Issues and Trends in Instructional Technology: Gradual Growth atop Tectonic Shifts

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This is the eighth in a series of reviews begun in 1998, examining the status of instructional technology in the corporate, higher education, and K-12 education sectors in the United States. These reviews draw together quantitative data reported in a wide variety of sources. By tracking the data over a period of years the authors are able to make some judgments about the direction of change.

The year since the previous review was written (Molenda and Bichelmeyer, 2005) has seen a slight improvement in the economy of the United States after several years of recession. For public K-12 and higher education, the most significant source of financial support is the tax revenue of each state. When state tax revenues fall, schools and colleges compete with other interests for shrinking resources. When institutions' budgets are cut technology investments decline; when budgets grow so does technology spending. That is what happened during the dramatic decline—then rebound—in state revenues between 2000 and the beginning of 2005, as shown in Figure 1. In fact, the percentage increase of the first quarter of 2005 compared with the first quarter of 2004 was the largest increase in over a decade (Jenny, 2005). This increase in state revenues has not immediately found its way to increases in information technology budgets.

[Insert Figure 1 here.]

Overall Developments

Over the past year, businesses, colleges, and schools have continued to invest in their technological infrastructure, especially by upgrading their Internet connections to broadband capability and by building wireless networks to complement their wired networks. Such Web-connected networks have become pervasive in the United States, enhancing the opportunities to

leverage learning through technology. We have come to learn, though, that pervasive availability does not equal pervasive use. In general, the past decade has seen very slow and piecemeal application of information and communications technologies (ICT) in training and education. Change has been evolutionary rather revolutionary, with the ratio of users vs. non-users increasing by single digits increments per year. At the same time, changes broad enough to be termed tectonic shifts have been taking place beneath the surface. Forces such as global economic competition, advances in ICT hardware and software, changing demographics, government economic policies, and pedagogical reform movements have caused major rearrangement of the landscape even as incremental changes take place in the use of ICT for teaching and learning. In this chapter we document both the incremental changes and the tectonic shifts, which are less visible to unaided eye.

One of the traits of current technological evolution is its tendency toward convergence of formats. In the days of analog media it was easy to distinguish among different media formats—video, film, slide, overhead transparency, audio cassette—but with digital media it is possible to combine still and moving images, sometimes with sound, in a seamless package. At the same time, functions that were once performed by separate devices—telephone, radio, television, calculating, text messaging—are now converging into a single instrument, usually designed to be handheld. Along the same lines, instructional methods that were once seen as distinct—face-to-face classroom, video, Web-based—are converging into hybrid or blended learning formats.

The pace of adoption and type of adoption vary from sector to sector since different social and economic forces play out in different ways in the three sectors. This review will treat the corporate sector first, the higher education sector second, and the school sector third.

Corporate Training and Development

The general expansion of business that began in 2004 carried over into 2005, ending the string of years in which corporate spending for training had actually declined. Although spending was not yet rising in 2004 (and was still lower than it was in 2000), at least the decline had ceased. However, expenditures for off-the shelf training materials continued to decline, being lower in 2004 than in 2000 (Dolezalek, 2004).

We have been tracking the results of the annual survey of corporate training conducted by *Training* magazine since 1997, during which time the survey methodology and response items have been consistent enough to allow reasonable longitudinal comparisons of various media and methods over this eight year period.

Issue 1: Use of Technology-Based Media for Delivery of Instruction

Live classroom instruction vs. computer-based. Despite earlier predictions to the contrary, the learning environment that is most universally used is the face-to-face classroom, currently being used always or often at 85 percent of all companies (Dolezalek, 2004). As shown in Figure 2, this represents a small decline since 1997, although this figure has not otherwise varied far from 90 percent over this period.

[Insert Figure 2 here.]

A more meaningful figure would be the *proportion* of time that trainees spend in different learning environments. Respondents' reports are a bit difficult to interpret because they are increasingly forced to classify situations that combine different delivery systems, for example, a live instructor who is speaking to one audience face-to-face and another one via videoconference. In any event, the estimate of 70 percent of time spent in face-to-face instruction has also not varied much over the years. At the same time, organizations report that they are making increasing use of Web-based and DVD-based delivery; in 2004, 17 percent of training was delivered by computer with no live instructor (Dolezalek, 2004).

ASTD's annual state of the industry report (Sugrue & Kim, 2004) reports data from a different sample of respondents, with similar findings. They estimate that trainees spent 68 percent of their learning hours in live, instructor-led settings versus 10 percent in self-paced online study and 6 percent in instructor-led remote or online work. This represented a small shift toward technology-based delivery over the previous year. Overall, technology-based methods may be replacing face-to-face methods to some degree, but they appear to be supplementing face-to-face methods to a high degree.

Printed Materials. Manuals and workbooks are alive and well. They were used always or often at 77 percent of businesses (Dolezalek, 2004), indicating a small decline each year since 2002, as shown in Figure 3[1].

[1] Note that the data from 1997 to 2000 are not directly comparable to those from 2001 and after. In the former period, the question was asked simply, "do you use this method or not?" while in the latter period the question was phrased as "do you use this method always, often, seldom, or never?"

[Insert Figure 3 here.]

However, the 2004 level of use is virtually the same as in 1997, indicating that there are small yearly fluctuations but not really a trend over this period.

The dream of a paperless office has been with us since the advent of computers in the 1960s, but thoughtful observers are now talking instead about the *myth* of the paperless office (Sellen & Harper, 2001). Per capita paper consumption actually grew greatly between 1991 and 2001 (In praise of clutter, 2002). Clearly, paper has affordances—things that it allows humans to do—that continue to make it an attractive medium for writing, for reading, and for studying.

The popularity of print materials suggests that independent self-study might be a rather commonly used method of instruction. Actually, self-study as a method was not included as an option in the *Training* surveys until 2002, where "self-study non-computer" was used always or often at 25 percent of businesses, remaining at about 23 percent in 2003 and 2004 (Dolezalek, 2004), as shown in Figure 4.

[Insert Figure 4 here.]

The other category of self-study, "self-study Web-based," was used always or often at 36 percent of responding companies in 2002, rising to 44 percent in 2003 and holding at that level in 2004 (Dolezalek, 2004, p. 32).

[Insert Figure 5 here.]

It appears that for several years more organizations have been making frequent use of the Web for self-directed learning than have been using print materials for self-directed learning, by a ratio of about 2:1. However, this ratio does not seem to be changing dramatically, nor has it affected the overall use of manuals and workbooks. Clearly, manuals and workbooks are used for purposes beyond self-study. They accompany all sorts of classroom and computer-based instruction and are used both as instructional media and as reference materials during and after the training.

Traditional Media. Videotapes are used always or often at 56 percent of responding organizations (Dolezalek, 2004, p. 34). As is shown in Figure 6, this figure has declined a few percentage points in recent years, but the trajectory is not steadily downward.

[Insert Figure 6 here.]

Compared to videotapes, it has been less common for audiotapes to be used as the primary delivery system for pre-recorded training modules or courses. Consequently, it is understandable that the reported usage of audiocassettes dropped markedly when the question was changed in the 2001 *Training* survey from "do you use…?" to "how often do you use…?" As shown in Figure 7,

only seven percent of companies used audiocassettes “always” or “often” in 2002 and that figure declined slightly in 2003 and 2004. Some of the drop may also be accounted for by a change in media format; it may be that when audio materials are used they are now more likely to be stored and used in some digital format rather than in tape format.

[Insert Figure 7 here.]

Games and Simulations. It may not make sense to use the same measurement scale to track the adoption of more specialized methods, such as games and simulations. As opposed to training manuals or videos, they are probably not as generically applicable across the whole range of content and objectives. Hence, one would not expect them to be used “always” or even “often” within most organizations’ training programs. For this reason, the survey responses are counted a little differently for this category. Usage is counted according to how many respondents report using games and simulations “seldom,” “often,” or “always.” By this measure, the frequency of some usage is quite high—65 percent of companies making some use in 2004 (Dolezalek, 2004, p. 32). As is shown in Figure 8, the reported use of non-computer games and simulations has declined a bit in the past several years.

[Insert Figure 8 here.]

Telecommunications media. A small proportion of organizations use broadcast or satellite television to disseminate training programs to multiple sites. Some 20 percent of respondents reported using broadcast or satellite television in the period of 1998-2000. When the *Training* survey changed the question to measure *frequency* of use, it was found that only around ten percent of companies were using this delivery method “always” or “often.” The number has varied only slightly over recent years (Dolezalek, 2004, p. 34), as shown in Figure 9.

[Insert Figure 9 here.]

Two-way videoconferences distributed over satellite, cable, or Web are used always or often for training at 19 percent of all organizations (Dolezalek, 2004, p. 34), as shown in Figure 10. This indicates a plateau after an increase over each of the prior three years. However, two-way videoconferences are not used for a large proportion of training time except in the military services. They tend to be used as supplements to other forms of training or for special purposes, such as the introduction of new products or the rollout of new tools at organizations with widely scattered locations.

[Insert Figure 10 here.]

Computer-based media. Computer-based delivery systems have played a gradually expanding role in training over the past decade. In the early 1990s, this meant modules delivered via floppy disk or local network (LAN). Since then computer-based material is more likely encountered by means of CD-ROM or DVD modules or by connecting to the Internet or organizational intranet. In the 2004 *Training* survey 60 percent of companies report using instruction in digital storage media "often" or "always," as shown in Figure 11, an increase over the previous year.

[Insert Figure 11 here.]

However, 54 percent used Internet or intranet delivery, as shown in Figure 12, a decrease from the previous year, indicating the stalling of a trend of the previous years (Dolezalek, 2004, p. 34). A possible explanation for this reversal is in respondents' perception of what is an "Internet course." The trend has been to combine online and offline activities into new hybrids, possibly reducing the number of training experiences that are exclusively one or the other.

[Insert Figure 12 here.]

Unexpectedly, the *Training* magazine survey respondents report that the use of computer-based games and simulations has also been stagnant, if not declining, during this same period. As shown in Figure 13, computer-based games and simulations are being used "seldom," "often," or "always" at about 50 percent of all organizations. We suspect that this is something of a definitional issue, since there seems to be an increasing incorporation of Flash-based video simulations in several sorts of training materials, especially computer applications training and soft skills training. It is likely that these simulations are viewed as supplements rather than as the primary medium or method being employed.

[Insert Figure 13 here.]

More advanced applications, put under the rubric of "virtual reality," have been tracked by the *Training* survey since 1997. As with games and simulations, it would not be expected that virtual reality media would be applicable across the whole range of training content or objectives. So it probably makes more sense to track how many organizations use it at all, not how many use it often or always. Counted this way, around 20 percent of organizations make some use of virtual reality training methods (Dolezalek, 2004, p. 32), as shown in Figure 14. Unexpectedly, this category shows little evidence of increase over the past several years.

[Insert Figure 14 here.]

Taken together, information and communications technology (ICT) delivery now accounts for roughly a quarter of the time spent in training. This proportion has not been growing at a steady

pace over the years, and some indicators actually fell in the most recent surveys. However, it is predicable that ICT-based instruction will grow, if only because so many companies, in the face of global competition, make changes in their products and services at an accelerating rate. These changes usually entail some employee and customer training, at least of the informational type. This sort of training is highly time-critical, and delivery through an ICT channel can be done faster and cheaper and can be updated more easily than by using live-classroom instruction or print materials sent through the mail.

Issue 2: Constraints on Acceptance and Use of Technology

The global business cycle is probably the largest constraint to rapid expansion of ICT-based learning. The business economy drifted downward after 2000, but was showing continuing recovery in 2004 and 2005. Spending on technology was on the rise again after a period of contraction.

E-learning remains a tempting prospect for improving return-on-investment (ROI) in training. However, there does not seem to be a simple recipe for substituting cheap e-learning for expensive face-to-face instruction. E-learning initiatives require substantial front-end investments in equipment and materials as well as in development time and talent. E-learning obviously works as well as other forms of instruction when the objective is merely information transmission. But for more advanced cognitive skills or skills in the interpersonal, affective, and motor domains, more sophisticated pedagogical methods are necessary, whether delivering in face-to-face and for ICT formats. The secret still lies in involving learners in engaging, challenging real-world tasks and guiding their budding abilities to accomplish those tasks (Merrill, in press). To the extent that e-learning can provide such a learning environment, it will grow and prosper.

Unfortunately, e-learning courses often suffer a high attrition rate, indicating either that trainees often enter with insufficient reason for staying or that the instructional methods they encounter fail to hold them. A text-heavy, didactic approach is commonly found in e-learning courses, which contrasts sharply with the problem-based, inductive approach advocated for adult learners seeking usable skills.

