AECT Definition and Terminology Committee

USING

version 4.1.1

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October 20, 2005

Importance

Any definition of educational technology would be incomplete without explicit acknowledgement that "using…appropriate technological processes and resources" is the end purpose for which the field exists. The whole point of creating technological resources—instructional materials and instructional systems—is that they be *used* by learners. This term also refers to the acceptance and use of technological processes, such as instructional systems development. It is not enough to study such processes or to create them, such as when one proposes a new instructional design model. Educational technology fulfills its mandate when learners actually use instructional materials and systems and thereby benefit from the analysis and design work that has preceded the use.

This chapter will focus on the concepts and principles related to "using technological *resources*." The use of technological *processes*, including the processes associated with creating and managing instructional systems, will be addressed in other chapters.

Introduction

The element of "using" can be understood by examining the theories and practices related to bringing learners into contact with appropriate learning conditions and resources. As such, it is the main arena, where the solution meets the problem. Using begins with the *selection* of appropriate processes and resources—methods and materials, in other words—whether that selection is done by the learner or by an instructor. Wise selection is based on *materials*

evaluation, to determine if existing resources are suitable for a particular audience and purpose. If the resources involve new or unfamiliar media or methods, their *usability* may be tested before use. Then the learner's encounter with the learning resources takes place within some environment following some procedures, often under the guidance of an instructor, the planning and conduct of which can fit under the label of *utilization.* When teachers incorporate new resources into their curricular plans in an articulated fashion, this is referred to as *integration*.

In some cases there is a conscious effort to bring an instructional innovation to the attention of potential users, to market it. Within the context of instructional development projects this would constitute the *implementation* phase. Viewed in terms of spreading an innovation beyond its original source, to users far and wide, it can be regarded as a *diffusion* process. Thus the element of "using" can be viewed as a spectrum of activities ranging from an individual teacher or learner choosing one specific bit of material to a large-scale project shifting an entire organization's training strategy from one format to another, for example, from classroom instruction to online delivery.

Materials Evaluation and Selection

The use of any technology-based resource usually begins with the process of selecting specific materials, either by instructors using "off-the-shelf" technological materials or by media specialists maintaining collections for others to use. The selection process may begin with a search through reviews of available materials. To aid educators without the time or means to preview audiovisual materials themselves, clearinghouses such as the Educational Film Library Association (later the American Film and Video Association) has systematically collected and published evaluations from respected subject-matter experts. Many other review sources are available for other classes of audiovisual and digital media.

Selection criteria for instructional materials

The decision whether or not to select a particular item depends on many factors. However, there are generic criteria pertinent to instructional materials, regardless of media format:

- Are the objectives of the material aligned with the lesson objectives?
- Does the material match the entry level of the target learners (especially reading and vocabulary level)?
- Is the information accurate and up-to-date?

- Is the material free from objectionable bias?
- Is the material likely to arouse and maintain learner interest?
- Does the material encourage a high level of mental engagement by the learner?
- Is the technical quality acceptable?
- Is there any evidence of success, such as results of field tests?

Research over the past half century has examined what attributes of software are most closely connected with effective learning. The net result is an understanding that different criteria must be given priority in different circumstances. For example, a remedial reading teacher might choose a particular vocabulary game because it is likely to spark interest in her students, thus giving them the necessary practice, as a priority over other qualities of the software. On the other hand, an elementary school teacher with a class that is very diverse ethnically might give priority to materials that show special sensitivity to racial and ethnic issues, as a priority over other attributes.

Some selection criteria are specific to certain media formats. For example, video materials raise the issue of pace of presentation, which would not be pertinent to verbal and still-picture formats such as textbooks or Web pages. On the other hand, a computer-based game or simulation might be judged primarily on how much relevant practice and feedback is offered, which would not be pertinent to teacher-presented media such as a PowerPoint ™ presentation.

Evaluation checklists evolved in the 1920s and 1930s for teacher appraisal of silent and sound films. Over time these checklists have been adapted to newer media, to provide more specific guidance for various audiences and distinct subject areas. The practice of using such checklists had evolved to such a level of complexity by the late 1970s that Woodbury required a three-volume set of books to encompass the subject. In the volume devoted to selection criteria used at the teacher level for instructional materials, she provides criteria and checklists for: free materials, federally funded materials, government documents, pictorial media, print materials, nonprint media, games and simulations, toys and manipulatives, television, and film (Woodbury, 1980).

Checklists and the selection criteria developed for audiovisual materials have been reinvented for the world of digital media. The *Educational Software Preview Guide*, in its twenty-first edition in 2004, is published by the International Society for Technology in

Education (ISTE, 2004). The criteria listed on the Educational Technology Resource Evaluation Form include familiar considerations:

- Objectives promoted: creativity, collaboration, discovery, higher order thinking, problem solving, memorization
- Grade or ability level … Readability level
- Content is current, thorough, age appropriate, reliable, clear
- Content is free of bias
- Motivational qualities
- Technical quality

The checklist does not explicitly ask about evidence of effectiveness. It does, however, add questions about embedded learning strategy and about built-in assessment methods:

- Learning strategy incorporated in the design
- Assessment: has pretest/posttest, record keeping by student.

Some realities of materials selection

Education theorists propose that teachers should begin lesson planning by focusing on learners and lesson objectives, then proceed from there to selecting the materials and activities that will reach those objectives. Since the 1970s there have been several major studies of teachers' actual planning processes. The first, by Taylor (1970) found that secondary school teachers first directed their attention to the materials that were already at hand and the time they had in class to use them. Kerr's later research (1981) revealed a similar planning sequence. The thought processes of teachers as they plan become routinized, as Yinger (1979) discovered, in order to save planning time. He found that teachers typically began by gathering the available materials and then thinking of activities based on the materials, not by specifying objectives and conducting a search for materials that would lead toward those objectives. An ethnographic study by McCutcheon (1979) reached a similar conclusion, that elementary school teachers were primarily concerned with immediate, practical issues: Will this help me maintain order? Will this fit in the time allotted? Will these materials be available? Other studies have shown that "available" means immediately accessible, in the classroom or in the building.

So, the reality is that teachers begin with materials that are immediately accessible, including the old reliable textbook, and then plan outward to activities and ultimately may

possibly link to curricular goals. They do not necessarily select those materials following a systematic selection process.

On the other hand, many materials appraisal and selection decisions are not made by individual teachers but rather by committees. Such committees are a ubiquitous part of the textbook selection process; they are often also used to decide on what nonprint media are purchased at the school or district level. Checklists are critical for committee work for two reasons. First, they provide a more objective way of comparing opinions, providing a framework for discussion. Thus they ensure that truly pertinent issues will be raised and used as deciding factors. Second, they provide a post-facto documentation of the committee's decisions, indicating not only the choices made but the rationale for those choices in case those decisions are questioned at a later time.

