THE AMERICAN JOURNAL OF DISTANCE EDUCATION,
Vol. 4 No. 3 1990

An Instrument for Evaluating the Potential Effectiveness of Electronic Distance Education Systems

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Introduction

Many educators have recognized the value of electronic distance education (EDE) in solving the problem of educational inequities for isolated learners. Some scholars, however, plunge headlong into EDE before its potential has been studied, making uniformed choices about purchasing expensive devices. While there is interest in studying cost effectiveness of EDE systems, such studies, by their nature, take place after expensive devices are in place and even then, relate more to cost than to effectiveness. While a study of effectiveness may not be possible before a project is in place, potential effectiveness can be estimated in advance of installation. The purpose of this article is to describe a procedure which can be used as a guide for device selection prior to making costly commitments. While the value of this procedure is most apparent in EDE, it has applicability to distance education in general, including such methods as correspondence.

Before describing the procedure, some fundamental concepts associated with EDE will be discussed so as to provide a context for use.

Problems with Traditional Media Selection Schemes

Most media selection schemes do not deal with critical dimensions of EDE (Reiser and Gagné 1982). These dimensions (treated in detail later) include time and place dependence, ease of use, immediacy of communication, communication linkages, and degrees of abstraction. In EDE, media are not merely supplementary but are the means of all communication. Selection of an EDE system differs from typical “media selection” in that what is selected is communication channels (media) through which instructional materials or messages (media) must pass, thus giving new meaning to McLuhan’s (1964) well known quote, “The medium is the message.”

This highlights the fact that the term *media* has too many definitions to be of much value to EDE. For example, *media* is defined by UNESCO (1984) in two ways; (1), "a generic term for all of the forms and channels used in transmission of information" (p. 71) and (2), "…those means which present a complete body of information" (p. 37). The first definition may encompass the concept of an EDE system, but the second refers to educational materials. Association for Educational Communications and Technology (AECT, 1977) avoids the term *media* in favor of the term *devices* which is defined as "Items (usually called hardware) which transmit Messages stored on Materials" (p. 152). This terminology is similar to that used by Verner (1962) who fifteen years earlier defined the processes of adult education in such a way as to be applicable to EDE today.

Methods, Techniques, Devices, and Systems

Verner (1962) in clarifying the terms *device*, *method*, and *technique*, pointed out that devices are those "mechanical instruments or environmental factors [which] may be employed to augment instruction...but cannot themselves function independently as techniques for the acquisition of knowledge" (p. 10). Verner uses the term *method* to describe relationship between an institution and learners. In other words, *methods* are the way learners are organized in society. A class is an example of a large group method, an apprenticeship is an example of an individual method, and an assembly is an example of a mass method. *Technique* describes instructional relationships between the learner and the material to be learned. Examples of techniques are lectures, group discussions, case studies, debates, and panels. For Verner, *devices* were those things in the environment which assist learning. Examples of *devices* include the ubiquitous chalkboard as well as the often over-looked chair. For example, the arrangement of a room could be a *device*.

Burnham and Seamons (1987) have observed that in EDE, "...devices, especially electronic devices and systems, can affect methods or even create methods....[this] is a departure from the conventional notion that method and technique largely determine devices used" (p. 10). This new relationship between devices and method is that devices *enable* (or *disable*) methods and techniques by the nature of communication they allow. This interconnection of devices, methods and techniques, along with the other parts of an instructional setting can be viewed as a *system*. A *system* is defined in Merriam-Webster as "a group of units so combined as to form a whole and to operate in unison" (p. 694). Any learning situation where methods and techniques enabled by electronic devices combine with instructors and learners who physically separated and who use methods, techniques enabled by electronic devices to transmit instructional messages over the distance between them is an EDE system. Such a system is represented in Figure 1.

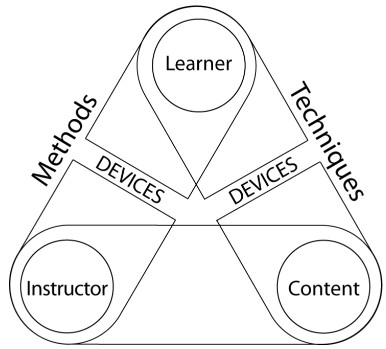

Figure 1. An Electronic Distance Education System

Note that this representation includes the instructor and learner, though we do not consider them in this article. Here, we deal with a system's *potential* effectiveness as it applies to devices and methods.