Issue 3: Challenges to Existing Paradigms

Blended learning. In the past, trainers tended to classify learning events into discrete categories: face-to-face classroom instruction, online learning, self-directed study, action learning, and so on. In today's corporate training programs, however, learning events increasingly consist of combinations of different formats and methods. An example from management training would be a hybrid course consisting of: 1) a kick-off session in a face-to-face setting with a facilitator, 2) a self-

study period of four hours of online study to be completed over two weeks, 3) coaching sessions by telephone, one per week, with a mentor, and 4) bi-monthly review sessions in which small groups discuss their progress and share ideas.

Such hybrids have come to be recognized as a "third path," referred to as blended learning. The advantages of combining formats are obvious. Online activities offer self-pacing, standardization of information dissemination, and rapid deployment of new material; while face-to-face learning allows practice with feedback, team building, networking, and the other functions that are tied to people's emotional responses.

The trend toward blended learning has been under way for at least five years but is probably still early on the adoption curve, with many organizations still at the awareness or trial stages. There is potential for much more widespread adoption in the coming years. An indicator of the strong foothold of this new paradigm is indicated in the finding cited earlier in this section that face-to-face instruction continues to be employed at as many organizations as ever while *at the same time* e-learning formats are taking off in terms of more and more frequent use. How can both modes be flourishing? By being used as complements to each other in the form of blended learning.

Workflow learning. Learning needs are escalating while the time available shrinks. Organizations are loath to pay for the downtime involved in sending employees to training. What they learn during formal training doesn't seem to stick or to last very long. What is the answer? Workflow learning, learning that is embedded in everyday work, learning activities available on demand.

This concept came to the fore as the cover story for the February 2005 issue of *Training* magazine, although it had been brewing for some time. As cited earlier, Merrill's (in press) synthesis of instructional principles indicates that at least for cognitive learning, we process and remember best what is relevant to our immediate needs and what is practiced in a realistic setting. So the idea is to embed the training in the job itself.

Cross and Driscoll (2005) relate workflow learning to the earlier concept of electronic performance support systems (EPSS): "workflow learning is networked EPSS, operating in an environment where the worker is plugged into the job and learning is delivered in small chunks as it is needed" (p. 32). Although this concept has elements of older, more familiar practices, it can be seen as a whole different paradigm for thinking about training. Instead of starting with the assumption that training takes place away from the job, workflow learning starts with the assumption that learning opportunities can be embedded in the work.

We are still at an early stage of figuring out how to analyze workflow learning needs and then design and develop the mechanisms for facilitating it. This is one of the exciting challenges facing the field.

Higher Education

As we have previously explained, the use of instructional technology in higher education is similar to the corporate sector in that it is affected by both external economic forces and internal socio-cultural influences. The downturn of the US national economy beginning in 2000 and continuing through 2003 led to severe shortfalls in state tax revenues, which led to tightening of budgets at most state-supported universities and eventually at private institutions as well. These budget reductions in turn forced cutbacks in planned information technology upgrades or expansions. Although the business cycle began improving in 2004, those improvements had not begun to ripple into college and university budgets by 2005.

Government financial support is not the only economic issue. In any organization, investment in new technology tends to be driven by the expectation of payoffs, particularly economic payoffs—increases in benefits or decreases in costs. In the case of higher education, information technology has begun to pay off in terms of administrative costs and improvement of student services and other auxiliary activities at a more affordable cost. But information technology has not proven to be a cost-reducer on the educational side of operations. Indeed, as long as universities are organized as they are (teacher-centered decision-making, professors as independent operators, decentralized academic fiefdoms), there is little possibility to reduce instructional costs. So, instructional technology advocates are left with the claim that benefits increase: greater numbers of students reached, students more satisfied, faculty more content and/or productive, and the like. This benefits argument is not as potent as the economic one, so the provision of technology support tends to be lower in the academic arena than in other parts of the administration.

In any event, the tempo of educational change is driven as much by the dynamics of socio-cultural forces within colleges and universities themselves as by economics: by whom instructional decisions are made, whose interests have priority, and how rewards are allocated. In this section we will examine how these forces interact to affect the pace at which technologies are adopted and the manner in which they are used.

Issue 1: Used of Technology-Based Media for Delivery of Instruction

Classroom media: Analog and digital media. In past years, we treated traditional audiovisual media and digital media in two distinct sections. As discussed earlier, one of the overall

trends in instructional technology is the convergence of media formats—analog and digital, and higher education has taken a lead in this regard. It has become an increasingly difficult exercise to organize a discussion of media so that analog and digital media are treated separately.

In fact, two important developments in higher education this year are examples of this convergence. One development is the introduction of an Internet-based campus television network. College television stations, which have as long a history (though admittedly a less glamorous) as commercial stations, received a huge boost in distribution and viewership when the Open Student Television Network went online in Spring 2005 (http://www.ostn.tv). The network uses streaming video to air shows from the campus television stations of 33 schools that use Internet2's high-speed network (Young, 2005). While viewership is somewhat limited at this time because of the Internet2 membership requirement, the potential viewership for the college television stations that are involved with this project is still much greater than it would be without the online network, and it will likely grow as more universities become members of Internet2.

The second development will likely be a slower one, and its unclear as yet how issues will be resolved, but the outcome will be very important for higher education and very interesting to watch. This development has to do with the emergence of electronic books ("ebooks") and the future role of traditional print-based textbooks on college campuses. The ever-increasing costs of textbooks along with the advancement of wireless computing and tablet PCs are key factors that are influencing this situation. The fact that the University of Phoenix, the nation's largest private university, has eliminated print textbooks and replaced them with all digital resources has certainly added urgency to this discussion (Marketwire, 2005). It is not clear yet how rapidly textbooks will become digitized, but the stakes are enormous.

Course management systems. The big story in terms of student contact with technology in the classroom is course management systems (CMS). The Market Data Retrieval Service (2005a) reports that virtually all higher education institutions now use course management systems (compared with only 83% when they first started collecting such data in 2002). The most popular course management systems continue to be Blackboard, which is supported in 51 percent of higher education institutions, and WebCT, which is adopted by 32 percent of institutions. Blackboard's biggest competitor is viewed by industry watchers at *BusinessWeek* as the open-source software collaborative between Stanford, MIT, Michigan, and Indiana University that has been dubbed "The Sakai Project" (Yang, 2004). As explained in this chapter last year (Molenda and Bichelmeyer, 2005), the goal of the Sakai Project is to provide high quality open source code for a range of

applications, especially a new and improved CMS. Through the shared development process the consortium hopes to innovate more quickly than for-profit competitors and to reduce the costly licensing fees that must be paid by colleges and universities.

In the meantime, college students seem to be relatively satisfied with their experiences using CMSs. Eighty-three percent of respondents to a 2004 EDUCAUSE survey have taken a class that had a course management system, and of those students, 76 percent felt positive or very positive about the experience, while 17 percent expressed neutral feelings, and only 7 percent expressed some level of negative feelings about the experience (Kvavik, Caruso & Morgan, 2004). This seems to be an exceptionally positive response to a software application that is still in its early stages of development and it bodes well for the future of CMSs.

Emerging digital technology. "Clickers" are popping up on college campuses (Wired News, 2005). Personal response systems, also known as audience response systems, are being adopted by many universities for use in the classroom, primarily in the sciences. They are novel enough that there are not yet reliable estimates as to the extent of adoption or how effectively they are being used for improving learning. This is a technology ripe for research. If you are not familiar with what clickers are or how they are used, refer to the K-12 section titled "Emerging digital technologies" later in this chapter.

Distance education. When the dot-com bubble burst in March 2000 it signaled the beginning of the collapse of the most highly touted new US distance education (DE) initiatives. Then in 2004 the major British effort, UK eUniversities Worldwide (UKeU) was dismantled. As further indication of the fading of the land-rush mentality, in EDUCAUSE's annual survey of top issues facing administrators, for "issues with a high potential for becoming significant in the coming year," distance education dropped from first place in 2001 to off-the-chart in 2004 (Spicer et al, 2004).

Curiously, at the same time dot-coms were deteriorating into dot-compost many more modest DE programs were quietly gaining a foothold. Leading the way were proprietary institutions such as University of Phoenix Online, Jones International University, and Capella University. Their initial success in attracting enrollments drew the attention of planners at mainstream residential colleges and universities. They were not only enrolling increasing numbers of students, they were making a profit. This was an enticing prospect for the administrators of not-for-profit institutions, who saw DE as a way to increase their revenue stream and slow the loss of enrollments.

By 2003 the great majority of all residential four-year colleges and universities and two-year community colleges operated DE programs; for large public universities the proportion was about 90 percent. Figure 15 shows the growth between 2002 and 2003 and the breakdown among public and private institutions.

[Insert Figure 15 here.]

The most comprehensive survey of online enrollments, conducted by the Sloan Consortium in 2004, shows that 1.6 million students in the US were taking at least one online course in the Fall of 2002; by the Fall of 2003 this number had grown to 1.97 million, a year-to-year growth rate of 23 percent (Allen & Seaman, 2004). The respondents in this survey also predicted that enrollments would continue to grow at that rate for 2004. Two universities that have reported DE enrollment data for Fall 2004 are University of Maryland University College, which grew by 15 percent over the previous year, and University of Illinois Springfield, which grew by 28 percent. These data indicate a continuing healthy increase into 2004. At both these institutions the proportion of students enrolled in online courses versus face-to-face courses is increasing, leading to speculation about an enrollment "tipping point" at which the character of a traditional campus will change (SchWeber, 2005).

Among dual mode institutions (those with both residential and distance programs), an operational model that appears promising is the consortium approach— a group of universities having a common portal, sharing course development and marketing costs, but facilitating enrollment at any one of the participating schools. Over thirty states have formed such distance learning consortia, and some have experienced growth above the average for individual institutions. For example, UMassOnline enrolled 17,000 students in 2004, up 19 percent over 2003, and Illinois Virtual Campus reported 80,000 enrollments in Fall 2004, an increase of 60 percent over Fall 2003.

Interestingly, the audience for DE programs at dual-mode universities seems to be shifting. DE programs initially targeted such "non-traditional" niche groups as single mothers, employed adults, people with disabilities, and those living in remote areas. By 2005 these programs were becoming more fully integrated into the universities' traditional programs, drawing many students who are already enrolled in regular on-campus courses of study.

During the years 2000-2005 much of the expansion in online enrollments went to the proprietary, for-profit institutions, but nonprofit institutions have been offering more and more competition, slowing their overall loss of enrollments. The growth of online programs has become

so significant that in 2004, for the first time, *US News & World Report* included a section on online graduate programs in its annual college rating issue.

Issue 2: Constraints on Acceptance and Use of Technology

Administrative Issues - Funding. Financial reports for campus IT have been decidedly bleak since the downturn of the national economy in 2000. In 2004, there were mixed signals regarding the financial condition of campus IT programs. The number of campus IT programs that reported budget cuts for *academic* computing dropped from 41.3 percent in 2003 to 24.3 percent in the 2004 Campus Computing Survey (which is good news). Also, the number of campus IT programs that reported budget cuts for *administrative* computing dropped from 42.3 percent in 2003 to 25.3 percent in 2004 (Campus Computing Project, 2004). Clearly, it would be a more positive report if we were able to say that there have been actual budget gains; however being able to report decreases in budget cuts is certainly a trend toward the positive. Campus IT budgets are obviously still tight, and for many higher education institutions (more public colleges and universities than private ones), budgets continue to decline.

One result of this ongoing difficult budget situation is, for the third consecutive year, that campus IT officials report IT fundingas their main concern and the issue that consumes most of their professional time (Maltz et al, 2005).

Figure 16 reveals a variety of the strategies that IU administrators are considering and planning to implement in order contain campus computing costs in their efforts to live within their declining budgets (Goldstein & Caruso, 2004).

[Insert Figure 16 here]

Some of the most widely considered strategies that have been considered include sharing of purchases through consortia relationships and shared technology implementation as well as the use of open source programs. The most likely strategies to be used, however, will be across-the-board cuts, cuts in renewal and replacement costs, and cuts in the number of technologies that require support.

Faculty acceptance of instructional technologies. The burgeoning of course management systems (CMS) has triggered an interesting payoff for improved teaching. Most institutions now support a single primary CMS and encourage individual instructors to make at least minimal use of the system. A recent study casts light on the reasons why professors decide to make use of a CMS and the how that adoption decision leads to later pedagogical consequences.

Morgan's (2003) study of 730 faculty members in the University of Wisconsin system, including a survey and further interviews, found that successful adoption took place against a background of active administrative encouragement. Typically, a shell was set up for each course on campus, and faculty were invited to use it or ignore it. Enforced adoption by administrative decree tended to lead to resentment and early abandonment. A more laissez-faire approach allowed curiosity to arise and for peer support to evolve naturally.