Usability

Hardware and software that have been created or acquired frequently have qualities that are unfamiliar to users. Users, of course, could be students, teachers, technology support staff, or administrators. A new laptop computer being purchased for a high school science club could pose challenges to the administrator in terms of figuring out what add-on features are necessary to order. The technology coordinator would have to deal with how to add peripherals and load software. The science club advisor might puzzle over how to navigate through the new version of the physics simulation software. And to the club members might struggle over using a mouse in unfamiliar ways to draw geometric shapes. Each of these could be usability issues.

Usability simply refers to the quality of being easy to use for some purpose. The International Standards Organization defines usability more formally as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of user" (Usability Professionals' Association, n.d.). Those who design materials and equipment for use in schools must think about how to make them accessible to teachers with a wide range of technological competency. Students, too, may struggle with computer software that is difficult to navigate, that has flashy graphics that divert attention from the content, or that has an unhelpful Help system. If the functions and features are intuitive to use, everyone can focus on the educational value of the material rather than how to make it work.

Usability was an issue long before the computer era. Audiovisual users had to struggle with film projectors that were cumbersome to operate. Synchronized slide-tape players seemed to go out of sync all the time. Opaque projectors could build up heat so high that it caused burns. And it wasn't just the hardware. Studies of students' reactions to innovative multimedia programs showed that learners often focused more on the novel features of the presentation than on the content. But it was the advent of computers that brought usability problems to the forefront.

Stimulated by the pioneering work of Donald Norman (1988) and Jakob Nielsen (1994), a technology of usability engineering has evolved. The field of usability engineering recognizes many potential sources of usability problems: between user and tool, user and task, user and other users, and user and environment. In terms of software development, concern tends to focus on issues such as:

- consistency, making sure, for example, that specific colors and icons mean the same thing throughout the program and that specific functions are located in the same place
- simplicity, keeping the layout clear and uncluttered
- structure, easy to navigate
- suitability to the needs and abilities of the intended users, including those with vision impairment
- availability of online help that is actually responsive to problems.

To these issues Booth (1989) adds:

- ease of learning
- ease of remembering
- visibility.

To ensure that products are as easy to use as possible, designers typically conduct usability testing on prototypes. Ideally, usability testing entails real users working on real tasks in their real environments. Methods such as think-aloud protocols and other observation instruments are used to determine how users react to the prototype so that problems can be detected and resolved before the product is widely distributed (Rubin, 1994). Sometimes surveys and questionnaires are also used to determine users' feelings about the prototype, their satisfaction with it.

Usability *testing* is primarily the province of designers, but judgments about usability are an important part of the job of teachers and technology specialists when making decisions about hardware and software to be acquired or used in a particular context.

Evolution of Research and Theory on Media Use

Post-World War I period

Utilization may have the longest heritage of any of the elements in the definition, in that the regular *use* of audiovisual materials predates the widespread concern for the systematic design and production of instructional media. During the early years of the twentieth century teachers were using theatrical films in the classroom, thus creating a market for films designed specifically for educational purposes. The earliest formal research on educational applications of media was Lashley and Watson's program of studies on the use of World War I military training films on the prevention of venereal disease with civilian audiences (Lashley & Watson, 1921). The focus was on how these films might be used to best effect. And "use" meant instructor use. Indeed, the research during this period and the next half century tended to focus on what the instructor did with media, rather than what students did. Research dealt with media formats such as film, slides, radio, and later, television and audio recordings. Until convenient self-instructional formats were developed (such as eight-millimeter films and audio cassette recorders) these media were usually experienced as a presentation made to a group, so the "user" was the teacher.

A later large-scale effort to design and produce a set of films specifically for schools was the *Chronicles of America Photoplays,* produced by Yale University in the late 1920s. Knowlton & Tilton studied the use of these history films in seventh grade classrooms. One of their major conclusions was that the educational value of such films lay not only in the quality of the materials but also in how well teachers used them:

> The ability of the pupils to grasp and appreciate these relationships was in no small degree determined by the teacher's own interest in them and the emphasis which she attached to them. However inherently effective the photoplays may be—and the evidence submitted here indicates the potentialities of such material—it will only attain its highest degree of effectiveness when accompanied by good teaching.… (Knowlton & Tilton, 1929, p. 91)

This finding, that the instructional value of any media product is determined largely by *how it is used*, would be rediscovered by each succeeding generation with its new media—radio, then television, then programmed instruction, then computer-based instruction.

World War II period

Later, during the World War II era, the US War Department's Information and Education Division invested tremendous amounts of funds and manpower on the development and use of "audiovisual aids," particularly 16mm films, to support its "rapid mass training" effort. It also invested in research on how to design better films and on how instructors could make better use of the materials provided to them. Much of this research was conducted by the social scientists in the Experimental Section of the Research Branch. Their findings (Hovland, Lumsdaine, & Sheffield, 1949) were reported after the war as part of a multi-volume collection published by Princeton University. The findings were used during the war to guide the practice of trainers when using "audiovisual aids."

Audiovisual education period

The period between World War II and the advent of microcomputers in 1982 could be viewed as the audiovisual education period. In this era, Educational Technology research and practice focused on the design and use of analog media—such as still pictures, slides, overhead transparencies, audio recordings, films, and video recordings—in the teaching-learning process. Johnston (1987) provides a succinct synthesis of research findings in this arena. One of the generalizations he reaches is that "The electronic media are vehicles through which programming is passed to a learner. We cannot explore the potential of a medium independent of the programming being carried on it" (p. 3).

Audiovisual education textbooks (for example, Heinich et al., 1982) of this era focus on the advantages and limitations of each of the media formats and how instructors can improve the efficiency and effectiveness of their teaching through careful selection and utilization.

Theoretical Bases for Use of Media in Teaching

Empiricism

Comenius was an early pedagogical theorist (1592-1670) who created an extensive body of work about educational reform, particularly advocating the use of sensory stimuli to help children achieve meaningful understanding as contrasted with rote memorization. One of his major books, *Orbis Sensualium Pictus* (Comenius, 1991), was a richly illustrated textbook meant be a sort of visual-verbal encyclopedia. The methodology of the book—pairing the descriptions of concepts with pictures of them—exemplified the core empiricist theory that he embraced: that the primary source of knowledge is experience, which enters through the senses. To be meaningful and useful to the learner, new knowledge had to be based on the learner's sensory experiences, as opposed to rote memorization, which was the dominant pedagogical paradigm at the time. Comenius followed the inductive method, advocated by Francis Bacon (1561-1626). Since it was not practical to bring all the phenomena of the world into the classroom for children to experience directly, the next best alternative was to provide pictures of those phenomena. In *Orbis Sensualium Pictus* and *Didactica Magna* Comenius provided a comprehensive educational philosophy and the most fully elaborated theory of visual media usage until the 20th century.

