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The Effectiveness of Instructional Orienting Activities in Computer-Based Instruction

Richard F. Kenny

Abstract: The growing interest in interactive multimedia has created an increased demand for appropriate instructional design strategies. In response. the ROPES+ meta-model (Hannafin & Rieber. 1989) was proposed for the design of instructional prescriptions for computer-based instruction (CBI). The '0' in ROPES refers to 'Orienting' activities. an activity which acts as a mediator through which new information is presented to the learner. Included in this category are attention-gaining techniques, lesson objectives, prequestions and instructional organizers. This paper reviews the research literature on instructiona1 organizers and provides a comparative analysis of their effectiveness with CBI. The review considers what evidence there is that any of these techniques affect learning or retention and examines how they have been used with CBI. Three cognitive theories, Ausubel's (1963) Subsumption Theory, Wittrock's (1974) Generative Learning Hypothesis and Schema Theory (Anderson, 1977; Rumelhart & Orteny, 1977). are compared to discern which most strongly predicts the effectiveness of these techniques.

Résumé: L'intérêt grandissant que suscite l'approche multimédia interactive a crée une demande croissante pour l'élaboration de strategies d'éducation adaptees, Pour répondre a cette situation on a propose l'utilisation du meta-mode1 ROPES+ (Hannafin & Rieber. 1989) pour la conception de méthodes pédagogiques dans l'enseignement informatise (Computer-based instruction ou CBI). Le «O» dans ROPES fait référence à l'expression «Orienting» (orientation), une activite qui tient le rôle de médiateur a travers lequel la nouvelle information est présentée à l'apprenant. Cette catégorie comprend des techniques qui «attirent l'attention» des apprenants, des objectifs de leçons, des préquestions et des structures de formation.

Dans cet article, nous examinons la recherche qui a été faite sur les structures de formation, et nous faisons une analyse comparée de l'efficacité de cesstructures en matière d'enseignement informatise (CBI). L'etude pose un regard critique sur les indices existants démontrant que ces techniques affectent l'apprentissage ou la rétention et examine comment ces techniques ont été utilisées dans l'enseignement informatise (CBI). Trois théories cognitives ont été comparées : Ausubel's (1963) Subsumption Theory, Wittrock's (1974) Generatwe Learning Hypothesis et Schema Theory (Anderson, 1977; Rumelhart & Orteny. 1977). Cette comparaison vise a Identifier laquelle des trois théories peut le plus efficacement predire le rendement de ces techniques.

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The relatively low cost and accessibility of the microcomputer has placed the power and flexibility of computing into the hands of the individual and opened a new range of instructional possibilities. Included among the latter are computer-based instruction (CBI) and its more recent derivative, interactive multimedia instruction. While a precise definition of multimedia has eluded even technology experts (Galbreath, 1992), the term interactive multimedia instruction essentially refers to a computer-controlled system which provides the possibility of varying combinations of digitized audio, graphics and text, analog and digitized video, accessed through the computer itself and/or a variety of peripheral devices such as videodisc players, compact disc players and music synthesizers (cf. Schwier & Misanchuk, 1993; Gayeski, 1993). Defined in this way, interactive multimedia instruction can be seen to encompass other more specific terms, including computer-based interactive video (CBIV) and hypermedia. While the use of CBI, as a general class of technology, has been promoted for its capability to individualize instruction, interactive multimedia instruction extends the power of the computer to support student interaction by adding the richness of the various audio and visual media. To use Jonassen's (1984) description of CBIV, interactive multimedia instruction can be seen both as adaptive and interactive. Jonassen defines adaptive as "the ability to adapt or adjust the presentation sequence, mode or sign type to meet a variety of instructional requirements", a capability requiring the availability of various media, while interactivity is seen as "the program engages the learner to participate in a variety of ways that utilize learner responses." (1984, p.21). Hannafin (1989) further details interactivity, noting that it encompasses various instructional capabilities such as confirmation of response, learner control of pacing and lesson sequencing, inquiry (glossaries and libraries) and elaboration, techniques which allow learners to combine known with to-be-learned lesson information.

Computer-based instruction, and especially interactive multimedia, while providing great flexibility, is not without problems. One is the potential for learner disorientation, the loss of one's sense of location or of the structure of the material. Navigation is the most commonly identified user problem in hypermedia (Jonassen, 1989; Kinzie & Berdel, 1990; Rezabek & Ragan, 1989). Learners can easily become lost and frustrated and may give up without acquiring any information from the program. Another potential, and related, problem with interactive multimedia is cognitive overload. Jonassen (1989) also notes that the exponentially greater number of learning options available to learners places increased cognitive demands upon learners that they are often unable to fulfil. Tripp and Roby (1990) claim that disorientation leads to the expenditure of more mental effort to maintain a sense of orientation in the program which in turn reduces the mental resources available for learning.

A major challenge for teachers and instructional designers is to learn how to make effective use of the capabilities of such interactive learning systems to assist people to learn while avoiding the inherent problems. To guide research on the design of instructional prescriptions for CBI, the ROPES+ meta-model (Hooper & Hannafin, 1988; Hannafin & Rieber, 1989) was proposed. ROPES+ refers to Retrieval, Orientation, Presentation, Encoding, and Sequencing, "+" the influence of contextual factors. The "0" in ROPES+, then, refers to any form of "Orienting" activity which acts as "a mediator through which new information is presented to the learner" (Hannafin & Hughes, 1986, p. 239). Included are attention-gaining techniques, lesson objectives, pre-questions and advance organizers.

It is this category of orienting activities that may suggest methods for alleviating the problem of disorientation and cognitive overload in CBI. Tripp and Roby (1990), for instance, suggest that it has been the advance organizer which has traditionally been used as a device to orient students to content. However, other related instructional organizers might also be useful. Among these are the structured overview graphic organizer (Barron, 1969) and the pictorial graphic organizer (Hawk, McLeod & Jonassen, 1985), both derivatives of the advance organizer.

The purpose of this paper is to review the research literature pertaining to the use of these three forms of instructional organizer and to provide a comparative analysis of their effectiveness with CBI. The review will first consider what evidence there is that any of these techniques have an effect on learning or retention. Second,it will examine the relevant research on the use of such orienting techniques with CBI. Third, the paper will compare two cognitive theories, Ausubel's (1963) Subsumption Theory and Wittrock's (1974) Generative Learning Hypothesis, to try to discern which most strongly predicts the effectiveness of these techniques. A third theory, Schema Theory (Anderson, 1977; Rumelhart & Ortony, 1977; Jonassen, 1989), and a related instructional orienting technique, the hypermap (Jonassen, 1989; Reynolds & Dansereau, 1990; Reynolds et al., 1991), are suggested as an alternative for further investigation.

INSTRUCTIONAL ORGANIZERS

The advance organizer, first proposed by David Ausubel (l960,1963), is meant to facilitate the retention of meaningful verbal information. It is introduced in advance of the learning material itself and presented at a higher level of abstraction, generality and inclusiveness (Ausubel, 1963). Since its main function is to bridge the gap between the learner's cognitive structure and the material-to-be-learned, the advance organizer must be stated in terms familiar to the learner.

The graphic organizer was first advanced as a "structured overview" by Barron (1969) as a modification of the advance organizer and later renamed (e.g. Barron & Stone, 1974). It is a tree diagram which introduces the new vocabulary to be used in the material-to-be-learned and uses the spatial characteristics of diagrams to indicate the relationships and distances between key terms (Hawk, McLeod and Jonassen, 1985). It is unlike the advance organizer, however, because it is written at the same level as the to-be-learned material and uses lines, arrows and spatial arrangement to depict text structure and relationships among key vocabulary (Alverman, 1981). Hawk, McLeod and Jonassen (1985) further developed Barron's modification. Their form of organizer is a more pictorial, visual, or graphic presentation than the two previous organizers. Pictorial graphic organizers take one of two forms: participatory organizers, in which students participate in the completion of the organizer, and final form organizers, in which they do not.

RESEARCH ON ADVANCE ORGANIZERS

Ausubel's Studies

Probably the most-cited research supporting the effectiveness of the technique has, not surprisingly, been provided by the author of the technique, David Ausubel, and his associates (Ausubel, 1960; Ausubel & Fitzgerald, 1961,1962; Ausubel & Youssef, 1963). Ausubel (1960) tested the learning of undergraduates from a 2500 word passage on metallurgy and produced statistically significant results in favour of the expository advance organizer group. Ausubel and Fitzgerald (1961) compared the effects of an expository advance organizer and a comparative organizer on learning from a 2500 word passage on Buddhism. The comparative organizer group significantly outperformed the expository group on a posttest given after three days, but there was no significant difference between the expository and control (descriptive passage) groups. A posttest given after 10 days indicated that both organizer groups retained significantly more of the material to be learned than the control group.

Ausubel and Fitzgerald (1962) also compared the effects of an expository advance organizer on learning from two sequential passages on endocrinology. No significant main effect was shown for either passage. However, a significant main effect was demonstrated for subjects in the lower third subgroup of a test of verbal ability as predicted by advance organizer theory. Finally, Ausubel and Youssef (1963) compared the effects of a comparative advance organizer on learning material from a passage on Zen Buddhism to a control group. They reported a significant main effect for the organizer treatment when both verbal ability and knowledge of Christianity (to which Buddhism was compared in the organizer) were controlled.

A recent detailed analysis of these four studies (McEneany, 1990), however, calls these results into question. McEneany claims no consistent evidence across the four studies in support of advance organizers nor for predicted interactions with verbal ability. He suggests that "a sound operational defmition of an advance organizer eludes even Ausubel himself' (p. 95), a claim previously advanced by other writers (e.g. Hartley & Davies, 1976;

Lawton & Wanska, 1977; Macdonald-Ross, 1978; Clark & Bean, 1982). Nor was McEneany (1990) the first to dispute the effectiveness of advance organizers. Hartley and Davies (1976) reviewed the technique and found conflicting evidence. Regardless, they were able to conclude that advance organizers facilitated both learning and retention'. Barnes and Clawson (1975) were less generous. They rated 32 studies and found that non-significant results prevailed 20 to 12, leading the investigators to judge the technique ineffective. The Barnes and Clawson (1975) review, however, was itself strongly criticized on methodological grounds (Ausubel, 1978; Lawton & Wanska, 1977; Mayer, 1979a).

Based on the above reports, the early research on the advance organizer was, at best, inconclusive. Certainly, these studies and reviews did not provide sufficiently strong evidence to support the use of the technique in instruction. Later analyses and reconceptualizations, however, proved to be more positive.

