Journal of Science Education and Technology, Vol. 5, No. 4, 1996

Instructional Design for Distance Learning

Jacqueline Bourdeau[1] and Anthony Bates[2]

An intrinsic link exists between instructional design (ID) and distance learning (DL). Their inextricability in the real world raises specific problems of interest in the field of ID. In no other teaching/learning situation is ID so essential as in DL. The conditions of DL make it a necessity to have long-term instructional planning, cost analysis, curriculum and course development, instructional materials development and maintenance, delivery plans, and detailed evaluation rules. Without all of these components, DL simply could not happen. It took some time for this neccessity to be acknowledged, as can be seen in the history of DL. However, ID becomes even more critical as increasingly costly and complex means are used. Conditions of learning have special features in DL, such as the role of media, since the professor, teacher or instructor is replaced by media for either transmitting information or for organizing learning activities. In this paper, the term distance learning will be used to mean media-based, remote or asynchronous learning supported by an instructional system. This paper introduces general features of DL and examines essential aspects of ID for DL, with special emphasis on ID methodologies and on media selection.

KEY WORDS: Instructional design; distance learning; media.

1. The Essential Role of Instructional Design and Media in Distance Learning

As much as DL and ID are intrinsically related, so are DL and media, since there can be no DL without media. DL has evolved with the development of ID practices and tools, as well as with the arrival of new media and technologies.

Four Generations of Media. The first generation started in the late 1800s in England and in the United States with Correspondence Education, which rapidly spread to France, Germany, and Sweden (Bååth, 1980). The main feature of Correspondence Education is a two-way communication by postal mail, which means the use of printed material such as textbooks, self-study material, and teaching letters. Credited education is managed through envigilated exams in accredited centers.

A second generation started to make use of radio and telephones at the beginning of this century. Whereas radio is a one-way audio media, effective for delivery to a large and widely spread population, telephones were used for two-way individual tutoring. Radio is still a very effective and low-cost delivery media, requiring only electricity as an infrastructure; it is still today the most, if not the only, appropriate way to deliver distance education to remote areas with poor infrastructure.

The third generation, the McLuhan generation, developed during the 50s with television and satellites; it is the era of the "University of the Air". Television is a much richer media than radio, providing dynamic visual information that is essential for teaching certain content and skills. Being essentially a one-way delivery media, television is often used in combination with either two-way postal mail, telephone tutoring, or classroom meetings in study centers.

[1]Université du Québec a Chicoutimi and Téllé-université, 555, Boul. de l'université, Chicoutimi, QC, Canada, G7H 2B1.
[2]University of British Columbia, 2329 West Mall, Vancover, B.C., Canada, V6T 1Z4.

1059-0145/96/1200-0267$09.50/0 © 1996 Plenum Publishing Corporation

The fourth generation, starting in the 70s, brings computer and information technologies, with CAI (Computer-Assisted Instruction) and CBT (Computer-Based Training) as stand-alone delivery methods for learner materials. Analogical videoconferencing via satellite was developed, a two-way video media for interactive delivery and meetings, although a high-cost one.

The fifth generation emerged in the late 20th century with all-digital technologies, integrating telecommunications and information technologies in digital networks, offering interactivity between people and access to large amounts of multimedia information stored in different sites and on different storage technologies. This had led to audio-graphics, interactive television, digital desktop videoconferencing and broadband videoconferencing being used for distance education. Infrastructures like MAN (Metropolitan Area Network), WAN (Wide Area Network), and national high-speed broadband networks, and standards like ISDN (Integrated Services Digital Network) allow effective real-time transmission of dynamic information as well as rich interactions between students and their sources of information and of support.

Evolution of Instructional Design in the History of Distance Learning

Analyzing the evolution of ID for DL, Kaufman introduces three characteristics: learner control, dialogue, and thinking skills. He gives a historical perspective of three generations in the evolution of ID (Kaufman, 1989). (Table 1.)

Distance Learning and the Notion of Distance. To better understand what ID means when applied to DL, the term "Distance Learning" must be examined first. The use of "distance" to qualify or specify a learning situation is rather recent, dating from the beginning of this century. Whereas early on it reflected a situation where there was a geographical distance between students and teaching resources, the term has evolved to encompass distance in time. With the emergence and spread of electronic media, the concept of distance refers to the use of media to overcome any problem of remoteness or synchronization of learning and/or teaching activities.

Useful Distinctions in Distance Learning

Different terms are used for different types of actions taken to bring about remote learning: Distance Education, Distance Teaching, Distance Learning, Open Learning, Flexible Learning.

Distance Education. Whereras Holmberg (1986), defines Distance Education as having three characteristics: (1) non-contiguous communication, (2) preproduced courses, and (3) two-way communication, this term is most often used to describe situations where an institution or an educational system is targeting a widely spread population for general education. Distance Education often shares with Adult Education its humanistic philosophy of andragogy, where personal development prevails over acquisition of knowledge, and where adults are viewed as self-directed learners.

Formal recognition of distance education happened in 1982 when the UNESCO-affiliated ICCE, the International Council for Correspondence Education, changed its name to ICDE, the International Council for Distance Education.

Distance Teaching. The term Distance Teaching emphasizes the teaching aspect, where the major role is given to the teaching system rather than to the learners. This view refers to a teaching model where teachers are transmitters of information, and students are seen as receivers. This view has certain implications for methods and media:

Methods are content-driven and most efforts are put into transmitting the most complete and precise content

Media selection is diffusion-oriented, and the teacher or the teaching system is at the center: either teachers linked to students to transmit their personal expertise, or a teaching system with information made available for students through books, audio- or videocassettes, or television.

Distance Teaching is used in traditional universities which have standards, requirements, and the need to maintain an equivalence with on-campus teaching. NTU, the American National Technical University, is a good example of Distance Teaching as it provides video lectures to engineers and technicians via satellite as a professional and career development tool.

Distance Learning, Open and Flexible Learning. Distance Learning (DL) can refer to put an emphasis on the activity of learning rather than teaching, or to representing all types of remote learning situ-

Table I. Three Generations of Course Design in Distance Education (Kaufman, reprinted with permission).

	CONTROL	DIALOGUE	THNKING SKILLS
1st Generation "Correspondence Education"	-No choice provided to learners in program -Learner has no power -Little support provided other than written feedback on assignments -Evaluation is mainly by final exam	-Low dialogue -Mainly postal service. Some telephone, some phone-in to on the air radio forum	-Little or no emphasis -Focus on coverage
2nd Generation "Distance Education"	-Some learner choice of courses within a program -Some choice of topics or projects undertaken within a course -Learner has no power -Some pre-enrollment counseling and study skills training is available by phone as well as in writing -Some audio-teleconferences and face-to-face sessions are used -Evaluation is by assignment, projects and final exam	-Modern dialogue available at specified times -Mainly postal service -Use of telephone, audio & teleconferencing -Interactive television	-Some emphasis particularly in some British Open University courses -Focus still on content coverage
3rd Generation "Open Distance Education"	-Learner choice of why, what, how where and when to study -Some learner choice of how their learning will be evaluated -Power is mainly in the hands of the learner -Institution and other learners provide ongoing support to assist the learner in becoming independent	-High dialogue available -All of the above methods, plus computer-mediated communication	-Major emphasis throughout curriculum on problem solving, decision-making critical thinking

ations, independently of the approach taken. When used to put emphasis on the learner activity, it reflects a theory of instruction where the learner is central and active in the process of acquiring knowledge and know-how. The corresponding ID methods are then to develop learning activities such as exercises or problem-solving, rather than simply presenting the knowledge to be acquired. In its second meaning, DL can be integrated into different learning situations, where distance equals either space or time; it can be a complement or a supplement to non-remote situations such as classroom or regular campus situations.

