Evaluating Instructional Applications of Telecommunications in Distance Education

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SUMMARY

Telecommunications in both terrestrial and satellite-mediated forms is becoming an integral part of the instrumentation of distance education. Although considerable experience has already been accumulated with respect to the use of telecommunications in distance education, the rapidly advancing possibilities in this technology are challenging those involved in the design, implementation, and evaluation of electronically distributed learning. In particular, the issue of how to predict and evaluate the educational impact and added value of new possibilities in telecommunications while these are still in evolution is a major challenge. In this paper, various issues in the evaluation of telecommunications as educational instrumentation are discussed and a general approach for evaluating this instrumentation is described. Application of the approach is illustrated with an example.

DISTANCE EDUCATION AND TELECOMMUNICATIONS TECHNOLOGIES

Distance education, although long established, is currently in a stage of rapid evolution (see Smith, 1988, for an international overview). The most fundamental motivation for distance education, that of reaching learners who are geographically hindered from meeting in a traditional setting, has been expanded to include other motivations such as time tailoring and flexibility to learner characteristics. At the same time, advances in the capabilities of technological media are adding other new dimensions to distance education. In particular, the contribution of 'electronic distance education' strategies with respect to the problem of inequities in opportunity for isolated learners or for learners with special needs is becoming increasingly recognized (Stubbs and Burnham, 1990).

The basic instrumentation for distance education has long been printed materials, delivered back and forth between learners and instructors using

ordinary postal services. This technology still dominates the methodology of distance education and training. However, with rapid evolution of new information and communication technologies involving telecommunications, distance education can now draw on more possibilities for human interaction (see Zorkoczy, 1990, for an overview of 11 'state-of-the-art' examples). Among the currently available telecommunications technologies used in distance education are:

- Terrestrial (cable-or fibre-mediated):
 - Audio conferencing
 - Computer messaging
 - Computer conferencing (teleconferencing)
 - Slow-scan video with audio conferencing
 - ISDN multichannel networks
- Satellite telecommunications (broadcast transmission):
 - Video only
 - One-way video with two-way audio
 - Videoconferencing
 - Narrowcasting (available through encryption)
 - Frame-addressed synchronous addressing

- Combinations of satellite and terrestrial media.

The recently completed Exploratory Action of the European-wide DELTA project included seven clusters of projects in its so-called 'Action Line 3' relating to multinational investigation of telecommunications as instrumentation for 'flexible and open learning' through distance delivery (Collis, 1991c; Commission of the European Communities, 1991). All forms of instrumentation listed above were included in the various Action Line 3 projects.

In addition, there is also a parallel growth in creative ideas for didactical interaction in distance education, made possible because of the developments in telecommunications. New instrumentation (for example, within our Division (ISM) at the University of Twente) is being developed to stimulate computer-supported cooperative work over distances, to allow shared access over a distance of 'electronic books' and other electronically organized information sources to provide support tools for 'telecooperation' (Heeren, 1991) and to facilitate more portable on-line learning environments (for what Lewis, 1991, calls the 'itol model' – information technology-based open learning; see Collis and De Diana, 1992).

EVALUATING INSTRUMENTATION FOR ELECTRONIC DISTANCE EDUCATION

Importance of evaluation

Given this new potential for distance education and open learning generally, related to the rapid growth of tele-communications as instrumentation for distributed learning, evaluation studies are particularly important. One reason is to provide timely feedback and constructive criticism (that is, formative evaluation) to the designers and developers of such innovative instrumentation while the instrumentation is still in evolution. However, another reason evaluation studies are important with respect to telecommunications in distance and open learning is the need to convince decision makers to support the necessary infrastructure for telecommunications use even before evidence is available to support the educational 'results' of using these new

technological possibilities. Such preliminary support is essential, and expensive, in that small-scale, exploratory experimentation with telecommunications is generally not possible until a considerable investment in technical infrastructure has been made (Collis, Veen and de Vries, 1992).