The Advance Organizer and Assimilation Encoding Theory

Mayer (1979a) reinterpreted subsumption theory in terms of assimilation encoding theory. This theory predicts that the organizer will facilitate both the transfer of anchoring knowledge to working memory and its active integration with the received information. Encoding theory also predicts that the advance organizer may have no effect if the content and instructional procedure already contains the needed prerequisite concepts, if the content and instructional procedure are sufficiently well-structured to elicit the prerequisite concepts from the learner, or if the organizer does not encourage the learner to actively integrate the new information. Further, if the learner already possesses a rich set of relevant past experiences and knowledge and has developed a strategy for using it, the advance organizer would not be effective (for example, a high ability learner).

Thus, Mayer stipulates the following characteristics for constructing advance organizers:

1) Short set of verbal or visual information.
2) Presented prior to learning a larger body of to-be-learned information.
3) Containing no specific content from the to-be-learned information.
4) Providing a means of generating the logical relationships among the elements in the to-be-learned information.
5) Influencing the learner's encoding process (Mayer, 1979a, p. 382).

Mayer (1979b) also reviewed 27 published advance organizer studies which contained either an advance organizer group and a control group or a post organizer group. He concluded that, when used, there was usually a small but consistent advantage for the advance organizer group. As well, he claimed that advance organizers more strongly affected performance when material was poorly integrated, that they more strongly aided inexperienced learners and that they facilitated transfer more than specific retention of details.

Meta-Analyses of Advance Organizer Research

Summary reviews such as those discussed above have been strongly criticized as overly subjective (e.g. Wolf, 1986). Two later reviews of the advance organizer research (Luiten, Ames & Ackerson, 1980; Stone, 1984), however, use meta-analysis, a technique which permits quantitative reviews and syntheses of the research issues (Wolf, 1986), and Glass' effect size statistic (E.S.) in particular (e.g. Glass, McGaw & Smith, 1981). The E.S. allows the comparison of studies which vary in design, sample selection and setting in order to form conclusions and, because it is based on standard deviations, also permits an assessment of degree of effect. Thus, for t-tests of independent means, an E.S.'s of 0.20 could be considered of mild strength, an E.S. near 0.50 moderate and those 0.80 and above as strong (Cohen, 1988, p.25-26). The E.S. will be used in this paper for the analysis of studies reported since the publication of the Luiten, Ames & Ackerson, (1980) and Stone (1984) reviews.

The first meta-analysis (Luiten, Ames & Ackerson, 1980), examined 135 studies and reported mean E.S. of 0.21 for learning and 0.26 for retention. They concluded that advance organizers had a small, facilitative effect upon learning as well as retention. The effect on learning, however, runs contrary to predictions based both on Ausubel's subsumption theory and Mayer's assimilation encoding theory. Luiten et al. (1980) also found advance organizers effective for all ability levels but especially for high ability learners (mean ES. of 0.23) which also contradicts both theories.

Stone's (1984) meta-analysis (Table 1) more closely followed Mayer's model. The review included only studies with a control group or a post organizer group and those in which a posttest was administered one week or later after the treatment (retention only). Consequently, Stone's results were consistently higher than those of Luiten et al. (1980). She reported a mean effect size of 0.66 indicating that advance organizers facilitate the long term retention of new, unfamiliar material. However, she also compared "true" advance organizers (those acting as subsumers) to those which were at the same level as the material-to-be-learned. The mean E.S. for the subsuming organizers (0.75) was only slightly larger than that for non-subsuming organizers (mean E.S. of 0.71). As well, Stone (1984) found no special facilitation for low ability learners. While generally supportive, these results contradict two main assumptions of both subsumption theory and assimilation encoding theory.

Table 1
A Comparison of Effect Sizes for the Luiten et al. and Stone Meta-Analyses

Variable	Luiten et al.	Stone
learning	0.21	---
retention	0.26	0.66
low ability	0.13	0.26
medium ability	0.08	0.64
high ability	0.23	0.34

A Review of More Recent Advance Organizer Research

A comparison of several more recent studies of advance organizers reflect the same variable results (Table 2) and are discussed below. Four studies (Carries, Lindbeck & Griffin, 1987; Tripp & Roby, 1990, 1991; Kenny, 1992) used advance organizers with CBI and will be discussed in a later section. Most of these studies produced positive E.S.'s but these ranged from very mild (0.14) to very strong ((1.25). Three studies (Corkhill, Bruning & Glover, 1988; Kloster & Winne, 1989; Kenny, in press) report negative effect sizes.

Positive results. Corkhill et al. (1988) conducted six experiments to investigate retrieval context set theory. This theory holds that re-reading advance organizers before the posttest will aid retrieval of the information from long-term into working memory. The investigators supplemented the advance organizers in three experiments with additional activities such as paraphrasing. Advance organizers were used unsupported in the other three. The mean effect sizes for the latter are 3.75 for the cue condition (re-reading the organizer before the test of learning) and 2.24 for the no cue condition. Since the cue condition may have added a practice effect to the presumed subsumption function of the advance organizer, only the results for the no cue condition, which represents the use of advance organizers as specified by Ausubel and Mayer, are reported in Table 2. As the measure oflearning in all three experiments tested retention, the average E.S. of2.24 is strong evidence for the facilitating effect of this instructional technique.

Tajika, Taniguchi, Yamamoto and Mayer (1988) used pictorial advance organizers with fifth grade Japanese mathematics to produce strong results (E.S.'s for the integrated organizer treatment of2.04 for learning and 4.08 for retention). The treatments compared two types of pictorial advance organizer to a control: (a) an integrated organizer, presenting two geometric figures divided into component parts in an organized manner and (b) a fragmented organizer, presenting the same shapes in a disorganized way. The students studied the organizers before reading a 550 word passage about an imaginary land emphasizing geometric shapes and were assessed using free recall tests of learning and retention. Effect sizes were highest for the retention test as predicted by theory.

Lenz, Alley and Schumaker (1986) investigated the effects of the delivery of an advance organizer prior to each lesson on Learning Disabled (LD) students' retention and expression of information from a given lesson. Learning was assessed by an after-class interview recording the number of statements made by the student related to the lesson in which the organizer was used. Results indicated improvement both after teacher training and again after student training on taking notes from the organizers. The first improvement can be attributed to the use of the advance organizer per se and conflicts with Mayer's theory which indicates that it should not be effective for learning. The student training result could be ascribed as much to the generative activity of note-taking as to the advance organizer. Studies by Gilles (1984) with surgical nursing content (E.S. = 0.33 for retention) and Doyle (1986) with college mathematics (E.S. = 0.74 for learning and E.S = 1.03 for retention) indicated expository advance organizers affected both learning and retention with stronger support for the latter, thus supporting assimilation encoding theory.

Negative results. Three studies fall into this category. Corkhill, Bruning and Glover (1988) also compared the effects of concrete and abstract advance organizers on students' recall of prose (i.e. learning). The concrete organizer was hypothesized to function as a comparative advance organizer and the abstract organizer as an expository advance organizer. The abstract organizer treatments produced a mean effect size of -0.62 while the concrete organizer treatments had a mean effect size of 2.25. These results provide support for comparative but not expository advance organizers, yet both should be effective and for retention, not learning.

Kloster and Winne (1989) randomly assigned 227 eighth grade mathematics students to four treatment groups: (1) expository advance organizer, (2) comparative advance organizer, (3) outline and (4) unrelated passage (control). A mean E.S. of -0.18 was obtained for the expository advance organizer and -0.15 for the comparative advance organizer indicating a slightly negative effect for advance organizers. Finally, as will be detailed below, Kenny (in press) compared the use of an advance organizer to that of participatory and final form graphic organizers with a CBIV program on cardiac nursing. In this study, the final form graphic organizer was the most effective treatment.

Table 2
A Comparison of Effect Sizes for Recent Advance Organizer Studies

Study	Learning	Retention
Carnes, Lindbeck & Griffin (1987)	0.49	0.14
Corkhill et al. (1988)		
Expt. 3 (after 1 week)	--	1.96
Expt. 4 (after 24 hours)	--	2.85
Expt. 5 (after 2 weeks)	--	1.91
Corkhill, Bruning & Glover (1988)		
Concrete Organizer - Expt. 1	1.56	--
Concrete Organizer - Expt.2	2.93	--
Abstract Organizer - Expt. 1	-1.02	--
Abstract Organizer - Expt. 1	-0.21	--
Doyle	***0.74***	1.03
Gilles	0.015	0.33
Kenny (in press)		
Adv. Org. > Partic. Graph Org.	0.45	**0.95**
Adv. Org. > Final Form Graph Org.	-1.17	-0.45
Kloster & Winne (1989)		
Comparative Organizer	--	-0.15
Expository Organizer	--	-0.18
Lenz, Alley & Schumaker (1986)		
After teacher training	1.03	--
After student training)	2.93	--
Tajika, Taniguchi, Yamamoto & Mayer (1988)		
Fragmented Pictorial	0.078	1.49
Integrated Pictorial	2.04	4.08
Tripp & Roby (1990)	1.25	--
Tripp & Roby (1991)	0.33	--
Mean	0.76	1.16

Based on these reviews, the research evidence concerning any facilitative effect of advance organizers upon learning and retention is unclear. Much of the evidence appears positive, and yet, it is quite variable. Effect sizes for the more recent studies range from -1.02 to 2.04 for measures oflearning and from -0.18 to 4.08 for tests of retention. It may be that this range represents the distribution of study means around the true effect size mean for this instructional technique. The variability could reflect differences in experimental design, subject selection and methodology. Given the frequent discussion of the difficulty in constructing an advance organizer (e.g. Hartley & Davies, 1976, McEneany, 19901, one likely source of error is treatment fidelity. Much of this variability may reflect the lack of clarity about the definition and design of an advance organizer.

If advance organizers do affect learning, how do they achieve this effect? The inconsistent support for subsumption theory (Ausubel, 1963) and for assimilation encoding theory (Mayer, 1979a) calls their ability to predict into question. Corkhill, Bruning and Glover (1988) suggest that concrete (comparative) advance organizers may furnish ideational anchorage in terms already familiar to the learners, that is, to provide meaning by association with existing schema. They may assist the learner to visualize the content of the organizer more readily. These authors also stress the importance of ensuring encoding of the organizer using techniques such as paraphrasing, generative techniques to be discussed below.

In summary, the effectiveness of the advance organizer as a pedagogical strategy and the validity of the theory on which it is based to predict its effectiveness are both still in question. What, then, of the other variations on the advance organizer concept? The next section extends this discussion to include two of its progeny: the structured overview form of advance organizer and the pictorial graphic organizer.