Early Theories of Cognitive Development

Prior to the 1960s the approaches to media utilization were shaped mainly by early-20th century psychological theories of cognitive development, such as Kurt Lewin's (1936) field theory—the proposition that human behavior is the function of both the person and the environment, meaning that one's behavior is related both to one's personal characteristics and to the social situation in which one finds oneself. He proposed that learning is best facilitated when there is a conflict between immediate concrete experience and detached analysis within the individual. The cycle of action, reflection, generalization, and testing is characteristic of experiential learning.

This view is reflected in Hoban, Hoban, & Zisman (1937), an early influential textbook on audiovisual media applications. They refer to a theory of cognitive development based on the processes of differentiation and integration, and they place emphasis on the value of concrete experiences in promoting progress in differentiation. Hence a major rationale for using audiovisual media is to support young learners' mental development through progressive stages, from concrete experiences to abstract generalization.

After World War II, thinking about media utilization was reflected in Edgar Dale's *Audio-visual methods in teaching* (1946), which continued to influence the field through its third edition in 1969. Dale took a rather eclectic approach, not referring much to specific theories of instruction. Instead he emphasized the pursuit of "permanent learning," which was associated with "meaningful learning" coupled with motivation and application (use of the new knowledge). He combined these into the construct of "rich experiences," which formed the basis of his prescriptions for effective teaching:

> Rich experiences…are often flavored with direct sense-experience. They have a quality of newness, freshness, creativeness, and adventure, and they are marked by emotion (p. 23).

Dale advocated purposeful engagement with ideas in environments that were rich with sensory experience. In this he foreshadowed the constructivist movement that was to come forty years later. His construct of "the cone of experience" was a way of categorizing teaching methods according to the extent to which they immersed learners in active engagement with concrete, authentic experiences. It reflected a concrete-to-abstract continuum suggested earlier by Hoban, Hoban, & Zisman (p. 23).

By the 1960s and afterward, following the so-called Cognitive Revolution, similar ideas were being supported with the cognitive theories of Bruner and the developmental theories of Piaget. Behaviorism continued to have a strong influence in the realm of instructional design, but less in the realm of classroom utilization. Indeed, it is notable that neither before nor after the Cognitive Revolution did textbooks on audiovisual media use refer to behaviorist theories—neither to Watson and Thorndike in the early 20th century nor to Skinner at mid-century. Although Thorndike's principles of exercise (repetition), effect (pleasure-pain), and readiness were well-known and influential in the literature of education they were scarcely noted in the literature of educational media. The media advocates were passionate opponents of empty verbalism and rote learning, which were all too often associated with behaviorist theories.

Behaviorist influences

Behaviorist theories of learning flourished parallel to cognitivist theories through the first decades of the 20th century. Edward L. Thorndike developed his theory of connectionism in the animal laboratory, but shifted his focus to human learning when he joined the Teachers College faculty in 1899. Thereafter he developed a comprehensive and influential body of theory in

educational psychology. Thorndike was not particularly concerned with audiovisual media, but Saettler (1990) claims that his "development of a science and technology of instruction unquestionably marked him as the first modern instructional technologist" (p. 56). Thorndike's connectionism was superseded by a more comprehensive theory of behaviorism, represented by John B. Watson, which dominated American psychology in the 1920s and 1930s.

However, as alluded to earlier, the audiovisual textbooks of the 1930s through the 1950s really reflected current cognitivist theories much more than behaviorist ones. Then, in the 1960s, a new interpretation of behaviorism, represented by B.F. Skinner's operant conditioning, gained a powerful influence in American psychology and led to the concept of educational technology as we know it today.

Operant conditioning theory revolved around the centrality of the learner's response and the consequences (reinforcement) that followed. The main tasks of instructional designers were to identify behavioral objectives, analyze them into their component parts, diagnose what menu of reinforcers might be useful in a given case, then to guide the learner to perform the desired behavior, which would be followed by appropriate reinforcement (Skinner, 1954, 1968).

The behaviorist prescription really was a paradigm shift for educational media theory and practice. The previous approach of designers was shaped more by the Gestalt psychology perspective, which offered an understanding of how the mind made sense of or made wholes of separate parts, summarized in the idea that the whole is greater than the sum of its parts. Gestalt notions of figure and ground, closure, and principles of similarity, proximity, and continuity provided a vocabulary for discussing message design principles. Interest focused on creation of stimulus materials that aided conceptual understanding. By contrast, the behaviorist movement focused on the activities that *followed* the stimulus materials—what the learners did and what consequences followed that action. Not only did focus shift from the stimulus to the response and its consequences, it also shifted from a free-form production process to a scientific and systematic design process. Teacher use of media became one step in an integrated process of analyzing, designing, producing, implementing, and evaluating instructional systems.

Cognitive influences

Theory base

In the decades since the 1960s instructional methods have been informed increasingly by principles drawn from sources other than behaviorism, especially cognitive psychology. The

foundations of contemporary cognitive psychology were laid in the late 1950s when seminal papers by George Miller and Herbert Simon offered an information-processing model of the mind and Jerome Bruner and Noam Chomsky argued for the importance of mental processes in mediating behavior. By 1970, when the journal *Cognitive Psychology* was begun, this perspective had gained not only legitimacy but dominance.

The cognitive approach emphasizes the importance of the learners' mental and emotional processes during the course of instruction. From this perspective, learners use their memory and thought processes to generate strategies as well as store and manipulate mental representations and ideas. One branch of cognitive theory, information-processing theory, conceives the human learner as a processor of information, similar to a computer. In this view, represented by the work of Atkinson & Schiffrin (1968), sensory inputs are selected, encoded, and stored in short-term and possibly long-term memory. Later, well-stored information may be retrieved and used.

Another branch, assimilation theory, traceable to the ideas of Jean Piaget, focuses on the human learner's cognitive structure and the processes whereby new information is integrated into the overall structure. Ausubel's schema theory (1980) views *schemata* (more than one schema) as providing mental scaffolding, containing "slots" that can be filled in with particular cases. These schemata allow learners to organize information into meaningful units. This theory implies that the learner's cognitive structure at the time of learning is the most important factor in determining the likelihood of successful learning.

All branches of cognitive theory emphasize that learners are active processors of the perceptual information that they encounter in their environment and that the new knowledge must be meaningful to the learner if it is to be retained and used in the future.