Open or Flexible Learning, as well as DL, stresses learner activity and autonomy, and emphasizes the use of methods such as self-study, self-assessment and self-pacing. The British Open University and the Council for Educational Technology in London have been promoting this approach for several years, and documented it with tools such as the Open Learning Guides (Lewis, R. and Spencer, D., 1986). Open and Distance Learning (ODL) was chosen over Flexible Distance Learning as the official name by the European Community.

In the real world, most situations are hybrid and situations called Distance Teaching contain activities where learners are asked to be actors in constructing their knowledge or know-how. As a corollary, situations called Distance Learning often contain a large amount of information transmitted to students in order for them to simply have access to it.

Distance in Space and Time

Distance referring to remoteness in geographical space was the first reason for creating a special educational system for students unable to participate in

the regular school or university systems. Since then, geographical remoteness is still the raison d'être of distance learning, even if it is no longer the primary reason for which many students are involved in it. What does remoteness mean today? It may be the case of remote areas in countries where the population is scattered over a large area, as in Canada or Scandinavia. Remoteness may also be due to lack of transportation or climatic difficulties that prevent access to remote locations, as in Iceland. Remoteness can also apply to students in specific programs which are not offered in their own areas, as in Asia (National Institute of Multimedia Education, 1992). In other cases, remoteness is of a linguistic nature, when students are far from a school in the language they require. For some children that travel all year around, such as families living on canal-boats, correspondence education has always been the most appropriate system. For people wanting to study at home, for handicapped persons, or for prisoners, distance learning offers an alternative to a regular system they do not have access to. More recently, the need for distance learning has come from students who either work during the day and want to study at night, or who work on irregular schedules, like nurses, who need a completely flexible system. For these students, distance learning is a solution to a synchronization problem.

Digital computer communications, as well as satellites and wireless communications, bring with them a "no-distance world" which may well bridge the gap between distance and no-distance education. This radical change implies a merging of two contexts that have been separate until now.

With growing needs for lifelong learning, one expects the student population to become in the majority adult working people looking for flexible, effective and efficient educational solutions. Since Distance Education has long focused on offering opportunities to adults to complement or supplement their education, DL appears to be closely related to the idea of lifelong learning (Report of the Task Force on Distance Education, 1992). Lifelong learning, although not a new idea, is seen as essential to personal and professional development in the 21st century. DL, based on computer technology and on telecommunications, may offer the kind of solutions that our societies need for ensuring access to a lifelong learning process (Stahmer, Bourdeau and Zuckernick, 1992; Report of the Task Force on Distance Education, 1992).

Students' motivation for participating in DL vary from wanting a flexible and independent learning system to having no other choice. Common to distance students is their intrinsic motivation for learning.

2. Instructional Design Methodology for Distance Learning

Whereas face-to-face teaching can happen with minimal ID, DL cannot exist without a complete one, and DL has always been a field where systematic ID is conducted. Historically, ID has been recognized and developed in parallel with DL (Inglis, 1989).

Theoretical Framework

Methodologies of ID for DL should rely on a specific theoretical background. Are there theories of ID for DL? ID theories rely on both theories of learning and theories of instruction, and aim at linking them to produce a theoretical design framework. In a comprehensive review of how learning theories can apply to distance learning, Bååth finds that all of them are meaningful and can be applied (Holmberg, 1985). Holmberg, viewing DL as a guided didactic conversation, suggests designing DL to support this view (Holmberg, 1982). Verduin and Clark (1991) suggest a typology of distance learning situations based on Moore's theory of independent study, and on three main dimensions called dialogue/support, structure/specialized competence, and general competence/self directedness (Moore, 1977). However, specific theoretical work on ID for DL is in its beginning stages (Burge, 1989; Köymen, 1989).

Design, Development and Delivery

ID represents the whole instructional design process, and can be decomposed into three sub-processes, Design, Development, and Delivery,. Design as the first subprocess means architecture, i.e. drawing the system, designing the structure of components and their functioning. Development is undertaking construction, building and assembling the parts. Delivery means disseminating, giving access to the user with instructions for use, offering service and main-

tenance. Evaluation of both process and products is part of each sub-process and is an on-going process.

The questions raised here are: What are the particularities in designing, developing and delivering for DL? What does the instructional designer have to know?

Designing for Distance Learning

ID can be approached from different perspectives: systematic (Gagné, Briggs, and Wager, 1992); systemic (Romizowski, 1981); motivational, following Keller's principles of motivational design (Keller, 1983); andragogical following Knowles' principles (Knowles, 1980); or cognitivist (Merrill, 1983; Reigeluth, and Stein, 1983). It is the choice of Instructional Designers (and/or of their organization) to use one of the above design approaches. However, some pragmatic guidelines are always useful, in the forms of principles, such as Burge's principles for the design of conferencing (Burge, 1989). Principles of ID for solving DL problems are given in a further section.

From a systemic point of view, the distinction made by Romizowski (1981) between macro- and micro levels is useful here: designing instructional systems is at the macro level, whereas designing instructional material is the micro level.

Designing for DL at the macro level implies planning and cost analysis, as well as design of the curriculum, courses, instructional materials, learning activities, instructional evaluations, student support systems, and support staff training. Of specific relevance to DL are: (1) market and cost analysis, (2) student support systems, (3) media selection, (4) diffusion modalities, and (5) evaluating learning outcomes at a distance. Major challenges are: (1) explicitness of instructional materials, (2) quality standards, (3) variety of learning activities, (4) accessibility of media, and (5) dialogue with students.

Designing for DL at the micro level means designing printed material, audio-cassettes, radio and television programs, interactive audio activities using telephone tutoring and audioconferencing, audiographics material, interactive television or interactive satellite sessions and multimedia documents. Of specific importance to DL at the micro level is the design of: (1) the learning activities and instructional evaluation, and (2) the student support system. More particularly, since DL is media-based, the instructional design process must be completed with constant thought to being flexible or adaptable enough to respond to all students with their differences. For instance, wherever possible students should be offered the option of self-directed learning vs. frequent interaction with a tutor or with peers, the option of audio-visual vs. printed material, etc.

A common illusion in DL is to think that it is sufficient to take a course syllabus and course material from on-campus teaching and send it by mail or transfer it to television. The designer should know that DL

> (. . .) is a form that demands that the design, production and distribution of programs be specifically geared to distance education learning objectives and take into account all of the special needs and requirements of individual programs. It also demands management systems and assessment tools that are carefully designed to serve the realities of study outside of the face-to-face model. (Report of the Task Force on Distance Education, 1992).