RESEARCH ON THE USE OF GRAPHIC ORGANIZERS

The Structured Overview Form of Graphic Organizer

The graphic organizer was first presented as a variation on the advance organizer. However, as indicated previously, key characteristics of this technique vary from its predecessor (See Alverman, 1981). Since it is not an advance organizer, does independent evidence exist that this strategy affects learning or retention? A meta-analysis by Moore Readance (1984) reported an average effect size of 0.22. They also noted an average effect size of 0.57 for graphic post organizers constructed by the instructor with the class or by the student alone. They concluded that the structured overview form of graphic organizer does have an effect, especially for university students, that vocabulary learning is most positively affected and that post-organizers benefit learners more than advance organizers.

More recent studies appear to support these conclusions (Table 3). Alvermann (1981) found that partially complete advance graphic organizers had an effect on ninth grade students' comprehension and retention of text. The results indicated the strongest effect for the less well organized text. Two studies (Boothby & Alvermann, 1984; Alvermann & Boothby, 1986) found the graphic organizer to be effective as a strategy for facilitating fourth graders comprehension and retention of social studies text. While the second (Alvermann & Boothby, 1986) study did not test for retention, it did indicate that graphic organizers had an effect on a transfer of learning task.

Bean et al. (1983) reported a study in which tenth grade world history students were divided into three groups: those taught to construct summaries and post graphic organizers, those taught to construct post graphic organizers only, and those taught to build outlines only. Results indicated a small effect for combined organizer and summary training group (0.16) but a negative effect for the organizer only group (-0.11). Because a true control group was not used in this study, effect sizes were calculated using the outlining group as a control.

Finally, Carr and Mazur-Stewart(1988) found that avocabulary overview guide (a multi-page booklet) which included a graphic organizer was significantly superior to a traditional form of instruction in improving the vocabulary comprehension and retention of college students. While the results are neither extensive nor consistent, taken overall, these studies do indicate that the structured overview form of graphic organizer — especially the post organizer type — does affect learning and retention.

Table3

A Comparison of Effect Sizes for Recent Structured Overview Graphic Organizer Studies

Study	Learning	Retention
Alvermann (1981)		
Descriptive Passage	1.26	1.76
Comparative Passage	0.06	0.41
Boothby & Alvermann (1984)	0.98	0.99
Alvermann & Boothby (1986)		
Passage 1	-0.34	--
Passage 2	0.45	--
End of chapter test	0.41	--
Bean et al. (1986)		
Organizer and Summary Training	0.16	--
Organizer Only	-0.11	--
Carr and Mazur-Stewart (1988)	0.89	1.23
Mean	0.42	1.10

The Pictorial Graphic Organizer

A review of the pictorial graphic organizer research is reported in Table 4. Two experiments by Jonassen and Hawk (1984) tested teacher-constructed participatory graphic organizers in regular classrooms. The results indicated a stronger effect for learning than for retention. Two studies (Hawk, McLeod & Jeanne, 1981; Hawk &Jeanne, 1983, cited in Hawk, McLeod, & Jonassen, 1985) reported statistically significant results in favour of participatory pictorial graphic organizers. However, insufficient data were available to calculate effect sizes. A more recent study by Hawk (1986) also found this technique to be effective in facilitating retention for above average students studying life science in the sixth and seventh grades.

Darch, Camine and Kameenui (1986) compared the cooperative (group) and individual completion of participatory pictorial graphic organizers to a more traditional directed reading approach. The graphic organizers, especially for the cooperative learning approach, were found to be more effective in facilitating retention than the traditional approach. Learning was not tested.

Table 4

A Comparison of Effect Sizes for Pictorial Graphic Organizer Studies

Study	Learning	Retention
Jonassen & Hawk (1984)		
Experiment 1	1.17	0.67
Experiment 2	1.82	0.77
Hawk (1986)	--	0.64
Darth, Carnine & Kameenui (1986)	--	
Cooperative Graphic Organizer	--	1.59
Individual Graphic Organizer	--	0.72
Alvermann (1988)		
Self-perceived High Ability	-0.64	--
Self-perceived Low Ability	3.94	--
Kenny, Grabowski, Middlemiss, & Van Neste-Kenny (1991)	0.59	-0.07
Kenny (in press)		
Participatory Graph. Org. > Adv. Org.	-0.45	-0.95
Final Form Graph. Org. Adv. Org.	1.17	0.45
Mean	1.09	0.48

Alvermann (1988) investigated the effects of a final form graphic organizer designed to induce students to look back in their texts for missed information. The organizer facilitated learning for self-perceived low ability students (those whose ability as measured by a standardized achievement test matched their own perception of their ability) compared to a control group of self-perceived low ability students who only read the passage. The organizer appeared to interfere with the learning of self-perceived high ability students compared to the equivalent control group. For this study, the organizer was designed as a road map to guide students back to sections in the text in order to answer posttest questions.

Finally, studies by Kenny, Grabowski, Middlemiss and Van Neste-Kenny (1991) and Kenny (in press) used pictorial graphic organizers with CBIV and found evidence to support the technique. Again, these are discussed in the section on organizers in CBI. In summary, the evidence reported above, while once again inconsistent, is generally positive. Pictorial graphic organizers of both forms appear to facilitate the learning and retention of information, at least for younger learners. Learning, though, seems to have been more consistently affected than longer-term retention of information.

Taken overall, there is positive evidence for the effectiveness of all three of these techniques. The question posed by this review, however, is whether or not these results generalize to instruction delivered by CBI. Can one expect any of these techniques to help alleviate such potential problems as disorientation and cognitive overload? Research specific to the use of instructional organizers in CBI is discussed next.

INSTRUCTIONAL ORGANIZERS WITH CBI

While the majority of studies reviewed used text-based advance organizers, the strategy can be produced in other formats. Mayer (1979a) noted that advance organizers could be verbal or visual material and used a pictorial advance organizer in a later study (Tajika, Taniguchi, Yamamoto & Mayer, 1988). Therefore, it is not too large a leap of faith to presume that they might be effectively incorporated into CBI, a class of technology which can effectively combine both text and visuals. Hannafin and his associates have published a series of papers, based on the ROPES+ meta-model discussed above, on orienting activities in CBI generally and CBIV in particular (Hannafin, Phillips, Rieber & Garhart, 1987; Hannafin, Phillips & Tripp, 1986; Hannafin, 1987; Rieber & Hannafin, 1988). Hannafin, Phillips, Rieber and Garhart (1987) found that both behavioral and cognitive orienting activities, used in CBI with university students, improved factual learning. The cognitive orienting activity was: “designed to provide an integrative method for establishing meaningful relationships, while also serving as a subsumer of lesson detail” (p.80). This is labelled an advance organizer, however, the one example they give, “In the next section, you will be presented information about: The importance of studying cultures." (p.77), seems insufficient to affect encoding.

Similarly, Hannafin, Phillips and Tripp (1986) used a one sentence cognitive orienting activity in a CBIV lesson on artists and art periods with 80 volunteer college students. They noted a significant interaction between the orienting activity and processing time but no main effect. Another study (Hannafin, 1987) compared the effects of orienting activities, cuing and practice on the learning of material on space voyages by ninth grade students. A significant interaction was found between the cognitive orienting activity and practice but the orienting activity alone was not a significant component. Again, the cognitive orienting activity provided, "The Next Section Presents the Following Concepts: ===> Unique lighting found throughout the solar system (and) ===> Matter found throughout the solar system", based on Mayer's (1979a) characteristics of an advance organizer, seems meagre. Rieber and Hannafin (1988) also studied the effects of textual and animated cognitive orienting activities on a CBI lesson explaining Newton's laws of motion to 111 elementary students. Three types of orienting activities (one minute duration each) were used: a text only, one sentence summary of the particular basic concept, an animated graphic sequence, or a combined text and graphic sequence, all presented throughout the lesson before each basic concept. There was also a control (no activity) group. The authors found no statistically significant effects.

These orienting activities all meet three of Mayer's (1979a) characteristics: (a) a short set of verbal or visual information, (b) presented prior to the material-to-be-learned and (c) containing no specific content from that material. However, none seem of sufficient scope to meet the other two conditions; (d) generate logical relationships among elements in the to-be-learned material, or (e) to sufficiently influence the learner's encoding process. The organizing activities used in these studies were probably not advance organizers.

Some studies, however, did use true advance organizers in computer-based instruction. Carnes, Lindbeck and Griffin (1987) used a computer-based tutorial on kinematics with 100 high school students. There was no statistically significant difference between the advance organizer treatment group and a non organizer group (which read a related passage designed not to act as a subsumer). However, effect sizes of 0.49 for a test of learning and 0.14 for the retention test indicate a mild positive effect by the advance organizer.

Krahn and Blanchaer (1986) tested the use of an advance organizer to improve knowledge application by medical students in a computer-based simulation. Post-test scores showed a statistically significant difference between the experimental and control group, both for the total scores and particular questions designed to test far transfer, as predicted by assimilation encoding theory. The test, however, was given immediately after completion of the simulation and consisted of only six questions. No validity or reliability data were provided. Insufficient data were reported to allow the calculation of effect sizes and, hence, this study was not included in the previous table (Table 2).

Tripp and Roby (1990,1991) reported the use of an advance organizer in two studies with a Japanese-English hypertext-based lexicon. They measured immediate recall and assessed rote learning, which runs contrary to assimilation encoding theory. The authors reasoned, however, that the advance organizer, rather than act as a bridge to existing cognitive structures, would convey the structure of the database and so contribute to meaningful learning.

The results of the first study were not statistically significant ($p < 0.171$) yet the E.S. was 1.25, indicating a probable lack of power in the study. As well, a significant negative effect was reported for the interaction between the advance organizer and a visual metaphor for half the group. In the second study, the advance organizer was rewritten to provide a metaphorical structure hypothesized to be congruent with the visual metaphor treatment. The authors reported a significant main effect for the advance organizer treatment, but not for the visual metaphor, nor was there a significant interaction. The E.S. of 0.33 for this study **may** be more accurate given the larger number of subjects used. Regardless, these studies clearly contradict advance organizer theory since they demonstrated that the technique facilitated rote, rather than meaningful, learning.

Kenny, Grabowski, Middlemiss and Van Neste-Kenny (1991) compared participatory graphic organizers to the identical final form versions on the learning of nursing students from a CBIV program on nursing elderly patients with pulmonary disease. The participatory graphic organizer group substantially outperformed the final form group on a test of learning, scoring an average of 1.77 points higher on an 18 question multiple choice test (E.S. = 0.59). The difference, however, was not statistically significant. As well, there was only a slight difference on the retention test, in favour of the final form version (E.S. = -0.07). Considerable extraneous note-taking by subjects in both groups likely confounded the differences in generativity between the two treatments.