Most distance education situations, traditional or involving telecommunications, recognize the importance of evaluating their component instrumentations, although the majority of published evaluation reports focus either on client satisfaction with the productivity of an overall distance education package (where organization and distribution aspects are at least as important as instrumentation) or on factors correlated with learner persistence or attrition. Hoogveld (1990), for example, evaluated the use of media in 11 courses offered by the Dutch Open University and presented findings primarily related to use frequencies of the different media, and attitudes of the learners relative to the contribution of the different types of instrumentation. McIsaac (1989), more generally, has done a meta-analysis of 64 evaluation studies of distance education published during 1987–89. She found that, although a number of studies included variables related to learner output (in terms of meeting training objectives), many focused on learner satisfaction or learner attrition. Garrison (1990) summarized evaluations of the use of audio conferencing in 34 courses in a Canadian university and also found attitudinal data describing student reaction to the overall experience of telecommunications-mediated distance learning to be the primary level of analysis of the studies. Collis (1992) and Collis and de Vries (1991) inventoried the evaluation strategies described in more than 120 different projects involving telecommunications as instrumentation for distributed learning (mostly) at the secondary school level and concluded that 'evaluation is apparently difficult to do', as most project reports mention no evaluation strategy at all and, of the few who do, most supply only impressionistic or attitudinal evaluation data.

Criteria for evaluating telecommunications-based educational instrumentation

Perhaps one of the reasons that educational projects involving telecommunications are only marginally evaluated relates to the difficulty of

finding appropriate methodology or criteria for such an evaluation. There are a number of reasons for this difficulty.

First, there are different reasons why evaluations are done – for formative suggestions during instrumentation design and development, for decision-oriented ('go – stop' or commitment-oriented) purposes, to justify expenditures to date or requested, to choose among alternatives, for public-relations reasons, or as a preamble to critical formal comments on a project or its management (Collis, 1989a; Flagg, 1990). The context of an evaluation, who will pay attention to it, and what will happen to its results all interact to make program/project evaluation difficult and more of an art than a science (Stufflebeam and Webster, 1980).

Another reason for the apparent difficulty in evaluating telecommunications as educational instrumentation is the fact that projects involving telecommunications in distance education are by definition multipartner and each partner brings with him or her multiple agendas (Collis, 1989a). Because institutions and communications services must be involved, politics and jurisdictional issues further complicate scientific assessment, while multiple cultures and languages can make 'measurement' even more difficult (McIsaac, 1989). In addition, many projects are fuelled by a sense of 'potential and vision', rather than by any statement of explicit and measurable outcomes (Baker, 1988; Collis and Carleer, 1992) and thus partners may avoid elaborating their separate agendas or resist the idea of criticism among the partners in exchange for building a viable working relationship among their institutions (see, for example, Collis, Aarntzen, and Tholen, 1990). Thus, a close analysis may be felt to be unwelcome or, at the least, premature (Collis, 1989a).

Finally, the 'visionary' aspect of many projects involving telecommunications sometimes leads those who pioneer the projects to be so convinced of the project's worth that the simple act of proceeding with the project is accepted as an indicator of success (Collis and de Vries, 1991).

However, there are examples of explicit criteria for evaluation of instructional media in distance education that go beyond the 'Do they like it?', 'Can they use it?' or 'Do they stay with it?' level

and that also can be applied to an evaluation of telecommunications-related instrumentation in distance education. The Open University in the United Kingdom, for example, has systematic procedures for assessing the cost-effectiveness of components of its program (Rumble, 1990) and Smith, former director of the same institution, has analysed 'cost to whom and to what benefit?' on an international scale (1988). Stubbs and Burnham (1990) have suggested a 'potential effectiveness inventory' for media used in distance education involving criteria relating to:

- (a) the degree of time- and place-independence made available by the media,
- (b) the level of realism in instructional materials supported by the media,
- (c) flexibility in communication paths maintained through the media,
- (d) ease of use of the media, and
- (e) immediacy (how fast information and feedback are available with a particular medium).

The technical attributes of the instrumentation used in distance education coupled with the instructional design decisions made with respects to the construction of this instrumentation can be evaluated with respect to these criteria and thus can offer designers more critical insight into the potential use and impact of their products.