Application of the theory

The cognitive approach involves instructional activities that present information to the learner or allow the learner to read or view material and think about it. The concerns revolve around attending to relevant messages, interpreting the new material, relating it to existing mental structures, and remembering it so that it can be retrieved later when needed. Teachers work to gain the learner's attention, in competition with the many distracting stimuli in the environment. Then they want to present the new information in ways that will encourage its melding into the learner's existing mental structures or schemata. Analogies, examples, outlines,

and mnemonic devices make new information easier to remember. To improve retention and use of new skills, it is helpful to embed practice in a realistic setting.

A rather complete set of cognitive prescriptions for instructional design is offered by Foshay, Silber, & Stelnicki (2003) as "a cognitive training model." They offer 17 specific tactics organized around the strategic phases of gaining attention, linking to prior knowledge, structuring the content, presenting the new knowledge, and strengthening the new knowledge through practice and feedback.

Training and education designed according to the cognitive approach is likely to take the form of lectures or recorded presentations incorporating audiovisual supplements. In many cases it is more efficient to package cognitive instruction for self-study in the form of textbooks, or other text materials, such as Web documents. In any case, the pattern is likely to consist of a carefully constructed arrangement of information designed to attract and hold attention and to build the new knowledge onto the learner's previous knowledge. The lesson will likely include opportunities to practice in the form of problems, exercises, or quizzes embedded in the readings, provocative questions asked by the teacher, group discussions, or other types of classroom activities that encourage mental engagement with the material.

Implications for utilization

Teachers who are influenced primarily by cognitive concerns are likely to look closely at the message design of the materials they choose or the documents and presentations they create. They may lean toward the use of novel media formats, such as games and computer-based practice, in order to capture the attention and arouse the interest of learners. However, they are likely to use presentations (including illustrated lectures, videos, and *PowerPoint* ™ presentations) and assigned readings (including textbooks, handouts, and Web "tutorials"). They would also employ demonstrations (including how-to-do-it demonstrations and peers or instructors serving as role models), large and small group discussions, and drill-and-practice exercises.

Constructivist influences

Theory base

The most talked-about theoretical orientation during the last two decades of the 20th century is labeled "constructivism." It is difficult to characterize the claims of "constructivism"

because there are so many claimants, embracing a wide diversity of views. The label itself is most closely identified with the self-educated philosopher, logician, linguist, and cognitive theorist, Ernst von Glasersfeld, beginning with his treatise, *An introduction to radical constructivism* (1984). Von Glasersfeld attempted to construct an epistemology, a theory of knowing, in which the "experiential world is constituted and structured by the knower's own ways and means of perceiving and conceiving, and in this elementary sense it is always and irrevocably subjective" (1992).

Early advocates for constructivism in instructional technology, such as Duffy and Jonassen (see, for example, Jonassen, 1991 or Duffy & Jonassen, 1992) tended to use "constructivism" as an umbrella term for a wide range of ideas drawn primarily from recent theories in cognitive psychology, such as situated cognition, anchored instruction, cognitive flexibility, problem based learning, cognitive apprenticeship, and everyday cognition. Such theories are not dependent on "a new epistemology." Nevertheless, advocates of constructivism called for a rejection of pedagogical practices based on "the old epistemology."

A recent analysis of "constructivist didactics" by Terhart (2003) relates to this apparent contradiction. He attempts to parse out which elements of constructivist didactic theory are dependent on a new epistemology and which are consistent with evolution of thought within cognitive psychology. He concludes that it is difficult to distinguish "moderate constructivist" principles of instruction, which are the ones most frequently encountered in education literature, from cognitivist principles. On the other hand, radical constructivism "would ultimately render didactic thought and activity in specific subjects impossible as well as morally illegitimate" (p 33). Terhart concludes that:

> …constructivist didactics really does not have any genuine new ideas to offer to the praxis of teaching. Rather, it recommends the well-known teaching methods and arrangement of self-directed learning, discovery learning, practical learning, co-operative learning in groups. I think that the 'new' constructivist didactics in the end is merely *an assembly of long-known teaching methods (albeit not practiced!*) (p. 42).

Based upon these analyses, "constructivism" will be used here to refer to the body of instructional principles and methods that could be grouped under the umbrella of moderate or cognitive constructivism, as suggested by Terhart.

Application of the theory

Terhart (2003, p. 36) cites Meixner's (1997) concise summary of a dozen constructivist design features:

> Place the units of knowledge that are to be learned into a situative context. … Add to this relevant context materials that are as authentic as possible and make the learner take ownership of the material to be learned. … Use as many motor aspects and different sensory channels as possible. … Place the learning task into a surrounding social field. … Establish maieutically conducted discourse as the form of dialogue in the classroom. … Bring the learner to the point where she builds her knowledge autonomously from the context and interactions and where she learns from her own mistakes. Aim at flexible application of the knowledge; generate learning environments which promote knowledge transfer (p. 97).

Implications for utilization

The most obvious implication of the constructivist approach is that the center of control shifts from the teacher to the learner. Instead of teachers using media and technology, learners sit in the driver's seat. Instead of learning *from* media, they are learning *with* media, as proposed by Kozma (1991). In the behaviorist and cognitivist perspectives the primary user is the teacher; in the constructivist perspective the primary user is the student. The popularization of digital media has made possible the implementation of all sorts of learner-centered activities that are too labor-intensive or too expensive to conduct through traditional face-to-face instruction. Examples:

- Learners producing their own multimedia productions, hypertext documents, and other projects, especially those that are developed collaboratively.
- Hands-on participation in business scenarios and social simulations.
- Tutorial programs that truly allow variable consequences and multiple branches.
- Immersion in "microworlds," including virtual reality, that allow the learner to visualize and manipulate dynamic interactions, such as experiments in mathematics, biology, chemistry, and physics.

Digital technology also makes it possible for reading-type activities to become less passive, more active, and more learner-controlled. Examples:

- Web text with links allowing the reader to connect related ideas (hypertext), possibly incorporating sounds and motion images (hypermedia).
- Web-based practice exercises that allow learners to choose different answers in order to experience the consequences of their decisions.

Writing-type activities, too, can profit from the digital environment. Examples:

- Creating written documents using word-processing software.
- Keeping a journal or blog to provide an outlet for reflections or debriefing after varied sorts of learning activities.

It is not an accident that the constructivist view came to popularity around the same time as computer technology began to be widely accessible in schools and universities. The personal computer and the World Wide Web offer many avenues for learner-centered and learner-controlled activities, the sorts of activities promoted by advocates of constructivism.

Eclectic approaches

Theory base

The eclectic approach (from the Greek *eklektikos*, "selective") simply combines doctrines from different theories without accepting the whole parent theory for each doctrine. Practitioners, no less than philosophers, may adopt an eclectic stance because they find merit in ideas that happen to be promoted by opposing parties. The arbitrary combination of clashing doctrines can produce incoherent theoretical structures in philosophy, but in practical matters eclecticism often yields useful syntheses.