How Systems Affect Learning

Ample evidence exists to demonstrate that devices (media) affect the learning outcomes only as they affect methods and techniques. For example, Clark and Salomon (1986) stated that "...media do not affect learning in and of themselves" (p. 474). Hoko (1986) said, "There appears to be no distinct advantage of one medium over another divorced from what that medium presents to the learner" (p. 18). Schramm (1977) observed that, "A common report among [media] experimenters is that they find more variance *within* than *between* media—meaning that learning seems to be affected more by what is delivered than by the delivery device. How a medium is used may therefore be more important than the choice of media..." (p. 273). Over the years comparisons of various media to one another have found no evidence that one is better than any other in terms of learning outcomes (Clark and Salomon 1986).

This may be generalized to EDE systems. There is evidence that learning and performance are not affected by the delivery devices used, but by the quality of instruction that passes through them (Rudolph and Gardner, 1986; Rushton and Branson, 1983; Weingand, 1984).

The Potential Effectiveness Inventory (PEI)

The more kinds of communication an EDE system permits, the greater its potential to deliver high quality distance education. It is on this potential that the proposed procedure is based. The process for determining a system's potential effectiveness resulted in the development of the Potential Effectiveness Inventory (PEI). As noted earlier, in EDE, new devices are often the building blocks of new methods: by looking at what the devices allow, we can make decisions about which ones will enable productive methods of distance education.

Rating EDE Systems

To devise a rating system, consideration was given to various media-related studies (Dale 1969; Paulsen 1988; Keegan 1988; Shale 1988; Mitchel 1981; Philips and Pease 1987) and informed by the authors' personal experiences with existing and developing EDE system. These considerations provided the following five critical dimensions associate with potential effectiveness. Though there is a wider agreement about the importance of some of these qualities or dimensions that other, all those conceived were included here. While this list may not be all-inclusive, it appears to cover every possible way an EDE system could be viewed. The five dimensions are Time and Place Independence, Realism, Communication Paths, Ease of Use, and Immediacy (or Speed).

Time and Place Independence. There appears to be a rift in the literature between distance educators who insist that the independence of the learner from time and place of learning is most important, and those who believe that interaction between students and teacher is the most vital. The dividing line falls primarily between those who define distance education along the lines of the Open University concept espoused by the British (see Keegan, 1988), and those who lean toward the methods enabled by new communication technologies (see Shale, 1988). In theory, they appear to be contradictory; in fact there is at least one existing EDE system—computer conferencing—that allows for both. Other systems may soon follow.

Realism. Generally media which permit transmission of realistic, concrete information are capable of transmitting abstract information as well, though the reverse is not generally true. Therefore, the more *realis-*

tic information (as opposed to symbolic information) that can be transmitted, the more *kinds* of communication are allowed. For example, electronic chalk is capable of transmitting representational graphics, but not photographic (concrete) visual images. A video system, on the other hand, which is intended for use with photographic images, can be readily used to photograph an abstract diagram drawn on paper or chalkboard, thus enabling transmission of abstract information as well as realistic.

Communication Paths. This dimension deals with the abilities of EDE devices to link people in conversation. In a classroom setting, learners and instructors form multiplex linkages as each person in the room can hear and talk with all others in the room. At the other end of the scale is simplex linkage where communication is one-way—from teacher to student, for example. Note that this dimension also takes in situations where the teacher-to-student communication channel is more powerful than student-to-teacher (semi-duplex) and where duplex communication is mimicked by a computer (pseudo-duplex).

Ease of Use. Ease of use refers to skills needed to operate an EDE system. Some EDE devices can be operated by the instructor with minimal training, while others require technicians to operate. In a system where a technician is essential to operation, that technician, for purposes of this analysis, could be considered a part of the "hardware," and the costs associated with the technician should be included in any cost analysis.