Stubbs' and Burnham's criteria, however, do not particularly suggest a systems-level examination of instrumentation; given the multi-system environment in which distance education must be embedded (Potter, 1990), an evaluation approach that combines product and process variables in a broad-range contextual framework seems most productive. Such an approach has organized our evaluation projects for a number of years (see, for example, Collis, 1989b, and Collis and Bergers, 1987, for its application to national level large-scale courseware development projects); the approach has been recently applied to evaluations of telecommunications use in distance education in school settings (for example, Collis, 1987; Collis *et al*, 1990) as well as in multinational professional education initiatives (Collis, 1991b). The approach is based on the pioneer work of the American evaluation specialist Stake (Stake, 1973). In the following section we give an overview of our adaptation of Stake's model and briefly illustrate its application in terms of a recent study involving telecommunications in distance education.

AN EVALUATION MODEL AND ITS APPLICATION TO ELECTRONIC DISTANCE EDUCATION

Our evaluation approach is a simplified version of Stake's (1973) model that maintains some of this model's basic characteristics: an ongoing analysis of (a) the logical association between the assumptions and expectations of a project, (b) the congruence between project intentions and planning and project realization, and (c) a readjustment of assumptions and expectations based on an interpretation of the level of (in) congruence in step (b).

Figure 1. *Stage 1: Gathering information about the assumptions and intentions of a project*

Stage 1

Figure 1 diagrams the starting point for application of the approach. With this approach, the evaluator begins by examining assumptions about the context of a project (Box A), the general intentions of the project (Box B), the planning with regard to the execution of the project (Box C), and the expectations of the project partners as to short- and long-term indicators of project success (Box D). The evaluator encounters predictable difficulties in Stage 1.

For example, project partners often have not clearly articulated their assumptions about the overall situation (including the motivations and interests of the groups involved), or are so convinced of the various perspectives that they are not aware these are assumptions (eg 'Learners learn better with computers', 'The instructors in our system want this innovation', 'The participants in our distance education situation want to be interacting with each other' or, more subtly, 'The

team of persons available for this project will be able to work effectively together').

Box B is often difficult because general intentions in innovative projects, those involving telecommunications, are often expressed very broadly (eg 'To improve education', 'To improve the cost-effectiveness of our education', 'To survive in a competitive market'). In addition, as mentioned earlier, partners sometimes do not want to state explicitly what their range of motivations is for participating in an initiative; to complicate this further, these general expectations often get interconnected with the personal agendas of key project participants.

Box C is frequently the easiest to document, as project plans often are reasonably well articulated, at least at the beginning of a project, although this becomes more difficult if the evaluator comes to a project that is already in operation, or if the evaluation focus is on an on-going enterprise rather than a specific project.

Box D is frequently difficult, because projects often set up their short-term indices of success relative to aspects related to maintaining the project itself rather than its ostensible goals (eg '500 teachers were trained to use the program', 'The multi-media data base was developed and tested in its beta version', 'Regular project meetings were held, project reports are being written, a project infrastructure is being set up and functions smoothly', 'Funding for a new sub-project was secured' etc). It is very unusual to find an innovative project where specific measurable milestones are expressed in terms of better or faster learning results. Most projects describe what the project itself will do, rather than what it will measure in its target learners in order to see if they are learning or doing better (Collis and Carleer, 1992).

Stage 1 requires the evaluator to talk to key people, and also to people whose opinions may not be those of the project spokesperson(s). This becomes difficult in telecommunications projects with international partnerships, as time and money usually do not allow much in-depth interviewing. Deciding how much or how far one should go in understanding and writing about the intentions and assumptions of a project is a mixture of art, science, and political insight.

Stage 2

The second stage of the evaluation approach is

what Stake (1973) calls assessing the 'logical contingencies' among the assumptions and intentions cells. This means, based on insight and previous experience, what can the evaluator say about the likelihood of the project meeting its intended goals (Boxes B and D), given its planning (Box C) and its assumptions of the context (Box A)? The relationship of Box B with Box D is also considered; will the overall goals of the project be likely to be met, given the hoped-for success indicators, short- and long-term, of the project? Figure 2 shows the interrelationships that the evaluator must consider.