Kenny (in press) next compared the use of an advance organizer to that of participatory and final form graphic organizers with a CBIV on cardiac nursing. In this study, the final form graphic organizer was clearly most effective, garnering the highest mean scores on both tests of learning and retention. The participatory graphic organizer group had the lowest mean scores while the advance organizer group fell in the middle. The difference between the final form and advance organizer group means was statistically significant at the $p < 0.05$ level for learning (E.S. = 1.17) but was not significantforretention (E.S. = 0.45). The difference between the advance and participatory organizer group means was statistically significant at the $p < 0.10$ level for retention (E.S. = - 0.95) but not significant for the test of learning (E.S. = - 0.45). The effect sizes reported here (and in Table 4) assume the advance organizer as a control. Extraneous note-taking was controlled.

However, the cardiac program used a guided discovery approach design (unlike the pulmonary program) which demanded considerable interaction on the part of the learner and may have interacted with the organizer treatments.

Overall: there appears to be mild evidence to suggest that advance organizers and pictorial graphic organizers could be effective if incorporated in instruction based on CBI. Furthermore, this literature is congruous with the research on the use of these techniques in instruction in general, that is, the evidence of their effectiveness is mostly positive, if somewhat variable. Why are these generally positive results not reflected more often in the research? In the case of the studies focusing on CBI, many of the organizers did not appear to be properly constructed, that is, they were insufficient to produce a subsumptive effect. Again this may reflect the theme sounded by McEneany (1990) that a sound operational definition for the construction of advance organizers is lacking. The format and construction of the pictorial graphic organizer is similarly unclear and often (in the experience of the author) difficult.

Perhaps there is also a problem with the theory underlying instructional organizers. If subsumption theory and assimilation encoding theory are not effective in predicting when instructional organizers will be effective, will another theory be more accurate? In a discussion of the psychological underpinnings of hypermedia, Borsook and Higginbotham-Wheat (1992, p.62) note that as "we explore some of the ideas of what we know about how we learn and apply knowledge, it becomes obvious that activity as well as interactivity [emphasis added] are integral components of both theory and its application in the technology of hypermedia." Cognitive principles suggest that learning is an active, constructive process in which learners generate meaning for information by accessing and applying existing knowledge (Borsook & Higginbotham-Wheat (1992, p.64). The authors point out that Wittrock's (1974) generative learning theory incorporates such principles. Generative learning theory is considered next.

THE GENERATIVE LEARNING HYPOTHESIS

In Wittrock's (1974, p.88) view, "it is the learner's interpretation of and processing of the stimuli, not their [the stimuli's] nominal characteristics, which is primary". Learners must construct their own meaning from teaching (Wittrock, 1985). This meaning is generated by activating and altering existing knowledge structures to interpret new information and encode it effectively for future retrieval and use. Further, generative learning involves not only generating meaning, but overt activities as well, such as generating associations among words, and generating pictures (Doctorow, Wittrock & Marks, 1978). These learning activities require the learner to relate new information to an existing knowledge structure and depend on complex cognitive transformations and elaborations that are individual, personal and contextual in nature. Information is transformed and elaborated into a more individual form making it more memorable as well as more comprehensible (Borsook & Higginbotham-Wheat, 1992).

Of the instructional organizers discussed above, only the participatory form of the pictorial graphic organizer (Hawk, McLeod and Jonassen, 1985) and the student-constructed form ofstructured overview (Moore & Readance, 1984) elicit, by design, a generative response from the learner. In fact, Hawk, McLeod & Jonassen (1985) recommended the participatory version because it was their belief that "the more generative the nature of student participation, the more likely it is that transfer and higher level learning will be affected" (p.179). These organizers elicit generative activity because they require the learner to actively search a body of material to select information to complete the organizer. Advance organizers, on the other hand, cannot necessarily be considered to be generative since they invoke a covert response rather than specifically engage the learner in overt, active learning. Perhaps this explains why the research on instructional organizers is so variable. Given how difficult advance organizers are to construct, some investigators may have unknowingly developed organizers or other activities that engaged the learners in generative learning.

Moore and Readance (1984) note superior results for structured overview graphic organizers constructed after reading the learning passage. In support of Wittrock's hypothesis that familiar words facilitate the learners' generation of meaning for the passage (Marks, Doctorow & Wittrock, 1974, Wittrock, Marks & Doctorow, 1975), Corkhill, Bruningand Glover (1988) demonstrated the advantage of concrete advance organizers over more abstract ones, suggesting that the former furnish ideational anchorage in terms alreadv familiar to the learners. Even the Alvermann (1988) study of final form graphic organizers directed the learners to engage in what can be argued to be a generative activity by asking them to use the organizer as a map in an active search back in the text for question answers. Thus, some of the most impressive results were garnered when students were actively engaged in the learning process.

Generative Instructional Organizers with CBI

Generative learning theory as applied to CBI, at least as pertains to instructional organizers, has yet to be widely tested. The few studies completed have not provided strong evidence to suggest that generative learning activities can be successfully applied to computer-based media. Two studies described earlier (Kenny, Grabowski, Middlemiss & Van Neste-Kenny, 1991, Kenny, in press) obtained mixed results. Kenny, Grabowski, Middlemiss and Van Neste-Kenny (1991) obtained a mild effect size in favour of a participatory pictorial graphic organizer used with CBIV. Kenny (in press), however, found the final form graphic organizer with CBIV to be the most effective on both measures of learning and retention. The group using the hypothetically generative participatory organizer achieved the lowest mean scores. However, analysis of interview data indicated that the guided discovery design of the CBIV program may have interfered with the generative nature of the participatory graphic organizer. The learners were already engaged in a demanding learning activity and the normally generative organizer, rather than helping to make learning more meaningful, likely contributed to, rather than alleviated, cognitive overload.

Harris (1992) compared the use of learner-generated summaries to the completion of multiple choice questions with tutorial courseware delivered by CBIV. Contrary to predictions, the control group, which received the treatment considered to be least generative (multiple choice questions completed at the end of each module), achieved the highest mean score on a test of learning (given right after completion of the modules). Effect sizes were - 0.44 for the learner-generated summaries without feedback and -0.12 for those with feedback. None of the differences were statistically significant.

Finally, Jonassen and Wang (1992), conducted three studies on acquiring structural knowledge from hypertext. Structural knowledge is that of how concepts in a particular domain are interrelated (Jonassen & Cole, 1992). In the second study, Jonassen and Wang (1992) tested the use of a generative activity with a HyperCard-based text. The control treatment consisted of referential links embedded in the cards, while the generative treatment asked the learners to classify the nature of the relationship between the node they were leaving and the one they were traversing to. The control group scored higher on average on a test of recall (E.S. = - 0.64) and on 2 of 3 tests of structuralknowledge (E.S. for relationship proximity = 0.36, E.S. for semantic relationships = 0.43 and E.S. for analogies = - 0.15). Again, none of the differences were statistically significant.

Once again, this group of studies is not conclusive. Three of these studies use small sample sizes and may have been underpowered. Only the first provided any evidence for the effectiveness of generative activities in CBI. While, theoretically, the application of generative learning theory to the use of instructional organizers with CBI seems to hold promise, there has been little evidence to demonstrate that it more effectively predicts the effectiveness of instructional orienting activities than the theories considered previously. Given this, is there any theory that can be shown to provide guidance? Borsook and Higginbotham-Wheat (1992) suggest a number of theories, generative learning among them, which may provide insight about how and why hypermedia (that is, interactive multimedia instruction) might be used to deliver effective instruction. Perhaps most prominent among these cognitive theories is schema theory (Rumelhart & Orteny, 1977, Anderson, 1977).

Schema Theory and the Hypermap

Jonassen (1989) claims that it is schema theory that describes the organization of human memory, not Ausubel's hierarchical, or subsumptive, model. A schema for an object, event or idea is comprised of a set of attributes, that is, associations that one forms around an idea. Schema are in turn arranged into semantic networks, sets of nodes with ordered relationships connecting them (Jonassen, 1988). Kiewra (1988) indicates that an outgrowth of schema theory has been applied research on the effectiveness of spatial learning strategies. Such strategies involve the reorganization ofinformation into some form of spatial representation that clarifies the inherent relationships among ideas or concepts. Such representations allow information to be more readily processed since they reflect cognitive structure and provide multiple retrieval cues for accessing it. As the graphic organizer is one form of spatial representation, schema theory may help explain the effectiveness of the technique. In the study by Kenny (in press), for instance, the filled-in (Final Form) version of the pictorial graphic organizer was most effective and may have acted as a form of cognitive map.

To reflect an individual's knowledge structure, then, an instructional organizer, rather than being constructed at a higher, more abstract level as is an advance organizer, might be designed to reflect either novice or expert schemata. Jonassen (1989), for instance, advocates the use of hypermaps, or graphical browsers, an instructional orienting technique similar to the graphic organizer. A hypermap provides a graphical view of the program structure. The user may select a node on the hypermap and be taken immediately to that part of the program. Hypermaps represent a graphical interface between the user and a hypertext that is designed to reduce navigation problems (Jonassen & Wang, 1992). They can be expected to be effective because they should enhance the learner's structural knowledge (the knowledge of interrelationships between ideas) of the information in the program (Jonassen, 1989).

Research on hypermaps, however, has been even more scant than that on generative techniques in CBI. In the first study described above, Jonassen and Wang (1992) compared the effectiveness of a hypermap to a control treatment consisting of referential links embedded in the cards. Again, the control group significantly outperformed the hypermap group on a recall test. Tests of structural knowledge acquisition, however, showed no significant differences between the techniques. In the third study, Jonassen and Wang (1992) provided learners with either a control treatment as described above or a hypermap to use for navigation. They informed half the learners in each group that they would be responsible for developing a semantic network (essentially their own hypermap) after completing the program. While this activity was ceased after only a few minutes in order to control for time-on-task, those given the semantic network task performed significantly better on the semantic relationships scale and the graphical browser/semantic network group was significantly better on the analogies subscale. In effect, the instructions to the semantic networks groups may have been sufficient to lead them to actively engage the material, that is, to elicit generative learning. The analogies subscale result, then, is one that could be explained by either Wittrock's (1974) theory, by schema theory, or both. These two studies appear to be the only ones to date testing this form of orienting activity, although a variation of the knowledge mapping system (e.g. Dansereau et al., 1979) has been tested.