Respondents' major explicit reason for using the CMS (chosen by 34 percent) was pedagogical, particularly to a) increase discussion among students, b) post grades online, c) provide additional course materials, or d) address individual differences. Most users (62 percent) said that their usage increased over time, while 33 percent remained at the same level and only 5 percent decreased their usage.

Most interestingly, the findings suggest that the initial level of adoption seems to serve as a wedge that expands to encompass more and larger changes. Professors report that they tend to use the CMS more and more extensively because they gradually see more potential uses of its features. It begins with content presentation tools, and for some it ends there. But many users go on to make use of the discussion forums, quiz tools, and gradebook. Thus many are drawn step by step into ever more sophisticated uses, uses that yield more learning benefits for students.

For generations, predating the digital age, teachers have been coming to terms with new technologies. Especially at the college level, instructors have traditionally been slow to adopt technologies that require a change in their power relationships or alteration of their teaching routine. Online distance education presents a challenge on both issues, since it removes the instructor from face-to-face contact with students, requires the use of methods other than oral presentation, relies on a technical infrastructure that is largely beyond the control of the instructor, and often entails a team effort in development.

Given the extra time demands needed to develop and maintain online courses and the altered role played by the online instructor, it is not difficult to anticipate faculty resistance to distance teaching. Nevertheless, a growing number of faculty do accept this challenge every year. If DE is to continue to grow it will need to have the support of increasing numbers of faculty, which requires an understanding of the sources of resistance and possible avenues to bypass these barriers. An earlier study of faculty attitudes toward DE (National Education Association, 2000) found that those teaching distance courses received little if any extra compensation and believed that they invested

more hours in the job, yet they indicated quite a high level of satisfaction and willingness to continue.

A more recent study tapped the perceptions of 913 professors teaching online courses in the state of New York system. It found that 90 percent of respondents were satisfied with the course they were teaching and 96 percent were satisfied with online teaching in general (Shea, Pickett & Li, 2005). Those who taught residential courses at the same time as distance courses were asked to compare student performance in the online and face-to-face settings. As shown in Figure 17, 48 percent felt there was no difference, and 41 percent felt that the online students actually performed better; only 11 percent rated the in-class students' performance as better. Fully 98 percent said they were willing to teach an online course again!

[Insert Figure 17 here.]

These happy findings must be read with some caution however. The response rate to the survey was 34 percent, and there is every reason to suspect that those who responded were those who were more invested in DE. Nevertheless, even among technology enthusiasts this would be quite a ringing endorsement.

Shea et al went on to explore the factors that were associated with faculty satisfaction. Their first finding corresponded closely with a finding of the National Education Association study that "high levels of interaction are frequently mentioned as one of the potentially positive aspects of online teaching" (Shea et al., p. 13). In both studies, respondents indicated that they had a higher level of interaction with their online students and tended to form stronger personal bonds with them, and they found this a gratifying outcome. They also found that the new environment of online teaching forced them to reflect more deeply about teaching and to develop new teaching skills. Finally, this group of faculty experienced a course management system that was relatively easy to use and has solid technical support. These conditions contributed significantly to their satisfaction.

These findings suggest that resistance to online teaching can be overcome and that there are inherent rewards, particularly the gratification of forming close bonds with students and seeing them succeed, that draw professors to online teaching.

Student acceptance of instructional technologies. The EDUCAUSE Center for Applied Research conducted a mixed method study during 2004 that included surveys of nearly 4,500 freshman and seniors at 13 higher education institutions and focus group interviews with 132 students at 6 higher education institutions (Kvavik, Caruso & Morgan, 2004). Results from the study provide a rich description of students' experiences and attitudes related to campus computing.

The computer applications most commonly used by students are word processing (99.5 percent), electronic mail (99.5 percent), recreational Internet surfing (97.2 percent) and for course activities (96.4 percent). More than 81 percent have broadband access to the Internet through university or commercial services, while the remainder access the Internet through dial-up modems.

Students rate themselves as highly skilled at using computers for communication, word processing and the Internet, and less skilled at creating and editing audio, graphics and video. There was some discrepancy between students' self-ratings and interview data, which indicated that, beyond basic functions in Microsoft Office, students have just enough technical knowledge to accomplish their work and are lacking in-depth knowledge of even the most popular computer applications.

Most students prefer that faculty usea moderate amount of technology use when teaching their classes, as opposed to extensive use or limited use. The biggest complaints from students about faculty's misuse of computers during courses were 1) over-reliance on PowerPoint ™ during presentations, 2) wasting class time while dealing with hardware issues, and 3) requiring online discussions when faculty do not monitor them, provide feedback in the discussion space, or comment about the discussions during class meetings.

The greatest benefit of using computers in classes, according to half of the student respondents, was convenience. Another big benefit that was cited was "saving time." Perhaps the most troubling finding of the study is that only 13 percent of the students cited improved learning as the most valuable benefit of classroom computer use. The problem with educational computing cited by the most students (17 percent) was that using computers "feels like extra work" (p. 13). Fourteen percent of students complained about applications not working on their computers. Thirteen percent of students identified lack of access to printers as a problem. About 10 percent of students said the lack of technical support is a barrier to classroom IT use.

Issue 4: Emerging Themes

IT accessibility for students with disabilities. One unforeseen consequence of the effort of higher education institutions to move more of their classroom and administrative resources onto the Internet is that these same institutions are likely moving further out of compliance with the Americans with Disabilities Act of 1990 and the Rehabilitation Act of 1998, both of which require all public entities and recipients of federal funds to ensure that individuals with disabilities have access to programs and services equal to their non-disabled fellow citizens.

In sum, this means that higher education institutions *must* make certain that their information technology hardware, software, operating systems, products, programs, services, Websites, multimedia, and interactive digital materials are fully accessible to individuals with disabilities. This is no small task, and it is an important one. It's also a goal toward which we have a long way to go.

Slightly more than 50 percent f the 91 institutions surveyed as part of an EDUCAUSE study have a staff member dedicated to addressing issues of Web accessibility. Just less that two-thirds of these institutions have Web accessibility policies, and just more than one-third have IT accessibility policies. Figure 18 identifies several promising practices for improving IT accessibility, and shows the percent of surveyed institutions that are taking each of these steps (Thompson, 2005).

[Insert Figure 18 here]

Lest we delude ourselves into thinking this is a problem that only impacts a small number of higher education students, Figure 19 shows the number of registered students with disabilities at the 39 institutions that were able to report these data.

[Insert Figure 19 here]

Twenty percent of reporting institutions reported have less than 250 registered students with disabilities, 33 percent have between 250 and 499 students with disabilities, 20 percent have between 500 and 750 students with disabilities, and 25 percent have more than 750 registered students with disabilities (Thompson, 2005).

Clearly, this is a large-scale issue that will only become larger as the use of information technology comes to pervade every aspect of life in higher education.

K-12 Education

In last year's chapter (Molenda & Bichelmeyer, 2005) we noted that, though computers and networks have become ubiquitous in schools, the focus has changed from using computers for teaching and learning to using them for assessment. This shift, driven by President George W. Bush's No Child Left Behind (NCLB) initiative, in a boon to the for-profit educational technology industry, puts the primary focus of computer use on computer-based assessment and the warehousing of assessment results .

This year, we see the natural progression of that initiative, with further forays of the for-profit education industry into the educational technology sector through the development and marketing of test-preparation software. Further, federal funds for educational technology may be redistributed through the elimination of the "Enhancing Education Through Technology" federal

grant program, which will decrease funding for educational technology to cash-strapped states while providing more funds through block grants to for-profit vendors who are aggressively marketing to the poorer school districts that are struggling to meet NCLB requirements.

Issue 1: Use of Technology-Based Media for Delivery of Instruction

The story this year regarding the use of technology for delivery of instruction is that there is no story – or at least not much of a story. Our prediction last year that one consequence of the NCLB legislation would be to increase the use of computers for data warehousing and database management appears to have had merit.

Data management vs. delivery of instruction. In a recent survey of state education representatives regarding their state's top two priorities in spending for education technology this year, 16 listed data management as a priority, the second most frequent response with only professional development receiving more responses (Education Week, 2005). Figure 20 shows the relative lack of interest in using technology for instruction , with only five states citing integration of technology with instruction as a priority, while four states cited curriculum software as a priority, and two states listed laptop programs as a priority.

[Insert Figure 20 here.]

The 2005 *Education Week* Technology Counts issue reported that "educational technology spending priorities of the nations' largest school districts appear to be leaning heavily toward technologies that help educators analyze student-achievement data and then adjust their teaching based on what those results show" (Gehring, 2005, p. 38).

SchoolMatters (www.schoolmatters.com), a partnership of nonprofit and for-profit agencies, is one of the first efforts to take advantage of the development of these databases. A $45 million project of the National Education Data Partnership, the goal of the initiative is to make education data such as student demographics, student achievement scores and school finance figures available to the public..

As the NCLB initiatve has turned student assessment into a lucrative market through data warehousing, we predict that we will see more for-profit education technology companies following the lead of the Educational Testing Service, which announced in March 2005 that it will enter the K-12 formative-assessment market (Olson, 2005).

Computer-based media. Laptop computers and wireless networks were two leading-edge technologies in schools that showed significant growth during the past year. Laptops accounted for a fair amount of new hardware purchases by schools. The overall inventory of laptops in schools

increased four percent in just one year, from 13 percent to 17 percent of total computer inventory. Mobile computers were available in 54 percent of all K-12 schools during 2004. (Market Data Retrieval Service, 2005b). At all school levels, the percentage of buildings that have wireless networks continues to grow. Figure 21 shows that secondary schools have the highest percentage of wireless networks (54 percent), while 51 percent of middle schools and 40 percent of elementary schools report having wireless networks (Market Data Retrieval Service, 2005b).

[Insert figure 21 here.]

The historical benchmark for technology integration in schools has been the "students per instructional computer" ratio, which dropped slightly from 4.0:1 in 2003 to 3.8:1 in 2004, while the student-per-Internet–connected computer ratio dropped from 4.3:1 in 2003 to 4.1:1 in 2004 (Education Week, 2005). Though Education Week reports that these are the recommended ratios of the U.S. Department of Education for technology integration, two-thirds of the teachers who participated in the CDW-G "Teachers Talk Tech" 2004 survey felt that they do not have the right number of computers in their classrooms, and 55 percent felt that the lack of computers for students to use is a "very" or "extremely" serious problem (Rother, 2004, p. 46). The disparity between the Education Department recommendations and these teachers' concerns about student-computer ratios may reflect the long debated issue of whether computers serve learners better when located in classrooms or in computer labs. We predict that the issue of where computers are located in schools will become less problematic as more schools install wireless networks, because it will become easier to locate Internet-connected computers throughout the building.

Traditional audiovisual media. Analog audiovisual (AV) collections are still used in K-12 schools, and they will likely continue to be used as long as the media are in good repair, but will eventually be replaced with media in digital AV formats. As we reported previously, new purchases of video tend to be in digital format, so over time we should expect to see the percentage of digital AV materials increasing while analog AV materials will decrease.

This shift from analog to digital audiovisual is also evident in the 2005 Bi-Annual Survey of the National Association of Media & Technology Centers (NAMTC). The 48 education service agencies (representing 35 percent of institutional members) that responded to the survey indicated they are taking on increasing responsibility for providing technical support related to technology integration and to the implementation of emerging technologies (Ehlinger, 2005). Figure 22 shows that while video circulation activities continue at a high level without dropoff, services related to

tech equipment, video streaming, videoconferencing, and other electronic resources have increased since 2003.

[Insert figure 22 here.]

Emerging digital technologies. Last year we reported that handheld PCs were finding entry into schools, where they were being used by students as digital readers and graphing calculators, for word processing and spreadsheet creation, and for specific instructional activities, such as concept mapping.

This year we are seeing the emergence of a more specific type of handheld device that is in keeping with the emphasis on assessment resulting from the NCLB initiative. "Clickers," or personal response systems, are small electronic devices that look similar to a television remote control. Clickers allow students to answer multiple-choice quiz questions during a classroom activity and have the results immediately tallied and presented on a computer screen. These devices are marketed to schools by companies such as eInstruction, HyperActive Teaching Technology, Promethean Limited, and Qwizdom. Clickers are promoted as being valuable for helping students prepare for testing, and for providing teachers with immediate feedback on instructional strategies by taking a measure of what students are learning. Critics of this emerging technology are concerned that their emphasis on multiple-choice measures are simplistic and emphasize trivial learning over complex and higher-order thinking (Trotter, 2005).

Teacher computer use. The good news according to *Education Week* (2005) is that forty states have technology standards for teachers. Additionally, twenty states have a technology test or technology training as requirements for teachers' initial licensure or endorsement, and ten states have a technology test or technology training as requirements for teachers' recertification. The bad news, according to *Education Wee,k* is that many of these states do not have enforcement policies to ensure that teachers meet the standards which have been set.