Figure 2. Stage 2: Assessing the logical contingencies among project intentions and assumptions

This stage is very much dependent on the evaluator's knowledge of the overall type of project, system, and groups involved. There is also an insight aspect, and to be effective, a necessity for the careful and sensitive expression of one's ideas, especially if making the comment that there appears to be a lack of logical contingency in the overall intentions/assumptions system. When expected relationships are not probabilistically logical (for example, the expectations of the project are not reasonably consistent with the characteristics of the setting in which the project will be carried out), the evaluator can make a contribution by sharpening awareness of these

inconsistencies. If and when the system's intentions and assumptions change, the evaluator needs to redo the Stage 1–Stage 2 loop, obviously in an iterative, responsive and timely manner.

Stage 3

The third stage of the evaluation approach involves making observations – about what is actually occurring with regard to the project's planning and its expected 'success indicators' and about the actual characteristics of the situation in which the project is occurring. These observations are represented by Boxes E, F, G, and H in Figure 3. For example, Box F involves an awareness of what seems to be actually most important to the project or the driving motivation stimulating the project. This can be related to personal ambition or the project's desire to perpetuate itself, as much as it may relate to the stated goals of the projects.

Stage 4

The fourth stage of the evaluation process involves what Stake called an assessment of the (in)congruities in the system. By this he means an assessment of the goodness-of-fit between what was planned and what is observed to be happening. In terms of Figure 4, this means a comparison of boxes on the same line – Box A and Box E, Box B and Box F, Box C and Box G, and Box D and Box H. This comparison process can take place at any time, and can be relatively informal, or formal.

Stage 5

The fifth stage involves the interpretation of incongruities in the system, sometimes leading to a comment that assumptions, intentions, planning, and expectations of success predictors should be reassessed (what Shapiro, 1985, calls repairing 'theory failure'), and sometimes noting that execution is not going as planned, for various reasons ('implementation breakdown', in Shapiro's words), but not because the general intention side of the project needs revision. Usually, however, interpretation of incongruities involves a complex of reasons, some of which relate to initial planning and assumptions and some of which relate to human decisions in carrying out the planning. (Implementation breakdown can be related to theory failure, for example, if expectations are higher than a group can deliver, given their resources and personal

Figure 3. Stage 3: Observing the actual context and implementation of the project

Figure 4. Assessment of (in)congruities between what was intended and what is occurring

characteristics.) Another aspect of this analysis is for the evaluator to predict how likely it is that the project will meet its goals (explicit or implicit) or achieve its success indicators given the current state-of-affairs of the project. Predicting in the early days of a large project what the final result of the project will be requires experience and the information to back up one's prediction if challenged.

The output of this stage is a set of recommendations for changes in the system, relative to any of its eight boxes. Sometimes this will involve recommendations about change or fine-tuning of expectations and assumptions (Boxes A, B, C and D); other times it will involve suggestions for implementation changes (Box G) or procedures for assessing success (Box H). Often, new success indicators arise in an unplanned-for manner; the evaluator can suggest that the project capitalize on them or explore their occurrence more deeply (Box H, perhaps leading

to changes in Box D). Thus, at the end of Stage 5 the evaluator should consider him(her)self starting again at Stage 1 (or Stage 1') of an iteratively fine-tuned system.

The strength of this approach is that it can offer immediate feedback at any point in the life cycle of a new development or implementation project for innovative educational instrumentation, in that, as indicated by the double arrows at the top of Figure 5, interpreted observations can continually lead to better tuning of expectations and planning. A', B', C', and D', stand for recommended changes in the assumption-intention-planning-expectation states of the system.

Applying the approach: an example from professional education involving telecommunications

As an example of this approach, we can describe

Figure 5. Stage 5: Interpretation of incongruities between what was intended and what is occurring

very briefly a recent evaluation project involving the multinational European project, EuroPACE (Collis, 1991b). EuroPACE uses three technologies for the delivery of professional education to senior engineers and managers in European electronics industries: printed text, satellite broadcasting and (terrestrial) telecommunications. A basic assumption in EuroPACE is that senior specialists can share a common professional education experience in a virtual electronic community, through the various technologies used in the project. The evaluation study was commissioned by one of the multinational companies investing substantially in the project, in order to explore reactions to the innovative project among its own employees.