Immediacy. This refers to how fast the system transmits information. Some systems can require minutes, hours, or even days, while others are instantaneous. For example in a dial up telephone service (often used in conjunction with broadcast video) is usually considered instantaneous when, infact, it may require several minutes to get an answer when a learner must dial a toll free number, wait for it to ring and be answered, ask the question of an aide who screens questions and who then passes the question on to the instructor who finally answers it. On the other hand, a learner using a system based on dedicated phone lines could interrupt the instructor in mid-sentence, if desired, to ask a question.

Each of these dimensions can be represented as continua with values assigned to a number of points along each continuum. Table 1 presents the five continua with three to five points defined along each.

The assigned values on each of the continua were used in to construct the PEI. Each point value was obtained by assigning the optimal level the number three, and the least optimal end of the continuum one, and then dividing each continuum among the points between one and three.

Table 1. EDE Dimensions with Assigned Point Values on Each Continuum

Time/Place Independence		
3.0	independence	No set time or locations are needed for learning activities
2.0	semi-dependence	Time/place dependent and independent activities are about equal
1.0	dependence	Students and teachers must always meet at specific times and/or places
Level of Realism (or Abstraction) Possible		
3.0	concrete	Capable of realistic (photographic) rendering
2.0	representational	Between abstract & concrete, representative rendering (i.e., graphics)
1.0	symbolic	Capable of symbolic (verbal) rendering only
Communication Paths Available		
3.0	multiplex	Student-to-teacher, teacher-to-student and student-to-student interaction possible.
2.5	duplex	Student-to-teacher & teacher-to-student, but no student-student interaction
2.0	semi-duplex	Student-to-teacher interaction is less capable than teacher-to-student interaction.
1.5	pseudo-duplex	Simulated interaction by computer
1.0	simplex	Teacher-to-student communication only
Ease of Use		
3.0	novice	No special training required for use
2.0	amateur	Special training needed for use
1.0	professional	High degree of training required for
Speed		
3.0	instantaneous	No delay between transmit and receive
2.5	seconds	Takes up to a minute to transmit
2.0	minutes	Takes up to an hour to transmit
1.5	hours	Takes up to a day to transmit
1.0	days-weeks	Takes several days to weeks to transmit

Rating the Dimensions

To study the inter-relationships between these dimensions, a survey was crated which compared each of the dimensions to one another. For the survey, all dimensions were stated as the most positive end of their continuum and respondents were then asked to compare the importance of these positively-stated references to the dimensions in an EDE system. No intra-dimensional rating was attempted.

Because the survey was conducted by telephone, every dimension was compared to each of the others (one-on-one) using a methodology similar to that used by political pollsters as they compare individuals campaigning for public office. This pairing of the five dimensions provided a total of ten comparisons or questions. Three additional comparisons were asked in reverse order as a validity check to the original ten. The thirteen questions were randomly ordered for the interview.

Conducting the Interviews

Twenty three individuals were identified as “experts” by referring to the literature and by asking these people for additional referrals of knowledgeable individuals. An initial phone call was placed to arrange for the interview followed by a letter which confirmed the interview time and, more importantly, described and defined the dimensions to be ranked. Out of 23 experts originally identified, 19 were actually interviewed. The remaining four could not be reached.

Respondents were classified as: theorists, practitioners, or consultants. There were eight theorists, generally college or university professors; seven practitioners, teachers and instructors who actually used an EDE system; and four consultants from industry who worked for communication companies or consulting firms.

Respondents were asked to rank the dimensions. Whenever a respondent wanted to give a tie to the dimensions being ranked, they were instructed to answer as if all other factors were equal, which usually solved their dilemma. Whenever a respondent seemed unable to differentiate two items, they were allowed to rank them as equal.

Results of the Interviews

Responses were scored by giving one point to each selection of the pair. On a tie response, half points were given to each. These points were then tallied to give each respondent’s survey a rank score for each dimension. Because each dimension is compared in the survey four times, the maximum number of points possible (i.e., the highest ranking) is four. Pearson’s r was calculated using the reversed questions as the second variables and provided a coefficient of .88 indicating a high degree of consistency within respondents' rankings.