Like the graphical browser, the knowledge map represents multi-dimensional knowledge in associative networks akin to semantic nets or schemata. Nodes denote the type and importance of the content and the spatial properties of the map clarify the organization of the domain (Reynolds and Dansereau, 1990). Perhaps the greatest distinguishing feature of the knowledge map is the use of 8 specified link types to label linkages between nodes while Jonassen's version uses flexible labelling for links. Two recent studies (Reynolds and Dansereau, 1990, Reynolds et al., 1991) have presented this technique to learners in computerized form as a hypermap. Two variations of a statistics package were developed: a "standard" hypertext version and a version in which all the concepts were represented in hypermap versions of the knowledge map, that is, no standard textscreens were provided. Since these studies used this format for the main body of the learning material rather than as an orienting activity, these studies are not reviewed here.

CONCLUSION

As presented, the research pertaining to the use of instructional organizers in CBI has not been extensive. Much has been conducted based on the ROPES+ meta-model proposed by Hannafin and his associates. While advance and graphic organizers are included in the orienting activities category, it is doubtful that the cognitive orienting activities used by these theorists (e.g. Hannafin, 1987, Hannafin & Hughes, 1986, Hannafin, Phillips, Rieber, & Garhart, 1987) have represented forms of these techniques at least as described by the originators of the strategies (e.g. Ausubel, 1960,1978; Mayer, 1979a). Where such organizers have been constructed according to original guidelines, they have been somewhat more successful. In general, there is substantial, if variable, evidence that these strategies can influence learning and retention. Based on these results, some tentative recommendations for the effective use of instructional organizers in CBI can be made.

Advance Organizers

The designer should be clear about the reasons for incorporating this strategy. Advance organizers were proposed as a means to facilitate the retention of meaningful verbal information. The technique is founded on the premise that the structure of memory is hierarchical in nature. Based on the above review, advance organizers are probably best used with at least some of Mayer's (1979a) conditions in mind:

1. Use advance organizers in CBI intended to present information that is hierarchical in nature and for which more general or more abstract subsuming material can be designed.

2. Be clear that the advance organizer encourages the learner to actively integrate the material to come. Will it truly provide a means for generating logical relationships among the elements in the material to come and thereby influence the learner's encoding process? The wording or design of an advance organizer for CBI can be difficult if one also wishes to limit the number of screens of text in which it is presented. Ausubel typically used advance organizers of about 500 words. Such length may be unacceptable for CBI, particularly if learners have the choice whether or not to read the organizer.
3. Explain the purpose of the organizer to the learners before they encounter it whether they have the choice or not to use it.
4. Be certain to word the organizer in terms familiar to the learner. It is intended to be a form of prior knowledge to which the coming material is to be related and must be meaningful.
5. Use an advance organizer if the CBI is poorly organized or lacks the prerequisite concepts contained in the organizer.
6. Do not use an advance organizer if the CBI also makes use of other learning strategies that engage the learner in overt, generative activities.

Graphic Organizers

By definition, graphic organizers can contain material from the main CBI program and are not advance organizers. However, they can be used as a pre-instructional strategy, that is, presented at the beginning of a program. Again, based on the research presented in the above review, graphic organizers are also probably best used under certain conditions in CBI:

1. Design the organizer so that it elicits generative activity from the learner either as a part of the on-going interaction with the CBI or right after the learner has completed the program (or a substantial part thereof).
2. Do not use a graphic organizer if the CBI also makes use of other learning strategies that engage the learner in overt, generative activities.
3. If you intend to use a graphic organizer as a pre-instructional activity, design it to reflect the structure of the material such that it provides a conceptual overview of the material to come.
4. Consider the structured overview form of graphic organizer if it is important or helpful to present new vocabulary to learners prior to their encountering the material to come.

The Role of Theory

As this review has indicated, there is substantial evidence to indicate that instructional organizers can be effective learning strategies but the evidence has been variable. Of the three instructional organizers discussed, only the advance organizer is founded on a strong theoretical base (subsumption theory and assimilation encoding theory), and yet, these theories have not consistently predicted the effectiveness of the strategy. However, neither has the limited research testing instructional organizers on the basis of two other theories, generative learning theory and schema theory, been strongly indicative of their predictive value. Given the evidence presented here, it may be that no one theory is sufficient in and of itself to predict the effectiveness of instructional orienting techniques and to guide their design. Rather, it may be necessary to consider various theories acting in concert. If the results of the third Jonassen and Wang (1992) study, which combined a hypermap treatment with a generative activity, are indicative, the design of instructional organizers may have to be based on features from various theories, each of which describes a different aspect of human cognition. While further research on both the application of generative learning and schema theory to CBI is needed, perhaps this will be most fruitful if it combines the two. Simple tests of theory may not be sufficient.

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NOTES

1. The term “learning” will be used throughout this document to mean a measure of learning completed by the learner within 24 hours of having studied the material-to-be-learned. This is consistent with the use of the term in the research literature pertaining to advance organizers and is not meant to imply solely the immediate recall of facts or verbal information. “Retention” will refer to any measures of learning given 24 hours or more after the completion of the lesson.

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A Case Study: Development of Interactive Multi-Media Courseware in Dentistry

Benoit David
Arto Demirjian
Steven Shaw

Abstract: This article details a project undertaken at the School of Dentistry at the Université de Montréal concerning the development of multi-media computer-based instruction for clinical and anatomical subjects in dentistry. Under the direction of Dr. Arto Demirjian. six courses were developed on Macintosh and PC platforms in three languages (English. French and Spanish) and packaged on CD-ROM. The courses, produced between January 1992 and December 1993, are intended primarily for dentistry students but are also being marketed as a vehicle for continuing professional education of practicing dentists. The article describes the contents and design features of the various courses, outlines the human and technical resources which were implicated in their development and production and relates the approaches which were taken to promote their use.

Résumé: Cet article décrit un projet entrepris par la Faculté de médecine dentaire de l'Université de Montréal. Il s'agit de la mise en place d'un programme d'enseignement multimédia informatise pour les études cliniques et anatomiques du domaine dentaire. Sous la direction du Dr. Arto Demirjian, ce projet de six cours a été mis au point en trois langues (française, anglaise et espagnole) pour les systèmes Macintosh et PC, sur progiciel CD-ROM. Les cours, développés entre janvier 1992 et décembre 1993, s'adressent d'abord aux étudiants en médecine dentaire mais ils sont également adaptes à la formation professionnelle continue des dentistes praticiens. Cet article donne un aperçu du contenu et des caractéristiques de conception des différents cours, il présente les ressources techniques et humaines qui ont contribue à leur élaboration et à leur production, et relate les démarches entreprises pour la promotion et l'utilisation de ceux-ci.

INTRODUCTION

A two year research project in multi-media courseware development was undertaken at the Faculty of Dentistry of the Université de Montréal, from January 1992 until December 1993, under the direction of Dr. Arto Demirjian, professor of anatomy.

Funding for this project allowed us to assemble a diversified team of human resources, and provide up-to-date equipment and software, for both Macintosh and PC/Compatible platforms. The development team involved several people with different backgrounds, providing a wide variety of resources: content expert, designer, programmers and medical illustrator.

The courseware developed was intended primarily as a learning tool for undergraduate students at different stages of the dentistry program. However, it was also envisaged that it would serve as a continuing education tool for dentists who are practicing their profession. Some, of the courseware is already in use by students and it is being evaluated in different parts of the world, mainly in the United States, but also in Canada, Europe, Australia and South America.

In this report we are going todescribe the courseware, then address the context in which the project was completed, the methods employed to achieve the goals, and finally the promotion and diffusion of our work.

COURSEWARE

The following courses, presented in a chronological order of production, are the tangible results of our efforts. Each successive module was treated as an opportunity to design and test new interfaces and evaluate various refinements concerning the interactive features.

Anatomy & Anaesthesia of the Mandibular Nerve (AAMN)

Written for dentists, professionals and students alike, this course, the first to be produced during the project, describes the anatomy and anaesthesia of the mandibular nerve as well as other anatomical structures in the area. It contains three chapters of theoretical information (Osteology, Dissection and Clinic) and a Quiz section.

The original version was developed prior to this project, by Dr. Demijian and Richard Tanguay, with the authoring software SuperCard. That initial version served as a prototype for the development of a second one, created with Macromedia's Director software. Basically, the object was to improve the interface and graphic design, while the content was mostly left untouched.

The content comprises more than 100 photographs, diagrams and medical illustrations. The standard screen layout (Figure 1) presents an image on the left, accompanied by a descriptive text on the right. The text contains highlighted words that double as buttons. When clicked on, these button activate the corresponding structure in the image, in a particular manner, through animation or highlighting.

A location and access map of the contents is always available through the use of a Where Am I?" button (Figure 2). This brings up a flowchart of the different sections of the document with the present location of the user highlighted. The user can also access any part of the content by clicking on the corresponding section of the flowchart.

The Quiz section was originally one module consisting of multiple choice questions. It was modified by adding a second module, an anatomical puzzle