After a variety of data collection strategies, the assumptions and general intentions of the project were identified (ie Boxes A and B). There was general agreement that this project was 'the way to go' and also general agreement with respect to many of the assumptions of the project. However, while planning expectations were clear (Box C), assumptions (Box A) were often not explicitly acknowledged and, sometimes, when explored, showed contradictions among the participants (Box E). For example, training directors welcomed the cost-saving aspects of the approach (it is much less expensive to encourage participation in a 'virtual community' than to send top engineers away to conferences), but it was not clear that the engineers themselves wished to replace their occasional interaction within a

human community of their peers with electronic interaction, even if this meant interaction could occur much more regularly and inexpensively than is possible in face-to-face terms. The assumption that the target group wanted an interactive virtual community had not been critically examined (Box A) and appears unfounded, at least within the parameters of this professional education program (Boxes E and G).

An examination of the fit between planning and execution (Boxes C and G) showed many incongruities, with a notable example being the lack of use of the telecommunications options of the project. The evaluation approach allowed a reasonable separation of 'implementation breakdown' from 'theory failure' (Collis, 1989a; Shapiro, 1985) to account for these incongruities and formed the basis for different levels of recommendations. In particular, the analysis justified recommendations for redesign of the instrumentation used for the telecommunications aspect of the project (Box G). Attention was given to suggestions for improving the instructional design of the video materials and the integration of the educational media used in the project (Box G, but also Boxes A and C, in that there appeared to be a fundamental assumption that senior engineers did not need 'bells and whistles' and therefore instructional design of their learning materials was not necessary). Changes have subsequently been made in both the theory and operation of EuroPACE; however, some fundamental assumptions in the project might still have

to be modified (for example, the assumption that the target group of European senior engineers will be comfortable interacting and learning in a virtual English-speaking electronically connected community) before changes in instrumentation will be likely to have their desired effect.

CONCLUSION

Educational instrumentation is not a 'pure science' but rather an applied response to real-world needs and conditions. Specialists in educational instrumentation must always be sensitive to the balance between technique and product on the one hand, and context and field acceptance on the other. Telecommunications-based instrumentation confounds the difficulties in maintaining this balance, in that the technical demands are so complex and strong that it is difficult not to be overwhelmed (or over-impressed) by them, and also that the real-world context in which telecommunications is used involves by definition multi-site settings. With multi-site implementation contexts, each of the clusters of factors affecting the portability of educational instrumentation (Collis and De Diana, 1990, 1992) becomes magnified in its salience. Thus, the emerging field of instrumentation for distance delivery or sharing of educational resources needs to function in a highly tuned contextual orientation (see also Collis, 1991a). The approach to project evaluation described in this paper can help to direct this orientation toward the formative evaluation of both development process and product toward the emerging area of educational instrumentation related to telecommunications and distance education.

REFERENCES

- Baker, E. (1988) *Sensitive Technology Assessment of ACOT*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans.
- Collis, B. A. (1987) *An Evaluation Study of Technology Policy and Application*. Saanich Public School District, Victoria, British Columbia, Canada.
- Collis, B. A. (1989a) *Assessment of Educational Programs: How Can We Evaluate 'Dynamics and Vision'?* Presentation at IBM International Customers Executive Seminar, La Hulpe, Belgium.
- Collis, B. A. (1989b) *Problems and Perspectives on the Evaluation of Regional and National Computer-related Educational Activity*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.
- Collis, B. A. (1991a) The evaluation of electronic books. *Education and Training Technology International*, 28, 4, 355-363.
- Collis, B. A. (1991b) *An Evaluation of EuroPACE as an Aspect of European Professional Education*. Paper presented at COTEP, Second International Conference, Corporate Training for Effective Performance, Enschede, The Netherlands.
- Collis, B. A. (1991c) Telecommunications-based training in Europe: A state-of-the-art report. *American Journal of Distance Education*, 5, 2, 31-40.
- Collis, B. A. (1992) Supporting educational uses of telecommunications in the secondary school: Part 1, an analysis of experience. *International Journal for Instructional Media*, 19, 1, in press.
- Collis, B. A., Aarntzen, D. and Tholen, P. (1990) *Research Study on the Implementation of the Multimedia Series 'Computerjournal' (Final Report)*. SLO, Enschede.
- Collis, B. A. and Bergers, L. (1987) *Evaluation Design: POCO Project Cycle I*. ECC (Educational Computing Consortium B.V.), Enschede.
- Collis, B. A. and Carleer, G. (1992) *Technology-Enriched Schools: Nine Case Studies, with Reflections*. International Society for Technology in Education, Eugene, OR.
- Collis, B. A. and De Diana, I. (1990) The portability of computer-related educational resources: an overview of issues and direction. *Journal of Research on Computing in Education*, 23, 2, 147-159.
- Collis, B. A. and de Vries, P. (1991) *Telecommunications in Secondary Education*. PRINT (Management Group for New Technologies, Ministry of Education and Science, The Netherlands), Hoevelaken.