Application of the theory

In the area of utilization, teachers can easily see that different psychological theories offer guidance for different sorts of learning goals. The theories do not necessarily conflict, but they explain different phenomena better than others. Ertmer & Newby (1993) propose that the behavioral approach is best suited to learners with lower levels of task knowledge and for learning goals requiring lower cognitive processing; the cognitive approach is best suited for middle levels of task knowledge and cognitive processing; and constructivism is best suited for learners with a higher level of task knowledge, working on higher-level tasks (pp. 68-69).

Implications for utilization

By the 1980s textbooks on media use tended to take an eclectic approach in applying theories to support good practice regarding the selection and use of media for instruction. In one

typical textbook, the authors counsel that "instructors and instructional designers need to develop an eclectic attitude toward competing schools of learning psychology" (Heinich, Molenda, & Russell, 1993, p. 15).

A model for teachers' planning for media use, the ASSURE model, recommends these steps:

- Analyze learners
- State objectives
- Select media and materials
- Utilize media and materials
- Require learner participation
- Evaluate and revise

(Heinich et al., 1993, pp. 34-35).

This model reflects a combination of prescriptions from behaviorism (state objectives, require learner participation) and the systems approach (analyze learners, state objectives, evaluate and revise), while the authors' advice on selecting and using media and materials draws heavily on cognitive and cognitive-constructivist perspectives.

By the late 1990s and early 2000s traditional media courses in many teacher education institutions were supplanted by courses focusing on the use of computers. By 2000, over seventy percent of introductory technology courses for teachers had a primary emphasis on use of computers as opposed to the use of traditional audiovisual media (Betrus, 2000). Textbooks aimed at these courses, like the earlier textbooks aimed at audiovisual media, also tended to reflect an eclectic mentality. For example, Lever-Duffy, McDonald, and Mizell (2003), after presenting behaviorist, cognitivist, and constructivist perspectives, advise: "You may choose to use some parts of each theory or accept a learning theory in its entirety. At this point, you should examine all the options and let your own mental model of learning develop" (pp. 16-17).

In another widely used textbook on computer integration, Roblyer (2003) vigorously defends the selective use of what she refers to as directed, constructivist, and combined approaches in integrating technology into curriculum planning. For example, she recommends that "when the absence of prerequisite skills presents a barrier to higher level learning or to passing tests, *directed* instruction usually is the most efficient way of providing them" (p. 73). On the other hand, "Resources such as Logo, problem-solving courseware, and multimedia

applications often are considered ideal environments for *constructivist* activities that get students to think about how they think" (p. 73).

In short, there is a widespread consensus that when instructors are considering ways to facilitate learning with media, an eclectic approach can provide a varied menu of appropriate materials, methods, and activities.

From Utilization to Integration, Implementation, and Adoption

Integration

Media and technology can be viewed as being *integrated* into instruction when they are woven into the fabric of the curriculum in a seamless way, as opposed to simple occasional use, such as using an overhead projector to illustrate a point. In the fullest sense of the term, integration implies a holistic combination of the educational setting, the needs and interests of learners, the curricular content and the objectives related to it, the assessment methods, the abilities of the instructor, the hardware and software resources, and the support system surrounding the operation. The epitome of successful integration would be a learner-centered environment in which instructional resources were selected and used efficiently and effectively to support learning activities aimed at deeper understanding and problem-solving ability. A concrete example could be imagined using the *Jasper Woodbury* series developed in 1989, an innovative collection of mathematics learning modules stored on laser disc. Each disc immerses the learners in a story entailing mathematical data for problems that learners need to solve to reach a successful ending. The problems address standards of the National Council of Teachers of Mathematics; they apply principles of anchored instruction and active learning, and require cooperative work. Evaluation studies showed that students using *Jasper Woodbury* outperformed those using more conventional approaches; they enjoyed mathematics more; and they employed generative methods in solving math problems (Barron et al., 1993).

The path toward such technology integration is shown in such contemporary textbooks as *Integrating educational technology into teaching* (Roblyer, 2006), which suggests a five-phase technology integration planning model. Such an approach to instruction is more likely to be successful when it takes place in a setting that is friendly to a systemic approach.

An example of such a holistic setting for technology integration is the elementary school curriculum known as Project CHILD, in which three subject-focused specialist teachers form cross-grade clusters (K-2 or 3-5) to facilitate standards-based learning. The teachers and students

stay together for three years to enhance continuity. There are three classrooms in a cluster–one each for reading, writing, and mathematics, one of which serves as the student's home base. Each of the three classrooms has at least six learning stations to facilitate diversified learning in three modes—technology, hands-on, and paper/pencil. Students rotate through the three cluster classrooms for instruction in each basic subject. Students spend 60-90 minutes in each of the cluster classrooms, returning to their home base for instruction in science and social studies. After a brief whole-group teacher-directed lesson, students work at the stations to practice and apply the lesson content using a variety of learning modes. The teacher assigns students to their beginning stations, but students move independently as they finish the first assigned task. They set goals and keep track of their station work using a logbook called a passport (Butzin, 2004).

The CHILD model, which has won national awards and been evaluated to verify its effectiveness and cost-benefit, illustrates that successful integration of technology and curriculum is not a utopian ideal, but an everyday reality in some places.

Implementation

One of the largest challenges of educational technology is to ensure that well developed instructional materials and systems are actually placed into use. There is a long history of exemplary products failing to find acceptance in the marketplace or of being abandoned after being used for a period of time. This problem, discussed in depth by Burkman (1987) can be viewed through various conceptual lenses.

Instructional development lens

First, actual use of an instructional product can be seen as one step in the instructional development process. Looking at a systems approach to instructional development, implementation is the fourth stage of the five-stage ADDIE model. However, Burkman and others advise that the probability of successful implementation depends on considerations related to earlier steps. Burkman advises a "user-oriented instructional development process" (p. 439) in which the identity and preferences of the potential adopter are considered from the beginning. With the potential adopter in mind, it is possible to consider the needs and values of the adopter during the design and development stages, with the goal of creating a user-friendly product. Later, at the implementation stage it is a matter of making sure that the potential adopters are informed about the innovation and its usefulness to them, and then that they receive support after they adopt the innovation.

Molenda & Pershing's Strategic Impact Model (2004) suggests a similar approach, but goes one step further by advising that "change management" issues be considered at *every one* of the ADDIE stages, not tacked on at the end. The model suggests that buy-in is most likely to happen if those affected by the change are allowed to participate in planning activities along the way.

Adoption of innovations

Another view focuses not on prescriptions for increasing user acceptance of instructional materials and systems but on the processes underlying teachers' adoption or rejection of innovations. Holloway (1996) offers an extensive review and critique of research on diffusion and adoption of educational technology.