FIGURE 1.
AAMN — Typical Screen Layout

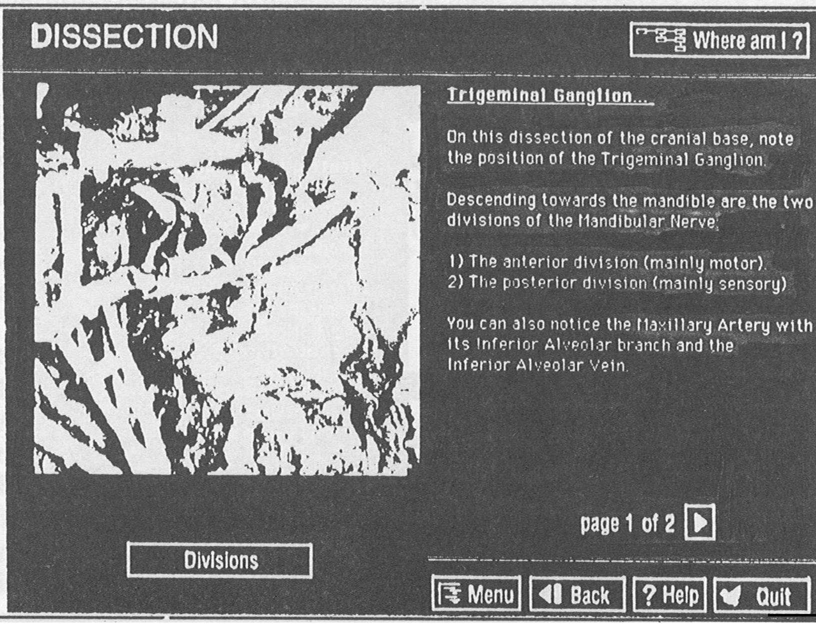


FIGURE 2.
AAMN Access and Location Map

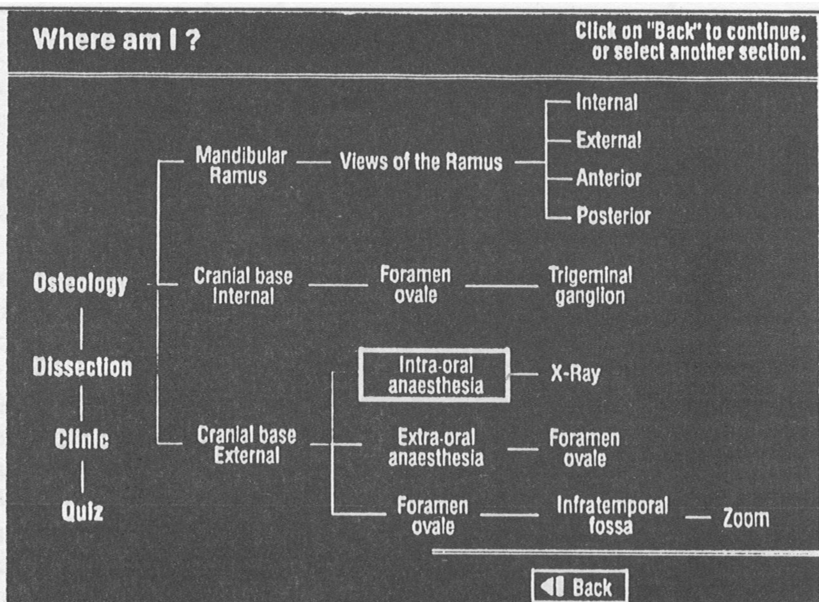


FIGURE 3.
AAMN — Multiple Choice Questionnaire

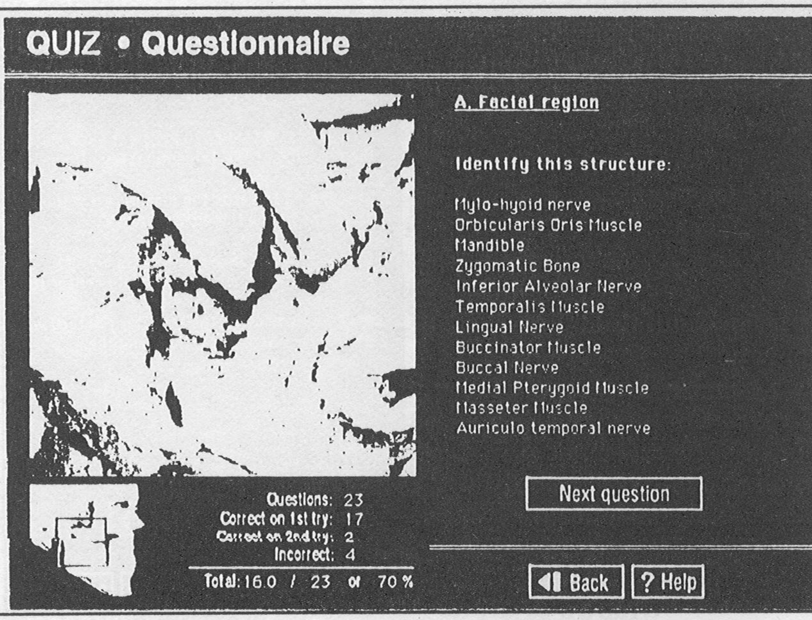
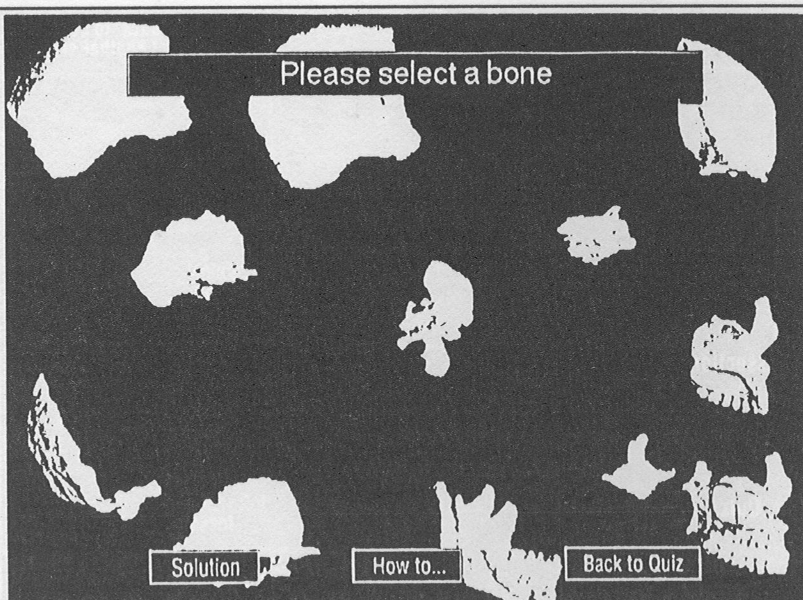


FIGURE 4.
AAMN — Puzzle



of the cranial bones. The two modules work as follows:

- The multiple choice questionnaire (Figure 3) presents 68 questions in random order based on 10 photographs of dissection material, each having six to eight different anatomical structures highlighted in some way. The user must identify each of these structures from a list of possible answers that is provided. After two incorrect tries the correct answer is provided. The user's score is compiled and displayed in the bottom part of the screen.
- The puzzle (Figure 4), presents the bones of a skull dispersed about the screen. The object is to reassemble the skull by putting each bone back into its correct position. The software verifies if the chosen position is correct. A response is then given accordingly. If the position is not correct, the bone is returned to its original position.

Dental Development

This interactive tutorial for the evaluation of Dental Age is based on the Bio-Age tutorial/database package, a product also developed at the School of Dentistry prior to this project.

The new Dental Development package was designed to offer a high-quality presentation of the findings of a 25 year research project on child growth and development. Aimed at dentists, orthodontists and pediatricians, the information given is divided into five sections: the Demirjian System, training modules for beginner and advanced users, a bibliography, a sample of longitudinal x-rays, and a clinical evaluation utility for practical application of the Demirjian System.

The section entitled "Demirjian System" presents the Dental Age Evaluation System developed by Dr. Demirjian. Each developmental stage is explained and illustrated with x-rays, photographs and diagrams (Figure 5).

Once the user has assimilated the theory, s/he can test himself or herself with the two self-assessment modules provided in the Training section: Beginner and Advanced. In both cases, the user is presented with dental X-rays on which specific teeth are pointed out. The object is to determine the stage of dental development reached by those teeth, out of three to four possibilities displayed in the lower part of the screen.

In the Beginner's module, the user chooses one dental x-ray out of 54 (nine x-rays for each of six patients, three boys and three girls, taken longitudinally from age six to 14) (Figure 6). Then he or she has to evaluate the dental age of the specified tooth. The information made available to the user includes the gender and age of the patient. The correct answer can be accessed through the use of a "Solution" button. The user can view all x-rays of the patient at the same time, and change x-ray or patient at any time (Figure 7).

With the Advanced module, the difficulty level was raised as follows: 378 questions are available in random order, and the only information displayed are the gender and age of the patient, the x-ray on which a tooth is pointed out, and the possible answers.

FIGURE 5.
AAMN — The Demirjian System

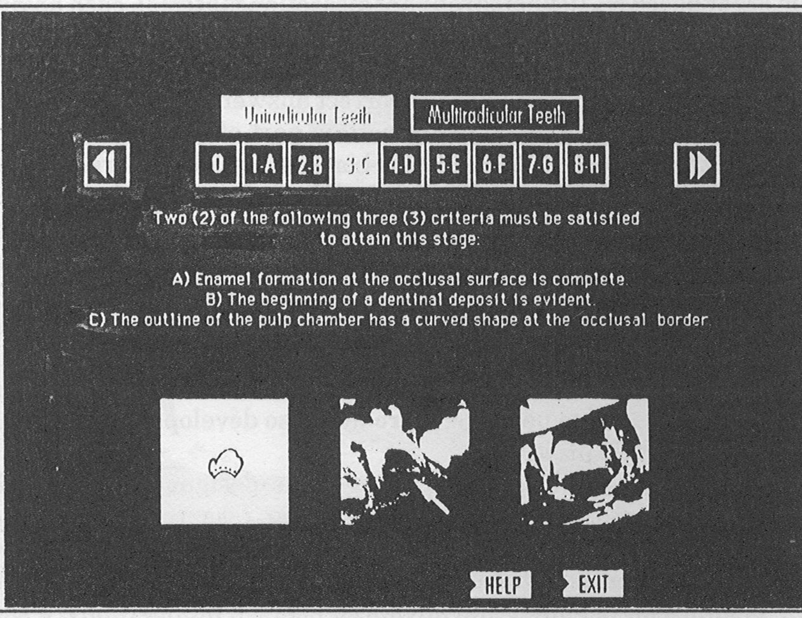


FIGURE 6.
AAMN — Dental Development X-ray Selection in the Self-Evaluation Section