The mean rank scores (in Table 2) *communication paths* was ranked highest, *ease of use* and *realism* were next, with *time/place independence* and *speed* ranked the lowest.

Table 2. Ranked Scores and Standard Deviations of EDE Device Dimensions

	Mean Rank Score	SD
Communication Paths	3.37	1.05
Ease of Use	2.24	0.92
Realism (degree of Abstraction)	2.16	1.03
Time and Place Independence	1.53	1.25
Speed	0.71	0.98

The relatively small standard deviations indicate that there was general agreement among respondents as to where particular dimensions rank in terms of importance.

While the ranking of dimensions is interesting, it is useful only if it can be used to evaluate EDE systems. To accomplish this, numbered points along each continuum (from Table 1) were multiplied by the continuum's rank to derive a weighted value. Table 3 provides brief descriptions of the points in each dimension, the means, and weighted values for points along each continuum (or dimension). It is these weighted values that are used to construct the PEI.

Table 3. Points, Means, and Weighted Values by Dimension

Dimension	Continuum Points		Survey's Means		Weighted Values
Communication Paths					
Multiplex	3.0				10.1
Duplex	2.5				8.4
Semi-duplex	2.0	x	3.37	=	6.7
Pseudo-duplex	1.5				5.1

Simplex	1.0				3.4
Ease of Use					
Novice	3.0				6.7
Amateur	2.0	x	2.24	=	4.5
Professional	1.0				2.2
Realism					
Concrete	3.0				6.5
Representational	2.0	x	2.16	=	4.3
Symbolic	1.0				2.2
Time-Place Independence					
Independence	3.0				4.6
Semi-dependence	2.0	x	1.53	=	3.1
Dependence	1.0				1.5
Speed					
Instantaneous	3.0				2.1
Seconds	2.5				1.8
Minutes	2.0	x	.71	=	1.4
Hours	1.5				1.1
Days/weeks	1.0				.7

Administering the PEI

A PEI is administered by selecting the description under each dimension (from Table 1) which most closely fits the proposed delivery system in typical daily operation, assigning the appropriate weighted value (from Table 3), and summing the weighted values. Note that the PEI score is of value only as a comparative score.

Take, for example, an imaginary satellite EDE system. A typical system consists of a satellite transmission to geographically scattered receiving stations. Feedback is by an open telephone line connected in all receiving sites. Technicians operate the entire system, so participants are free to participate.

This system's PEI would probably be as follows: On *communication paths*, this system would be rated as "semi-duplex" since the teacher clearly has better communication channels than students. Semi-duplex has a score of 6.7. Under *ease of use*, the presence of technicians handling the complexities of the system remove it from the real of "professional," but some training is still required, a probably rating of "amateur," a score of 4.5. The video capabilities of satellite are very realistic, so this system would probably rate as "concrete," a score of 6.5. The nature of this communication is that the people involved must meet at specific times and places, therefore it is *time/place* "dependent, for a score of 1.5. Finally, the system has been designed to have no delay; student receive transmissions practically "instantaneously," and their responses can also be "instantaneous" due to the open phone line. This give a score of 2.1 in *speed*. The PEI score for the EDE system described is 6.7+6.7+4.5+1.5+2.1=21.5.

The PEI score is meaningless, of course, unless it is used to compare this EDE system to a system with differing capabilities. Particularly interesting would be this comparison combined with a cost comparison.

It is important when evaluating an EDE system to remember that occasionally, a system has auxiliary devices or modes which make it appear to rate high on every single dimension. The rater must judge whether such modes are a part of typical daily operation, or are merely infrequent or potential circumstances. For example, in one correspondence course the professors phone number is included on the syllabus with a list of hours available; a student could *potentially* contact the instructor independently by telephone to ask a question. In another situation, students are given specific, toll-free telephone numbers to call for regular, specific further instruction or instructional support. In the former case, the telephone should not be considered a part of the delivery system, but it should be in the latter.

Discussion

While the ranking of *communication paths* as the most important quality in EDE seems obvious, there may be some disagreement due to perceived incompatibility between it and *time/place independence* (ranked fourth). We found it curious that *independence*, which has generated much discussion in distance education circles, is valued relatively low in this survey. This may be due to the fact that before the advent of EDE, one (if not the only) major virtue of distance education was the independence afforded to learners. EDE has changed that substantially. Clearly, the majority of respondents gave it significantly less value than *communication paths* as evidenced by the comparatively lower ranking.