Still, teachers appear to be developing more positive views about the value of technology for helping students learn than they have had in the past. The 2004 "Teachers Talk Tech" survey found that 81 percent of the teachers who participated believe that classroom computer availability increases student academic performance, and 62 percent think that computers helps students perform better on standardized tests (Rother, 2004).

The majority of teachers also find benefits in using Web resources for preparation of lesson plans and for teaching in the classroom. A study by Hanson and Carlson (2005) found that teachers use Websites more than any other resource, including textbooks, for curriculum planning. These

teachers also reported using Websites more than any other resource except textbooks during classroom instruction (see Figures 23a and 23b).

[Insert figure 23a here.]

[Insert figure 23b here.]

One reason teachers give high marks to Websites may be because they have less regard for another type of digital resource, educational software programs available in their schools. Only 45 percent of teachers rated software as "good" or "excellent," while 52 percent rated software as "Just OK" or "poor" (Rother, 2004). Interestingly, one-third of all school districts have a requirement that only software or online content that is backed by scientifically-based research may be purchased (Market Data Retrieval Service, 2005b). Again, this reflects current national education policies, the merits of which could be discussed at length.

Student computer use. Not surprisingly, research supports the everyday observation that the majority of children and adolescents use computers and the Internet with some frequency. But *which* children use computers and in how frequently? Figure 24 shows that children's use of computers begins when they are very young: 67 percent of nursery schoolers and 80 percent of kindergartners are computers users. Twenty-three percent of nursery schoolers and 32 percent of kindergartners also use the Internet. By high school, nearly all students (97 percent) use computers, and a great majority (80 percent) use the Internet (U.S. Department of Education, 2005).

[Insert figure 24 here.]

The really interesting story is about *how* adolescents are using computers. Would you believe that young people between the ages of 8 and 18 years-old spend an average of nearly *6.5 hours a day* with media? One-third of 2,000 third- through 12th-graders who completed a survey by Kaiser Family Foundation from Fall 2003 to Spring 2004 are media multi-taskers. These children and adolescents describe their media usage as chatting on the phone, surfing the Web, sending instant messages, watching TV, or listening to music 'most of the time' while they are also doing their homework (Rideout, Roberts & Foehr, 2005). The researchers at Kaiser Family Foundation have aptly labeled these young people as "Generation M," with M standing for media.

The imbalance between young people's in-school learning and out-of-school media use is well noted by Komoski (2005), who calculates that children's at-home investment of almost 6.5 hours a day in non-school-related media use, as compared to their in-school investment of 3.8 hours a day (five 45-minute periods) in core academic classes during a 180-day school year totaling 700 hours, creates a 3-to-1 imbalance of recreational media use over in-school learning. Komoski

presents the even more depressing thought for educators: “if we take into account research by David Berliner and others showing that during the typical 45-minute academic class, students are seldom engaged in on-task learning for more than a third of class time, the 3-to-1 imbalance balloons to 9-to-1. By either measure, this demonstrates a large time-attention learning imbalance for some 50 million 8 to 18 year olds” (p. 37).

If educational technologists are looking for a cause for concern, this would certainly be a good candidate.

Equity in access. As we reported in the section on student computer use, most students today use computers, so it may be fair to say that we have achieved a measure of equity in that respect. The “new digital divide” has to do with the students who do and do not use the Internet. The majority of students who currently do *not* use the Internet include Black (non-Hispanic) and Hispanic students, students in households where Spanish is the only language spoken, students whose family income is under $20,000, students in poverty and students whose parents have less than a high school credential (U.S. Department of Education, 2005).

One factor that may be contributing to the new digital divide is likely the mismanagement of the E-rate program, established by Congress in 1996 to provide more than $2 billion per year for Internet access to the poorest schools and libraries in the country. In recent years, the E-rate program has faced allegations of fraud, waste, and abuse, with federal prosecutors bringing charges against schools and districts in Atlanta, New York, San Francisco, and Puerto Rico, among other locales. This situation led to a temporary E-rate freeze and an audit from the Government Accountability Office (GAO) in 2004. The GAO report released in March 2005 criticized the Federal Communications Commission (FCC), which administers the program, for poor management and lax oversight. The GAO recommended that the FCC create accountability requirements for the E-Rate and establish performance goals and measures for the program (United States Government Accountability Office, 2005). Hopefully, improved management of the E-Rate program will help to minimize the gaps in Internet access that we currently face.

Another concern that has recently emerged related to the equity of technology integration is the targeting by education software vendors of poor schools that are struggling to meet NCLB student achievement requirements. These vendors are promoting sales of what are sometimes referred to disparagingly as “drill and kill” programs that may lead to an achievement gap on standardized tests. If we were to give an Annual Award for Investigative Journalism in Instructional Technology (which we would likely name the “IJIT” award), the winner for 2004 would be the

Baltimore Sun, for a brilliant exposé in a week-long series of articles about the questionable strategies and tactics of for-profit education software vendors, and how these vendors prey upon poorer struggling schools who have access to millions of dollars in federal funding to support their improvement (Baltimore Sun, 2004). The reports include descriptions of all-expense paid international trips for school administrators, riverboat cruises during the National Education Computing Conference in New Orleans, influencing in-school trials of education software, and the trail of money that connects education software vendor companies with elected officials in Washington. If nothing else, this series reveals that big money that is linked to the integration of educational technology in public schools.

Issue 2: Constraints on Acceptance and Use of Technology

Funding. Speaking of big money, the big news of the past year was the roller coaster ride of changing federal positions on funding for educational technology. Along with the E-rate program, the other federal mechanism that provides the majority of educational technology funding to public schools is the Educational Technology State Grants program, also known as the Enhancing Education through Technology (E2T2) program, which was signed into law as part of the No Child Left Behind Act. In late November 2004, Congress passed an omnibus appropriations bill which cut $191 million (27.7 percent) of these educational technology funds for 2005. In January 2005, the U.S. Department of Education released a new National Education Technology Plan which emphasizes the importance of educational technology for preparing learners to meet the challenges of the 21st century global society. On February 7, 2005, President Bush released his 2006 budget proposal with a cut of $500 million to the E2T2 program, in effect eliminating in its entirety the primary source of federal funding for educational technology (eSchool Newsonline, 2005a). On July 12, 2005, the Senate Appropriations Subcommittee on Labor, Health and Human Services, and Education reached a decision to provide $425 million in funding for the E2T2 program for 2006. At the time of this writing, the decision was pending for a vote from the full Senate Appropriations Committee (eSchool Newsonline, 2005c).

Administration officials argued for the proposed elimination of E2T2 because student-computer ratios have reached recommended levels and because they say technology can be better blended into teaching and learning through the use of Title I grants and other federal funds. Critics of the E2T2 cuts argued that schools continue to need funding for replacement and upgrade of computers, as well as for ongoing training of teachers who are still uncomfortable with their computer skills (Education Week, 2005).

The current administration's shifting position signals that something different is happening as we continue on our way toward computer integration. After more than 15 years of focused effort to get computers into schools, during the past year federal officials and school administrators alike have shifted attention from procurement to maintenance of the equipment we have spent past years acquiring. One manifestation of this shift is the increasing popularity among school administrators of a concept known as "total cost of ownership" (TCO). TCO is a calculation taken from business that attempts to determine what the real costs are of implementing technology, by factoring in hidden costs such as support, replacement, retrofitting, connectivity and software (Hurst, 2005).

Despite the possible cuts in federal funding, a remarkable 30 percent of school districts have projected increases in their technology budgets for 2006 (Market Data Retrieval Service, 2005b). Of course, this also means that 70 percent of school districts project flat or decreased spending, and we all know there is a difference between budget projections and actual funding. Come back next year to see how these districts fared with their projections.

Professional Development. For as long as educators have been working to integrate computers in schools, research and evaluations have shown that not enough money is being spent on teacher professional development and that teachers' perceptions about what little professional development they get are that it is not well-suited to their needs (eSchool Newsonline, 2005b; Gehring, 2005; Hanson & Carlson, 2005; Maryland Business Roundtable for Education, 2005; Rother, 2004; U.S. Department of Education, 2003; Bichelmeyer, 1991). Sadly, this failing continues.

Barriers to Use of Technology. Not surprisingly, one of the biggest barriers to technology integration in schools is lack of quality professional development for teachers. Other barriers to the use of technology cited by teachers include having too few computers in the classroom and lack of time to plan for computer use, both of which are also perennial issues related to technology integration (eSchool Newsonline, 2005b; Rother, 2004; U.S. Department of Education, 2003).

Technology support. While we're discussing old news, the amount of technology support provided to support teachers and maintain equipment in schools is still problematic (Hanson & Carlson, 2005). There is, however, an interesting solution to this problem that is becoming popular in many schools. Students are serving as technology support personnel (Borja, 2004a). State funding and grant programs are springing up to train students to provide technical support, set up and maintain equipment, and troubleshoot problems that arise. This seems to be evolving as a win-

win solution that helps schools keep equipment up and running while providing skills and experience that help students find good jobs when they leave school

Issue 3: Challenges to Existing Paradigms

Distance Education. The number and popularity and distance education programs at the K-12 level continue to increase, primarily due to the growth of virtual schools. Important stakeholders are not only taking notice, they are jumping on the bandwagon.

In the first large-scale, federal government sponsored study of distance education since virtual schools have become an option, the National Center for Education Statistics found that students in more than one-third of public school districts enroll in distance education courses, with greater proportions of these students being from large districts, districts with relatively high socioeconomic status, and from rural areas of the country. Seventy-six percent of students enrolled in distance education are in high school, 15 percent are in combined or ungraded schools, 7 percent are in middle or junior high school, and 2 percent are in elementary schools (Setzer & Lewis, 2005).

The current administration of the U.S. Department of Education has certainly jumped on the bandwagon. During an NCLB Leadership Summit in Orlando in July, 2004, a white paper was presented by a consulting group that works in the area of charter schools titled, "How Can Virtual Schools Be a Vibrant Part of Meeting the Choice Provisions of the No Child Left Behind Act?" (Hassel and Terrell, 2004). Last year we raised the possibility that the Bush administration is promoting virtual schools as an opportunity to further their agenda of privatizing education; this white paper seems to provide further evidence of that position.

Other stakeholders who are jumping onto the bandwagon of virtual schools include Michigan Virtual University (Carnevale, 2004); a for-profit cyber school business named Connections Academy (Borja, 2004b); and even the tiny 65-student school district of Branson, Colorado, where district administrators have found that offering online courses has allowed them to boost enrollments by more than 1,000 and increase the district's funding by about $15 million since they began the project in 2001 (Dillon, 2005). The rise of virtual schools is also seen as a key factor that has helped the home-schooling movement attract mainstream families (Kumar, 2004). The National Center for Education Statistics reports that there were more than 1.1 million homeschooled students in the United States during 2003 (United States Department of Education, 2004).

Based on these trends, we agree with the technology experts who predicted as part of the Pew Internet and American Life Project (2005):

> Enabled by information technologies, the pace of learning in the next decade will increasingly be set by student choices. In ten years, most students will spend at least part of their "school days" in virtual classes, grouped online with others who share their interests, mastery, and skills (p. vi).

Radio frequency identification devices. One of the more Orwellian developments related to the use of technology in education during 2005 was the case of the Sutter, California elementary school where the principal implemented a radio frequency identification device (RFID) for taking attendance (Bailey, 2005).

Students were required to wear badges with their photo, name, a tiny computer chip, and antenna so that when they entered classes, scanners located above the door could pick up the identification information, send it to the school's central database server and provide a master attendance list for the teacher on a wireless handheld computer. The RFIDs worked very well - at least until parents, the American Civil Liberties Union, and the Electronic Frontier Foundation raised protests about possible misuses of the technology. The protests led the RFID provider to shut down the project, though a company spokesman noted that all the press from the Sutter case had been good for business, with many callers expressing interest in adopting RFID technology for their schools. Based on that interest, we suspect that the use of electronic identification devices in schools is an emerging trend that we will be tracking for some time to come.

Conclusion

During the period covered in this review, schools, colleges, and businesses were still suffering from the budget exigencies inflicted by the recession of 2000-2003. Corporate training budgets actually contracted two years in a row and by 2004 had still not matched the level of 2000. In schools and colleges, many information technology operations absorbed budget cuts, working diligently to avoid service reductions. Information technology infrastructure has continued to expand nevertheless, so that access to computers and the networks which connect them has become virtually ubiquitous.

Adoption of new technologies and integration of them into instruction continues at a measured pace. For newer technologies the pace is fast at the beginning, but then plateaus. For more mature technologies, adoption moves more slowly as the market becomes saturated. In the public education sector, the marketplace has experienced a major biasing effect in the form of the NCLB

initiative, and we continue to see the effects of attempts to privatize and corporative K-12 education.