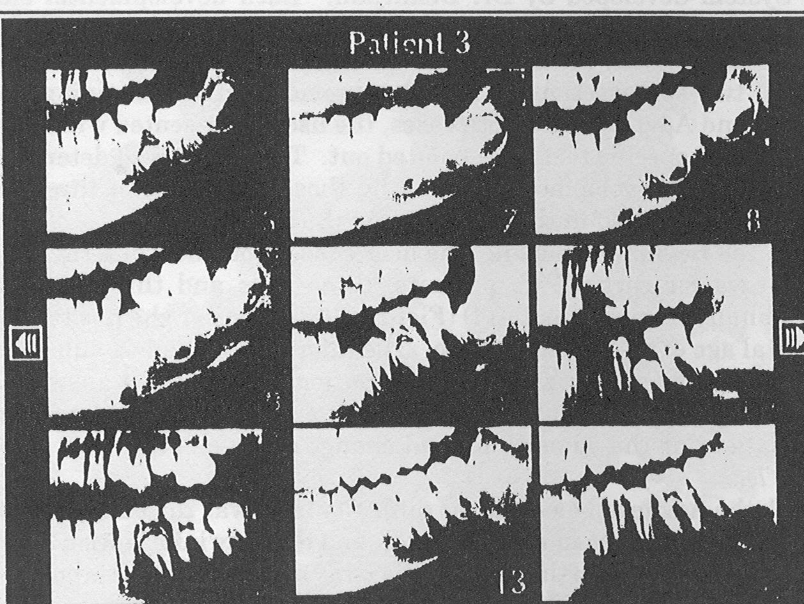


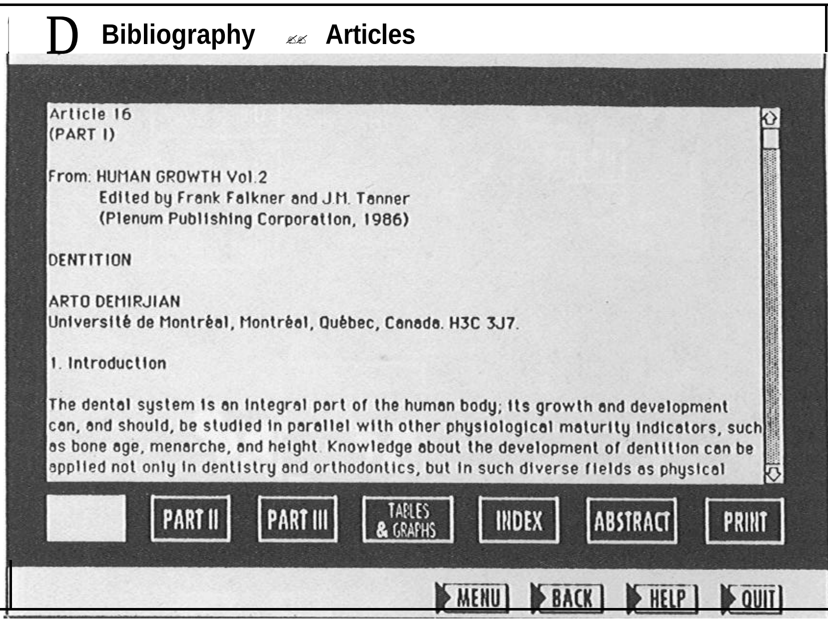
FIGURE 7.
Dental Development - Beginner's Module in the Self-Evaluation Section

The Bibliography section contains over 800 pages of text, tables and graphs, which represents the main body of literature published by Dr. Demirjian and others on the subject of dental development. Articles can be selected through an index or via abstracts, and are presented in scrollable fields (Figure 8), with their accompanying tables and graphs. There is a print function to generate hard copies. An external function (XFCN) was developed for that purpose since the authoring software used (namely Macromedia's Director) did not offer an elegant way to accomplish this task. When necessary, external functions like these are developed for both Macintosh (XFCN) and PC/Compatible (DLL Dynamic Linked Library) platforms.

The Sample X-Bays section shows a longitudinal collection of dental x-rays taken from the same patient from one and one-half to nineteen years of age. The images displayed were digitized with x-ray scanners, to present the user with the finest quality possible.

Finally, in the last section, the Clinical Evaluation, two calculation tools are made available as practical applications of the theory. These enable the users to calculate the dental age and maturity score of a patient, provided that x-rays of that patient are available. External functions were specifically developed for those tools, for both Macintosh and PC/compatible platforms.

FIGURE 8.
Dental Development — Browsing Through Articles in the Bibliography Section



Anatomical Puzzles

The anatomical puzzle of the cranial bones, originally designed as part of the AAMN courseware, was supplemented with a hand/wrist area puzzle and questionnaire, to form a stand-alone instructional game, to offer different, fun and challenging ways to learn.

As previously described in the puzzle of the cranial bones, with the hand/wrist puzzle the user is asked to place the previously dispersed bones in their correct configuration. The software verifies if each bone is properly placed, and reacts accordingly. However, with the hand/wrist area, a puzzle and a questionnaire are offered as two different methods of learning:

- The puzzle asks the student to position the bones of each of the three groups — Phalanges, Metacarpals and Carpals - in their correct locations (Figure 9). While similar to the puzzle on the cranial bones, this puzzle does not verify if the bones are dropped in their correct location. Instead, an outline is made available to facilitate the positioning of each bone. The user can hide or show that outline in order to modify the difficulty level.
- With the questionnaire, on the other hand, hand and wrist bones are displayed correctly assembled, and the student is asked to click on specific bones, one after the other, randomly, until there is none left (Figure 10). The user is given three chances correctly identify each bone, before the correct answer is revealed. The score is compiled and displayed on the left side of the screen.

FIGURE 9.
Anatomical Puzzles — Hand Puzzle

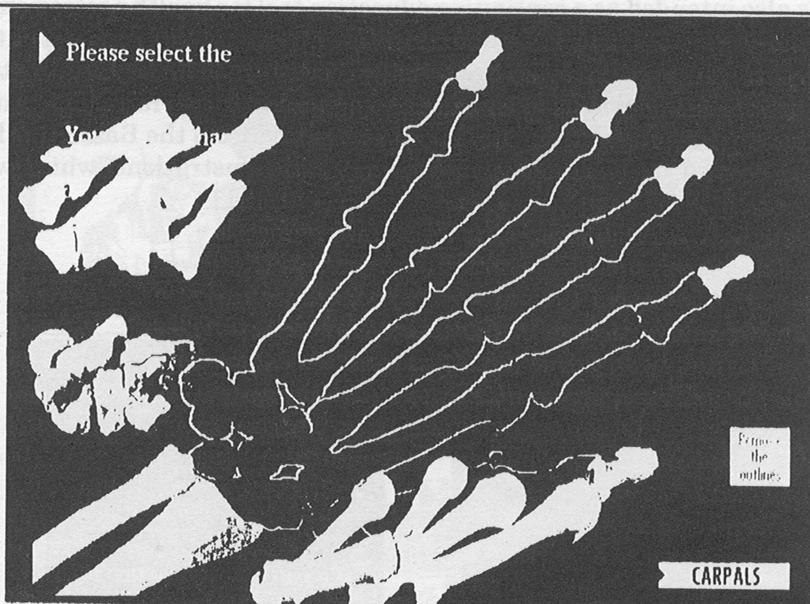
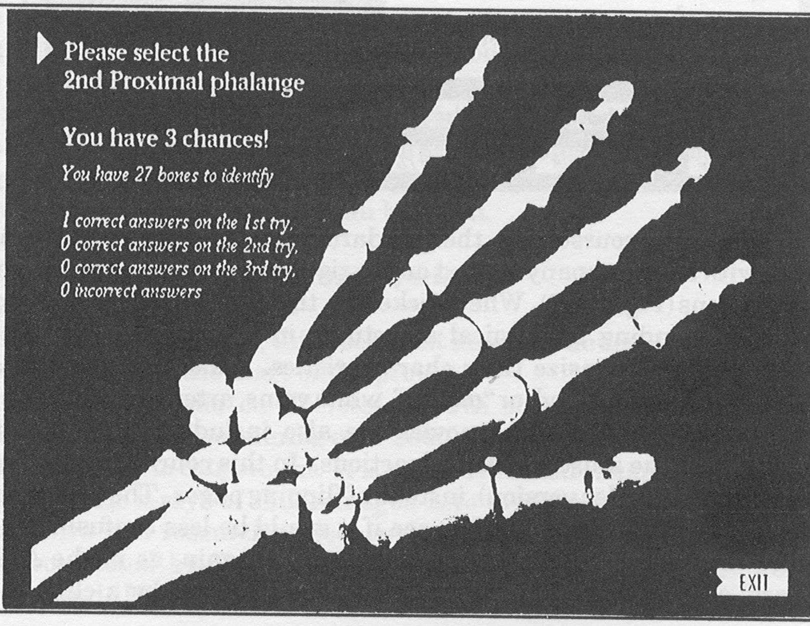


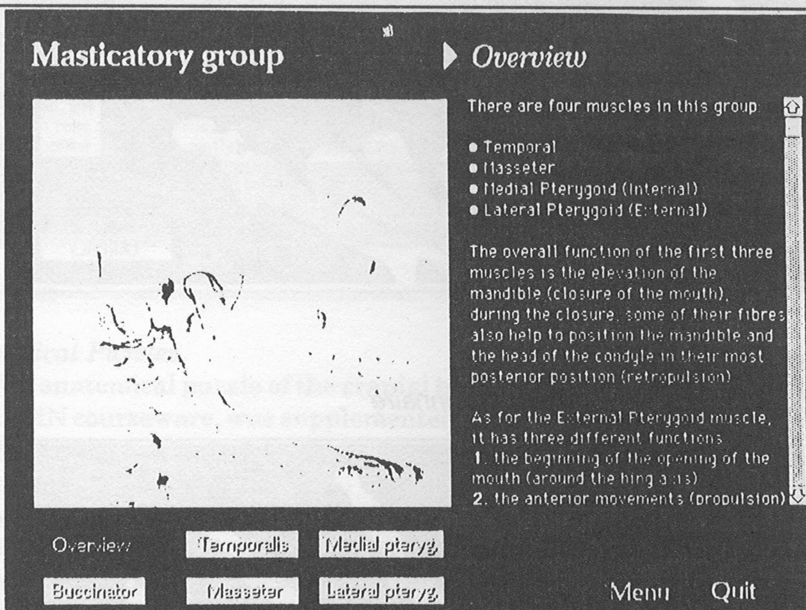
FIGURE 10.
Anatomical Puzzles — Hand Questionnaire



Masticatory Muscles

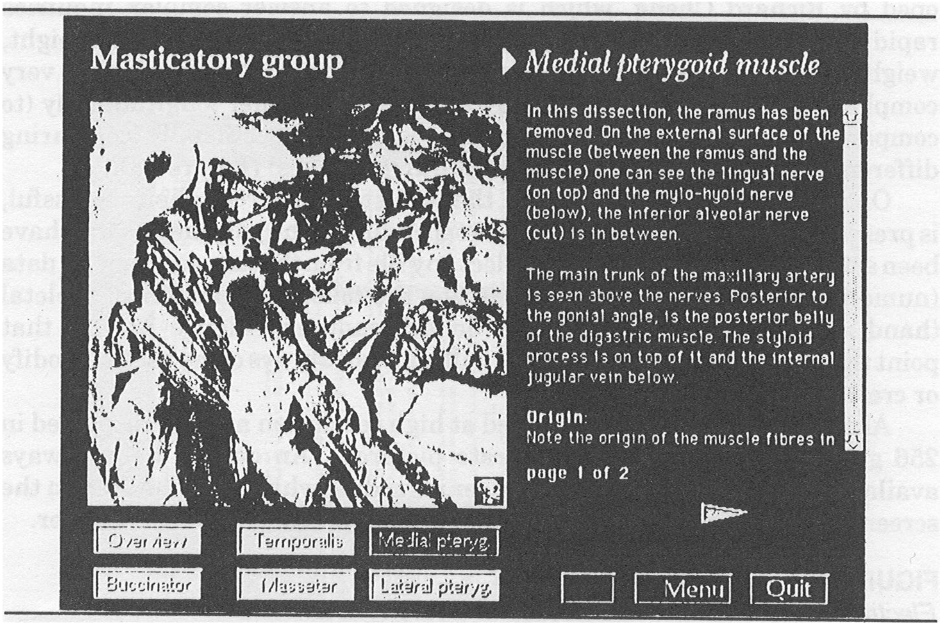
This courseware was prepared for first year medical and dental students, but it is also intended as a continuing education tool for health professionals. Three groups of muscles, the infra-hyoid, the supra-hyoid and the Masticatory group per se, are defined and an explanation of their origin, insertion, innervation and function is given. The contents of the course includes 21 high-quality dissection photographs (most were obtained from the Bassett Collection, at Stanford University) and several medical illustrations, which were commissioned specifically for this document (Figure 11).