There are a number of different perspectives on the processes of accepting and using new tools or practices, ranging from an atheoretical view to perspectives based on psychological, sociological, organizational, technological, systems, and ecological theories. Each casts light on different aspects of this complex problem area.

Atheoretical perspective

The early studies of teacher acceptance of audiovisual media in the 1960s and early studies of teacher acceptance of computer-based media in the 1990s and beyond have tended to be atheoretical; that is, factors associated with adoption are sought without reference to an overarching theory of how and why people adopt innovations. Surveys are often used to determine who uses media and what characteristics of the users or their environment seem to explain the pattern of acceptance or rejection. Henry Jay Becker and his colleagues at the Center for Research on Information Technology and Organizations (CRITO) conducted a decade of survey-based correlational studies regarding teacher use of computers and the Internet (Becker, 1991, 1994a, 1994b). In their most comprehensive survey they found that relatively few teachers involved their students in using the Internet in a substantial way. However, the factors most highly correlated with substantial student use were ease of access to classroom connection, computer expertise of the teacher, and belief in "constructivist" pedagogy (Becker, 1999). At that time, about one-half of teachers who enjoyed the most favorable working conditions made strong use of the Internet; the usage rates dropped rapidly along with

lack of supportive conditions such that very few teachers in the least favorable conditions group used the Internet at all.

Subsequent work by the CRITO group tended to subsume the notion of "favorable conditions" under the umbrella of the extent to which teachers receive support in their efforts to integrate computers into the curriculum. Ronnkvist, Dexter, & Anderson (2000, June) break "technology support" into a number of categories: facilities, technical support staff, professional development support staff and activities, and incentives. They studied the correlation between support received and the extent and variety of technology use. Among their findings:

- "Both the quality and perceived availability of support are significant predictors of the frequency of teachers' use."
- "Teachers in schools with high quality technology support are more likely to engage in a variety of different professional uses of technology…"
- "Computer skills (expertise) are a strong, positive predictor of variety of uses" (p. 24).

This atheoretical view seems to assume that teachers' adoption of innovations happens naturally under conditions of adequate support.

Systems perspective

Robert Heinich was among the first to analyze the acceptance and use of media as a problem embedded in the organizational system of schools. He observed that "classroom teachers tend to reduce all media to the status of aids" (1967, p. 19) despite the fact that by then at least two technologies had emerged—instructional television and programmed instruction—that enabled students to learn effectively without the presence of a classroom teacher. He refers to the "craft structure" of teaching and points out (1984) that current organizational structures give teachers the power to decide what media and methods would be used in their classroom. He further argued that teachers naturally resist the implementation of technologies that would diminish their power by replacing them or placing them in a subservient role. For example, in choosing textbooks, teachers will gravitate to those materials that preserve the role of the teacher as the primary deliverer of instruction, and will avoid alternatives in which the text itself is transformed into instruction, as in programmed instruction. Thus, to maintain their

accustomed role and to preserve their place in the organizational structure, teachers tend to "reduce all media to the status of aids" and to reject applications that require a more systemic rearrangement of power, roles, and structure. That is, teachers would be resistant to technologies or specific applications in which core teaching functions were included in the materials. Textbooks, yes; programmed texts, no. Supplementary materials on video, yes; televised lectures, no. Computers for communication and word processing, yes; complete self-instructional lessons, no.

Heinich proposed that if education were viewed as a system the tasks of instruction could be divided more rationally, yielding more effective learning at a lower overall cost. Curricular programs could be developed at a more central level by teams of specialists rather than being reinvented by every teacher in every classroom. Classroom teachers would devote more of their attention to adapting pre-designed programs to their students' needs and less to original creation. Of course, such systemic changes would entail changes in power relationships, relationships that are frozen not only into custom but also into law in some cases. Heinich predicted that such a systemic approach would be resisted by the education profession, whose attitudes "are based on a craft society and the result of a guild approach to production" (1967, p. 16).

In a more recent examination of this problem, a number of theorists have proposed applying "systemic change theory" to education—in which the organization of teachers, learners, and conditions for most effective integration of technology is viewed systemically and with an understanding of change processes (Banathy, 1991; Reigeluth & Garfinkle, 1994; Ellsworth, 1997). The first premise of this theory is that education is a social enterprise and that success depends on maximizing the satisfaction of the people that will affect and be affected by changes (Ellsworth, 1997, p. 2). Ellsworth's second major premise is that "change must be implemented as a package" (p. 3); that is, that lasting change requires not only actions in the classroom, but also in the surrounding system, such as the assessment methods employed, the teacher's reward structure, the technology support system, and possibly the support of parents and administrators. Finally, Ellsworth advises that systemic change requires rethinking of one's assumptions about education; he cites some examples given by Reigeluth (1994):

- Class levels vs. continuous progress

- Covering the content vs. outcomes-based learning
- Norm-referenced vs. individualized testing… (p. 8)

Thus, the systems perspective involves a change in mind-set about education as well as a different perspective on the process of implementation.

Sociological perspective

Contrasting with the systems perspective is one that focuses more narrowly on the roles that teachers play within the school (or college). This view tends to take for granted Heinich's notion of the "craft structure," that is, that the teacher-student relationship is the center of the enterprise and that this is inherently a labor-intensive process. This view is represented in the work of Cuban and his colleagues (Cuban, 1997; Cuban, Kirkpatrick, & Peck, 2001). They propose that "the essence of teaching is a knowledgeable, caring adult building a relationship with one or more students to help them learn..." (Cuban, 1997). Therefore productivity gains through technology are unlikely in formal education compared to the gains possible in low-skill manual work consisting of repetitive, routine tasks.

In this view, the important thing about introducing computers into the classroom is that they change social relationships among teachers and students. Teachers' and professors' beliefs about their authority and expectations of control are threatened by hardware and software systems that claim to replace some of the functions of the instructor. If the computer teaches, what's left for the teacher? A symptom of this perception of threat is the teacher's preference for keeping the computer in a separate lab rather than in the classroom. In this view, teachers' and professors' reluctance to embrace new technologies is not simply resistance to the new but "a struggle over core values."

Psychological perspective

A number of models have been developed based on psychological theories of the stages through which potential adopters progress on their way to acceptance and use of an innovation (any idea that is perceived as new to the individual). These "diffusion" models take a psychological perspective, almost a marketing perspective, focusing on the question of why some individuals adopt and others reject innovations, with the decision being seen primarily as a personal, rational choice. The best known model is that of

Everett Rogers, originally published in 1962, in which the author synthesized findings from 405 studies culled from fields as diverse as education, medicine, public policy, and farming. The synthesis was reported with a model and case histories to substantiate propositions about the stages, process, and variables involved in diffusion, which was defined as the spread, adoption and maintenance of an innovation. In later editions Rogers encompassed over 3000 diffusion studies (1983), then nearly 4000 studies (1995), and then nearly 5000 studies (2003).