We must remember that pervasive access to information technology infrastructure does not guarantee its use in teaching, nor any improvements in effectiveness of instruction. Human factors such as resistance to practices that require new ways of working and the need for specialized training impinge on trainers', teachers', and professors' use of ICT. Because of these human factors, as they play out in training and education, it is inevitable that technology use lags behind technology availability.

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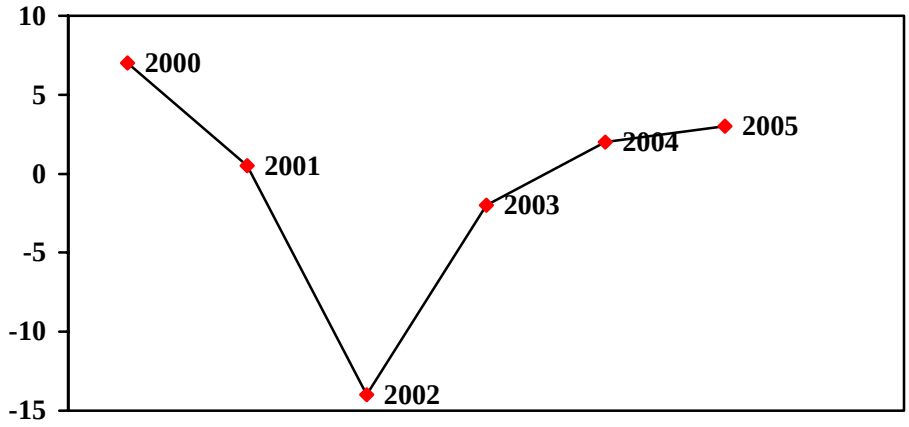

Figure 1. Year-over-Year Percent Change in State Tax Revenues, 2000-2005. Source: Jenny, 2005.

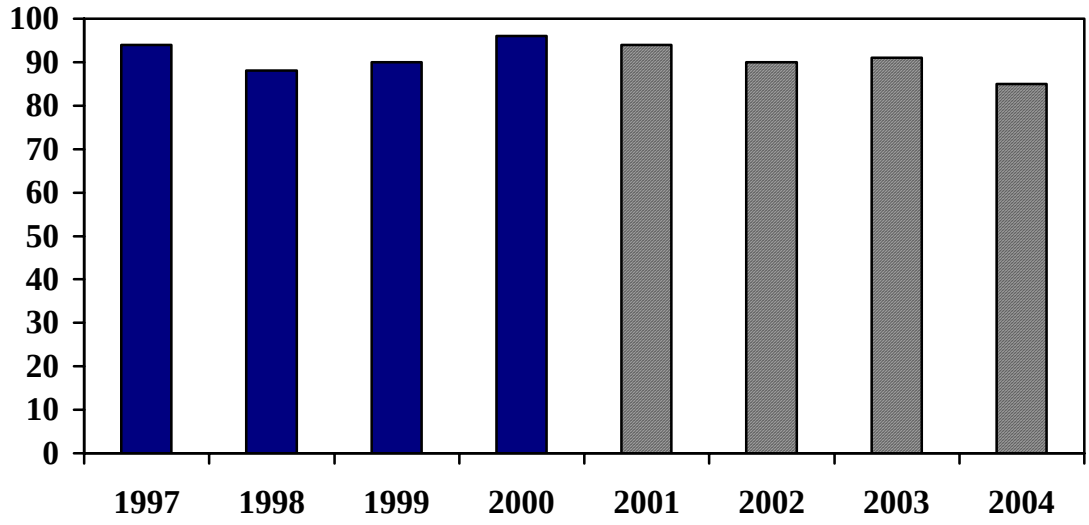

Figure 2. Percentage of organizations using **Live Classroom**

(In 1997-2000, shows those who use "ever." In 2001-2004, shows those who use "always" or "often.") Source: Dolezalek, 2004.

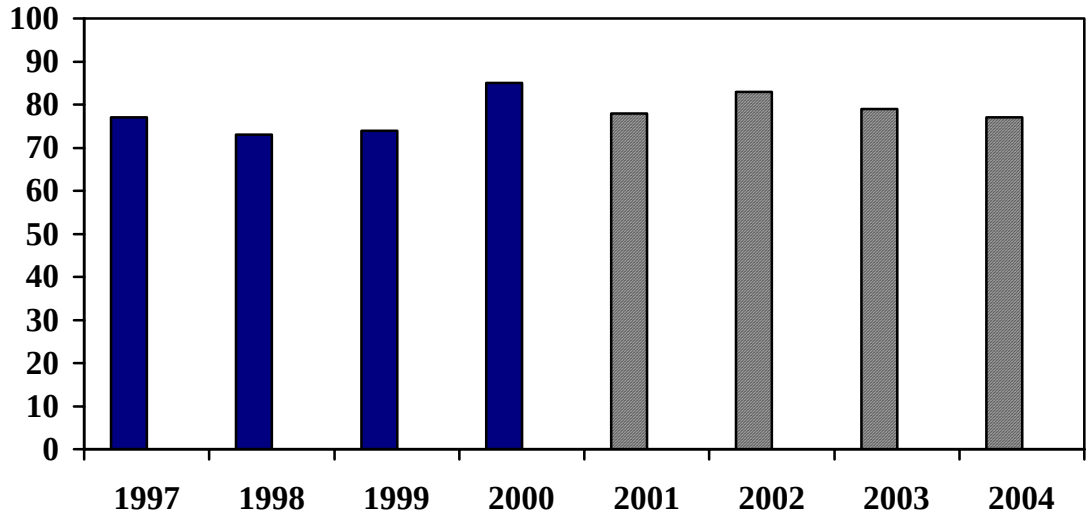

Figure 3. Percentage of organizations using **Workbook/ Manual**

(In 1997-2000, shows those who use “ever.” In 2001-2004, shows those who use “always” or “often.”) Source: Dolezalek, 2004.

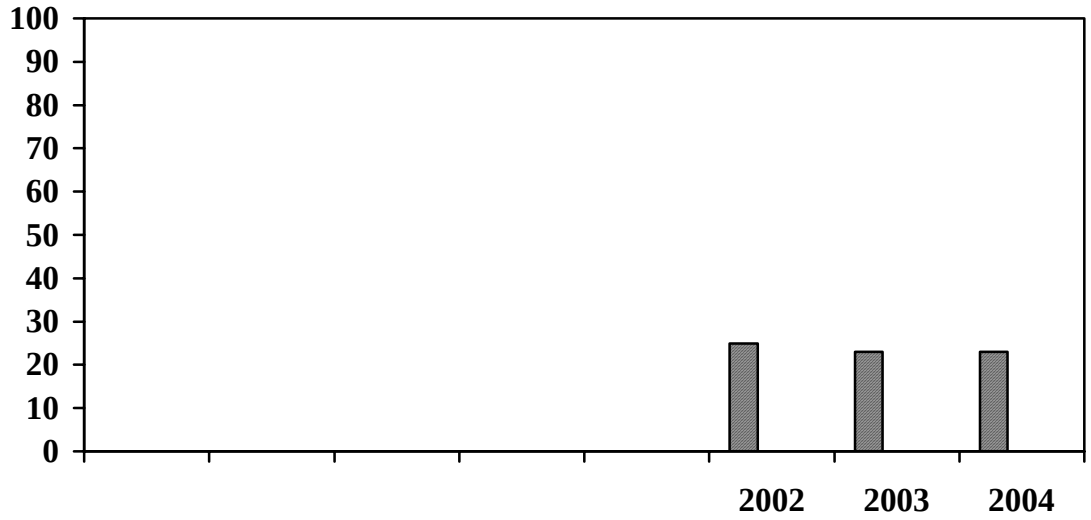

Figure 4. Percentage of organizations using **Self-Study, non-computer** “always” or “often.” Source: Dolezalek, 2004.

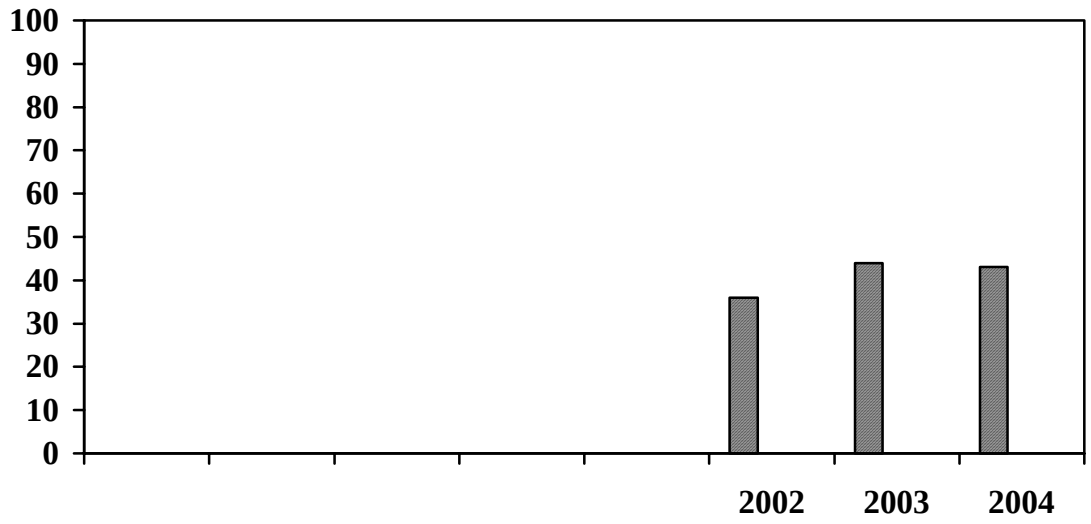

Figure 5. Percentage of organizations using **Self-Study, web-based** "always" or "often." Source: Dolezalek, 2004.

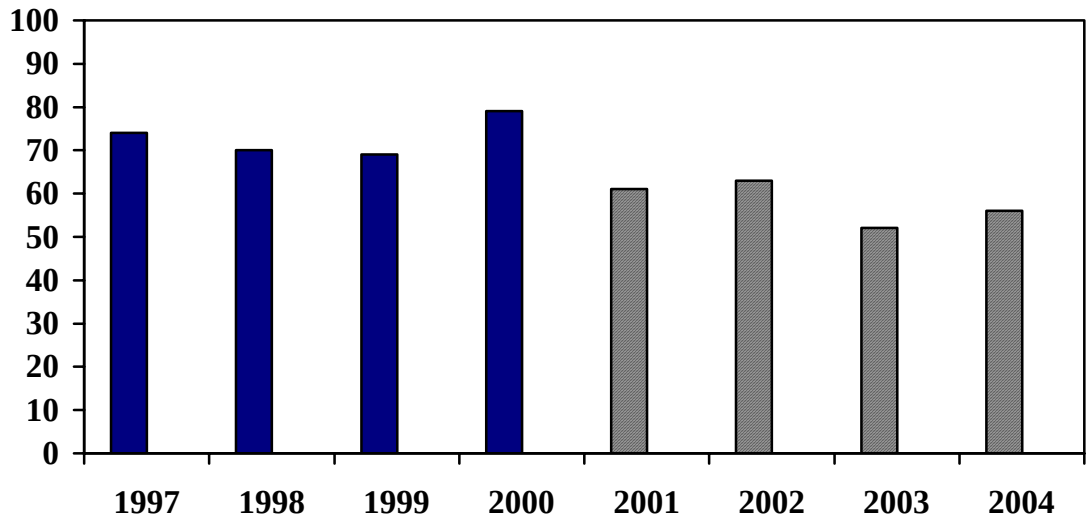

Figure 6. Percentage of organizations using **Videotapes**

(In 1997-2000, shows those who use “ever.” In 2001-2004, shows those who use “always” or “often.”) Source: Dolezalek, 2004.

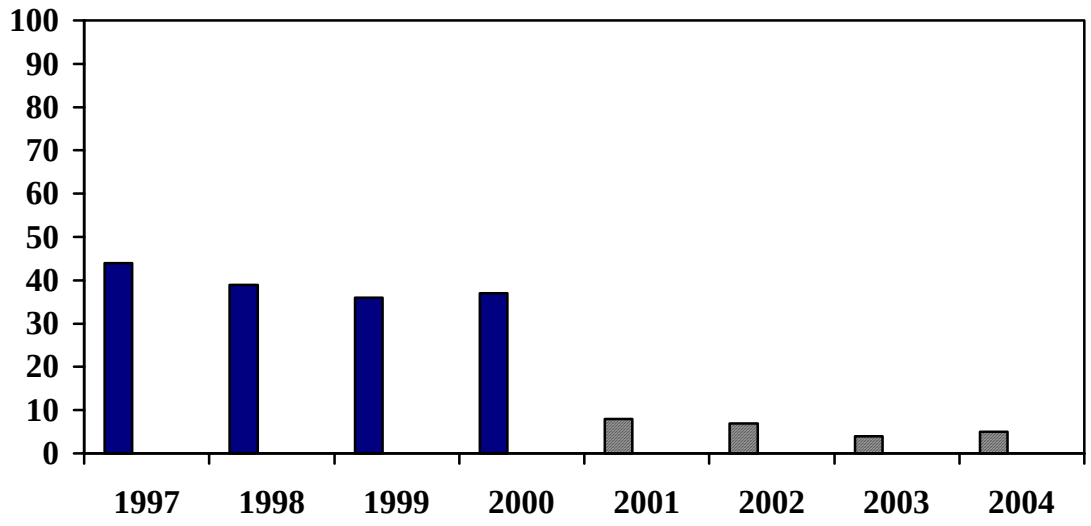

Figure 7. Percentage of organizations using **Audiocassettes**
(In 1997-2000, shows those who use “ever.” In 2001-2004, shows those who use “always” or “often.”) Source: Dolezalek, 2004.