In fact, the real challenge is to intertwine content, learning activities, guidance and student support, to have a complete distance learning "package." The instructional designer has to deal with questions such as:

- How to give the students full access to content through media. Whereas on-campus teaching does not need to consider this, since the professor is present to complement information, answer questions, check understandability, and correct errors, DL must give complete access to the content to be learned.
- How to design asynchronous guidance and feedback-giving to student, with no or little inter-student interaction.
- How to make the best possible media selection, given cost analysis and accessibility for students to the equipment needed.
- How to make a design appropriate for a student population with very different profiles and motivations, with no possibility to check and adjust once delivery begins.

Developing for Distance Learning

Going from design to development means making design ideas a reality, e.g. writing and timing learning activities, preparing assignments and examinations, electronic publishing of printed documents,

authoring courseware, producing videos or audio-cassettes. Questions raised by the instructional designer are:

- How to guarantee explicitness and overall quality of instructional materials?
- How to develop in such a way that it is most feasible and economical for updating and maintenance?

The instructional designer should prepare a variety of learning activities, and stimulate dialogue and inter-student interactions. Field-testing and regular evaluation of instruction is essential to maintain quality and relevance.

A number of manuals and guides from distance learning institutions give detailed information on course writing and on development of instructional material (Holmberg, B., 1982; Lewis, R. and Spencer, D., 1986; Lewis, R., 1990; Harrison, N., 1991). Bååth provides a useful checklist for developing instructional material and activities (Holmberg, B., 1982).

Delivery in Distance Learning

Delivery is where DL differs completely from face-to-face instruction, mainly because of its asynchronicity. A key component of the delivery system in DL is the student support system. At minimum, this system can simply be postal correspondence; if fully reliable, it can be very successful. However, as recommended by most authors, a more real-time type of two-way communication is richer and probably more effective, as in telephone tutoring, meetings, audioconferencing, or computer conferencing. Collaboration between students is most often—but not in every case—an added value, sometimes an essential component. In addition to a student support system, a good administration system must be in place to take care of registration, file management, and all other administrative issues.

Delivery questions may be:

- How to prevent student isolation, loss of interest, lack of support, and finally a high attrition rate?
- How to organize evaluation of learning outcomes in order to ensure good quality standards and/or accreditation?
- How to organize student administration in a most efficient way?

Quality control is essential throughout the whole design process, with checkpoints at critical events in the process. Evaluation of the design, both formative and summative, should deal with factors such as access, relevance to needs and expectations, quality, learning outcomes, impact, effectiveness and efficiency, and generation of knowledge (Verduin and Clark, 1991).

Instructional Design Principles for solving Distance Learning Problems

From the perspective of using ID as a way to solve instructional problems, principles are given for avoiding obstacles and facilitating problem-solving in distance learning.

Problems specific to DL relate to: (1) the particular conditions of learning and the associated limitations in communication between teachers and students, (2) limitations in the types of learning that can be supported by DL, (3) economic aspects of DL, infrastructure and logistics needed.

In a DL situation, communication between students and teachers is reduced as compared to face-to-face teaching in three ways: (1) in quantity, since it happens only on an occasional basis, (2) in completeness, with only voice or written text instead of full live presence, (3) in interactivity, since interactions are rarer, and (4) delayed instead of immediate ("not-in-time" instead of "just-in-time"), and since media commonly used like radio and television are one-way. In DL, communication between teacher and student is mediated mostly by instructional material for transmission of knowledge, organization of learning activities or evaluation of learning outcomes. Conversations are mediated by communications means such as postal mail, telephone or electronic mail.

Types of learning that can be supported by DL are limited, although this tends to be reduced by new technologies. Psychomotor and perceptual skills could not be fully supported unless learning is completed by on-site sessions. Learning of social interactions, of teamwork, of leardership or of negotiating skills also requires physical presence and real-time activities.

Economic aspects must be underlined as critical in the design of DL activities, and with them the issues of equal access for remote and urban areas, and for poorly equipped and well equipped sites. Appro-

priate ID for DL must find the best trade-off solutions between sound ID principles and economic aspects.

Consequently, problems for which ID has to provide solutions can be considered under three major points:

- Accessibility: lack and/or cost of access to a distance instructional system, to media-based content and activities,
- Attrition: due to isolation of students, lack of motivation, interactivity, support, or peer collaboration,
- Quality: few quality standards, lack of feedback to and from students, lack of maintenance and updating, absence of quality in the support system.

The ID principles for DL given below aim at solving these problems and have three main goals:

- provide accessibility—principles 1 and 2: media selection, readability, understandability, explicitness, feasibility
- keep motivation—principles 3 to 7: two-way communication, learning activities, student support, peer collaboration
- ensure quality—principles 7 to 10: feedback from and to student, error anticipation, evaluation of learning outcomes, evaluation of instruction, revisability, support staff training.

A short description of these design principles is given below and summarized in Table II:

Principle 1. Select media based on access for students so that students have easy, equal, and economical access to instruction; determine access to equipment for students from home or work place, or at resource centers; make cost assessment (see the next section on Media Selection).

Principle 2. Develop fully readable, understandable and feasible material and guidance with detailed and multimodal descriptions; be explicit and provide detailed guidance; test feasibility with students (level of difficulty, quantity and duration of learning activities and assignments).

Principle 3. Plan both synchronous and asynchronous two-way communication with opportunities and means for two-way communication; stimulate feedback from students to tutors; give students access to asynchronous feedback from tutors and from other students.

Principle 4. Design a variety of learning activities, offer different methods and techniques, individual or team-based; when possible, design interactive software or television material.

Principle 5. Design a structured interactive student support system with tutoring, meetings, conferencing, networking; plan support staff training and stimulate collaboration between tutors.

Principle 6. Plan opportunities for peer collaboration, stimulate collaboration between students, plan opportunities for collaborative learning activities at a distance, for document exchange and teamwork.

Principle 7. Provide appropriate feedback to students, just-in-time as much as possible, be it by tutors or by courseware; collect data from field-testing and adjust ("fine tune") instructional material and activities.

Principle 8. Anticipate errors by students, both in content and process in order either to prevent them or to have students learn from them; collect data from field-testing and make a "bug catalog" to identify them.

Principle 9. Determine clear evaluation standards of learning outcomes to compensate high distribution of students and of tutors and to ensure equity.

Principle 10. Plan for evaluation of instructional materials and of student support with checkpoints for evaluating and revising; design easy-to-update material, activities and support system; plan support staff training and collaboration between tutors.

3. MEDIA AND MEDIA SELECTION

The Problem of Choice

It is useful to make a distinction between media and technology. Media refers to the generic forms of communication associated with particular ways of representing knowledge. While certain technologies are closely associated with each media, a variety of different technologies may be used to deliver these media, as Table 3 indicates.

