtual High School, and the Utah Electronic High School, are early full-curriculum models that states, districts, and schools have looked to for guidance as they develop appropriate distance education programs for their particular systems.

Virtual high schools can also be operated by consortia, districts, or choice or charter school programs.[7] For the elementary and middle school grades, full-curriculum options are increasing. For example, K12, founded by ex-Secretary of Education William Bennett, offers a full-curriculum K–12 Virtual Academy for elementary and middle school students, which is currently being used by schools in Arizona, California, and Wisconsin (Blomeyer, 2002). K12 also offers a full-curriculum home schooling option for these grades.

The more prevalent model for distance education at the K–12 level is that of supplemental courses, for which a number of development and delivery options exist. Some examples are the Concord Virtual High School (VHS), CLASS.com, and Apex Learning. Concord VHS, for example, is a consortium that offers courses to students in nearly 25 states and 9 nations. The for-profit CLASS.com offers schools nationwide content developed by the University of Nebraska's Independent Study High School Online Diploma Program. Apex Learning, also for-profit, offers advanced placement, foreign language, and general courses. As with the full-curriculum model, distance education options for elementary and middle schools are also increasing, albeit primarily in the offerings of for-profit vendors such as Scholastic, Inc. and Apex Learning.

Identified characteristics of K–12 programs, courses, and services are present in curricular arrangements ranging from full curricula to curricula supplements, and tend to be organized around any or all of the following categories: curriculum; funding and sponsorship; student services; teacher certification and professional development; access and equity; instructional delivery mode, technology, or platform; and accreditation.

[7] It should be noted that there has been some controversy about whether certain states' charter school laws authorize the formation of "cyber charter schools" or other educational bodies that have the potential to weaken current educational systems. For example, some argue that new virtual schools constitute an unregulated form of education that violates certain provisions of Charter School Law. Others suggest that new virtual schools constitute home schooling outside the scope of Home School Law. In addition, there is a more general concern that virtual schools siphon much needed funds and resources from districts. See Thomas (2002) for a general account of the difference between a state virtual school and an online charter school. See Trotter (2001) for a general sense of the growth of cyber charter schools. See Pennsylvania School Boards Association (2001) for a thorough treatment of how the issues raised here have played out in Pennsylvania.

The fact that models for the postsecondary sector are more diverse may be because the goals and clientele of the K–12 sector are more standard — even when state or local differences are taken into account — and are thus bound by more restrictive regulatory environments. In the postsecondary sector, more diverse organizational goals seem the result of the more diverse client or consumer bases and, thus, require more flexibility in how institutions are configured and run. Certainly the postsecondary program and curricular requirements are more varied for young and older adults, and the jurisdictional requirements of teacher certification and institutional accreditation are less geographically bound than those for K–12. Because of this, a wider range of types of partnerships may also be more likely at the postsecondary level.

Although the literature does not indicate whether certain models are emerging as dominant or preferred, the sheer proliferation of distance education models and services is affecting traditional educational goals, delivery, supports, and institutions by requiring that they be reevaluated and rethought. According to Hanna (1998, p. 93), "While [distance education] opportunities will abound for all, the abundance of opportunities will demand greater focus and clarity about purpose and competitive strengths as organizations compete in a larger, more complex marketplace."

The literature reviewed here is skewed toward information about higher education and the K–12 sectors in a U.S. context. Publicly available, research-based information on the career/training sector is hard to find. Discussion of international distance education activity, while important, is complex and considered beyond the scope of the report.[8] Similarly out of scope is the literature on how libraries, librarians, and information specialists fit in the distance education picture as key resources and distance education facilitators. That being said, there can be no doubt that library facilities and their staff are highly technological and technologically literate as a result of needing to access and use online information resources. In addition, librarians have been proactive in creating standards for in-house and online library services (c.f., The Dublin Core Metadata Initiative at http://dublincore.org), lobbying for consumer interests regarding legislation such as the Digital Millennium Copyright Act, and advocating for distance education as an integral part of general educational service (Kirk & Bartelstein, 1999).[9] As important as this professional sector is to effective distance education, the influence and support of libraries and librarians and information specialists are not well integrated into thinking and research about distance education conceptually or practically.

[8] See the Open University, Commonwealth of Learning (COL) http://www.col.org/, Guri-Rosenbilt (1999), WorldWideLearn http://www.worldwidelearn.com/global-education.htm, and the International Council for Open and Distance Education http://www.icde.org/oslo/icde.nsf/ for insight into international issues in distance education.

[9] See the American Library Association's Association of College and Research Libraries' Guidelines for Distance Learning Library Services. Available at http://www.ala.org/Content/NavigationMenu/ACRL/Standards_and_Guidelines_for_Distance_Learning_Library_Services.htm; the Center on Library and Information Resources http://www.clir.org/; and the Digital Libraries Initiative (Phase 2) http://www.dli2.nsf.gov/ for more information.

What emerges most clearly from this literature on models and characteristics for distance education is that educational institutions — particularly traditional postsecondary institutions — are increasingly being faced with the need to change and the need to embrace beneficial methods of change. Again, Hanna (1998, p. 93) states, "Leaders of all institutions and programs, to be effective in this era of digital competition, need a strong rationale and framework for organizational change." DuMont (2002), citing Baldridge and Deal (1983), argues that understanding and managing internal and external environments — a balance between maintaining traditional and long-term stability versus change — is critical for distance education's success.

It is Harley (2002), however, who suggests that a search for overarching models may be a bit misguided, especially because little time is available to evaluate their short- and long-term impact before another technology or approach is introduced. Thus, the current context of ad hoc adoption and evaluation may be a necessity. She states:

> Rhetoric suggests that Information and Communication Technologies (ICTs) will be an important solution to the triad of pressures facing colleges and universities: a) holding down costs, b) providing access to an increasingly diverse demographic, and c) maintaining quality. It is in this environment that university leaders are faced with making decisions about internal and external markets, but with no clear models to reference. Not only are answers to questions of educational efficacy, revenue streams, and nature of potential markets elusive, but the creation of high quality online offerings is expensive, and requires huge capital investments…[our work leads us to think that] predictions about the future consequences of ICTs for higher education are complicated by both the diversity and rapidly changing character of institutions, student populations, and technologies themselves. Such diversity and speed of change suggests that predicting the emergence of one, or even a few, U.S. models for flexible learning may be impossible. (p. 1)

In a context of such rapid change, it is most important that distance education models are distinct to the educational functions intended by an institution or organization. Specifically, it is important that distance education flexibly incorporates the necessary supports to ensure its effectiveness for different education sectors: pre-K, elementary, secondary, tertiary, adult and continuing education, and training for industry or professions. Models for these various sectors need to be more clearly developed and applied.

(1) Instructional Models: Media and Delivery Platforms

There is often conceptual confusion about what makes up instructional media or ICTs and how these differ from instructional methods. These distinctions are also represented in the models referenced in Table 1 previously. Sanders (2000), for example, distinguishes between instructional methods (e.g., group discussion, lecture, demonstration), presentation methods (e.g., face-to-face, audio, video-based teleconferencing, Groupware for online interactions), and distribution methods (e.g., CD-ROM, e-mail, Internet, videotape). Some might argue, however, that his distinctions conflate instructional media (e.g., the medium of e-mail) and methods of instruction or distribution (e.g., the instructional use of e-mail).

In this review, instructional media and ICTs are conceived primarily as distribution methods. Note that "certain presentation methods may be transmitted via only one distribution method (e.g., telegram by telegraph), while others can have an array of distribution options (e.g., a letter distributed by fax, airmail, or e-mail)" (Levin, 2001, p. 6). "Delivery platforms" should be understood also to refer to slight differences within a technology that is often, but not always, distinguished by proprietor (e.g., WebCT vs. Blackboard or Microsoft vs. Apple computer operating systems).

Statistics regarding the use of technologies for K–12 instruction outside of computers and the Internet are not gathered by NCES. The Department of Education's Star Schools initiative and its Distance Learning Resource Network link to many interesting and important distance education resources that address statistics regarding the use of various technologies in distance education. However, these are either not up to date or focus on higher education. Other research that tracks technology use in K–12 education also focuses primarily on computer and Internet use, or discusses technologies that now either are obsolete or are used with less frequency (e.g., audio-conferencing, broadcast or Instructional Television Fixed Service [ITFS], satellite television and/or video-conferencing,[10] and/or compressed video) (Clark, 2001; Thomas, 1999; Hezel Associates, 1998). Clark (2001) states that "a majority of virtual schools appear to be using Web- or Internet-based instruction as their only distance learning method." Some, he notes, do use independent study or videoconferencing methods.

Delivery platforms vary in the K–12 sector, but Blackboard and eCollege seem to be the most common. E-mail, synchronous and asynchronous online discussions, and videos and CD-ROMs are also used (Lizardi, 2002; Educational Partnerships and Learning Technologies & University of Washington, 2002; Kozma, 2000). However, it is instructive that a "foundations of distance education" textbook published in 2000 highlights the Internet as distance education's primary delivery technology (Simonson et al., 2000). Thus, although the literature on distance education in K–12 schooling is full of references to various synchronous and asynchronous technologies that can be used, more detailed information is needed regarding what technologies are actually being used for distance education delivery in the K–12 sector — particularly for elementary and middle school students.