Another interesting finding was that *speed* was valued the least among the five dimensions. Many distance educators value the immediacy of communication and are not satisfied, for example, with slow-scan images that take up to a minute to transmit because of the time lag between lecturing about some graphic image and its actual appearance to the learner is detrimental to learning. Yet, curiously, raters placed this dimension as the least important of them all. Possibly respondents did not consider the alternatives to speedy communication, were unclear about the negative impacts slow communication would have, or simply considered all the other dimensions to be so important that *speed* fell to the bottom of the list.

This points to one of the weaknesses in the development of the PEI. The high end of each continuum was rated against the high end of every other continuum. Perhaps different results would occur if points in the continua were rated against one another. The complexity of such a task was beyond this initial step in the development of an instrument that could guide individuals in evaluating EDE systems. Another issue for further study is the possibility that the points along the continua (which were treated as being equidistant) may vary within the dimension.

The PEI is intended as a first step in helping practitioners of EDE to evaluate educational delivery systems. It is our hope that it will help theorists think about how devices affect methods; and, that it will help administrators understand that productive educational practices should drive device selection, not glamour or high technology. We hope its use will help establish standards which can assist in evaluating EDE systems.

References

Association for Educational Communications and Technology. 1977. *The Definition of Educational Technology*. Washington, D.C.

Burnham, B.R. and Seamons, R.A. 1987. Exploring the landscape of electronic distance education. *Lifelong Learning: An Omnibus of Practice and Research*, 11(2), 8-11.

Clark, R. E. and Salomon, G. 1986. Media in teaching. In *Handbook of Research on Teaching*, 3rd ed. Ed. M.C. Whittrock, 464-478. New York: MacMillan Publishing Co.

Dale, E. 1969. *Audio-Visual Methods of Teaching*. New York: Holt, Reinhart, & Winston.

Hoko, J. A. 1986. What is the scientific value of comparing automated and human instruction? *Educational Technology*, 26(2):18.

Keegan, D. 1988. Problems in defining the field of distance education. *The American Journal of Distance Education*, 2(2):4—11.

McLuhan, M. 1964. *Understanding Media: The Extension of Man*. New York: McGraw-Hill.

The Merriam-Webster Dictionary. 1974. New York: Pocket Books.

Mitchell, P.D. 1981. Evaluating alternative strategies for allocating limited resources to develop a tele-education system. In *Distance Learning and Evaluation: Aspects of Educational Technology XV*, eds. F. Percival and H. Ellington, 40-49. New York: Nichols Publishing Co.

Paulsen, M. F. 1988. In search of a virtual school. T. H. E. Journal 15(5): 71-73.

Philips, A. F. and Pease, P. S. 1987. Computer conferencing and education: complementary or contradictory concepts? The American Journal of Distance Education 1(2):44-52.

Reiser, R. A. and Gagné, R.M. 1982. Characteristics of media selection models. *Review of Educational Research* 52(4):499-512.

Rudolph, S. and Gardner, M. K. 1986. Remote site instruction in physics: a test of the effectiveness of a new teaching technology. *Educational Technology Systems* 15(1):61-80.

Rushton, A. F. and Branson, R. K. 1983. Remote delivery of instruction in complex skills. *Journal of Educational Technology Systems* 11:315-323.

Schramm, W. 1977. *Big Media, Little Media*. Beverly Hills, California: Sage Publications.

Shale, D. 1988. Toward a reconceptualization of distance education. *The American Journal of Distance Education* 2(3):25-35.

United Nations Educational, Scientific, and Cultural Organization. 1984. *Glossary of Educational Technology Terms*. Paris.

Verner, C. (1962). *A Conceptual Scheme for the Identification and Classification of Processes for Adult Education*. Washington, D.C.: Adult Education Association of the United State of America.

Weingand, D. E. (1984). Telecommunications delivery of instruction: a comparison with the traditional classroom. *Journal of Education for Library and Information Science* 25:3-13.