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The medium and the message

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From discussions expounding the virtues of interactive multimedia (IMM) appearing frequently in the popular press, education and training literature, conference presentations and seminars, it could be construed that IMM is being heralded as the answer to training and education needs for the 1990s, but what does the phenomenon offer trainers and/or educators, striving to achieve cost efficient and effective learning? It seems reasonable to suggest that developments in the understanding of teaching and learning methods that enhance and nurture cognitive skill acquisition are what underlies the potential contribution of IMM to improved learning effectiveness.

The effectiveness of media based delivery methods on improving the learning outcome of students and trainees, has been the concern of researchers for some time. It can be argued (Clark, 1983, 1990; Jonassen, 1985, 1991) that it is the underlying structure of the subject content, the overall curriculum design and the instructional design of the learning experience that results in effective learning rather than the medium used to deliver the message, so interactive multimedia is no more or no less effective that other media.

It may be helpful to clarify what is meant by interactive multimedia. Richardson (1993) uses the term multi-media (with the hyphen) to described audiovisual installations or presentations, that used a combination of several different types of media, for example, film, 35 mm slides, videotapes, audiotapes, print etc.; the term interactive multimedia (without the hyphen) is used to refer to the delivery of information from a variety of media sources passing through a computer and providing learner control of and interaction with, the information flow.

It is surmised that the contribution made by IMM is that it provides a seamless delivery platform when moving between strategies of presentation or between media representations (Hedberg, 1989). This paper will reflect on these issues by discussing approaches taken to the selection and use of media since the 1950s, some specific design features pertinent to IMM and current uses of IMM.

Which medium to use?

Methods of media selection have formed part of various theories, systems and conceptual models of instructional design for several decades. Media comparison studies carried out in the 1950s and 60s were searching for evidence that one medium was more effective than another for various learning tasks (Mielke, 1968; Machula, 1978), however the desired results were not forthcoming and most reviews of these studies have acknowledged that using a particular medium did not contribute any benefit to learning outcome (Lumsdaine, 1963; Levie and Dickie, 1973).

The 1970s and 80s saw studies into media effectiveness fall into two strands; one which grew out of the media comparison studies resulted in the development of media selection models, and another which concentrated on media attributes and their relationship to information processing. By no means did these strands have absolutely clear boundaries.

Media selection models

Medium selection models suggested two categories of criteria for identifying appropriate media. One was based on administrative or economic concerns such as:

- cost, availability and technical quality (Gerlach and Ely, 1971).
- cost, availability, ease of use, familiarity with the media and potential maintenance problems (Gagne & Briggs, 1974).
- practical constraints, both administrative and economic (Romiszowski, 1988).

The second category was concerned with instructional issues such as:

- cognitive appropriateness, level of sophistication, (Gerlach and Ely, 1971)

- estimated effectiveness, anticipated acceptability to the learner (Gagne & Briggs, 1974)
- the choice of instructional method, the type of learning task, the characteristics of the student (Romiszowski, 1988).

Within their model Gagne & Briggs (1974) proposed matching the stimuli characteristics of the medium with the stimuli needed by the learning event. Gerlach & Ely's (1980) selection guidelines also suggested considering the relationship between the media characteristics and the instructional outcome, whereby "a high degree of transfer from the learning situation will occur if the content and procedures of the medium elicit responses which are very similar to or identical with the desired terminal behaviour" (p.150). This reflects Dale's *Cone of Experience* model (1954) which equated categories of media with the type of learning experience. However, despite the suggested instructional considerations, an assessment of research studies on types of media used in instruction conducted by Campeau (1974) concluded that decisions regarding the purchase of media devices had been based on considerations of cost, availability and user preference rather than on evidence of instructional effectiveness.