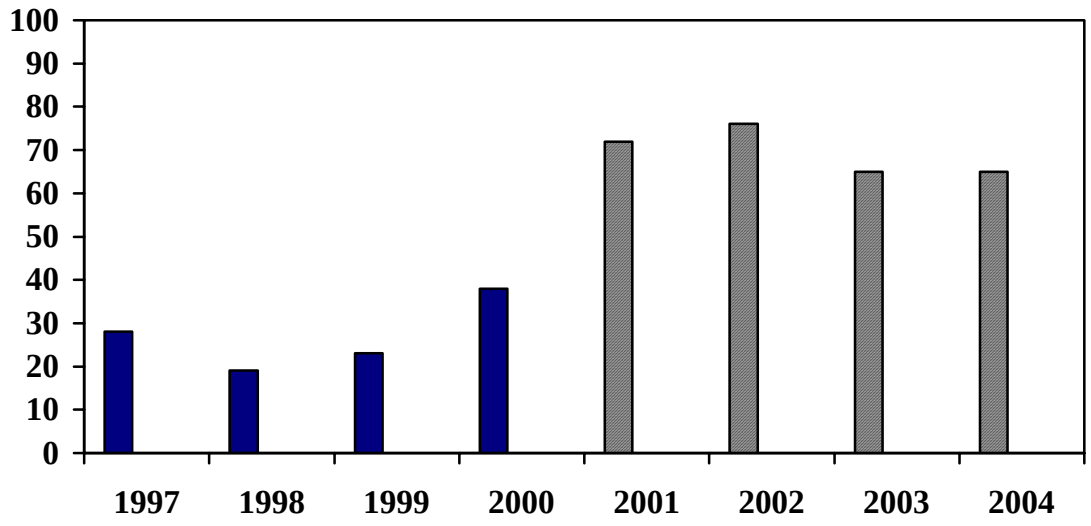

Figure 8.

Percentage of organizations using **Games/Simulations, non-computer** (In 1997-2000, shows those who use “ever.” In 2001-2004, shows those who use “seldom,” “always,” or “often.”) Source: Dolezalek, 2004.

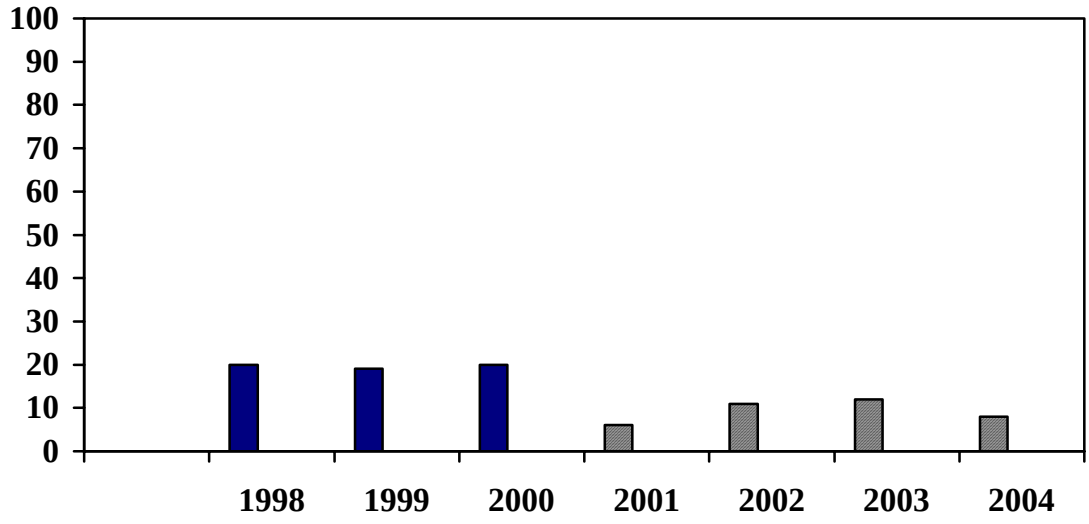

Figure 9.

Percentage of organizations using **Broadcast or Satellite TV**

(In 1997-2000, shows those who use “ever.” In 2001-2004, shows those who use “always” or “often.”) Source: Dolezalek, 2004.

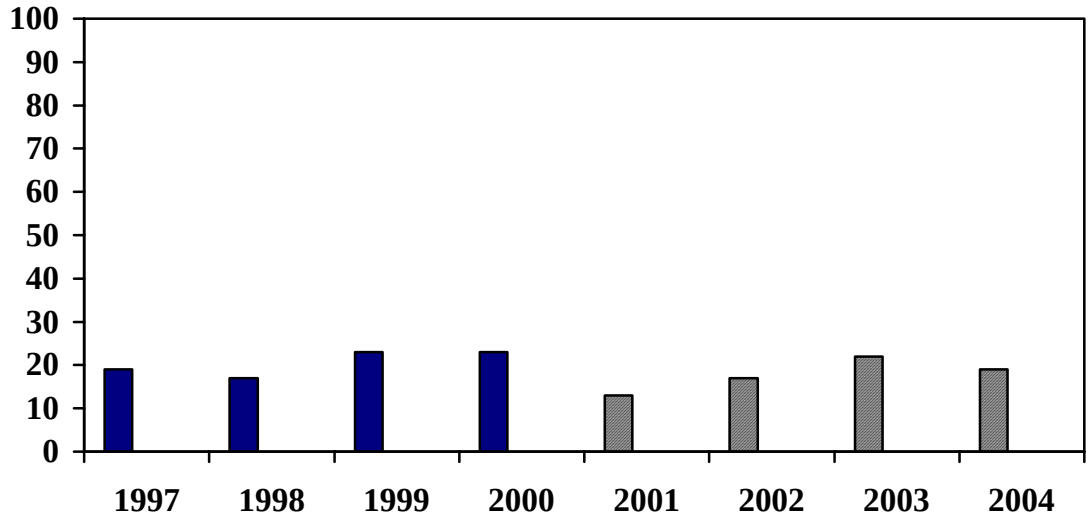

Figure 10. Percentage of organizations using **Videoconferencing**
(In 1997-2000, shows those who use “ever.” In 2001-2004, shows those who use “always” or “often.”) Source: Dolezalek, 2004.

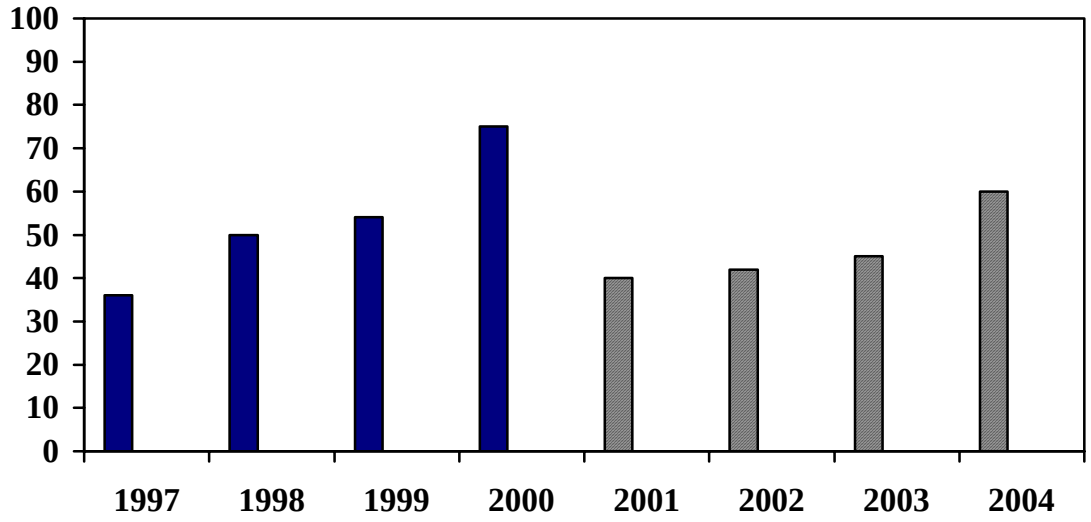

Figure 11.

Percentage of organizations using **Digital Storage Media--Diskette, CD, or DVD** (In 1997-2000, shows those who use "ever." In 2001-2004, shows those who use "always" or "often.") Source: Dolezalek, 2004.

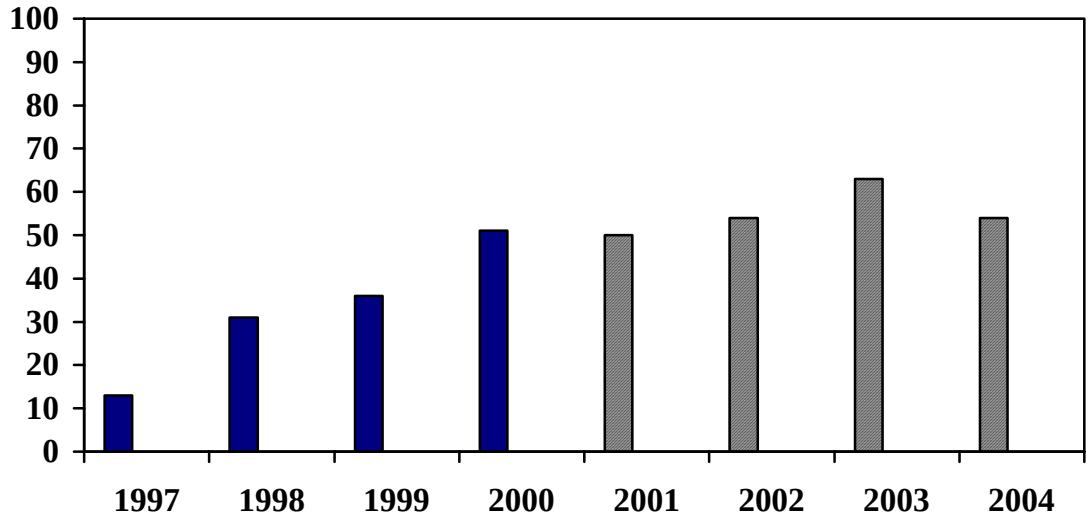

Figure 12. Percentage of organizations using **Internet or intranet**

(In 1997-2000, shows those who use “ever.” In 2001-2004, shows those who use “always” or “often.”) Source: Dolezalek, 2004.

Note: in 2001 Internet and intranet listed separately; combined total is shown.

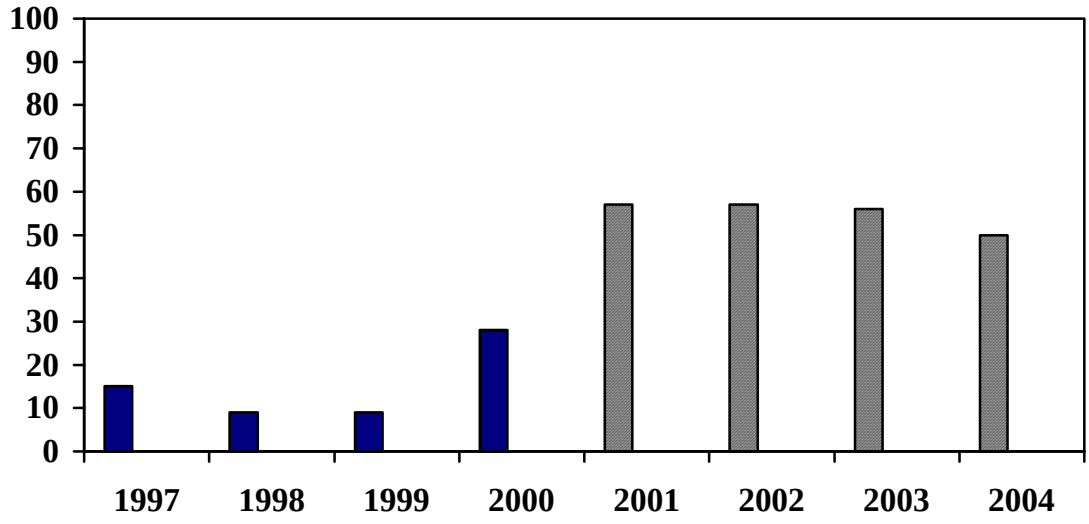

Figure 13. Percentage of organizations using **Games/Simulations, computer-based** (In 1997-2000, shows those who use "ever." In 2001-2004, shows those who use "seldom," "always," or "often.") Source: Dolezalek, 2004.