In distance learning, the four most important media are:

1. Text
2. Audio
3. Television
4. Computing.

Table II. Instructional Design Principles for Distance Learning

DL problems	ID solutions	ID principles for DL
Accessibility: to instruction	media selection	1. Select media based on access for students
to content	understandability readability explicitness feasibility	2. Develop fully readable, understandable and feasible material and guidance. Be explicit and provide detailed guidance. Test feasibility with students: difficulty, quantity, duration
Motivation (attrition)	two-way communication	3. Plan two-way, synchronous and asynchronous communication
	learning activities	4. design appropriate number and variety of learning activities
	student support	5. Design a structured and interactive student support system
	peer collaboration	6. Plan opportunities for peer collaboration
Quality	feedback to student	7. Provide appropriate feedback to student, just-in-time when possible
	error anticipation	8. Anticipate errors in content and process by students
	evaluation of learning	9. Determine clear evaluation standards for learning outcomes
	evaluation and revision of instruction	10. Plan for regular evaluation of instructional materials, and of student support system. Design for revision and maintenance of all components of the system. Plan support staff training & collaboration

Each media not only has its own unique way of presenting knowledge, but also of organizing it, often reflected in particular preferred formats or styles of presentation.

Table III is illustrative rather than exhaustive. One can see that media can be carried by more than one technology, and certainly these distinctions will become less meaningful with greater integration of

Table III. Media, Technology and Distance Education Applications

Media	Technologies	Distance education applications
text (including graphics)	print;	course units; supplementary materials; correspondence tutoring;
	computers	data-bases; electronic publishing
audio	cassettes, radio; telephone	programmes; telephone tutoring; audio-conferencing
television	broadcasting; video-cassettes; video-discs; cable; satellites; fibre-optics; IFTS; microwave	programmes; lectures; video-conferencing
computing	computers; telephone; satellite; fibre-optics; ISDN; CD-ROM; video-disc	computer-aided learning (CAI, CBT); E-mail, computer-conferencing; audio-graphics; databases; multi-media

IFTS = Instructional Fixed Television Service;
ISDN = Integrated Services Digital Network;
CD-ROM = Compact Disc, Read Only Memory;
CAI = Computer-Assisted Instruction;
CBT = Computer-Based Training;
E-mail = electronic mail.

media and technologies. Nevertheless, there are still significant differences in the bandwidth required for different media (uncompressed television requires 1000 times the bandwidth capacity of an audio telephone call) and the educational applications associated with different technologies, so these distinctions will remain valid well into the future.

Given the wide range of different media and technologies available, politicians, educational administrators, teachers and students are sometimes confused when it comes to making decisions about which media or technologies to use in distance learning.

Procedures for Decision-Making. The appropriate use and selection of technology depends very much on circumstances: context is all-important. Between countries with similar levels of economic development, decisions differ according to geography, local

technological infrastructures (e.g. availability of broadcast services), and educational structures. Within a single institution, different decisions are required, depending on the needs of the target group and the teaching requirements of a course.

In both educational and cost terms, there is no "super-technology"; different technologies have different strengths and weaknesses. This means then that a combination of technologies is usually the most appropriate decision, with the balance varying from context to context.

What is required is a set of procedures, or a check list of questions to enable appropriate decisions to be made regarding the choice and application of different technologies; in other words, these questions need to be asked in any context; the answers will depend on the context.

In approaching the process of media selection, one should be aware that there are basically two approaches. The first is strongly theoretical, is found taught on post-graduate courses in educational technology, and is sometimes applied in industrial and military training. The second is best described as pragmatic, is rarely taught, and is found in most schools, colleges and distance teaching institutions. Pragmatic media selection decisions are taken intuitively by teachers, senior decision-makers, and professional media producers; they are based on implicit assumptions, which are not necessarily applied logically or consistently to the decision-making process.

Theoretical approaches to instructional design are usually based on systems theory. The instructional process is defined as a closed system of linked procedures. Media selection is one of these procedures. Each procedure has a logical place in the order of events; hence some procedures need to be carried out before others, although early decisions can be modified in the light of subsequent decisions. In such a model, task analysis and the setting of instructional objectives usually precede selection of media, although media selection may be modified as a consequence of subsequent evaluation of student performance. Romiszowski (1986) provides a good example of a systems approach to instructional design and media selection. Reiser and Gagné (1983) have carried out a useful analysis of ten models of media selection and identified a number of common characteristics of such theoretical models.

One significant characteristic (following the work of Gagné, 1985) is the importance given to what are defined as instructional events. An instructional event may be presenting information, giving feedback on performance, providing guidance, etc. Most media selection models assume that there is a direct relationship between a specific instructional task/event and choice of appropriate media. As Reiser and Gagné put it: "some instructional events are impossible for some media, while others are inherently easy."

Some of the models use an algorithmic approach to deciding on appropriate media, i.e. if instructional event #1, then use media a; if instructional event 2, then use media b. Thus Anderson (1976) has a nine-page flow-chart of algorithms for media selection. Reiser and Gagné point out that flowchart approaches lead the designer to an increasingly narrower choice of media for each task. Other models use worksheets or matrices. Using these procedures, media selection is not made until all selection criteria are displayed, and the relative weight of each factor taken into account. The common factor though in all these theoretical models is that the decision-making process is based on very fine, detailed decisions regarding very small, finite instructional events. In other words, the instructional process is fragmented into basic elements of activity.

These approaches to media selection when applied to distance learning raise several problems. First, they assume that teachers or decision-makers have an unlimited range of media to choose from. However, in distance learning, media selection usually operates at two quite distinct levels. Senior policy-makers institutions take strategic decisions about what range of media will be made available to instructional designers. For example, policy-makers decided before the institution was created that the British Open University would use television, radio and print. Indeed the Open University began as the University of the Air, because of the widespread accessibility of the broadcast media, but planners soon realised that television alone could not economically be provided in such a way to cover the full range of content for all the subjects that were to be taught (Perry, 1976). Similarly, a distance learning institution may decide to install a networked computer system primarily for administrative reasons, but then find that it can also be usefully employed for instructional purposes. Media are often selected initially, not because they are appropriately matched to specific learning events, but for strategic or policy reasons.

Secondly, in theoretical models, the tactical level there has an implicit assumption of a direct relation-

ship between objectives, instructional tasks, and choice of media. However, these models very rarely spell out what these relationships are, and rarely provide the justification for assuming such relationship. As Reiser and Gagné put it, "Most of the models prescribe media for various settings and group sizes, but rarely indicate why certain media have been recommended; only occasionally is a rationale provided."

If research did manage to show that some media were better than others for specific instructional events, the procedure would still be impractical. Given the large number of combinations of possible instructional objectives and events, identifying the best media for every possible situation would not be possible. Since different media will be required for a rapidly changing sequence of instructional events, it becomes in practice impossible to switch constantly between different media, both in terms of design and development, and in terms of utilization. In practice, of course, instructional designers in most cases do not have the time to analyse minutely every instructional task that must be performed, let alone arrange for and organize the various pieces of equipment needed by the distance learner. Instructional designers therefore have to operate within coarser or broader categories of decision, assigning where possible certain broad roles or teaching functions for certain media, but knowing in practice that there will have to be considerable overlap and duplication.

Consequently, crucial decisions, both at a system level, and in terms of particular applications within a course, are made for a mixture of mainly non-instructional reasons: the availability of a broadcast service; the offer of free or cheap equipment; the familiarity of academics with print as an instructional media; the enthusiasm of a key decision-maker for a particular technology; the appointment of people with skills in a particular area, such as computer-assisted learning or video-production, and the need to maximize their services. In particular, once facilities and staff are in place, it is very difficult to change or add new media. When new technology is introduced, it tends to be added on to existing media, rather than to replace more costly or less effective media.