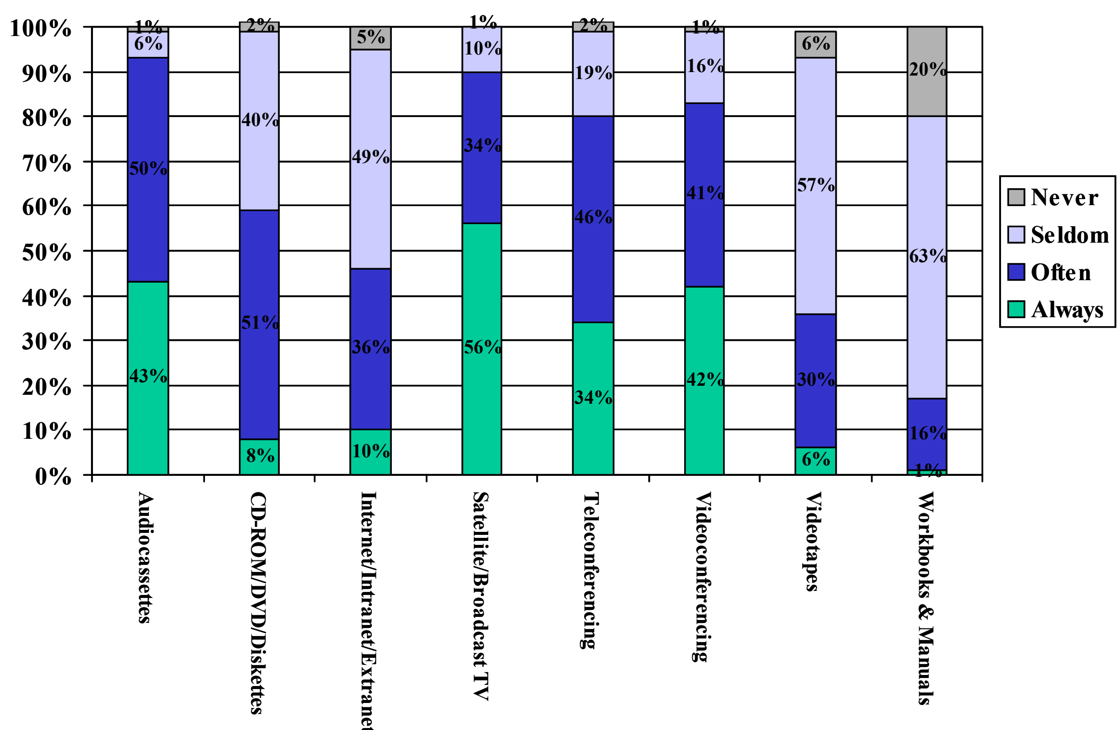
In the postsecondary sector, it is reported that live and prerecorded audio and television are used as distance education delivery media for undergraduate and master's level courses (37.3% live and 39.3% prerecorded for undergraduates enrolled in distance education courses; 44.9% and 29.3%, respectively, for master's students enrolled in distance education courses). The Internet is the delivery medium of choice, however, with its use by 60.1% of undergraduates and 68.3% of graduate students

[10] See the Satellite Educational Resources Consortium (SERC) for more information about satellite-based courses. Available at www.serc.org.

enrolled in distance education courses (National Center for Education Statistics, 2002).[11]

According to Galvin (2002), workbooks and manuals continue as the dominant instructional media in the career/training sector, with videotapes, the Internet, CD-ROM/DVD/diskette, teleconferencing, and videoconferencing being used progressively less (see Figure 2). These data are not particularly telling, however, because they represent only "traditional" educational delivery technologies and do not attempt to determine whether other, more innovative technologies are currently in use or on the rise (such as handheld devices, streamed or on-demand video via Internet, or virtual immersion). According to Navarro and Shoemaker (2000), lectures on CD-ROM, electronic testing, online threaded discussions, and online chat room discussions are all effective instructional technologies that are used in distance education settings. Students, however, seem to prefer CD-ROM lectures and how they enhance the traditional classroom.

Figure 2 – Frequency of Instructional Media Used In Career/Training Sector



Galvin (2002).

[11] See Gunawardena (1991) for her analysis of technologies used for the delivery of distance education in postsecondary educational institutions.

(2) Course Content, Instructional Design, and Instructional Methods

In general, distance education courses are held to the same state and district content and quality standards as face-to-face courses (Fulton, 2002; Center for Studies in Higher Education, 2001). That being said, aspects of distance education courses differ from traditional face-to-face courses. For example, a course's mode of delivery, the instructional methods used, the content modified to fit into mode of delivery and instructional methods (i.e., instructional design), and so on, can be quite distinct and require specific approaches. Thus, in many cases, traditional methods of course development, delivery, and evaluation do not apply to distance education. As a result, professional organizations such as the National Education Association (NEA), the American Federation of Teachers (AFT), and the Southern Regional Education Board (SREB) have developed additional standards, benchmarks, or guidelines for good distance education practices (Institute for Higher Education Policy, 2000; American Federation of Teachers, 2000; Southern Regional Education Board, 2000–2001).

In the K–12 sector, courses offered primarily at the secondary level have tended to include advanced placement courses; higher level mathematics and science courses such as physics and chemistry; foreign languages; and courses in core subjects (Thomas, 1999; Yamashiro & Zucker, 1999; Clark, 2000, 2001). Online preparation for high-stakes testing is also an important offering, and increasingly so in recent years (Interactive Educational Systems Design, 2002). As well, the full potential of distance education and education methods using technology may not be fully realized owing to differences in perceptions and desired activities and outcomes between teachers and students (Levin & Arafeh, 2002; BellSouth Foundation, 2003). However, as noted above, current research on the K–12 sector has not yet focused on distance education offerings outside of specific virtual schools — primarily virtual high schools.

In the postsecondary sector, 56% of institutions offered some kind of distance education courses, and 34% had certification programs. Institutions were found to be more likely to offer distance education degree programs (30%) than certificate programs (16%), with 21% offering undergraduate degree programs and 35% offering graduate or professional degree programs (National Center for Education Statistics, 2003a). NCES does not supply data on delivery models or what subject areas these programs or courses cover. Neither do a number of studies and literature reviews that discuss postsecondary distance education offerings (Web Based Education Commission, 2000; DuMont, 2002).

In the career/training sector, 24% of courses used a blended distance and face-to-face approach, with online-only interaction declining 3%, from 77% in 2001 to 74% in 2002 (Galvin, 2002). This last statistic is interesting in light of recent findings that students report wanting to pursue their educational objectives in courses or programs that combine distance and live-interaction elements.

Regarding curricular offerings and course content for distance education programs and courses, a fair amount of data can be found in all three sectors: K–12, postsecondary, and career/training. Information on distance education pedagogy and instructional approaches, however, tends to be descriptive (e.g., case studies), and much remains to be done in the way of data collection and systematic study to provide a clear picture of major trends in distance education instructional methods.

(3) A Different Educational Experience

Part of the differences between place-based education and distance education is that the instructional experience is different. Teachers, professors, and students find that their course loads, materials, pedagogical techniques, and interpersonal and collegial relationships differ, including what work they undertake and how their workload and work hours are configured. Many faculty find that their work is more time-consuming (often from increased time spent typing), is more isolated, and requires specialized skills (Paulson, 2002). In many cases, faculty members are not keen on participating in distance education initiatives at their institutions because of these changes. Of particular concern is the “unbundling” of their professional work into discrete tasks undertaken by both faculty and supporting content, technical, and administrative staff (Paulson, 2002; Williams, 2003).

Whether or not faculty’s experiences and proclivities regarding the adoption of education models are duly considered, nearly every discussion on improving distance education concludes that, at the very least, stepped-up efforts to increase and improve professional development opportunities for teachers are necessary. Discussions regarding distance education are no exception, although they focus on professional development from two perspectives: (1) educating teachers to be effective in teaching *at a distance* and (2) *using distance education* as a mode of delivering professional development and certification opportunities (CEO Forum on Education and Technology, 2000; Education Commission of the States, 2002; Branigan, 2003; Howell, Williams, & Lindsay, 2003). Because distance education involves a range of often new technologies, exposing teachers to them and helping teachers learn how they can be effectively used for course delivery — whether or not online — are key. However, schools of education have not effectively prepared teachers to use technology (Office of Technology Assessment, 1995). Of particular note is that ongoing and just-in-time support have been recognized as crucial training and support mechanisms for the use of technology in instructional delivery.

Barriers

Despite the fact that distance education has many advocates and has a strong foothold in the educational world, a number of technical, economic, and social barriers to its acceptance and implementation are cited in the literature. Barriers can be both institutional and individual. According to the Peak Group (2002), challenges and obstacles to growth of K–12 virtual schools include issues related to funding and policy, teaching online, technology, content development, developing a competitive environment, proof of effectiveness, and overcoming misperceptions. While 78% of respondents to the Peak Group survey cited outmoded brick-and-mortar credentialing requirements as the primary obstacle to growth, 58% cited funding, 18% cited policy issues (linked to funding), and 10% cited content issues (e.g., difficulty and expense in developing quality, cost of courseware, teacher time and effort to develop effective lesson plans for online work). Other barriers include a lack of planning time (Porter & O'Connor, 2001), human contact, and accountability, as well as the effects of what Dirr (1999) calls "The Double Glass Ceiling" (i.e., the disconnect between the use of technology in distance education programs and traditional pedagogical paradigms). This ceiling results in distance and virtual education programs "failing to take full advantage of a range of resources available to the instructor and learner and [failing] to employ the full power of some of the new information and communications technologies to support improved pedagogical approaches."

Perhaps more significant, or with more far reaching effects, are barriers resulting from funding and jurisdiction. According to the Pennsylvania School Boards Association (2001), funding that goes to online charter schools is funding that is taken away from traditional schools and districts. Whether the administration, faculty, and learners embrace distance education in such a situation depends on how they perceive their political, economic, and social interests, and whether they feel adopting distance education programs or courses would further them. Fulton and Kober (2002) draw attention to the provisions of the Higher Education Act discussed earlier, which refuse financial aid to students and institutions if distance education courses make up more than 50% of an institution's courses or if courses in institutions without traditional scheduling offer distance education courses for fewer than 12 hours per week. This creates a chilling environment that undermines the adoption of distance education efforts.

Kriger (2001) points out that reductions in funding, changes in legislation and policy that allow educational configurations that were not possible previously (e.g., charter schools, vouchers), and ongoing threats of educational staff reductions lead administrators and faculty to feel a loss of professional control. As a result, they straight-arm innovations that can be, but are not always, improvements to their own and their educational institution's status and practice. Even the Web Based Education Commission (2000) called for the revision of "outdated regulations that impede innovation" and their replacement with "approaches that embrace anytime, anywhere, any pace learning" (p. iv – see also pp. 87–97). Such policies can create distance education models that take money away from existing funds, require additional credentials, and undermine the conceptual and actual foundations of the extant educational system.