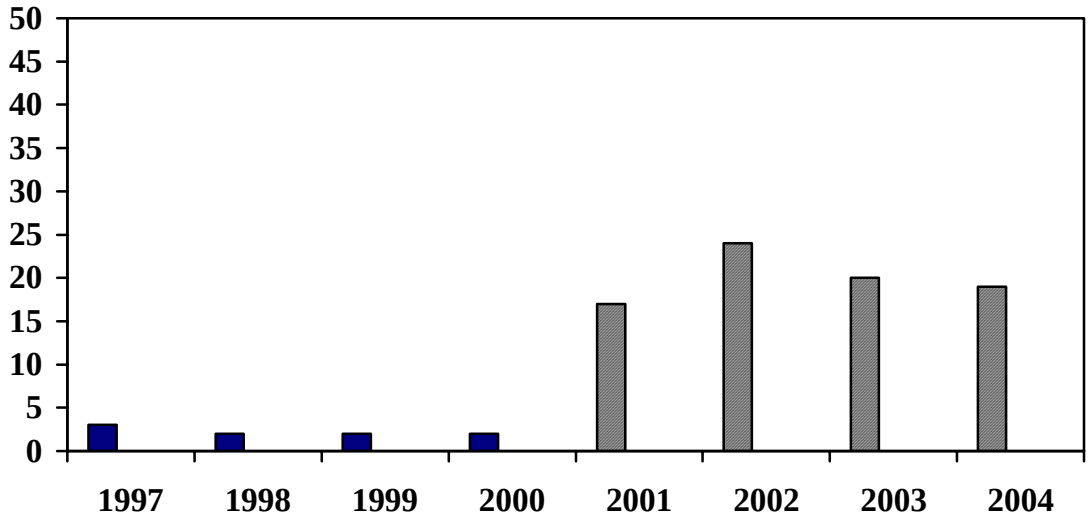

Figure 14.

Percentage of organizations using **Virtual Reality**

(In 1997-2000, shows those who use “ever.” In 2001-2004, shows those who use “seldom,” “always,” or “often.”) Source: Dolezalek, 2004.

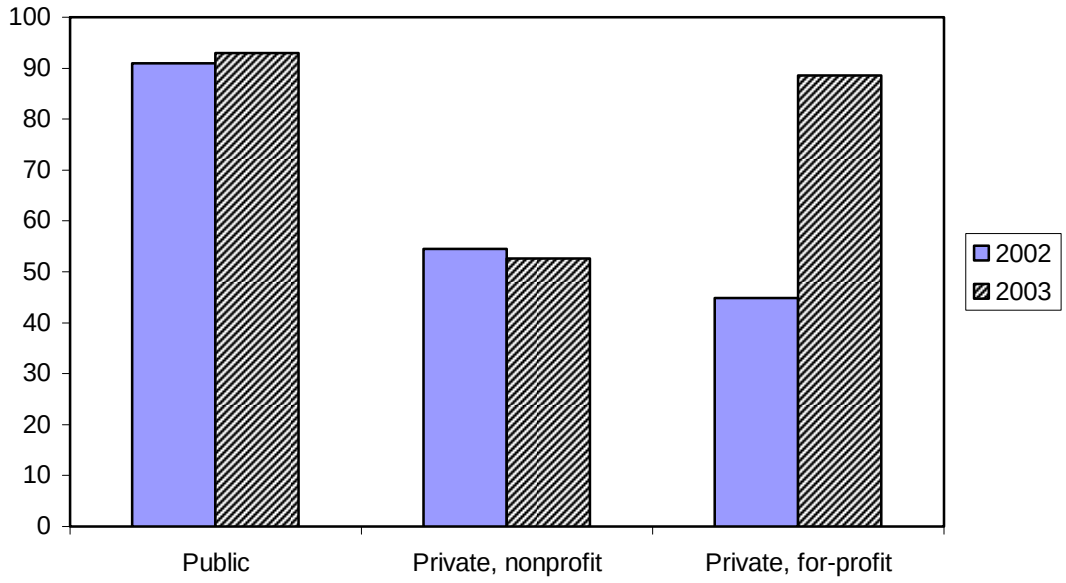

Figure 15. Percent of institutions offering online courses. Source: Allen & Seaman, 2004, p. 6.

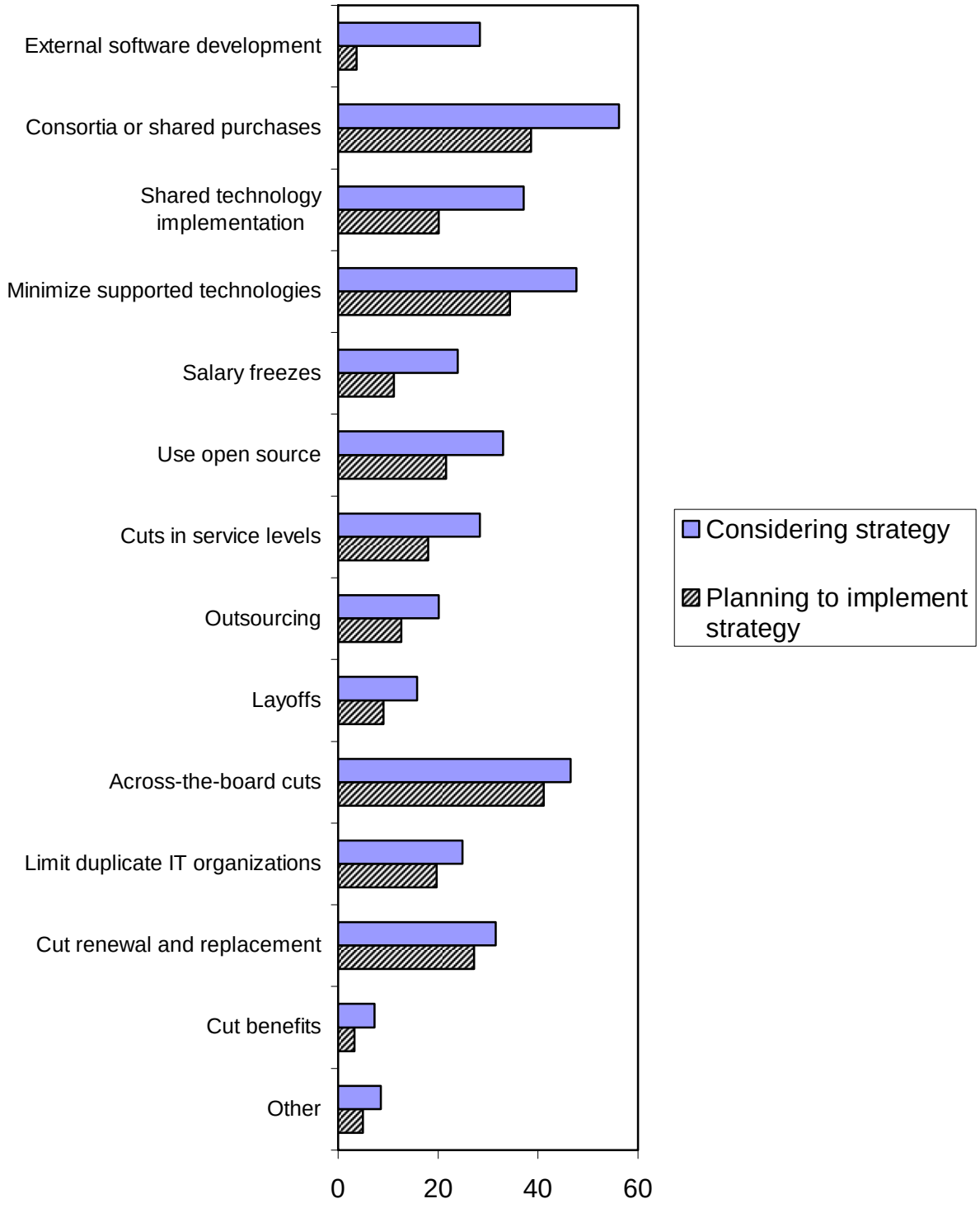

Figure 16. Cost-containment strategies. Source: Goldstein & Caruso, 2004, p. 5.

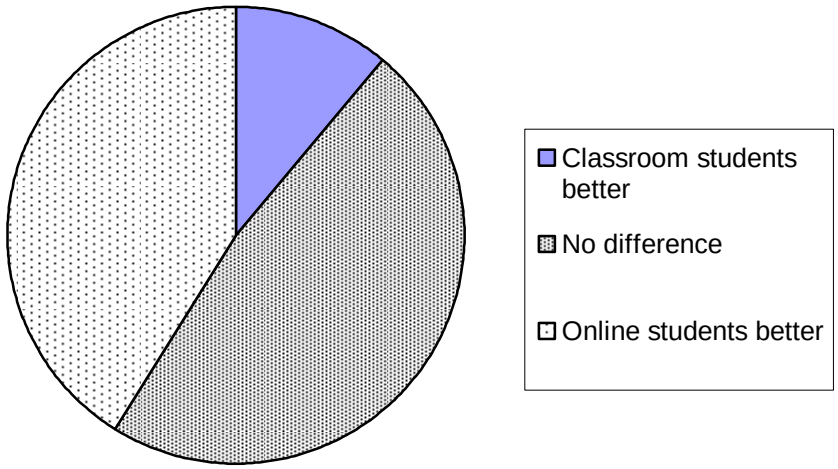

Figure 17. Faculty perception of online and live-classroom students' performance. Source: Shea, Pickett, & Li, 2005.

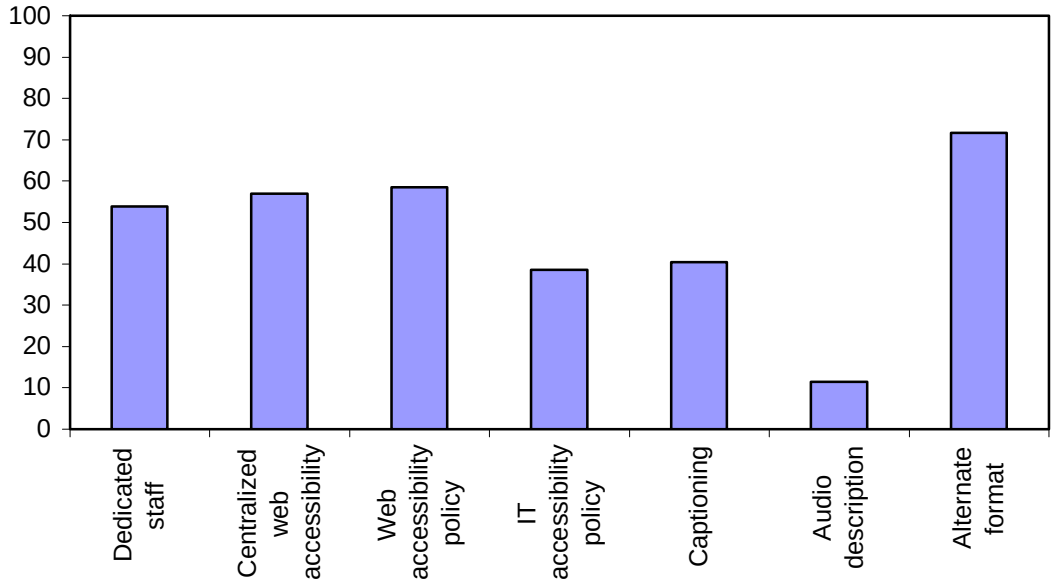

Figure 18. Percent of institutions taking steps to improve IT accessibility. Source: Thompson, 2005, p. 4.