A comprehensive overview of media issues presented by Schramm (1977) included comment on the complexity of media selection, the role of media in education in general, the economic considerations and influences for the use of different media and where the research into media selection and effectiveness had led and may lead in the future. Schramm argued that studies to 1977 told less about what had been learned than about what needed to be learned. He concluded that media selection did and probably always would depend on local conditions rather than universal systems of selection. Schramm suggested that learning was affected more by what was delivered rather than by how it was delivered (p.273). He speculated that ... cool hard reason and economics of scale would see decisions based on which medium would do what was needed within the limits of what was available (p.276).

Media attributes

The study of the attributes of media and their relationship to information processing during learning was undertaken with the expectation that the attributes were an integral part of the medium and a link between the use

of media and learning would be established, and that using the attributes of media would serve as a model for cognitive skills development (Clark, 1975; Salomon, 1974; and Olson & Bruner, 1974).

However, Clark (1983) pointed out the media attribute idea faced many of the same problems as the media comparison notion. As different media could present the same attributes, the media attribute could not be seen as an independent "media" variable. Salomon (1979) is cited by Clark as presenting some evidence that media attributes as a symbol system could "cultivate the mastery of specific mental skills by activating or overtly supplanting the skill"(p 452). The issue taken up by Clark was whether these attributes (symbol systems) were exclusive or necessary to learning. Clark concluded that symbolic elements that can be produced by various media could create sufficient but not necessary conditions to teach required cognitive skills. He went on to say that media are vehicles for delivering instruction but do not directly influence learning.

Similar conclusions were drawn by Moore, Wilson and Armistead (1986) after tracing the history and development of media-related research. From their studies they suggested that students learn from any medium and that media per se do not have a substantial impact on learning.

So by the mid-80s the debate continued, research continued to show no significant difference in learning outcome based on the medium of delivery of the learning experience. Choice of medium was seen as a process of matching attributes of a medium of delivery to the desired learning outcome. Why should interactive multimedia be any different from other media?

Developments in technology and interactivity

The difference might be found in the rapid development of a new generation of technologies with two major new features: first, the capacity to store large amounts of data in a form that is quick and easy to access; and second, access to the data is put into the hands of the learner. These two features are essentially the result of developments in computing and coincide with the size and cost of hardware decreasing while speed and storage capacity increase.

The feature of learner control promises the most exciting changes in educational media and has led to the prominence of the use of the term

interactivity. Interactivity implies an input/response relationship between the student and the IMM program. The interactivity could be simply a navigational tool which allows the student to move through the stored data, or it may require the student to engage in higher order problem solving where feedback to the input will dictate the path taken. Although interactivity in this sense implies learner control of the pathways taken through the learning material, in essence the pathways available are very much the dictates of the instructional program designer (Sandery, 1993). This suggests that it cannot always be assumed that IMM programs allow students freedom to pursue learning content in the sequence they prefer.

Interactivity also implies the active involvement of the student with the learning material, where the student for example, engages in active thinking or physically completes an activity rather than being a passive observer. Research has shown that active involvement by the student with "hands-on" activities (Okey et al, 1988; Wittig, 1992) or active information processing (Jonassen, 1985) has led to better comprehension and retention. It is reasonable to assume that the instructional effectiveness of the interactivity element of interactive multimedia relies on the powerful instructional interactions embedded in the course design (Reeves, 1992).

Computer based instruction (CBI) incorporating the interactive involvement of students through drill and practice, tutorial instruction, evaluation of student test performance, directing to appropriate instructional resources, recording student progress, providing a problem solving tool, generating student requested data to illustrate models and the executing of student developed programs, was the bases for a meta-analysis of CBI conducted by Kulik & Kulik (1991). Their analysis shows positive outcomes in student learning when using CBI as opposed to conventional classroom teaching, a reduction in instruction time and positive effects on attitude to instruction and towards using computers. Larsen (1992) argues that through the interactivity features of IMM, the learners' experiences are matched to their own learning style and consequently leads to increased learner satisfaction. Dejoy & Mills (1989) found that if opportunities were not available for adult learners to impose their learning strategies on the courseware, they became frustrated and the quality of the learning experience diminished.