In musing on the effects of full adoption of non-place-based higher educational institutions, Foreman (2003, p. 21) states, "Although student interest in a videogame Psychology 101 would have to be great, the consequences for place-based psychology departments would be transformative in ways that academics would not like to consider." In particular, note Kriger (2001) and Fulton and Kober (2002), faculty concerns abound about unbridled commercialism, market and technology models that dumb down and standardize both the learner and the curriculum, and the unbundling of the faculty role into discrete but unarticulated tasks distributed among a variety of support staff. The disconnect is partially due to differences in what the Center for Studies in Higher Education (2001) called “the industry view” and “the university view” — one with market and credentialing interests, and one that wants to maintain an outside-of-the-market culture of intellectual freedom, ownership of intellectual property, and learning for the sake of learning.

Concerns about the increasing commercialism — or unbridled commercialism according to Noble (2001) — were also addressed by the Web Based Education Commission (2000), as were issues of privacy. According to the Commission, “Advertising can interfere with the learning process and take advantage of a captive audience of students. Privacy can be endangered when data is collected from users of online materials. Students, especially young children, need protections from harmful or inappropriate intrusions in their learning environments” (p. iv).

Dede (2002, p. 8) suggests that the “fundamental barriers to employing these [distance education/distributed learning] technologies effectively for learning are not technical or economic, but psychological, organizational, political, and cultural. Powerful methods for scaling-up and transferring pilot implementations and for evolving the public’s conceptions of learning and schooling are essential to take full advantage of the opportunities new technologies pose.” While there is no one barrier to the prevalence and effectiveness of distance education, technological, policy, economic, and organizational issues all interact and are key.

CHAPTER 3: DISTANCE EDUCATION'S QUALITY AND IMPACTS

Until only recently, distance education was often perceived as the ugly stepchild to traditional forms of education. Distance education courses were thought to be poorly designed and less rigorous than traditional courses; distance education instructors were seen as ill-prepared and poorly certified; and distance education programs and institutions were characterized as fly-by-night credential mills (Noble, 2001). Although these perceptions were true in some cases, much has been done to improve the quality of distance education and to assess the nature of such improvements. The development of standards, benchmarks, and guidelines for effective distance education, as described previously, has been an important part of this process. Evaluations of distance education course content, instructors and instruction, and outcomes based on these criteria are crucial for ensuring course and program quality (Bruce, 2003; Belanger & Jordan, 2000; Anglin & Morrison, 2002), which, in turn, underpins the acceptance of distance education as a rigorous and effective educational model and form of instructional delivery.

Joy and Garcia (2000) suggest that evaluations of distance education efforts ask: "What combination of instructional strategies and delivery media will best produce the desired learning outcomes for the intended audience?" In keeping with this perspective but speaking in the context of postsecondary education, Hiltz, Zhang, and Turoff (2001) suggest that evaluations of distance education efforts must be able to discern the many factors involved in the effective delivery of content, resources, and pedagogy, and must move beyond the evaluation of single distance education courses while working to use the full range of evaluation measures (i.e., student performance, resource, opportunity, long-term impacts, and intervening variables such as type of student, type of course, teaching methods and technologies employed, course size, and course information available to students). Of course, in the final analysis, distance education is about whether or not educational institutions and personnel have been able to fulfill the learning objectives of whatever specific learners they teach (Belanger & Jordan, 2000).

Perhaps the most widely heard assessment of the effectiveness of technology in the improved provision of education is Russell's (2001) pronouncement that there is "no significant difference" between educational approaches that use technology and educational approaches that do not. On the basis of more than 200 citations of empirical research on elementary and secondary education, higher education, and adult education and training research, Russell contends that good educational content and pedagogy, not technology-based delivery systems or approaches, result in improved educational outcomes. Thus, technological course or program augmentations that result in positive effects do so because they are part of an effective teaching and learning scenario. Some have argued that studies that find no significant difference may be comparing traditional educational approaches with technology-based approaches designed to deliver the same traditional curricula and pedagogies, but that framing the research this way inevitably results in the zero-sum, no significant difference result

(Twigg, 2001). If it is the case that "the amount of learning produced by different media is similar (NSD) but adequate to meet our instructional goals," Clark (2001) reasons, "then all treatments are equally valuable for learning but will usually differ in their cost and convenience," which is an opportunity to adopt the model of education delivery that is most cost-effective — whether human- or media-based. According to Twigg, a number of innovations in online learning are helping us move beyond the no-significant-difference phenomenon — not least the recognition that we need more sustained and thoughtful empirical work on distance learning outcomes such as student learning (Anglin & Morrison, 2000; Wisher, Champagne, Pawluk, Eaton, Thornton, & Curnow, 1999; Cavanaugh, 2001). Fortunately, research on education technology and distance education is beginning to show that such a choice does not have to be either/or; combined and scenarios such as blended learning are also possible (Twigg, 2001; Dede, 1995).

For example, Hiltz, Zhang, & Turoff's (2001) meta-analysis of 19 empirical studies comparing student learning and other subjective measures in asynchronous learning (ALN) in Learning Networks to traditional face-to-face courses found that "the evidence is overwhelming that ALN tends to be as effective or more effective than traditional modes of course delivery at the university level." According to Verduin and Clark (1991), "Distance education methodology appears to achieve cognitive outcomes equal to those achieved by the more traditional means of education delivery for adults" and good student supports are needed to achieve this parity in learner outcomes. Cavanaugh (2001) also found a modestly positive effect size for grade K–12 learners and a negative effect in the case of foreign language study. Important to note, however, is that effect sizes were more positive for distance education programs that adopted a blended model by including some traditional classroom instruction. Wisher et al.'s (1999) meta-analysis of distance education in training applications found "a generally positive view of the effectiveness [of such courses]."

Other studies of effectiveness show that cyberlearners learn better than traditional learners of all types and have high rates of satisfaction (Navarro & Shoemaker, 2000). However, results of satisfaction do not necessarily equate to preference. For example, while undergraduate psychology students in introductory psychology distance education courses achieved more than non-distance education students, they did not prefer the distance education study approach (Carr, 2000).

An important recent Michigan State University study of the *HomeNetToo Project* found that children who spent more time online increased their grade point averages — ostensibly as a result of engaging more often and more deeply with the Internet's text-base (Jackson et al., 2003). Although the demographics of the students and families studied inevitably figure into the equation (largely low-income and African American), their increased exposure to text through online activities "is causing children to read more, resulting in improvements in grade point averages and performance on standardized tests of reading achievement" (Internet Education Exchange, 2003). Whether this finding can be generalized to formal distance education courses or programs for all sectors needs to be ascertained. However, the findings have important implications for the use of technology in education generally and its potential for not only improving achievement but, in the case of its success with lower income and at-risk populations, also helping bridge the digital divide.

A number of factors affect the effectiveness of online education. Hiltz (1994), Hiltz et al. (2001), and Jung and Rha (2000) highlight the importance of instructor and student characteristics and the social context of interactions as being key to successful and achievement-oriented online experiences. In Hiltz's (1994) study, online treatment outperformed traditional treatment when instructors responded more to individual students on the basis of their particular characteristics. According to Jung and Rha (2000) and Dede (2002), instructional design is another factor that affects online education effectiveness. As noted above, and in keeping with Moore's (1996) three types of learner interaction (i.e., learner-content, learner-instructor, and learner-learner), learners and their goals drive what constitutes effective distance education practice and outcomes.

Even if distance education proves valid for improving academic achievement, criticism exists of both the nature of distance education and the study of it. Regarding the nature of distance education, a long-standing critique has been that the remote interaction between students and teachers undermines the social development of participants. The recent *HomeNetToo* study, however, found (among adults) “no evidence that using the Internet at home reduces social contacts or undermines communication with family or friends” (Jackson et al., 2003).

The criticism of distance learning effectiveness research is more pronounced and potentially more damning. Some argue that such research is premised on misleading comparisons with traditional education because, although similar curricular material and general pedagogies might be employed in both traditional and online settings, they are not identical and, therefore, are ultimately not comparable (Smith & Dillon, 1999; Kozma, 2000). Others claim that research designs and measures have been flawed (Joy & Garcia, 2000; Champagne & Wisher, 2000; Wisher et al., 1999). Levin and Tinkler (2001, p. 4) highlight the concerns raised: lack of adequate experimental design, objective measurement variables, controls for extraneous variables, random assignment of subjects, validity and reliability of instruments used, and attention to “individual difference measures such as level of ability, motivation, time on task, media familiarity, self-efficacy, and student learning style.” In addition, much of the outcomes research cited has focused on the effects of technology or technological interventions on teaching and learning in general rather than only in distance education settings, and distance education is often treated as monolithic with little attempt to distinguish among delivery types or education sectors. Noble (2001) suggests that numerous mitigating issues — primarily regarding distance education’s role in the commercialization, privatization, and globalization of higher education — undermine not only democratic institutions and principles but also the execution of research, teaching, and learning because of its market focus (see also Kriger, 2001, and Fulton & Kober, 2002). According to Phipps and Merisotis (1999, pp. ii, 2), “There is a relative paucity of true, original research dedicated to explaining or predicting phenomena related to distance learning.… Too many of the questions posed above are left unaddressed or unanswered in the research, while policymakers, faculty, and students need to make properly informed judgments about key issues in distance education.”

In light of the research, it is probably best to say that instead of “no significant difference,” there is “no conclusive evidence” that distance education is an improvement over traditional education, although there seems to be some indication that the use of distance technology, such as the Internet, is tentatively showing positive effects on student outcomes (e.g., Jackson et al., 2003). In the end, Florini (1989) and Moore and Kearsley (1996) point out that the effectiveness of distance education courses and programs is less a matter of the delivery technology or platform than “how instructors use the technology” (Florini, 1989) and “how well [a course] is designed, delivered and conducted” (Moore & Kearsley, 1996). Since “the integration of interactive media into learning experiences [in distributed learning scenarios] profoundly shapes students’ educational experiences” (Dede, 2002, p. 7), more and more rigorously designed and executed research needs to be undertaken to better understand the use of technology in education for teaching at a distance at all grade levels and for all types of learners.