Rogers considers the main elements in the diffusion of new ideas to be: "(1) an innovation, (2) which is communicated through certain channels, (3) over time, (4) among the members of a social system" (1995, p. 35). He pioneered in analyzing case study data to discern a pattern in the individual's innovation-decision process, finding that an individual passes through the stages of knowledge, persuasion, decision, implementation, and confirmation (1995, p. 36).

Rogers's diffusion theory deals specifically with technological innovations. However, the situations on which the theory is built are somewhat different from the school or college situation in that typically Rogers examines rather discrete innovations being adopted by individuals outside the workplace setting for their own benefit. In the school or college setting, the acceptance and use of really consequential innovations tend to require collective decisions involving instructors, mid-level administrators, top administrators, and governing boards. And they entail complex change processes, not just acquisition of equipment or just implementation of a new practice.

A diffusion model that is directed specifically at the school setting is Hall & Hord's (1987) Concerns-Based Adoption Model (CBAM). This model views innovation adoption primarily as a psychological process revolving around the teacher's hierarchy of needs. It holds that people considering and experiencing change evolve in the kinds of questions they ask and in their use of whatever the change is. In general, early questions are more self-oriented: What is it? How will it affect me? When these questions are resolved, questions emerge that are more task-oriented: How do I do it? How can I use these materials efficiently? How can I organize myself? Why is it taking so much time? Finally, when self and task concerns are largely resolved, the individual can focus on impact. Educators ask: Is this change working for students? Is there something that will

work even better? The model identifies seven stages of concern: (0) awareness, (1) informational, (2) personal, (3) management, (4) consequence, (5) collaboration, and (6) refocusing. It also goes beyond other models in elaborating a spectrum of levels of use, not just adoption or rejection. Users may fall anywhere on a broad continuum of commitment to and maturity in using an innovation:

- 0. Non-Use: The user has no interest, is taking no action.
- I. Orientation: The user is taking the initiative to learn more about the innovation.
- II. Preparation: The user has definite plans to begin using the innovation.
- III. Mechanical: The user is making changes to better organize use of the innovation.
- IVA. Routine: The user is making few or no changes and has an established pattern of use.
- IVB. Refinement: The user is making changes to increase outcomes.
- V. Integration: The user is making deliberate efforts to coordinate with others in using the innovation.
- VI. Renewal: The user is seeking more effective alternatives to the established use of the innovation (Hord, Rutherford, Huling-Austin, & Hall, 1987).

In short, these models view acceptance as essentially an individual process of becoming a aware of a new product or practice and gradually accumulating data to make a decision about adoption. The organizational setting is not particularly relevant nor is the impact of the individual's decision on the larger system.

Ecological perspective

An emergent view, presented as "an ecological perspective" (Zhao & Frank, 2003) proposes an umbrella for these divergent visions of how and why instructors accept and use modern information and communication technology (ICT). Zhao & Frank propose the ecological systems of nature as a metaphor for the life cycle through which technology is accepted, adapted, and incorporated into educational institutions. They see a spectrum of qualitatively different uses of ICT, with these different uses finding different niches in the ecological system. Their ecological perspective subsumes earlier views such as rational choice theory:

> "..teachers use computers in ways that address their most direct needs, bring them maximal benefits, do not demand excessive time to learn, and do not require them to reorganize their current teaching practices. Thus teachers' choices of computer activities minimize costs." (p. 821)

They propose that human activities, within their environments, act like other organisms in other environments, seeking niches in which to survive. More precisely, they see different technology uses finding niches suited to them.

Summary on adoption of innovations perspectives

Viewed from these different perspectives, the adoption of ICT can thus be considered several different ways: (1) as a set of resources accepted and used by teachers playing their traditional roles in self-contained classrooms, (2) as a set of tools used by learners, empowering them to take responsibility for their own learning, or (3) as an infrastructure with transformational possibilities, an engine for restructuring the education enterprise. The user, likewise, can be viewed as an independent agent, choosing the best tools for the job, as a player in a larger game of power and authority, or as an interchangeable element in a complex, interconnected system. Each of these visions implies a different approach to implementation or diffusion, different potential adopter, a different client, and a different goal.

Actual Uses of Media and Technology

Media and technology are used differently and at different rates across the various major domains—corporate, higher education, and K-12 education. Since each domain has its own socioeconomic dynamics accounting for these differences, each domain will be addressed separately in the following sections.

Corporate training

The dynamics of using media and technology in corporate training programs are different from those in formal education. First, the money spent on training is considered a cost of doing business or, at best, an investment that must be recouped through revenue gains later. This leads to a bias toward efficiency that is significantly greater than in formal education. Second, instructors are not necessarily in a position to control the entire instructional process. In larger organizations the training function is divided among various specialties, including design, production, evaluation, and subject-matter

expertise, and major instructional decisions are made on a team basis. Third, businesses often have multiple sites, sometimes in multiple countries, so there is a premium on standardization and mass production of training events. Even without multiple sites, in some industries governmental regulations stipulate the type and frequency of training activities. Fourth, the delivery system for training is often determined by the ICT infrastructure of the organization. If a company builds a videoconferencing system for management communications, there is a bias toward using the excess capacity for other communications, including training.

Given the biases just mentioned, it may be surprising to note that face-to-face classroom instruction incorporating traditional media formats is still the dominant mode in corporate training, according to surveys reported in Training magazine over the past decade (Industry Reports 1996, 1998, 1999, 2000 and Galvin 2001, 2002, 2003)[1].

Over this period, the percentage of organizations that report using face-to-face classroom instruction "always" or "often" has remained stable at about 90 percent. The percentage using manuals and print materials has also been stable at about 80 percent, and over 50 percent use video materials.

Some five to ten percent of companies were using broadcast or satellite television delivery "always" or "often" during the period of 2001 to 2003.

Computer-based delivery systems played a gradually expanding role in training since the early 1990s. Earlier, this referred to 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. More recently, it occurs by connecting to the Internet or organizational intranet. In the 2003 *Training* survey, 45 percent of companies report using instruction in digital storage media "often" or "always." However, 63 percent reported that they used Internet or intranet delivery, a major increase over the previous year (Galvin, 2003).

It is interesting that the reported *proportion of time spent* in computer-based training has changed little over the years, reaching 16 percent in 2003 (Galvin). The true

[1] These surveys are, of course, self-reports by a sample of individuals in various organizations and thus suffer the usual limitations in terms of validity and reliability. For a description of the survey methodology see Galvin, T. (2003).

extent of use of ICT may be obscured by the method of reporting. It appears that "computer-only" courses are not replacing "classroom only" courses to any great extent. Rather, hybrid combinations ("blended learning") are becoming more and more common; that is, face-to-face courses may be preceded by readings posted on the Web and followed by a discussion forum conducted through the Web. Corporate training also includes more "just-in-time" instruction, short "help" sessions delivered through LAN or intranet networks to the worker's computer at the time it is needed.