The ACTIONS Model

From the lessons that have been learned, the salient factors which need to be taken into account when deciding on the use of technology for distance learning can be covered by the acronym ACTIONS, with the seven following factors (Bates, 1992):

> Access: where will students learn: home, work, local, centres?
> Costs: capital and recurrent; fixed and variable
> Teaching functions: presentational requirements of the subject; required teaching and learning approaches
> Interaction and user-friendliness: do students and teachers require a great deal of training to use this technology
> Organization: what changes in organization will be required to facilitate the use of a particular technology?
> Novelty: to what extent will the "trendiness" of this technology stimulate funding and innovation?
> Speed: how quickly and easily can material be up-dated and changed? How quickly can new courses be produced using this technology?

Access. The first questions to ask are: Who is the target group? Will there be open access to the course?

It is important to ask where the learner is expected to learn. There are several possibilities: (a) at home; (b) at work, either at an individual workstation, or in a company learning centre; (c) at a local public education centre.

Media selection may depend on what technology is already available for other purposes. For instance, if students have access to their own computer terminal for work purposes, then this might be used also for distance learning. If the teaching is home-based, and open-access, then the limited technology available in homes for every potential student is a major decision factor.

Open access, home-based learning is limited in many countries to relatively few technologies: print and radio in the poorest countries; print, radio, audio-cassettes, and possibly television in more wealthy countries; and in the most developed countries, video-cassettes and telephone as well.

Difficult decisions need to be made when some technologies are relatively common, but not available to all the members of the target group. Is the use of a technology to be denied to those who have access to it, so as not to discriminate against those who do not? What proportion of homes should be accessible before a technology is used?

The way to answer such questions is to be clear about the target group. If programs are aimed at the poorest sector of the community, then there is no point in using technology to which they do not have access. However, the aim may be to upgrade those who already have access to computer technology through the workplace.

One option is to make technology available through local learning centres, which may be located in existing colleges or schools, and may even be shared between distance learning students and the regular students. There are however several potential disadvantages in doing this (Gallagher and Marshall, 1976):

- Cost: costs can rapidly get out of hand. Not only must every centre have the hardware, but multiple copies of software are needed for each centre.
- Security: equipment located on someone else's premises is difficult to protect against loss, theft or damage.
- Management: access may need to be controlled through advanced reservations, or time limits. This adds to administrative costs, and reduces student access.
- Flexibility: the location of the centres or the times they are open prevent many potential students from using the service.

The workplace is becoming an increasingly frequent location for DL. Companies often have technologies that are not available in the home and can be used for DL, but cooperation with employers is essential. In practice, it may be difficult to access technology for study purposes, since work takes priority.

Costs

Some general statements can be made about costs. First, a distinction must be made between capital and recurrent expenditure, and central (or production) and local (or delivery) capital costs. Technologies such as television and computing require high initial capital expenditure—purchase of a mainframe computer or television studio. One problem with capital costs is the rapid obsolescence of equipment, particularly in computing: three to five years may be an appropriate replacement time.

Recurrent costs include the staff required to operate the capital equipment (e.g. TV production staff), the money spent on production or purchase of instructional materials, and on delivering it.

A more critical distinction is between fixed and variable costs. The cost of developing and producing a single television programme may be considered as fixed, independent of student numbers, because it will be the same whether one or 1000 students view the programme.

Some technologies have much higher average fixed costs than others for developing or producing one hour of study material. Table IV (adapted from Sparkes, 1984) reflects the ratio of preparation/production costs associated with various media in producing one hour of instructional material. This table is based on individual experience, and needs to be empirically verified; different people may have different views on the actual ratios.

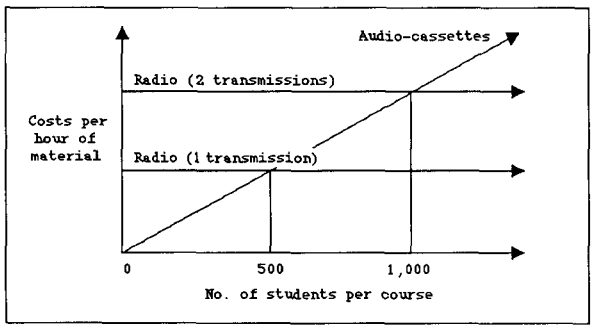
High fixed/production costs are more easily justified when there are large numbers of students following a course, especially if the material can be used over a number of years.

Technologies also differ considerably in their variable costs, i.e. the costs associated with the number of students using the learning material. The variable cost for delivering a radio programme is zero: it costs the same to transmit whether listened to by one or one million listeners; it varies for audio-cassettes in direct proportion to the number of cassettes that need to be sent.

Figure 1 shows the difference between radio broadcast and audio-cassette delivery in terms of variable costs per hour of material (Bates and Kern, 1977). At the British Open University, the cost of delivering audio as a single radio transmission was lower when there were more than 500 students per year on a course; if a programme has to be broadcast again at a different time (in order to reach the substantial number of students who would not be home

Table IV. Fixed Production Costs (including overheads) for One Hour of Teaching Material

Face-to-face lecture:	1 unit
Audio-cassette/radio/teleconference	2 units
Televised lecture	2-5 units
Computer-mediated communication	2-5 units
Print	2-10 units
High-quality TV programme	20-50 units
Pre-programmed computer-based learning	20-50 units
Computer-controlled video-disc (from scratch)	50-100 units



adapted from Bates and Kern, 1977.

Fig. 1. Radio and audio-cassettes: Structure of delivery costs (UK Open University).

to receive the first transmission), then the cost of radio was not lower than delivery by audio-cassette unless there were over 1000 students on a course.

CONCLUSIONS

Conclusions about the balance of costs for different technologies are that:

The cost of putting equipment into local centers can far exceed central capital costs in certain circumstances, e.g. for organizations with multiple study centers. The major cost of using technologies is in production and hence recurrent, rather than capital: for instance, the yearly recurrent cost often exceeds the total start-up capital cost; in general, the recurrent costs of producing good quality technology-based materials tend to be underestimated. Technologies vary considerably in their fixed and variable costs. Audiocassettes and radio have low fixed and low variable costs. Face-to-face teaching, computer-mediated communication and tutor-mediated telecourses have low fixed costs but high variable costs. Good quality broadcast television has high fixed costs and low variable costs. Computer-based learning and video-discs have both high fixed and high variable costs, if workstations are to be provided. Since production is the main cost, and hence fixed for any course, for most technologies currently used, fixed costs usually far exceed variable costs. This means that the economies of scale apply to traditional distance education courses: the more students, the more cost-effective technologies become. Some interactive technologies such as computer conferencing and audiographics reduce fixed costs, but have high variable costs; thus, while suitable for courses with relatively low student numbers, they are very expensive for courses with large student numbers. Broadcast distribution is uneconomical for national distribution with less than 500 students per course for television, or less than 1,000 students per course for radio; satellite distribution may be economically viable on a regional basis, if the production costs are justified in terms of the target audience. Audiocassettes are a particularly economical media; audio-cassettes plus print is usually a cheaper combination than the cheapest form of video or computer-based learning. It can be seen that the likely size of a course, in terms of student numbers, is crucial in influencing the choice of technology.