CHAPTER 4: LEARNERS, EDUCATIONAL GOALS, AND INFORMATION APPLICATIONS

> This is the 21st century. Ours is a world of 24-hour news cycles, global markets and instant messaging. Our education system should reflect the times we're living in.
> —Secretary Rod Paige, U.S. Department of Education

In the recent past, the thinking about students and learning has shifted. Although not necessarily driven by the advent of digital technology, this discourse of cyber schools, online education, learning for the future, and 21st century skills relies heavily on three notions: that brain research and research on learning styles offers improved information about how people learn; that new kinds of knowledge, skills, tools, and behaviors are increasingly necessary for successful participation in the U.S. and global society; and that certain supports are necessary and desirable for effecting these outcomes.

As noted earlier, there is recognition that legislation, policies, and regulations are key for facilitating the growth of distance education in ways that support and transform current educational institutions (e.g., National Institute for Literacy Policy; Porter & O'Connor, 2001, p. 7) and that, in some cases, it is just these policies or regulations that are impeding such transformations (Web Based Education Commission, 2000). However, to establish the infrastructure needed for effective distance education (e.g., broadband network capacity for Internet delivery models) and to ensure that institutions and individuals have the technical capacity to access these networks, regulatory mechanisms that encourage markets, result in funding opportunities, and encourage consumer behavior are going to be necessary to support educational change in the face of the barriers discussed earlier.

In 1991, the Department of Labor Secretary's Commission on Achieving Necessary Skills (SCANS) (Commission on Achieving Necessary Skills, 1991) published a report to determine the skills needed to succeed in the world of work and to help educators understand how curriculum and instruction might need to change to help students develop these skills. Foundational, the Commission found, are basic literacy, numeracy, and communication skills; creative thinking, learning, and problem-solving skills; and the personal qualities of responsibility, self-esteem, sociability, self-management, and integrity/honesty. Competencies identified as being necessary for the workplace are the abilities to identify and manage resources, work with others, acquire and use information, understand complex systems and inter-relationships, and work with a variety of technologies.

How educators and educational institutions should help students acquire SCANS skills was further detailed in a report the following year suggesting that improved learning would require change in schools, workplaces, and in the way we assess our students and workers (Secretary's Commission on Achieving Necessary Skills, 1992). Specific to schools, the SCANS report advocated teaching and learning "in context" so that students would be able to demonstrate not only knowledge but also skills related to such knowledge. Teachers would need new teaching skills, such as knowing and applying high performance principles to their work and to the diverse student populations under their care, as well as how to use new instructional management tools, many of which are technology-based. Assessments, crucial for ensuring on-target progress for students, teachers, and schools alike, would be based on clear educational standards, the Commission argued, but should be individually directed, perhaps consisting of an evaluative SCANS résumé of the skills students were acquiring.

Since SCANS, numerous other events and reports have attempted to come to grips with the question of jobs, knowledge, and skills for the future. Most of these advance agendas for the future include providing authentic, individually-based learning using technology and engaging in community (including global community) and workforce collaborations (e.g., American Society for Training and Development, 2003; Committee on Workforce Needs in Information Technology, 2001; U.S. Department of Commerce, Department of Education, Department of Labor, National Institute of Literacy, & Small Business Administration, 1999; International ICT Literacy Panel, 2001; Marsal, 1999; National Central Regional Educational Laboratory, 2002; Partnership for 21st Century Skills, 2003; National Science Foundation, 2003). In all cases, it is thought that achieving future-oriented educational goals requires transformations of learning institutions and processes, particularly in the ways education is conceived and delivered and in the ways students are assessed. Using technology to help deliver, manage, and appraise educational activities is key for the success of all educational activities. Helping teachers embrace these new models and teaching them about the tools, content, and skills they need to realize them are also key.

For example, the International ICT Literacy Panel (2001) talks about the importance of cognitive skills and how these are crucial for effective K–12 students' use of technology, which in turn effects reductions in the digital divide. Now that the e-Rate has greatly improved the network connectivity of K–12 schools and libraries around the nation, it is necessary to set goals, document progress toward them, and provide training for teachers so that they can effectively move forward technologically and educationally (Dickard, 2003). Thus, policymakers can conceive of equity issues as less about ensuring hardware and network access (although this is still important) and more about ensuring ICT literacy and skill. The skills advanced by this body — ICT proficiency — are to integrate cognitive and technical proficiency "to access, manage, integrate, evaluate, and create information…in order to function in a knowledge society." This should include investment in new approaches to assessment, the report argues.

Learners

For the postsecondary and career/training sectors, research has continued to show that students engaging in distance education have different demographic characteristics than students who do not enroll in such courses or programs of study (Ashby, 2002; National Center for Education Statistics, 2003a). To date, they have tended to be female, older, higher income, married, employed full time or studying as part of employment, attending school part time, and enrolled at public 2-year institutions. They typically use the Internet as their primary method of course delivery and interaction (National Center for Education Statistics, 2002). Because distance education is becoming more common as one of a range of educational services at most institutions, this student profile is changing so that the definitions of traditional students and traditional educational institutions are themselves beginning to change. This will be discussed in more depth below. As with what is known about the K–12 sector more generally, information on the characteristics of distance education students is limited but can be inferred from the types of courses offered (e.g., advanced placement, foreign language).

Successful learning takes into account the needs and proclivities of learners. In recent years, the thinking about learning and learners has changed, in part, as the result of new theories of multiple learner intelligences and new research on the importance of brain development and physiological stages of learning. Gardner (1986) has advanced that people's intelligence can be characterized as a composite profile comprising a mixture of different learning styles. Traditional notions of intelligence, traditional educational practices, and traditional tests of intelligence and aptitude do not adequately account for or nourish all of the intelligences (i.e., linguistic, logical-mathematical, spatial, bodily kinesthetic, musical, interpersonal, intrapersonal, and naturalist), Gardner argues. Instead, authentic, real-life learning situations are necessary for offering more kinds of educational opportunities that feed the "multiple intelligence." Gardner has also advanced the importance of "symbolic literacy," suggesting that cognitive ability alone cannot account for the ability to read and write across multiple symbol systems (Gardner, 1985). Gardner's work has been crucial for helping educators and policymakers see the importance of educating the whole person. While current educational systems are lagging on curricular materials and instructional approaches that are broad or varied enough to address the needs of multiple intelligences, efforts have been stepped up as a result of this research.

Having even more impact on educational systems and research is the brain research of Bransford, Brown, and Cocking (2000), which advances new physiological and cultural theories of how people learn. Bransford et al.'s evidence suggests that learning changes the physical structure of the brain. Prior knowledge biases what people learn and prefer to learn; infants know and learn from day one; learning contextualized in real-life experiences and guided by caring, capable adults is more effective, accessible, and understandable; and new technologies offer unprecedented models and tools for enhancing learning. Although some have critiqued this line of research on the grounds that enough is not yet known about neuroscience and that the findings are overgeneralized and overemphasized, it has had great effect (*Education Week,* 1997, November 12).

In addition to these developments in how people learn — and their obvious implications for changing educational approaches to better address these learning needs — the literature has also begun to acknowledge that students of today differ substantially and qualitatively from students of yesterday in many ways. Whether these students are baby boomers (pre-1964) returning to school or engaging in continuing education, Gen Xers (1964–1981) working on a degree part-time, or Millenials (post-1981) completing high school and considering what steps to take next, they all have different expectations for their lives, use education differently to meet their educational goals, are more technologically savvy, and take more responsibility for their personal and educational activities. In effect, there is a new breed of student (Oblinger, 2003) that has and needs different skills. These, in turn, require different educational experiences (Partnership for 21st Century Skills, 2003).

One difference in the students of today is that they have access to and use more media than students in the past (Harris Interactive & Teen Research Unlimited, 2003). For example, Roberts, Foehr, Rideout, and Brodie (1999) found that children aged 8–18 spend an average of 47 hours a week outside of school (almost 6.75 hours a day), and children aged 2–7 spend just over 24 hours a week (about 3.5 hours a day) using media such as text, television, computers, video games, movies, and music. Thus, although reading continues to be a standard and pleasurable activity, electronic media dominate children's lives at this time. A 2003 study by the Horatio Alger Association (2003, pp. 8, 29) corroborates that high school children aged 13–19 "own and use devices such as a cell phone, video game systems, DVD players, and computers in extremely high proportions" and "higher income students are only slightly more likely to own these devices than are average or lower income students." According to the National Center for Education Statistics (2003b), public school kindergartners and first-graders have a combined average of 81% access to the Internet in school, an average of 89% access to computers in their classrooms, and an average of 55% access to a computer at home, with income, gender, race, and ethnicity affecting their at-home use. Among college students, 79% use computers in their classes and 69% use computers at home for school (National Center for Education Statistics, 2002). One-fifth of today's college students began using computers at age 8 or younger (Jones, 2002), 55% of adults have a computer in their home, and 37% use the Internet (U.S. Census Bureau, 2001). Levin and Arafeh (2002) found that tech-savvy students expect their educational experience to support their use and knowledge of technology.

In such a media-saturated context, entirely new or significantly updated theories, systems, and supports will be needed to ensure that cyber- or place-based educational institutions can harness the best technology, staff, and clientele to result in high levels of access, quality, safety, and outcomes for these media-savvy students. These updates also include whatever research questions and methods are used to assess the state of affairs. As the Web Based Education Commission (2000) suggests, what is needed is a "new research framework of how people learn in the Internet age" (p. iv), one that looks at "*how* technology influences learning" that involves an "explicit consideration of relationships among technology capabilities, instructional strategy, psychological processes, and contextual factors involved in learning.…We need to develop both more sophisticated and more comprehensive theoretical frameworks, and also more valid methods and instruments than those which have characterized a majority of studies to date" (pp.1, 9).