- Collis, B. A., Veen, W. and de Vries, P. (1992) *Preparing for an Interconnected Future: Policy Options for Telecommunications in Education*. (Article submitted for publication).
- Commission of the European Communities (1991) *Developing European Learning Through Technological Advance: DELTA Exploratory Action Final Technical Report*. (Ref. DE2205). Directorate General Telecommunications, Information Industries and Innovation, Brussels.
- Flagg, B. N. (1990) *Formative Evaluation for Educational Technologies*. Lawrence Erlbaum, Hillsdale, NJ.
- Garrison, D. R. (1990) An analysis and evaluation of audio teleconferencing to facilitate education at a distance. *The American Journal of Distance Education*, 4, 3, 27–38.
- Heeren, E. (1991) 'Telecooperation': *Contract for Educational and Research*. Internal document. Universiteit Twente, Enschede.
- Hoogveld, A. W. M. (1990) *Evaluatie van het Gebruik van Elektronische Media in 11 Cursussen van de Open Universiteit* [Evaluation of the use of electronic media in 11 courses of the Open University]. Open Universiteit, Centrum voor Onderwijskundige Productie, Heerlen.
- Lewis, R. (1991) Computers in higher education, training and learning: Some aspects of research and development. *The CTISS File*, 11, 3–7.
- McIsaac, M. S. (1989) *Problems Affecting Evaluation of Distance Education in Developing Countries*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.
- Potter, G. (1990) Computer-related media portability in international distance education: Making informed decisions. *Journal of Research on Computing in Education*, 23, 2, 284–297.
- Rumble, G. (1990) On-line costs: Interactivity at a price. In R. Mason and A. Kaye (eds) *Mindweave: Communication, Computers and Distance Education* (pp.146–165). Pergamon Press, Oxford.
- Shapiro, J. Z. (1985). Evaluation of a worksite program in health science and medicine: An application of Stake's model of contingency and congruence. *Educational Evaluation and Policy Analysis*, 7, 1, 47–56.
- Smith, R. (1988) Growth and scope of distance learning. In J. Oliveira (ed) *Using Technology for Education and Training: An Economic Perspective*. Syllabus for an international seminar of The World Bank, (Economic Development Institute), Washington, D.C.
- Stake, R. E. (1973). The countenance of educational evaluation. In B. R. Worthen and J. R. Sanders (eds) *Educational Evaluation: Theory and Practice* (pp.106–125). Wadsworth Publishing Company, Belmont, CA.
- Stubbs, S. T. and Burnham, B. R. (1990) An instrument for evaluating the potential effectiveness of electronic distance education systems. *American Journal of Distance Education*, 4, 3, 38–50.
- Stufflebeam, D. L. and Webster, W. J. (1980) An analysis of alternative approaches to evaluation. *Educational Evaluation and Policy Analysis*, 3, 2, 5–19.
- Zorkoczy, P. (1990). *State of the Art in Open and Distance Education*. (Final Report, D1025). Commission of the European Communities, DG XIII (DELTA), Brussels.

BIOGRAPHICAL NOTES

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