Teaching Functions. Discriminating between media on the basis of access or cost is much easier than on teaching effectiveness. Each media can be used in a wide variety of ways. Consequently, differences within a media (for instance, between two television programmes, one a televised lecture and the other a documentary) may be greater than between media (for instance, between a face-to-face lecture and a lecture on a radio programme). Nevertheless, intrinsic differences between media are being identified which have implications for teaching and learning, and which can guide technology selection.

Media differ in the extent to which they can represent different kinds of knowledge (Bates, 1982). Some media are better than others for certain kinds of representation of particular significance to teaching. In particular, media differ in their ability to handle concrete or abstract knowledge (Olson and Bruner, 1974). Abstract knowledge is handled primarily through language, while media vary in their ability to represent concrete knowledge (examples, demonstrations, etc.). Video, for instance on television, can represent events that cannot be brought into the classroom or laboratory, and can provide full symbolic representation of events or movement. Experiments with television show that it is very rich symbolically, able to handle all forms of representation of knowledge, except direct experience (Salomon, 1979). Bates (1988) identified a number of appropriate functions for television, from research conducted on British Open University programs over a period of 15 years, including: (a) demonstrate processes or procedures, (b) "model" or construct concrete examples of abstract ideas, (c) demonstrate interpersonal communication, and (d) dramatize or reconstruct events through documentary-style production.

These representational possibilities are more critical for non-academic learners, who often require concrete examples or demonstration rather than abstract theory (Trenaman, 1967; Gallagher, 1977). However, this form of television is much more expensive to produce than the use of television for relaying lectures. Using television to relay lectures does not fully exploit the unique presentational characteristics of television; indeed, audio plus printed notes is equal symbolically to a televised lecture and is more likely to be effective.

Research has also indicated that media differ in the extent to which they can help develop different skills (Salomon, 1979). Part of this relates to the control characteristics of technologies and part to the representational features. For instance, computers are excellent for presenting and testing rule-based procedures, or areas of abstract knowledge where there are clearly correct answers.

Television on the other hand, because of its richness of symbolic representation, and hence the need for interpretation, is better at presenting ambiguous situations, where a variety of possible learner responses are equally acceptable. This quality can be particularly valuable for professional updating and training, where trainees already have a good knowledge base, but need to adapt to changing situations. Also, television is valuable for developing mechanical or procedural skills, where students need to see relationship between parts and sequencing of activities, for developing inter-personal skills, and for changing attitudes, through the use of dramatization or documentaries with which the student can clearly identify (Trenaman, 1967). Television on its own though is unlikely to be sufficient for the development of such skills; some form of practice and feedback on performance, or discussion of various interpretations, are also needed.

These pedagogic differences between media indicate the importance of course designers identifying clearly not only the content of a course, but also how best to present knowledge in a particular subject area, and what kinds of learning (comprehension, analysis, application of principles to actual cases, problem-solving, inter-personal skills, mechanical skills, attitude change, etc.) are required. A good understanding of what is required to teach a particular subject needs to be combined with good knowledge of the pedagogic strengths and weaknesses of different media. Consequently, the selection of media is not just a technical issue, nor one that is purely academic.

Interaction, User-Friendliness and Control. Another major criterion influencing choice of technology is the control over the media available to the learner. Research has indicated that learning from ephemeral media is much more difficult than learning from permanent material (Bates *et al.*, 1982). Furthermore, there are design implications, once material is available in permanent form. Television material for use on cassette for instance does not have to resemble the continuous, lengthy broadcast format. Videocassettes can contain short, unlinked sequences, with activities following each sequence, and feedback provided on the activity, either on the cassette itself, or in notes. Video-cassettes in particular lend themselves to group use, because of the need for interpretation and discussion of video examples. This can increase the activity and participation of the learner.

Interactivity is the ability for the learner to respond in some way to the instructional material, and obtain comment or feedback on the response—considerably increases learning effectiveness. There are two very different kinds of interactivity: 1) between people, between the student and a teacher or tutor, and between students; 2) between the learner and the instructional material. Media differ in their ability to provide these two types of interaction.

The significance of two-way technologies is that they allow for interaction between learners and instructors or tutors, and perhaps more significantly, in some cases amongst distance learners themselves. Table V (Bates, 1993) summarizes the distinctions:

One-way media, such as print and broadcasting, require supplementing by 'two-way' interaction with tutors, through correspondence, telephone or computer communication. Some technologies make it easier to provide feedback on student responses to the instructional material, such as in computer-based learning, where learners can be tested, corrected, or given remedial activities by the computer. Computer-controlled videodiscs or multimedia courseware combine the strong interactivity of computers with the powerful representational qualities of television. However, these technologies have great difficulty in handling learning contexts where individual interpretation or the development of argument is needed. Audio- and video-cassettes can be designed to increase learner interaction, and do allow for more open-ended and interpretative responses, but still

Table V. One-Way and Two-Way Technology Applications in Distance Education

Media	One-way technology applications	Two-way technology applications
text	course units; suupplementary materials	correspondence tutoring; data-bases; electronic publishing
audio	cassette programmes; radio programmes;	telephone tutoring; audio-conferencing
television	broadcast programmes; cassette programmes	interactive television (TV out, telephone in); video-conferencing
computing	CAL; CAI; CBT; databases; multimedia	E-mail; computer-conferencing

need supplementing with some form of two-way interaction with people.

Perhaps the most critical element of control is the ability for open-ended two-way communication under the students' control, allowing students to interact easily not only with tutors, but also with other students. Until recently, the telephone has been the only means of doing this for students at a distance, and costs have been high. Computer-mediated communication though now enables two-way communication at a distance, at asynchronous times, at relatively low cost, between students, and between students, regional tutors or even central academic staff. This could have revolutionary implications for distance learning, providing the means to free students from the centralized control of pre-prepared and constricted curricula.

What is clear is that the design of multimedia distance learning materials which encourage active learning requires considerable instructional as well as programming expertise. An understanding of both of media and learning is required.

Organizational Issues. The existing technological provision within a country or an institution is a major factor in influencing media selection. If there is already a broadcast network in place, it is much easier to introduce television for distance learning purposes. Television transmission then becomes a marginal cost on an already established system. On the other hand, the need to exploit the already existing technological infrastructure within an institution can be a major conservative influence limiting the application of new technologies.

Another organizational factor is the existing funding arrangements for course production within partner institutions. If courses have traditionally been based on typeset print, it is likely that the Director of Publishing or Head of Operations has a senior decision-making role, because of his or her control over a large budget. Introducing the use of a new technology may require the shift of funds away from traditional budgets into new lines. This is likely to lead to opposition from those who control the budgets of traditional technologies, who may feel that their power is being eroded.

Lastly, innovation in this area depends essentially on "champions for change" at a high level: a Vice-Chancellor, Dean or course team member who is willing to fight for the introduction of new technology and approaches. The reverse is also true: inappropriate choice often results from champions of a particular technology, who are often specialists in that technology, but not in others.