Educational Goals and Information Applications

Part of such an agenda is looking more closely and more complexly at the range and scope of what education goals are being pursued, which are different depending on the actor and its intent. For example, a nation's goal may be to support educational systems and processes that will build human capital in service of strong national or international economic and political growth. An institution's goal may be to better serve its students, turn a profit, or maintain its prestige and cultural capital. An individual's goal may be not only to acquire knowledge and skills to advance economically, but also to advance socially and culturally in one's own and one's peer's eyes. The information applications supporting these goals will vary depending on what goals are desired for what actors. These will depend also on the educational sector and level.

Most educational applications rely heavily on published information resources — books, newspapers, journals, and other print media. Increasingly, print and graphical information from the Internet is important for educational applications. These materials have traditionally been organized, categorized, and made available through library and bookselling services and searchable through print indexes and more recently, stand-alone and online computer databases and search engines. However, specialized information and data are now being made available through online-accessible databases (Read, 2003). In addition, middle and high school students have reported curricular content and lesson plans for nearly every age and interest; career and professional information and development applications; and skill and resource sites for students (also available on the Internet), ranging from student or class portfolios to ready-made crib notes, papers, and projects (Levin & Arafeh, 2002). Even market-research feedback about what terms users input into search engines is available (Carnevale, 2003b). As a form of educational delivery, distance education through the Internet contributes to these goals and uses these various information applications.

Although an in-depth discussion of the categorization of and access to information resources and applications is beyond the scope of this report, this is an important area of consideration for education in general and distance education in particula[illegible]t issue is the fact that as information resources and applications become increasingly digitized, questions about how they are selected, categorized, archived, and accessed become very important. Whether about the metadata used to categorize information resources (e.g., Dublin Core), or about the type and scope of databases developed (e.g., digital books, visual images, paperless systems), content management and digital asset management for both print and graphics is a topic of increasing interest (Wolf, 2003; Hilton, 2003). Although currently below the radar in education circles that do not actively consider the fields and resources of library and information science, such matters will become increasingly important not only for managing information resources for the content of education, but also for managing information related to the administration and management of educational institutions, data, and relationships.

Another important educational information application is the collection of data — particularly survey data — for the purpose of student assessment and research efforts and for state, district, building, and teacher administrative and management tasks. These applications have not only great import for the effective delivery of quality education but also significant economic impact. In recent years, Web-based testing and data collection have made the data collection process more accessible and efficient, provided new opportunities for interaction during testing and data collection activities, and increased speed of data analysis and feedback (Ricketts & Wilks, 2002; Byers, 2001). However, there are concerns about the validity and reliability of such assessment and tracking as well as the ability of these methods to deter cheating and account for a computer skills bias (Buchanan, 2002; Bothel, 2002).

A third information application is communication among education constituents — especially parents, students, and employers — for the purposes of both instruction and information relay. Currently available technologies for communication include the post, fixed and mobile telephones, broadcast or cable television, radio, fax, pagers, and the Internet (e.g., e-mail, webcasting, webpublishing, chat rooms, instant messaging, etc.). Although current efforts are exploring “next-generation” technologies such as PDAs and pagers for use as media for communicating with parents, these methods are still in their infancy and research on their utility is limited (Hanson & Johnson, 2001; Strom & Strom, 2002). In efforts to bridge the digital divide whenever possible, educators and administrators also will need to make special efforts to connect with unwired institutional and individual constituents (Revenaugh, 2000).

Whatever educational goals are being advanced at any particular time, what is important to note is that such national, institutional, and individual goals — and the information they require — are not static. Rather, they will change as circumstances and resources change. According to the National Academy of Sciences (Branford et al., 2000, p. 119), “A fundamental tenet of modern learning theory is that different kinds of learning goals require different approaches to instruction; new goals for education require changes in opportunities to learn.” Educating students at a distance has made important contributions to changing opportunities to learn. The current question is, “In what ways should education broadly defined (i.e., including distance education) be changed to address new and evolving educational goals?”

The answers range widely in detail but broadly argue that the following are necessary for education’s transformation: use of technology for education, communication, and classroom and institutional administrative purposes; professional development to prepare and maintain teachers and administrators in these uses; and ongoing assessment to ensure quality and appropriateness of direction.

In effect, “educational goals are tied to learning environments: as one changes, so must the other” (U.S. Department of Education, 2000, p. 6). The changing goals of education and, thus, what kinds of jobs, knowledge, and skills will be necessary in the near and distant future of this knowledge- or information-based economy are always of great concern. As a result, and as the examples above show, many efforts to forecast and rethink the needs of the future have been launched by both the government and private sectors. In some cases, the rethinking is based on a national desire to move beyond its hybrid industrial-knowledge economy toward an economy that more fully relies on the transfer of information as its most basic building block. Another approach has been to rethink education on the basis of new approaches to learning, teaching, and the needs and expectations of students in traditional and innovative learning environments. Yet another approach has been to look at what new innovations in technology make possible for the delivery and study of education. In Chapter 5, trend and forecast data on information and communications technologies will be considered, particularly how they are affecting distance education now and in the future.

CHAPTER 5: INFORMATION AND COMMUNICATIONS TECHNOLOGIES (ICTS): DEFINITION, TRENDS, AND FORECASTS

If the rapid development and deployment of the personal computer, the Internet, and satellite, DSL, and cable modem distribution networks characterized the 1970s through the 1990s, then the 2000s can be characterized to date by increased miniaturization and convergence of consumer appliances, increased long- and short-range wireless distribution networks, the rise of the mobile phone, and significant moves toward broadband network. The impact of these advances in technological devices and delivery on the enterprise of education is bound to be significant. However, little focused public research is exploring what kinds of technologies and applications are available or predicted and how these might affect the provision and nature of distance and general education.

This chapter outlines current and emerging information on communications technologies that will likely have an impact on the delivery of education — particularly distance education — now and in the future. Information for this chapter is drawn from public and market research reports and from industry and association articles. It is safe to say, however, that the literature on ICTs for the future of education is dispersed and disparate. In general, it ranges widely and has little coherence because the topics not only are still emerging but are of interest to many different fields and for many different purposes. As well, there are distinct differences in the way that disciplinary and lay audiences perceive the importance and relevance of information technologies (e.g., consumer electronics and applications) versus telecommunications technologies (e.g., communications infrastructures and networks). For example, the former tend to be seen as having more immediate impact and relevance to consumer interests and culture, even though capacity and developments regarding the latter integrally affect what is possible with the former.

Forecasting telecommunications markets and trends is a specialized research activity that uses different models depending on the questions asked and the data available. However, forecasters themselves acknowledge that the practice is imprecise. According to Fildes (2002), the demand for telecommunications forecasting is increasing, but many of the models employed — simulation, diffusion, penetration, and choice models — are problematic because they are either unvalidated or have limited validation and often must contend with changing valuations or uneven time frames. Speaking about Internet networks, Hamoudia (2002) suggests that “the forecasting of the growth of Internet services demand and the correspondent capacity requirements through traditional techniques such as econometric modeling…fail to accurately predict the future of this market.” He posits that “the accuracy of models is low due to the nature of the Internet’s evolution” and argues for more model flexibility. According to an opinion piece in *Wired* magazine about forecasting in general, “futurism is dead” primarily because “it now has a past: forty years of failed prediction” (Cristol, 2003,

p. 107). As a recent RAND report notes, although attempts at forecasting the future are speculative at best, they are important for decision making nonetheless (Anderson et al., 2000).

There is great utility in investigating those technologies that have either arrived and are being used for educational purposes or are on the horizon, and then trying to project how these will affect the design and delivery of education. Although these technological developments will not necessarily drive current and future educational experiences, they will have impacts on education.

Many studies over the years have described the state and possible futures of distance education, and as part of these descriptions, the current and potential impacts of “new” ICTs on distance education (e.g., Ashby, 2002; Olson & Wisher, 2002; Wilson, 2001; Kriger, 2001). Until recently, the focus has primarily been on the Internet. The Internet has changed the global information landscape irreversibly and, as part of this, has affected education in a number of ways. Yet, there is now reason to consider not only how further advances in Internet or online technology will affect distance education, but also the potentially more significant effects of “next-generation” technologies. In fact, one significant gap in the research literature on distance education and education delivery is information regarding the current and potential impact of these new technologies in context. This chapter outlines near- and longer-term forecasts of ICTs that seem likely to affect the future design and delivery of education.

ICT Trends

As discussed earlier, mail correspondence, telephone and fax interaction, and telephony-based videoconferencing continue to be used for distance education even as migration to a primarily online format (with or without face-to-face interaction) has taken place. Although the promise of online distance education has been great — and in many cases has been realized — technological, content, and cost constraints continue to limit the parameters of its delivery. In terms of technical constraints, three technological affordances have set limits on how computers, the Internet, and some other technologies have been used in education: (1) wire-based power sources; (2) wire-based, small file/packet transmission conduits; and (3) heavily text-based content and input/output requirements. Content constraints have resulted because of a lack of appropriate content or appropriate software or middleware for such content’s delivery. Cost constraints are the most straightforward; they occur when technologies for delivering educational content have exceeded what individuals or institutions can afford. Happily, recent technological developments have begun to mitigate most of these impediments.

For example, improvements in battery capacity and developments in fuel cell technology are making wire-based power sources less necessary. In a similar vein, improvements in wireless transmission technology and protocols, and the establishment of much-needed infrastructure, are supporting a significant increase in wireless capacity, devices, and their use — especially now that bigger broadband capacity is just on the horizon. As a result, the text bias of computer and Internet interactions that favor the skills and competencies of those with higher-level literacy skills — particularly English literacy skills — are likely to be superseded. Audio- and video-streamed content, along with audio- and video-based input and processing capacity, are predicted to both push and follow broadband's adoption.