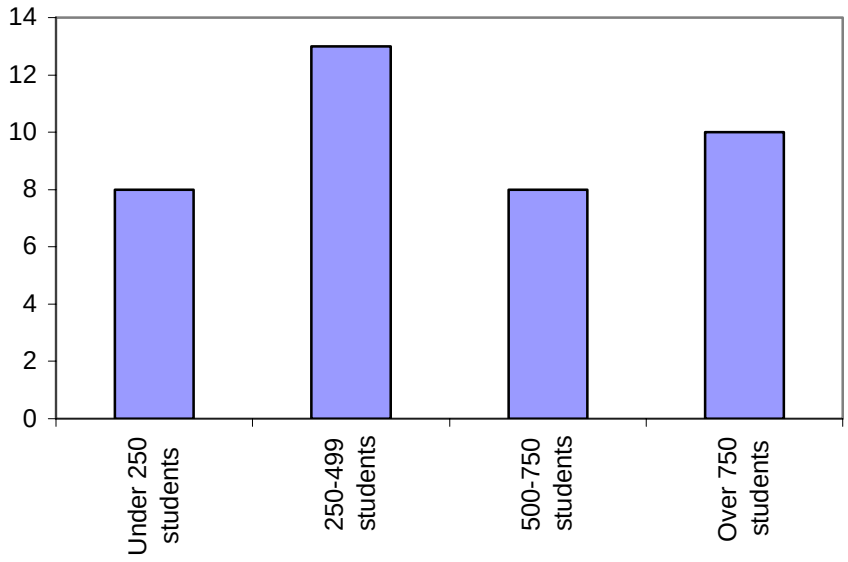

Figure 19. Institution by # student with disabilities. Source: Thompson, 2005, p. 9.

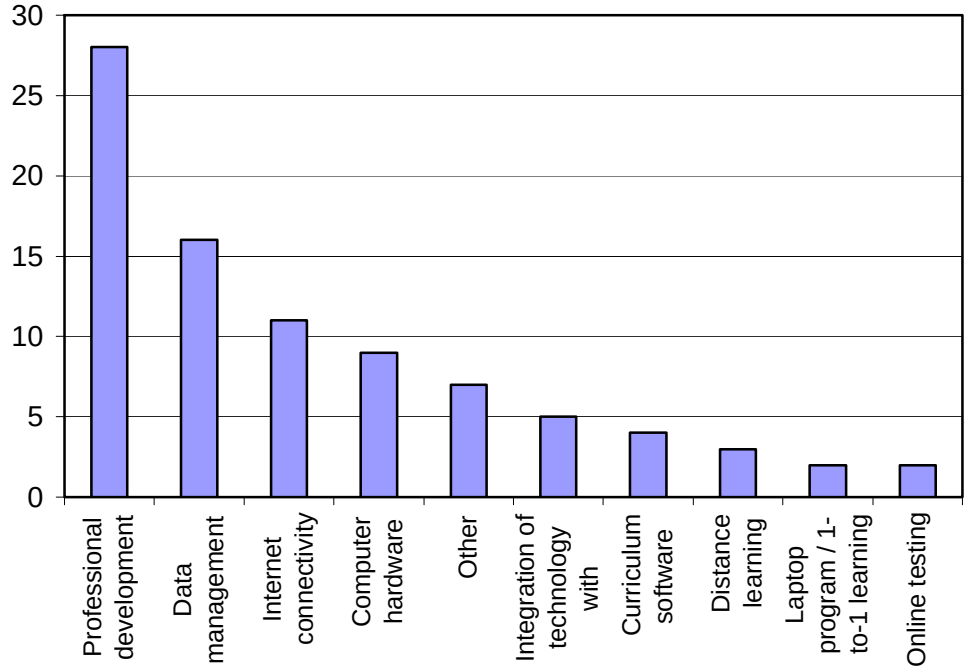

Figure 20. State priorities. Source: Education Week, May 5, 2005; p. 38.

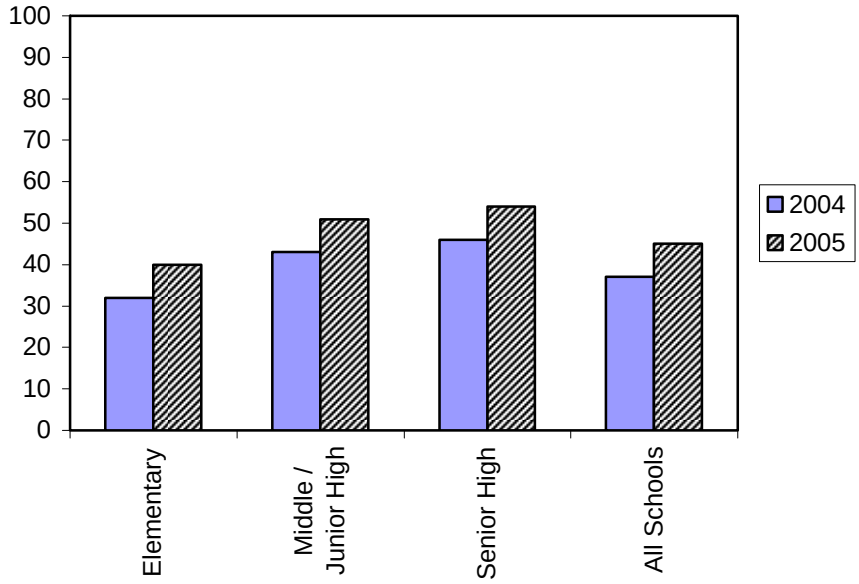

Figure 21. Percentage of schools having wireless networks, by school type. Source: Market Data Retrieval Service, 2005b.

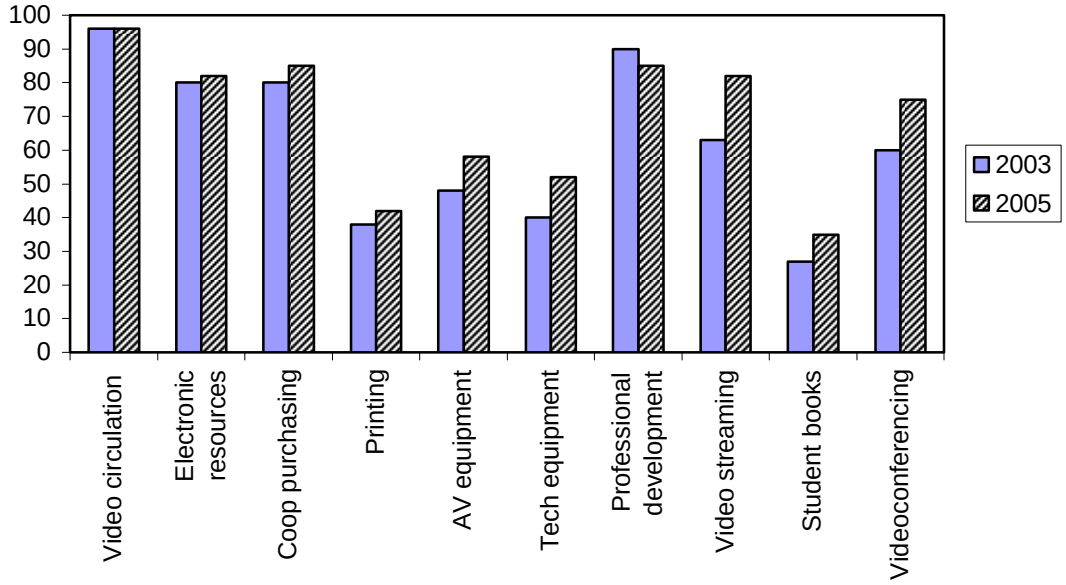

Figure 22. Services provided by ESAs. Source: Ehlinger, 2005, p. 11.

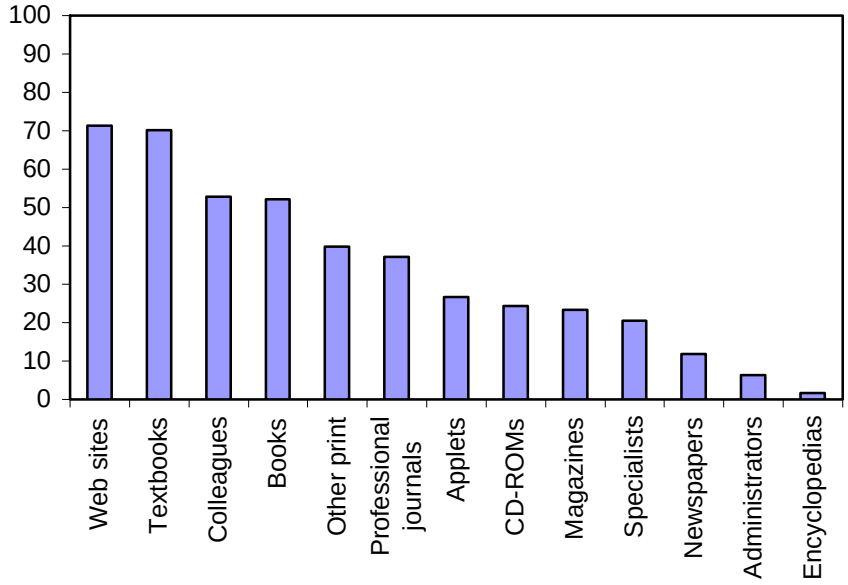

Figure 23a. Resources used during curriculum planning. Source: Hanson & Carlson, 2005, p. 24.

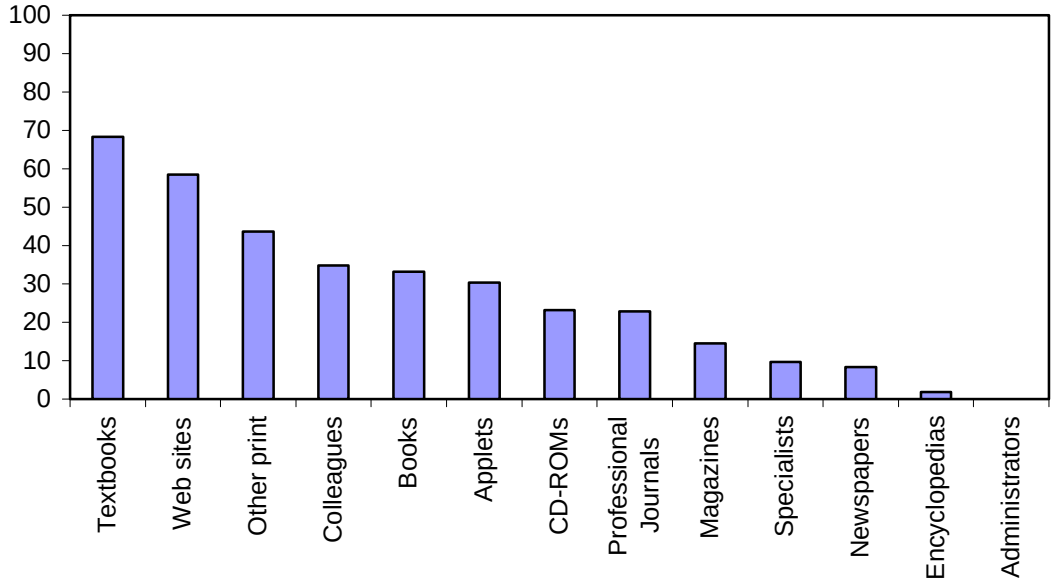

Figure 23b. Resources used during instruction. Source: Hanson & Carlson, 2005, p. 24.

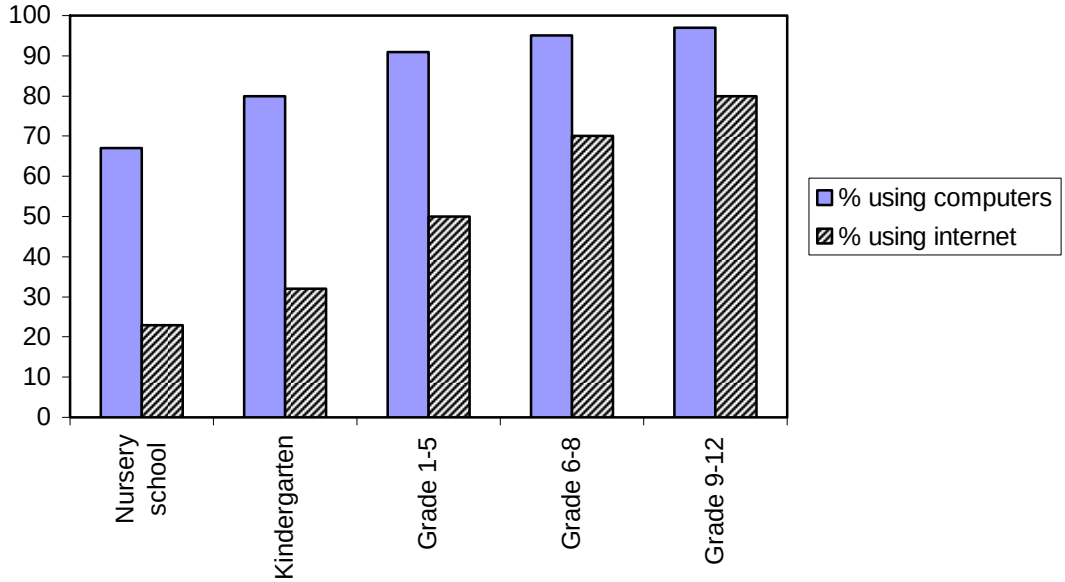

Figure 24. Percentage children enrolled pre-K through 12 using computers and internet. Source: United States Department of Education (2005), p. 2.