Novelty. This is perhaps the least important criterion, but it is often easier to get funding for new uses of technology. While audiocassettes combined with print materials can be a very low-cost but highly effective media, it is usually easier to persuade funding agencies to invest in more spectacular technologies such as computer-controlled videodiscs or satellite voice and data networks. Furthermore, the application of a new technology can stimulate change and development in well-established institutions that are becoming a little stale, and this new impetus may have more impact than merely the use of the technology itself.

Speed. An increasing problem for open and distance learning systems is the time it takes to produce a course, and the time a course has to last without changes once produced. It is not uncommon for a print-based course to take at least two years from the time approval for the course is given to the time the course is actually presented to students. Furthermore, once produced, many courses have to remain unchanged, despite known errors or weaknesses in the material, or changes in the subject matter that make the material out of date, because of lack of funds for major changes, or higher priority for the production of new courses.

Increasingly, particularly in the area of social sciences, information technology, research-based subjects, courses linked to public policy issues, and professional development, courses need to be put on quickly, and easily up-dated and changed. Print in particular is a slow technology; electronic publishing can enable relatively minor changes to be made, so that each year the materials are re-printed, but it still does not speed up much the initial design process.

Some of the more interactive technologies though, such as audioconferencing and computer conferencing, do allow for a quick development of a course and continuous up-dating.

Critical Points About Media and Technology in Distance Learning

Some critical points about media and technology in Distance Learning need to be underlined:

Media are Flexible. Media are generally flexible and hence interchangeable, i.e. what can be achieved educationally through one media can usually be achieved through any another media, given sufficient imagination, time and resources. The absence or non-availability of a particular media does not necessarily prevent learning goals from being achieved.

Professional Production and Design is Essential. Each media has its own aesthetic, and a different range of production skills is necessary to exploit the unique features of each media; this means that quality production counts.

There is No "Super-Media". All technologies have their strengths and weaknesses, and what is a strength in one media is often a weakness in another; this implies then that a multimedia approach is usually more desirable.

Good Teaching is Essential. The rules of good teaching (clear objectives, good structuring of learning materials, relevance to learners' needs, etc.) apply to the use of any media for teaching; if these are broken, then the teaching will fail, even of the unique characteristics of the media are stylishly exploited. Thus entertaining television programmes do not necessarily lead to effective teaching (Gallagher, 1978).

Balance Variety with Economy. The greater the number of technologies used, the more complex the design process, and the greater the chance of redundancy and wasted expenditure; the aim therefore should be to use a limited range of media in any given context, maximising learning effectiveness at minimum cost, balanced by convenience and ease of use to both learner and teacher.

Provided these caveats are born in mind, an analysis of each of the ACTIONS criteria should help considerably in choosing and using technology for Distance Learning.

4. FUTURE DEVELOPMENTS AND RESEARCH ISSUES

Developments are expected in the near future in the field of new media solutions, as well as of new designs associated with them. Since infrastructure efforts can be found is several countries, integrated digital technologies and multi-point two-way communications will spread out and offer solutions for distributed multimedia learning environments (Bourdeau *et al.,* 1994; Paquette, Bergeron and Bourdeau, 1993; Pea and Gomez, 1992). Low cost satellites and wireless communications are expected by the end of this century and should revolutionize the way distance learning can be designed and conducted. Nevertheless, low technology solutions like radio or printed material will continue to be needed where existing infrastructure does not allow more interactive ones.

In both technical and pedagogical areas, research and development programs and projects such as DELTA in Europe will continue to provide advanced tools and ideas on Co-authoring at a distance, Teleschool, Teletutoring, or Automated Instructional Design (DELTA, 1993).

Open research questions in the field of ID for DL can be classified under: (a) epistemology and theory, (b) methodology, and (c) tools and media.

A theoretical framework for ID in DL is badly needed to provide Instructional Designers with a comprehensive framework in which to work. One of the ID theories could be extended to DL, taking into account specific DL concepts, goals and constraints.

Epistemological foundations need to be investigated in this field as much as in instructional design in general, to provide a better understanding of phenomena, and to provide a basis for designing instructional environments (Holmberg, 1985; Lamontagne and Bourdeau, 1992).

Methodologies for ID in DL need scientific foundations and experimental validation (Bååth, 1980). One challenge from Bloom is the search for methods for group learning which would be as effec-

tive as mastery learning and one-to-one tutoring (Bloom, 1984). This challenge applies to group learning at a distance, and there is a need for significant ID solutions to be developed and tested, before one can observe and learn about these new phenomena (Salomon, 1992). The design of collaborative learning activities for DL should be studied in relation to new psycho-sociological phenomena emerging as soon as new technologies are tried (Dede, 1989). The design of instructional groupware, already investigated in general (O'Malley and Scanlon, 1989), should be studied more specifically according to DL situations.

Perspectives in Automated Instructional Design Environments provide sound tools and standard quality for instructional material, as well as reduce costs (Spector, M., Polson, M., and Muraido, D., 1993; Bourdeau et al., 1995); they should be explored more specifically for DL.

More areas needing investigation include:

Adapting and respecting cultural and multicultural identity in ID for DL, Quality insurance methodologies for ID for DL, Modes and types of interactivity in DL, and Links between media and learning outcomes in DL situations.

ACKNOWLEDGMENTS

Section 3 draws heavily on material previously published in *Technology in Open Learning and Distance Education*, a multimedia package prepared by the Open Learning Agency for the Commonwealth of Learning.The authors also wish to thank Dr. Laura Winer for revision and useful suggestions.

REFERENCES

Anderson, R. H. (1976). *Selecting and developing media for instruction*. Van Nostrand Reinhold. New York.

Bååth, J. (1980). *Postal two-way communication in correspondence education*. LiberHermods. Malmö, Sweden.

Bates, A. W. (1982). Roles and characteristics of television and some implications for distance learning. *Distance Education*, 3.

Bates, A. W. (1988). Television, learning and distance education. *ICDE Bulletin*, 16.

Bates, A. (Ed.). (1990). *Media and Technology in European Distance Education*. European Association of Distance Teaching Universities.

Bates, A. W. (1992). *Technology in Open Learning and Distance Education*. Commonwealth of Learning/Open Learning Agency. Vancouver, Canada.

Bates, A. W. (1993). Theory and practice in the use of technology in distance education. In D. Keegan (Ed.), *Theoretical Principles of Distance Education*. Routledge. London, U.K.

Bates, A. W., and Kern, L. (1977). *Alternative Media Technologies for the Open University*. Open University Institute of Educational Technology. Milton Keynes, U.K.

Bates, A. W. (1982). *Radio: The Forgotten Medium?* Open University Institute of Educational Technology, Paper No. 185. Milton Keynes, U.K.

Bloom, B. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher*, 13:(6), pp. 4–16.

Bourdeau, J., Jungiuger, S., Kuyrer, M., Marshall, I., Schwab, S., and Sorg, B. (1995). Automating Instructional Planning in Tennyson, R., and Baron, A., ed., *Automating Instructional Design: Computer-Based Development and Delivery Tools*. Berlin: Spring Valley, pp. 559–569.

Bourdeau, J., DeLaTeja, I., Frihida, A., and Gecsei, J. (1994). Accessing distributed multimedia databases for instructional use in Ottman, T., and Tomek, Y., in the *Proceedings of ED-MEDIA'94*. Charlotteville, VA.: AACE, pp. 523–528.