A major issue that affects technology development and adoption is the matter of what standards, platforms, and other technical specifications will emerge as the defaults over time. Although a discussion of these is beyond the scope of this report, it is important to note that technology development and adoption is highly dependent on whether clear preferences and standards in these areas have been either adopted or at least identified by organizations such as the International Telecommunications Union (ITU), the International Federation for Information Processing (IFIP), the Federation on Computing in the US (FOCUS), the Institute of Electrical and Electronics Engineers (IEEE), the Internet Society (ISOC), and the World Wide Web Consortium (W3C).

Of course, many other technological developments will have implications for educational structures, content, and delivery as will be detailed in the following sections.

Telecommunications Technologies: Facilitating Information Access and Distribution

Education generally, and distance education in particular, uses networks to transmit educational content or to facilitate teaching and learning. Although other technologies continue to be used to deliver education content, networked computing and the Internet are so well suited to the effective and efficient transmission of educational information and interpersonal communication that the Internet has all but become the de facto medium of delivery. The commercial, educational, and social importance of access to telecommunications networks and to the Internet has not been lost on policymakers who, in these last two decades, have sought to facilitate increased and equitable network connectivity for institutions and individuals (e.g., Universal Services/E-Rate Program, Digital Divide Research; Schools and Libraries Corporation, 1997; U.S. Department of Commerce, 2002).

Telecommunications equipment and services related to communications infrastructure and networking are the connectivity backbones that make it possible for people and machines to communicate with one another. The postal service; land-based and mobile telephones; broadcast, cable, and satellite radios and televisions; pagers; and the Internet all use telecommunications networks for their information or data transfer. Wired and wireless transmission media — such as twisted pair copper wire; coaxial cable; fiber optics, cell towers, and satellites; communications protocols and frequencies such as VHF, UHF, Wi-Fi, Bluetooth, 802.11, microwave, infrared, ISDN, ASDL, VPN, and ultrawideband (UWB); networks and network wiring such as LANs, WANs, WLANs and T-carrier lines; dial-up and cable modems and MUX; peer-to-peer and client-server networks; etc. — all facilitate the connectivity and transfer of information that makes communicating and learning at a distance possible.

The value of a network lies in its connectivity and reach on both the supply and demand sides — Metcalfe's Law (National Science Board, 2002). On the supply side, the more ubiquitous a network is (the more far-reaching it is and the more people or services that are connected to it), the more useful it is to those who use it. On the demand side, a network has value only if people can access it. Before the advent of electronic telecommunications networks for computing (i.e., the Internet), there were, and continue to be, robust mail, telephone (Local Exchange Networks), broadcast, cable, satellite radio, and television networks. What is significant about these networks is that their penetration rates in the United States are very high; 95.1% of all households in the United States had telephone service in July 2001 — up 1% from 1998 and the highest penetration level ever reported (Belinfante, 2002). Radio and television penetration in 1998 was 99% and 98.3%, respectively, with 84% of the total population over 18 years of age reporting listening to the radio and 93.5% reporting viewing television in 2000 (U.S. Census Bureau, 2000).

In the case of Internet connectivity, the U.S. Department of Commerce (2002, p. 1) reported that, in September 2001, over half the nation was online, with use "increasing for people regardless of income, education, age, race, ethnicity, or gender." This report noted a strong increase of broadband network use among all individuals (5 to 11%) and home Internet users (11 to 20%) within the year between August 2000 and September 2001. In 2002, the Federal Communications Commission (FCC) reported remarkable increases in consumer subscriptions to high-speed connections (i.e., > 200 kilobits per second broadband lines such as DSL or cable), with a 27% and 23% increase in the first and second halves of 2002, respectively — for a total annual increase of 55% (Federal Communications Commission, 2003). Clearly, people are using the Internet and demanding increasingly more capacity, ostensibly to improve functionality.

Because distance education access sites are not typically institution-based (e.g., many distance education students are studying from home), reporting on home-based network penetration and subscriber rates is appropriate for getting a sense of how distance education has advanced, although the numbers regarding distance education enrollments from home are elusive. As indicated earlier, however, audio and television — either live or prerecorded — are distance education delivery media used by higher education for undergraduates and graduate students (e.g., PBS), as well as for career/training populations. In many cases, telephone and the post are used as supplementary communications media for such courses. Of course, the Internet is currently the distance education delivery medium of choice for K–12 and postsecondary institutions, and is likely to increase as the primary delivery medium for the career/training sector as well.

Beyond the sheer ubiquity of these various networks, two recent developments have occurred that will affect both the technologies and the applications to which they are employed in service: (1) the increasing adoption of digital transmission formats for traditionally analog networks; and (2) the increasing move to wireless transmission. Digital telephony and digital radio and television (including High Definition Television

(HDTV)) are developments that, among other things, make it possible to transmit a wide range of digital information and data through their various networks if protocols and formats are compatible. The phenomenon of the mobile phone that can transmit text, data, and pictures and provide Internet connectivity is a useful example. As a result of being able to transmit and receive digital information, the once analog telephone increases significantly in functionality and convenience, and entirely new uses become possible.

Currently, most telephony and Internet connectivity is provided via the Local Exchange Network (LEC). In a report forecasting the LEC in 2015, Vanston (2001, p. 2) projects that LECs will be transformed from "a narrowband network of circuit switches and copper cable to a broadband network of packet switches and fiber optics." He predicts that 88% of all households will be online and that 82% of them will use broadband systems with speeds of 24 megabits per second (Mb/s) to 100 Mb/s to interconnect with their wireless home LAN. Multiple Internet access ports in one household will allow simultaneous online access and use — including high-bandwidth applications like streaming video — with a great deal of the routine surfing and management work being done by "bots" and self-activating agents. Provision of Internet, cable, and telephone service will likely converge to be offered by one company as shifts in consumer demand make it necessary to redefine industry boundaries. Wireless will have displaced wired networks for voice and other low-speed data applications (more than 90% of North Americans use digital wireless systems). Of these systems, 90% are third-generation (3G) systems that use packet data transmission. Businesses will primarily be served by fiber optic or 3G wireless networks (i.e., high-speed mobile networks) at speeds of 1 to 10 gigabits per second (GB/s). The United States is already on its way to realizing this vision as the telecommunications industry upgrades fixed networks to fiber and packet transmission, staggers under the sheer explosion of wireless applications and options, and eyes 3G wireless on the horizon.

The impact of wireless networking cannot be underestimated. First appearing in analog cellular technology and then PCS digital technology typically associated with mobile telephones, wireless networks using a wide variety of protocols now connect digital devices of all kinds — including computers with Internet access — at long and short range. The flexibility of being able to install either fixed or mobile wireless access points, which transmit to hardware or appliances with network interface cards (NICs), makes it possible for schools or households to "wire" more area for less money with the option of moving or changing access points as necessary over time. The wireless, roving laptop lab is one result of these new technologies. Wireless networks also make it possible to install networks in buildings or areas such as historically registered, toxic, and so on, that would otherwise be physically impossible to wire if it involved significant modification to the structure or property. The implications for this regarding consumer applications and uses will be discussed in the following section.

One other current infrastructure initiative is Internet2, a consortium of more than 200 universities working in conjunction with industry and the U.S. government to advance next-generation network capacity, new Internet applications, and the transfer of these to the consumer sector (Internet2 Consortium, 2003). The Abilene Network is the Internet2's infrastructure backbone. It transfers data across access nodes called GigaPoPs at the incredible speed of 10 Gb/s using the "next Internet protocol" IPv6. At the time of this writing, Internet2's primary beneficiaries are the postsecondary and research communities — with K–12 schools only beginning to be able to access Internet2 because of last-mile capacity issues. "They need category-5 cable with switched 100 Mb Ethernet connections inside their buildings and at least 50 Mb pipeline running into the school," note Murray, Branigan, Pierce, Korzeniowski, and Levin-Epstein (2003, p. 23). Roughly 7,100 elementary and secondary schools, 8% of schools nationally, and 1,500 public libraries are connected to Internet2 as part of the K–12 Initiative (Selingo, 2003). The K–12 Initiative's goal is to get "new technologies, applications, middleware, and the content of innovators" developed and deployed in schools as quickly as possible (Internet2 Consortium, 2003). Digital videoconferencing, digital video multicasting, and teacher training are what K–12 schools are currently asking for with reference to Internet2 (Selingo, 2003).

The combination of increasing network capacity and reach in both wired and wireless configurations will result in the ability to access and manipulate more information with more power than ever before. The key, of course, is having access to such networks in the first place. Thus, it is crucial that end-user devices be able to access and transmit whatever information is desired. In fact, when end-user devices are not powerful enough to take advantage of the network capacity available to them, such capacity is lost. This has often been the case, for example, when K–12 schools have older computers that are connected to high-speed networks and the computers cannot handle the network's information flow.

Networks will inevitably continue to improve in reach, capacity, and speed. As well, wireless networks — at least at the point of the end-user — will also likely grow for individual, home, and institutional use, if for no other reason than that it is becoming more cost-effective than attempting fixed line systems (Flowers, 2003b). As noted earlier, what standards, platforms, and other technical specifications emerge as the defaults will significantly affect network development and use. What is certain, however, is that robust and interconnected telecommunications networks are crucial for supporting the kind of information and devices needed for the different types of teaching, managing, and communication needed for 21st century educational institutions and their students.

Consumer Electronic Devices and Information Appliances: Points of Access

Consumer electronic devices or information appliances are hardware and software that have been designed and developed for specific consumer uses. Hardware and software support procedures for the input, processing, and output of information. What these supports are, how they are configured, and how input, processing, and output take place depend on what applications are being pursued. Operating hardware includes, but is not limited to, transmitters, receivers, microchips, expansion slots, ports, busses, hard- or disk-drives, fixed and battery power sources, connective wiring or circuitry, and central processing units as are typically found in such consumer appliances as computers, telephones, televisions, VCRs, and DVD players. Software typically refers to end-user application software (e.g., Microsoft Office, Adobe Premiere, Quicken or Quick Books), but also includes operating system code or "middleware" concerned with communication among a device's or application's components.