Higher education

Unlike the corporate realm, in higher education there is no consistent source of annual data on national trends in the use of media and technology, although there are occasional and partial reports that cast some light on trends in information technology. Regarding traditional analog media there is only silence. However, this by no means suggests that college faculty have abandoned audiovisual media. Based on anecdotal reports from university media centers, it seems that audiovisual media are alive and reasonably well. Overhead projectors are still ubiquitous in classrooms. Photographic slides continue to occupy a significant niche. Circulation of projectors is declining, but projectors tend to be built into classrooms and laboratories in departments that make heavy use of slides, such as biology, veterinary medicine, optometry, fine arts, classics, and drama. Demand for video recordings in VHS format remained steady through the 1990s, with thousands of bookings annually at universities with large central collections. As VHS video recordings have become less expensive, many individuals and departments own their own copies; showings of these do not appear on campus circulation records (Teach, 2004).

Discussion of technology use in higher education is almost totally focused on computer-based media. During the period of 1997 to 2002, as colleges and universities were expanding their information technology services at a rapid pace, there were national surveys of faculty use. According to annual surveys between 1997 and 2000 (Campus Computing Project, 2000), faculty adoption of certain computer-based teaching applications—such as course Web pages and use of Internet resources—grew each year during that period. However the percentage increase was *smaller* each succeeding year, indicating plateauing of the adoption rate. Unfortunately, the Campus Computing Project

has not continued to measure these indices. This lack of attention may be an indication of reduced interest in classroom media within the academic computing community. In fact, in the 2004 EDUCAUSE survey, e-learning, distributed learning, and course management systems have slipped from near the top to near the bottom of the list of concerns of information technology professionals (Spicer et al., 2004).

In any event, there are no current national data comparable to those of the Campus Computing Project. Based on a sampling of internal university reports, Molenda and Bichelmeyer (2005) speculate on how faculty are using information technology in teaching, noting that the patterns appear to be quite similar across the cases. Generalizing from these selected cases, they project that nearly 90 percent of all instructors exchange e-mail with students; some 60 percent use class listservs to communicate with students; about one-half assign students to use Web resources; 40 percent show digital presentations; about 20 percent ask students to participate in online discussion forums; and between ten and 20 percent provide online simulations or lab experiments. These figures tend to support the earlier theory that although usage continues to grow, the rate of increase has slowed since the late 1990s.

These findings also support the notion discussed earlier that that faculty incorporation of computer media in their teaching can be viewed as a wide spectrum of adoption decisions, not a single yes/no decision. Applications that require a greater investment of time and energy or that entail fundamental changes in teaching practices are accepted more slowly. Using E-mail is relatively easy to learn and makes work more efficient, but at the other end of the spectrum, the use of online simulations and lab experiments, require considerable investment of time and special expertise, hence attracting a much lower rate of adoption. As might be expected, professors do not seek out applications that substitute the computer for functions that faculty consider to be core functions, such as lecturing.

A factor that is promoting faculty use of information technology is the nearly ubiquitous adoption of course management systems (CMS). The existence of a CMS motivates faculty to create content to make use of this delivery system. Since the system is there and the university may apply pressure to at least post a syllabus online, many

instructors explore other functions of the CMS, typically on an incremental basis, adding applications year by year, leading to the sorts of uses described earlier.

K-12 education

Traditional audiovisual media

As with higher education, there are no ongoing annual surveys of a national scope to provide a clear picture of how teachers are actually using technology. And, as in higher education, there is virtually no recent research or published literature about rates of use of traditional media. Textbooks are still a mainstay of classroom instruction. They increasingly come with digital ancillary materials, but print still rules. Surveys have revealed that many teachers still use overhead projectors, audio cassette players, and VHS video cassettes. Elementary schools still keep and use record players (Misanchuk, Pyke, & Tuzun, 1999, p. 3).

School district and regional media centers continue to circulate audiovisual materials. Analog media formats, particularly videocassettes, are still widely used. District and regional media center collections include (from greatest to least number of titles): videocassettes, multimedia, curriculum materials, professional books, and digital media. However, purchases of digital media, including internet resources, DVDs, and multimedia, now outpace purchases of most types of analog media (NAMTC, 2003). Data on specific audiovisual utilization patterns are difficult to find, but anecdotal evidence paints a picture similar to the one in higher education: overhead projection and VHS video nearly ubiquitous, and slides used in specific subjects with high visual elements.

Computer-based media

There have been occasional surveys of a national scope regarding teachers' use of computer technologies. However, more recent utilization patterns are perhaps best portrayed by an intensive survey of nineteen elementary schools in a single state (Zhao & Frank, 2003). They found that usage could be characterized under the headings of "teacher use" and "student use." The most common *teacher* uses reported (proportion of teachers using weekly or daily) were preparation for instruction (58% used weekly or daily), communication with parents (54%), teacher-student communications (37%), and record keeping (29%).

The most common *student* uses reported were developing basic computer skills, such as keyboarding (53%); core curriculum skills, such as math drill and practice (41%); classroom management, including computer access as a reward (38%); remedial lessons (30%); and student inquiry (14%).

In American schools, access to information technology is ubiquitous and use of that resource is growing incrementally, to the point that it is now the norm for teachers to employ some computer technology at work (U.S. Department of Education Policy and Program Studies Service, 2003). However, as in higher education, the operative principle seems to be gravitation toward applications that pay maximum benefits for the user for minimum investment of time and energy. As Heinich predicted almost 40 years earlier, applications that entail core teaching functions tend to be less popular than applications that provide labor-saving measures for instructors.

Conclusion

The end purpose of educational technology is *using*, putting learners into contact with appropriate technological resources under conditions conducive to learning. Before using can take place the resources must be selected and evaluated by an instructor and a plan made for utilization. There is a considerable body of theory and research to guide utilization, with current practice favoring an eclectic approach, using behaviorist, cognitivist, and constructivist techniques as dictated by the learning goals and needs of learners. There are numerous lenses through which to view the processes by which instructors become aware of and decide to make use of technological resources. These lenses variously focus on the psychological processes of the user, the sociology of the educational environment, or the total system of the participants, the learning environment, and the surrounding social and political systems.

The extent to which technological resources are actually used depends, first of all, on the setting. The corporate, higher education, and K-12 settings each have different social and economic forces operating on participants. Together with the working theories and technological competencies of instructors, the social and economic forces interact to influence what technologies are used and to what extent.

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