Burge, L. (1988). Beyond andragogy: Some explorations for distance learning design. *Journal of Distance Education, 3*, pp. 5–23.

Burge, L. (1989). Making sense of Practice: Some inside-out theorising. In M. Parer (Ed.), *Development, Design and Distance Education* (2nd ed). Churchill Victoria, Australia: Center for Distance Learning, Monash University College, Gippsland. pp. 233–247.

Burge, L. (1990). Interactive audio classrooms: Key principles for effective practice. *Education for Information*, 8, pp. 299–312.

Dede, C. (1989). The evolution of distance learning: technology-mediated interactive learning. Report for the Study *Technologies for Learning at a Distance*, Office of Technology Assessment. Washington, DC.

DELTA (1993). *Telematics Systems for Flexible and distance Learning*. DELTA Publ. Brussels, Belgium.

Gagné, R. (1985). *The Conditions of Learning*. Holt, Rinehart and Winston. New York.

Gagné, R., Briggs, L., and Wager, W. (1992). *Principles of Instructional Design* (4th ed.). Harcourt Brace Jovanovich Publ. Fort Worth, Texas.

Gallagher, M. (1977). *Broadcasting and the Open University Student: the 1977 Survey*. The Open University Institute of Educational Technology. Milton Keynes, U.K.

Gallagher, M. (1978) Good television and good educational practice: Problems of definition. *Educational Broadcasting International*, 11.

Gallagher, M. and Marshall, N. (1976). *Report on VCR Project, 1974/75*. Open University Institute of Educational Technology. Milton Keynes, U.K.

Harrison, N. (1991). *How to Design Effective Text-Based Open Learning. A Modular Course*. McGraw-Hill. London, U.K.

Holmberg, B. (1982). *Distance Education, a Short Handbook*. LiberHermods. Malmö, Sweden.

Holmberg, B. (1985). *Status and Trends of Distance Education* (2d Ed.), Lector Pub. Lund, Sweden.

Holmberg, B. (1986). *Growth and Structure of Distance Education*. Croom Helm. London, England.

Inglis, A. (1989). Fifteen years of instructional design: A personal perspective. In Parer, M. (Ed.), *Development, Design and Distance Education* (2nd Ed.). Center for Distance Learning, Monash University College, Gippsland. Churchill Victoria, Australia. pp. 259–277.

Jackling, N. (1989), Weaving my own design. In Parer, M. (Ed.), *Development, Design and Distance Education* (2nd Ed.). Center for Distance Learning, Monash University College, Gippsland. Churchill Victoria, Australia, pp. 33–51.

Kaufman, D. (1989). Third generation course design in distance education. In R. Sweet (Ed.), *Post-Secondary Distance Education in Canada*. Athabasca University and Canadian Society for Studies in Education. Athabasca, Canada.

Keller, J. (1987). Motivational design of instruction, in Reigeluth, C., *Instructional-Design Theories and Models*. LEA, Publ. Hillsdale, New Jersey.

Köymen, Ü. (1989). Design theories for distance education. In M. Parer (Ed.), *Development, Design and Distance Education* (2nd Ed.). Center for Distance Learning, Monash University College, Gippsland. Churchill Victoria, Australia. pp.247–259.

Knowles, M.S., (1980). *The Modern Practice of Adult Education: Pedagogy vs. Andragogy* (2nd ed). Association Press/Follett. Chicago, Illinois.

Lamontagne, C., and Bourdeau, J. (1992). The Popperian connection: Toward an epistemology for Intelligent Tutoring Systems. In Frasson, C. Gauthier, G., and McCalla, G. I. (Eds.), *Intelligent Tutoring Systems*. Springer Verlag. Berlin, Germany.

Lewis, R. and Spencer, D. (1986). What is open learning? *An Introduction to the series*. Council for Educational Technology. London, GB.

Lewis, R. (1990). *How to Write Flexible Learning Materials*. A brief practical guide. National Council for Educational Technology, University of Warwick. Warwick, U.K.

Merrill, D. (1983). Component display theory, in Reigeluth, C. (Ed.), *Instructional-Design Theories and Models*. LEA, Publ. Hillsdale, New Jersey.

Moore, M.G. (1977). A model of independent study. *Epistolodidaktika*, 1, 6–40.

National Institute on Multimedia Education. (1989). Technological innovation and life-long education. In *The 2nd Symposium on University Distance Education*, Report on Multimedia Education, Oct. 19-20, Chiba, Japan.

National Institute of Multimedia Education (1992). *A Survey of distance Education in Asia and the Pacific*. Chiba, Japan.

O'Malley, C., and Scanlon, E. (1989). Computer-supported collaborative learning: Problem-solving and distance education. Centre for Information Technology in education, Open University. *Report No. 75*. Milton Keynes, U.K.

Olson, D., and Bruner, J. (1974). Learning through experience and learning through media. In Olson, D. (Ed.), *Media and Symbols: The Forms of Expression*. University of Chicago Press (The 73rd NSSE Yearbook). Chicago, Illinois.

Paquette, G., Bergeron, G., and Bourdeau, J. (1992). The Virtual Classroom revisited, in Davies, G., and Samways, B., ed., *Teleteaching, IFIP Transactions A-29*. Amsterdam: North-Holland, pp. 639–647.

Pea R., and Gomez L. (1992). Distributed multimedia environments. *Interactive Learning Environments*, 2, 73–109.

Perry, W. (1976). *Open University*. Open University Press. Milton Keynes, U.K.

Reigeluth, C. and Stein, F. (1983). The elaboration theory of instruction, in Reigeluth, C., (Ed), *Instructional-Design Theories and Models*. LEA, Publ. Hillsdale, New Jersey.

Reiser, R. A., and Gagné, R. (1983). *Selecting Media for Instruction*. Educational Technology Publications. Englewood Cliffs, New Jersey.

Report of the Task Force on Distance Education. (1992). Pennsylvania State University, November 1992. University Park, Pennsylvania.

Romizowski, A. (1981). *Designing Instructional Systems*. Kogan Page. London, U.K.

Romiszowski, A. (1986). *Developing Auto-Instructional Materials*. Nichols. New York, New York.

Salomon, G. (1979). *The Interaction of Media, Cognition and Learning*. Jossey-Bass. London, U.K.

Salomon, G. (1992). in *SIGCUE Outlook, Special Issue on Computer-Supported Collaborative Learning*, ACM Press, Spring 1992.

Sparkes, J. (1984). Pedagogic differences between media. In Bates, A. W. (Ed.), *The Role of Technology in Distance Education*. Croom Helm. London, U.K.

Spector, M., Polson, M., and Muraida, D. (1993). *Automating Instructional Design*. Lawrence Erlbaum Associates. Hillsdale, New Jersey.

Stahmer, A., Bourdeau, J., and Zuckernick, A. (1992). *Life-long Learning and Technologies*. Report to the Canadian Government, Prosperity Secretariat. Ottawa, Canada.

Trenaman, J. (1967). *Communication and Comprehension*. Longmans. London, U.K.

Verduin, J., and Clark, T. (1991). *Distance Education: The Foundations of Effective Practice*. Jossey-Bass Inc. Publishers. San Francisco, California.