Consumer electronic devices process analog or digital information by using an input-output model. Input-output data can be machine- or human-generated. For example, televisions, computers, and telephones receive machine-derived input when they transmit prerecorded programming, automatically loading Web pages, or computer-generated telemarketing messages. Conversely, human input can be gathered through a computer keyboard, a telephone speaker, a microphone, a camera, and so on. Whether input is machine- or human-generated, consumer devices process these data and then output them in a variety of ways that depend on the device and, ultimately, the desired application.

Input devices gather text, audio, or visual information. These devices include microphones, camera lenses, keyboards, satellite-based transmitters, game consoles and joysticks, mice, touch screens, digital pens, scanners, and advanced multitype user interfaces such as voice activation and recognition, and physical movement (i.e., haptic input). Output devices also process text-, graphic-, audio-, video-, or biology-based data. The type of output desired determines what kinds of output hardware and software are needed. Traditional output devices include audio speakers, projectors, monitors, and other screen-type displays whether computer-based or located in handheld or telephone-type devices; printers and plotters; drives and other devices for data storage or transmission; and, in manufacturing for example, mechanical devices such as robotic welding arms. Increasingly available are audio and visual output devices with 3-D functionality, low-level robots, and bio-mechanical devices to regulate bodily functions often through the use of some kind of external or internal prosthetic device. Of course, the ability to gather and use such data is based on the capacity of a device's operating system and processors. Consumer acceptance is also at issue as to whether a new technology is adopted (Baan, n.d.).

It is safe to say that there are very few electronic devices or components that are not being affected by research and development in the areas of digital technology, nanotechnology, biotechnology, and high-energy-density energy sources – even if new products have not yet been transferred to the consumer market (Anton, Silberglitt, & Schneider, 2001). Miniaturization of processing hardware and storage options and speed and capacity improvements in connective circuitry, in particular, are resulting from research in these areas with applications that are only now being identified (Adeogun et al., 2002). According to Skinner (2002), six areas of "next-generation digital disruption" will affect the way businesses, including education, do business: (1) evolutionary computing advances such as silicon-based microchips; (2) revolutionary computing advances such as nanotechnological optical, molecular, quantum, and DNA computing; (3) biotechnology; (4) intelligent systems and robotics; (5) changes in interfaces; and (6) improved connections. Although these developments are being pursued in high-level computing environments, they are rapidly trickling down to "prosumer" and consumer devices and applications.

In the case of processing speed, for example, supercomputers can process trillions of calculations per second. Japan's Earth Simulator, the world's fastest computer, can run 35.6 trillion calculations per second (Murray et al., 2003). Big Mac, a Virginia Tech student-assembled computer, can perform 10.3 trillion operations per second. In the area of storage, nanotechnology has made it possible to store 20 times the amount of data on rewriteable punch card-like storage devices with punch holes at the molecular level so that 15 to 20 gigabytes of data can fit in a wristwatch (Murray et al., 2003).

Even though the highest end computers are not being purchased for student use at any educational level (other than university research), even mid-range computers have increased processing and storage capacity. It is very common, for example, to see new computers arrive at market with 1 to 2 gigahertz processors. More capacious, more stable, and more flexible storage is also making an impact. New desktop and laptop computers typically offer at least 80 megabytes of hard drive storage with rapid-connect memory expansion and transfer options (e.g., USB connected external hard drives or flash memory sticks). PDAs are sporting from 2 to 64 megabytes of random access memory (RAM) and processing speeds up to 200 megahertz. Handheld computers — a powerful hybrid that combines computer functionality with PDA convenience — are where convergence is most fully embodied at this time. These devices have multiple input options (e.g., text, voice, music, photo, video, data), fast processing speeds, and removable memory, which then allow text, audio, and graphic/video outputs of high quality. Most are Bluetooth enabled, which makes it possible for users to quickly transfer information "wirelessly" between devices. Many are also wireless LAN enabled or include a wireless LAN slot for easy connection to the Internet. Finally, an increasing number of devices are offering wireless telephone capacity as well.

A study on the use of new media by teens and young adults aged 13–24 found that this demographic group uses an exceptional range of new media, such as computers, handheld video games, cell phones, digital cameras, televisions, personal digital assistants (PDAs), and pagers. And for the first time, Internet usage surpassed time watching television (Harris Interactive & Teen Research Unlimited, 2003). Other market research on information appliances and consumer electronics such as the *3G Wireless: Business Models and Strategies Report* (McLachlan, 2001), *Communication Technology Update* (8th Ed.; Grant & Meadows, 2002), or product analyses (Baan, n.d.; iSuppli, 2002) probably offers the most robust picture of consumer interest in and use of information appliances. However, many of these reports are not publicly available and, if accessible at all, require a substantial fee for use. It is interesting to note, however, in the online synopsis of *Communication Technology Update,* distance learning was characterized as a failing application of technology: "Columbia University announced in January 2003 that it is closing its for-profit learning program called Fathom. According to the *Chronicle of Higher Education,* Fathom never made a profit and joins a number of failed on-line for-profit ventures including those by New York University, Temple, and Maryland University College" (Grant & Meadows, 2002, p. 8).

Although "business" and "productivity" markets are useful for getting a sense of consumer appliance trends, perhaps the areas that offer the most insight to ICT futures are the entertainment and toy markets and what will broadly be termed the "science market" (including defense-related information). Entertainment markets are lucrative and demand high-end hardware and applications, which in many cases are later incorporated into business and mainstream domestic tools and applications. Thus, innovations developed for media (i.e., television, film, radio, and music areas) and video gaming have relevance for the future of electronic tools more generally (Prensky, 2001). Technologies are also continually being developed for scientific inquiry in both the natural and physical sciences. Technology transfer from these sectors also affects the consumer market even if technological innovations in the private and high-end research sectors do not always quickly transfer to the consumer market. In fact, it is often the case that even what is available in the domestic consumer market is not available in lower-end education markets (e.g., education sectors that are typically low-tech and with limited funding for technology, such as K–12 and community colleges).

In the media and entertainment markets, digital information is nearly ubiquitous. According to consumer reports of new technologies, this year is seeing interest in new thin display screens and monitors, increased DVD sales and use of DVD players, 3-D monitor displays (primarily for gaming), car-based visual media players, wireless communications of all kinds, and personal video recorders (PVRs) such as Sony TiVo. On the horizon are high definition and interactive television and online delivery of films and other video content (Consumer Guide, 2003; Nanotech Briefs, 2003; Associated Press, 2003, September 18; Wired, 2003, December; Grant & Meadows, 2002). Developments in the science areas of biotechnology, nanotechnology, genomics, materials science, and engineering are harder to characterize because their impacts on ICTs are not necessarily clear or immediate and because the research is spread in so many different areas (Adeogun et al., 2002). However, some very interesting developments are sure to have an impact on the delivery of education through ICTs in the future (National Science Board, 2002). For example, neuroscientific and nanotechnology research on the kinesthetic impact of thinking found that a monkey could manipulate a computer cursor by using neural signals (Serruya, Hatsopoulos, Paninski, Fellows, & Donoghue, 2002). The International Technology Roadmap for Semiconductors (2002) projects that semiconductors will be 0.1 microns thick by the year 2010 and will result in the ability to do more work more economically and with less bulk because carbon tubes (the focus of much current nanotechnology research) are both flexible and strong as they conduct electricity and heat (Nanotech Briefs, 2003). Research in these areas — particularly for the purposes of manufacturing, medicine, and defense — are also being touted as economic drivers (Office of Management and Budget, 2003).

In the final analysis, these micro-developments are resulting in a new generation of increasingly "smart machines." These machines are smart because they display certain forms of (artificial) intelligence. For example, automatic voice recognition and automatic language translation require machine intelligence that can perceive and process complex forms of audio and linguistic input for output. As a result, the use of electronic-based machines may no longer be limited to those able to perform text-based input in primarily the English language. Rather, voice or non-text physical input can be perceived and processed in languages other than English — with far reaching consequences. Silberman (2000) notes that research over past decades may now come to fruition as a “renewed international effort [gears] up to design computers and software that [may] smash language barriers and create a borderless global marketplace.” This growing technical capacity may make it unnecessary for local, non-English-speaking users of the Internet to develop Web pages and other applications in their own languages. Developments like these are just some of the modifications to technology input/output that provide increased access for people with disabilities and people with functional or cognitive limits for other reasons (e.g., the elderly, temporarily disabled; European Telecommunications Standards Institute, 2002).

Although the types of technology used for distance education in the various sectors were outlined earlier, the literature tends to emphasize the use of certain ICT technologies as the current “sweethearts” of promise for administrative, curricular, pedagogical, and communication functions. Computers and the ever-evolving Internet are at the top of the list for their informational and processing power, functional flexibility, and increasing ubiquity. PDAs and tablets — in effect, small, more flexible computers — are increasingly receiving attention for their educational promise, as are enhanced graphing calculators, data collection probes and probeware, and even gaming consoles (Vahey & Crawford, 2002; Leibiger, n.d.; SouthEast Initiatives Regional Technology in Education Consortium (SIER*TEC), 2002; Pownell & Bailey, 2001; Dede, 2001; Rose, 2002; Murray, 2003; Murray et al., 2003). Lastly, and further in the future, are the calls for virtual reality or simulation (e.g., multi-user virtual environment experiential simulators (MUVEES)) as promising education delivery technologies and methods (Kommers & Zhiming, n.d.; Patterson, 2001; Davies, 2003; Dede, 1995; Foreman, 2003; National Institute of Standards and Technology (NIST), 2002; Morissette, 2003).