Design and applications of interactive multimedia

Pedagogical design and the design of the interface between student and the technology are identified as the two elements that must be considered for the design of interactive multimedia instruction (Try, 1994). The coming together of these elements can help to refine the contents of the program, through, for example, the look and feel of the interface being designed to give clues that act as advanced organisers, or the use of visual metaphor, where access to a notebook function is through an icon representing the spiral binding of a notebook.

In teaching, research has shown that multi-sensory input enhances learning (Reese, 1983; Wills, 1990), and IMM can be seen as facilitating this input as it can provide a range of visual and aural sensory representations. Multi-sensory options enable the instructional design to provide a number of ways of presenting material which cater for a student's preferred learning style, for example engineering theory can be presented in a graphic form and/or as mathematical formulae. (Pemberton et al, 1994)

The power of IMM can be demonstrated to enable the presentation of scenarios that otherwise would not be available, where mistakes can be made without hurting real people. The convergence of media and computing in, for example, interactive video, has been used not only for skills training but also for decision making and problem solving situations such as in the British Airways operations training program called "Who Owns the Problem" (Bayard-White 1986). In this program a number of situations are presented where the trainee is put into a decision making position anywhere within the organisational hierarchy. The feedback as to the economic outcome, operational impact on the company and personal effect on other workers of the decisions made is instant and comprehensive. For example, a cut hand could eventually result in a five hour aircraft delay and cost the company $220,000. Although the program presents no "right" answers, it succeeds in raising an awareness of safety issues and the consequences of everyday decision making. The instant feedback feature of interactive video is cited by Bayard-White (1986) as a factor in improving training, as it enables students to see, respond and check answers without delay.

In describing another training program on interpersonal communications skills, Bayard-White (1986) sees interactive video making a contribution to shortening the time taken to develop the necessary skills and reduce

inefficiencies in the work place, by removing trial and error in the real situation. From these examples it is again clear that IMM is a powerful and flexible tool for delivering education and training. The combination of the pedagogical design and the flexible features of the medium can lead to effective learning.

Criteria for evaluating IMM

In assessing the contribution of IMM to effective learning it is helpful to consider by what criteria programs could be evaluated. Dejoy & Mills (1989) provide an evaluation checklist as part of a study of the nature of educational interaction between individual adult learners and interactive instructional material. A distinction is made between elements which relate to the learning process(content and instructional strategies) and elements which support the delivery of the instructional material (instructional presentation, documentation and technical). Reeves (1992) examines the pedagogical dimensions of interactive learning systems through a number of continua covering epistemology, pedagogical philosophy, underlying psychology, goal orientation, instructional sequencing, experiential value, role of instructor, value of errors, motivation, structure, accommodation of individual differences, learner control, user activity and cooperative learning. When the position on the continua of an interactive learning program is represented graphically, it provides an effective profile by which to assess the character of the program and its appropriateness for a particular educational situation. Reeves is seeking to swing the emphasis for design and selection away from the media elements and towards the pedagogical elements. It is the ability of the medium to represent and present these dimensions that could form the bases for selection of means of delivery.

The scope and flexibility of IMM as a delivery system are highlighted by Reynolds & Ehrlich (1992) when proposing their decision model and checklist for the design of IMM. Their design model is based on other traditional instructional system design models, however the issue of selection of delivery mode does concentrate on an understanding of what IMM can contribute to the educational process.

Conclusion

The strength of IMM would seem to lie in its ability to bring together educational "best practice" such as strong pedagogical design features, multi-sensory delivery, student meta-cognitive self monitoring assisted by instant feedback, and student control over the pacing of information flow and the pathways followed which in essence moulds the program to the student's preferred learning style.

Such checklists and dimensions profiles as mentioned can be used as a valuable guide by the teacher/instructor for selecting courseware and by the educational designer when developing courseware: however, one cannot help but be concerned that available resources could still over ride the best pedagogical intentions.

In the future the pedagogical design elements will be of even greater importance as technologies converge with computer networking such as Internet, and on-line access for students, video conferencing and even virtual reality, the technologies will capture the educational imagination and compound the challenge for the educational designer.

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