In many cases, consideration of technology is completely missing as a research focus. For example, Szabo and Rourke's (2002) content analysis of the *Journal of Distance Education* articles does not include “technology” or “discussion of use of technology type” as a categorizing topic. Similarly, Fisher's (2001) forecasts regarding research on online learning and distance education do not consider new technologies, only a standard notion of Internet-based online learning. And when new and emerging technology is considered in any depth, with a few exceptions, sustained consideration is advanced primarily by the private sector, such as Merrill Lynch (Moe & Blodgett, 2000), *EDUCAUSE* (Foreman, 2003), Hewlett Packard (Murray, 2003), Gateway (Flowers, 2003b; Murray et al., 2003), and Telemate.Net (Flowers, 2003a; Oblinger et al., 2001; Oblinger, 2003); and secondarily in speculative opinion pieces or literature reviews by educators and education researchers, such as Morrison (1999), Rakow (1999), Thornburg (1999), Saba (2000), Dede (2001), Moore (2001), Wilson (2001), DuMont

(2002), Harley (2002), Wilson (2002), Howell et al. (2003), Morissette (2003), and Kommers and Zhiming (N.D.). Even the Distance Education Clearinghouse (2003) at the University of Wisconsin–Extension links to the Telecommunications Industry Association (TIA), PCWorld.com, CNET.com, and ZDNet — commercial publications — in the technology trends and forecasting section of its Web page. Conspicuously missing from the literature are empirical studies attempting to identify what technologies beyond the Internet are being used in educational settings for teaching, learning, content development, or administration, or how they are being used in higher education, K–12, or the training/career sectors (see Galvin, 2002, for reference to technologies used in the training sector). Those that exist tend to be evaluations of specific programs or interventions (e.g., Vahey & Crawford, 2002).

Clearly there has been, and continues to be, a great deal of innovation and proliferation of telecommunications networks and consumer electronic devices. In particular, small, multiple input/output, wireless devices — often with phone capacity — are rapidly becoming the norm, with the Internet and World Wide Web driving and supplying most of the information available through them. Technological forecasting is evident in both the private and the government sectors. However, sustained discussion of the impact of new technologies on distance education at any grade level is limited. Despite this lack of empirical study, a number of themes emerge from the literature that underpin the question of what implications ICTs have for distance education and, following on this, what kind of research agenda should be pursued.

CHAPTER 6: THEMES FROM THE LITERATURE AND IMPLICATIONS OF ICTS FOR DISTANCE EDUCATION

Harley (2002) notes that "ICTs encompass many modalities and are underpinned by a plethora of new hardware and software that can be combined in an almost infinite number of ways….[S]ome of the standard modalities at the disposal of higher education institutions…[are] N-way video streaming, digital library and museum database management, simulations, teleconferencing, telephony and wireless communications…" (p. 5). While not all of these educational tools and applications are currently available to all students, they do herald the flavor of things to come. Still, when one looks back 20 years and realizes that personal computers were in their infancy, it is humbling to try to forecast what the future will bring. Thus, while this review offers information about the research on distance education to date, less satisfying is what is known about education, including distance education, in the future. There are, however, some themes from the literature that do suggest ICTs will have implications on distance education.

Innovations in ICTs will come in waves. Although the forecasting literature makes it sound as though all new technologies are equivalent and vying to be put to work, this is not the case. Some new ICTs are currently having an impact on distance education (e.g., PDAs, broadband and wireless networks, and converged telephone devices). Others are on a near-term horizon of 2 to 5 years but not yet upon us (e.g., anytime, anyplace audio and video streaming, interactive television, very high-speed Internet). Finally, some ICTs will have to wait 5 to 10 years or more before they are robustly incorporated into education delivery systems (e.g., fully functional, bio-embedded, haptic interfaces). These new and emerging ICTs are having, and will continue to have, an impact on how education is conceived and delivered, including what content and supports are needed. However, they exist within a system that can encourage or discourage certain types of technology and uses depending on how much they will cost, whether they afford desired applications and content, and whether regulatory and funding mechanisms to encourage their use exist.

ICT developments favor the learner and give him/her more power. By removing education from place-based institutions and constraints of time and face-to-face interpersonal contact, unbundling of the entire educational enterprise can occur. When an educational system can cater to an individual in this way, the individual can then drive certain aspects of the system by his or her interest in content or market. It will be important to understand more clearly what kinds of learners exist, what kinds of educational goals they are interested in pursuing, and what kinds of supports are needed to realize such goals in order to understand the future of education. This knowledge will be especially necessary to ensure that ICTs are used to foster equitable, quality access at low cost.

Detailed research about distance education structures, offerings, and ICTs used is still needed for all educational sectors but especially for grades K–12 and, in particular, for elementary and middle school. Because distance education tends to be adopted and evaluated in an ad hoc fashion (Harley, 2002), and because new forms of distance education and ICTs are constantly evolving, continued research on effective frameworks, models, and practices is crucial (Hanna, 1998; Vrasidas & Glass, 2002; Oblinger, 2003). Research on K–12 distance education initiatives is especially needed, and for elementary and middle school grades in particular.

Research detailing frameworks, models, and practices is needed, as is research on student practices and outcomes (Anglin & Morrison, 2002; Dede, 2001; Florini, 1989). Research questions and methods should be expanded to achieve the desired goals. Thus, in many cases, new questions and metrics are in order (Web Based Education Commission, 2000). Questions will need to consider ICTs specifically, and how users perceive and use them.

Information about the implications of ICT for distance education is fragmented by terminology and disciplinary and sector boundaries. Distance education is perceived and treated as being separate from traditional education. Research on education technology does not necessarily embrace distance-oriented ICTs. Research reflects that the fields of science and engineering do not see education as a sibling equally concerned with technological innovations and applications. Knowledge in one area, although relevant, is not sought or used in another (e.g., library and information science). Yet, from a systems perspective, interdisciplinary and cross-sector knowledge- and information-sharing are crucial for learning more about how to conceive and execute an education agenda for the future.

One solution is to continue to create and support interdisciplinary research centers and teams to explore topics related to the use of ICTs for distance education. By requiring educators, engineers, computer scientists, industry personnel, librarians, policymakers, and evaluators to work together to characterize current and emerging trends in ICTs and (distance) education, a clearer systems picture should emerge.

Private information outpaces public research on ICTs in distance education. Whether as a result of available funding, market, or disciplinary directives, many distance education efforts are private initiatives. There is much more of this type of information about emerging ICTs in relation to education generally, and distance education in particular, than there is publicly funded, research-based information. As discussed earlier, there are numerous calls for new research questions and, in particular, new research metrics and methods. However, whether and how these new approaches are pursued depends on the research bodies able to explore them. More public monies should be set aside for public research or, barring that, more public-private research partnerships should be formed with each supporting, but also having some autonomy from, the other. In this way, a more balanced and focused picture of the implications of ICTs for distance education may emerge.

ICTs are facilitating the convergence of distance and other forms of education where learners are driving the markets. Although those like Wilson (2002) are asking whether distance education is over because many e-learning start-ups have failed (or their hosting institutions have decided not to support them for other reasons), the disappearance of distance education he refers to relates to the fact that technological advances are making it possible for all educational institutions — place-based or not — to teach and learn at a distance. In effect, Dede's (1995) and Oblinger et al.'s (2001) focus on distributed education is more apt, especially when there are increased trends toward, and preferences for, blended distance and face-to-face learning.

Beyond this, however, is the importance of rethinking education's purposes and outcomes along with wholly new educational delivery sectors, structures, content, jurisdictions, and credentialing approaches. In addition, new approaches to assessment and evaluation are needed, as well as modifications to how such efforts are funded and regulated. Students may be the drivers here. Only when there is real movement to embrace the power that ICTs have to offer students of all ages — and their individual and institutional teachers — will the many significant barriers that impede envisioning education anew be transcended.

Regulations, funding mechanisms, and technical standards can influence how education is conceived of and configured. Many of the barriers to fully embracing education using ICTs, including distance education, are turf based – whether cultural, economic, political, or technical. Thus, it is important to get a sense of how ICTs contribute or take away from a sense of individual or institutional turf and, depending on the educational goals sought, how ICTs can be effectively employed to mitigate turf barriers and encourage future educational institutions and supports (Porter & O'Connor, 2001; Web Based Education Commission, 2000; Dede, 2001). As increased pressures, decreased budgets, and new digital divides require new configurations, the key will be to innovate without fearing overly strong repercussions of failure.

ICTs should support educational goals. Although there is no way to avoid a dialectic in which technology effects educational goals and systems, all sectors and stakeholders should work to ensure that educational goals drive the adoption and use of ICTs and not vice versa. Deciding upon what these goals should be is going to be very difficult — especially because ICTs make it unnecessary to maintain typical educational structures, relationships, metrics, and outcomes. For example, Wisher et al. (1999) argue that people prefer blended learning and not just ICT-based education. Findings like this should guide designers of educational systems and tools about the importance of human relationships on the perceived quality and desirability of educational services.

Much more research is needed on how faculty are being trained and how technology, content, materials and resources, and instructional methods are addressed. According to Dede (1995, p. 5), "The most significant influence on the evolution of distance education will not be the technical development of more powerful devices, but the professional development of wise designers, educators, and learners." Indeed, concerns about the nature and quality of preservice and inservice education liberally pepper the literature. But, as Dede notes, as the educational enterprise becomes more diffuse, we must also concern ourselves with the professional development of those other individuals and institutions that now have a significant hand in designing and delivering educational content and services. Thus, increased use of ICTs will require training of hardware and software developers, ISP operators, education foundations concerned with technology transfer to the market, and faculty and student support services, in addition to teachers.

The actual costs of education that integrally uses information technologies are unclear. At this time, a great deal of research is needed to determine what kind of distance education offerings exist in the various sectors, what kinds of ICTs are being used, what kinds of supply and demand behaviors there are, what the rates of return are, and, ultimately, what the costs of design and delivery are (Center for Studies in Higher Education, 2001). Again, how costs are defined will need to be broadened to include cultural and value costs in addition to economic and political costs.

According to Wilson (2002, p. 5), "The e-learning revolution is not over. It is just entering a more intelligent and less self-indulgent phase." This may indeed be the case as educators, policymakers, industry professionals, and others seek to integrate a world of active technological advancement with worlds that, in many cases, find it difficult to advance at the same pace. What seems certain, however, is that ICTs, educational governance and administration, and educational goals of general and distance education are converging toward a more integrated purpose in the education of the future. It is our duty to ensure that human thought and purpose drive those activities and not the technology itself.

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