FIGURE 11.
Masticatory Muscles — Typical Screen layout with Medical Illustration



As in the AAMN courseware, the standard screen layout shows an image on the left, with an accompanying text on the right in which highlighted words double as buttons (Figure 12). When clicked on, those buttons identify in some way the corresponding anatomical structures in the image, with special effects created to emphasize their characteristics. Basically, muscles and bone structures are animated, or “moved”, while veins, arteries and nerves are literally “highlighted”. Digital movies are also included at one point to illustrate some of the muscle group’s functions. In this courseware, we tried scrollable text fields (Mac version), instead of flipping pages. The text window is relatively small and we wanted to see if it would be less confusing to the user, since there would be fewer screen changes. Again, as in the AAMN courseware, a location and access map is made available by a click of the mouse.

FIGURE 12.
Masticatory Muscles — *Typical Screen Layout with Dissection Material*



The Quiz section was divided into two modules: one with multiple choice items, and the other with short answer questions. These questionnaires were developed with Macromedia's Authorware Professional authoring software. The first module, a multiple choice questionnaire based on dissection photographs, is basically the same as the questionnaire in the AAMN courseware. The second one, requesting short answers, was designed to have the student use the keyboard to enter responses to randomly asked questions. While very interesting, we found that this kind of self-assessment tool implies a lot more preparation, and is longer to develop and test, because of the larger number of different good answers that can be given.

Electronic Encyclopedia on Maxillo-facial, Dental and Skeletal Growth

Due to its complexity, this document has been under continuous development from almost the start of the project.

The Encyclopedia on Skeletal Growth supersedes the Biological Age Tutorial/Database (containing over 2000 x-rays) which was developed by Dr. Demijian prior to this project. It is a new collection of hand/wrist, dental and cephalometric x-rays of children aged zero to nineteen, acquired during the twenty-five year research project on the subject of child growth and development conducted by Dr. Demirjian at the Human Growth Center of the de Montreal, referred to earlier. This collection contains over 4000 x-rays (providing over 450 MB of data).

The Encyclopedia is based on a custom built relational database, developed by Richard Cheng, which is designed to answer complex inquiries rapidly. Multiple parameters (dental, skeletal, chronological age, height, weight and sex) may be combined together to create either simple or very complex search requests, which may be completed either longitudinally (to compare growth of children at different ages) or cross-sectionally (comparing different children of the same age or at different ages) (Figure 13).

Once a query has been launched, the result of the search, when successful, is presented to the user as a list of files responding to the parameters that have been set (Figure 14). The user can select any file from the list, and view its data (numerical and visual) by clicking on one the following categories: skeletal (hand-wrist area), cephalometric or dental (panorex) (Figure 15). At that point the user can change category at will, and can always come back to modify or create a new search request.

All the x-rays have been digitized at high resolution and are displayed in 256 grays, to provide highly accurate pictures. An on-line help (always available) is provided to inform the user regarding what he or she sees on the screen: the different parameters, their definition, what they are used for.

FIGURE 13.
Electronic Encyclopedia Selection of Search Parameters

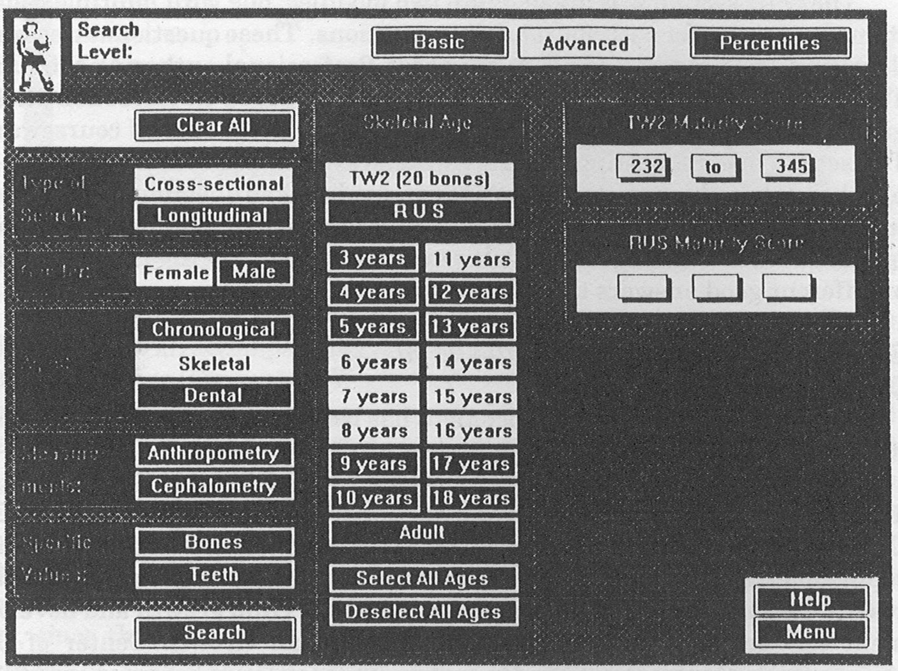


FIGURE 14.
Electronic Encyclopedia — Search Results and Subject Selection

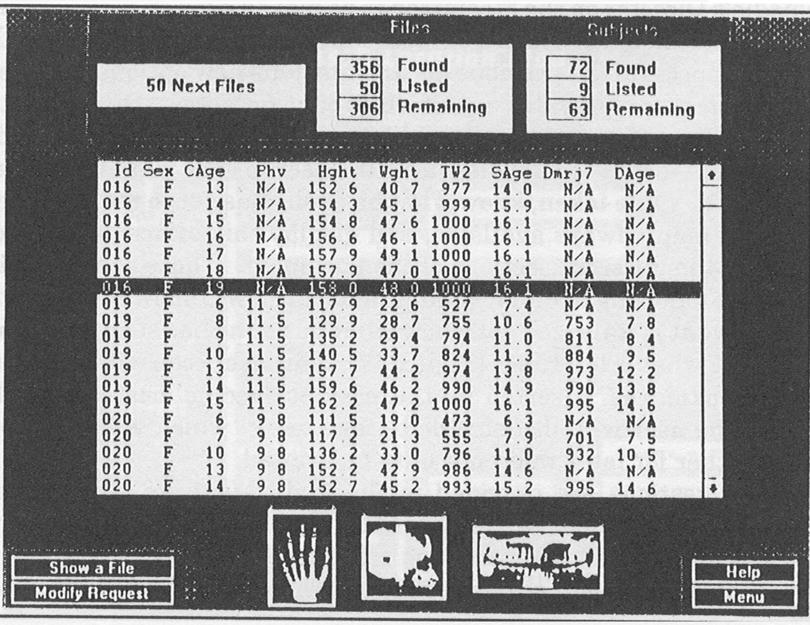
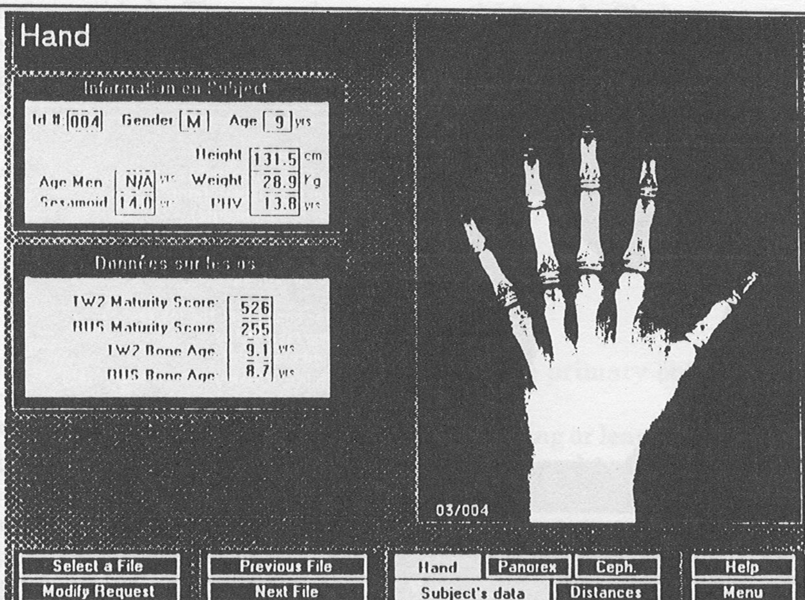


FIGURE 15.
Electronic Encyclopedia — Visualization of Subject's Data and X-rays



The Temporo-mandibular Joint (TMJ)

This document is currently under development. It is being produced with Macromedia's Director on the Macintosh to be played back on both Macintosh and PC/Compatible platforms. This courseware is being developed with all the positive aspects of the previous documents, plus new options (Figure 16). The newest feature provides monitoring of user access throughout the courseware. The information collected is recorded to external files under a user specified personal code. This allows the user to view what he or she has seen and, by the same token, know what he or she has yet to see. The Access and Location map, always available, will display this information through flowcharts of the different sections of the document. Those sections will be marked in the following manner: what is underlined will show the user where he or she is, what is italicized will show what he or she has seen, and what is bold will show what is left to see (Figure 17). This user code will also be used to record "bookmarks" inserted by the user at specific locations for later reference. The user will also be able to take notes, which will be recorded externally either for later reference or to be printed.

Review Questions are provided in the Main Menu as an advisement strategy to the user. The user has the choice of reviewing the questions with or without answers. If the questions cannot be answered correctly, it is assumed that the user will go back to the corresponding chapters for review.

FIGURE 16.
TMJ — Typical Screen Layout

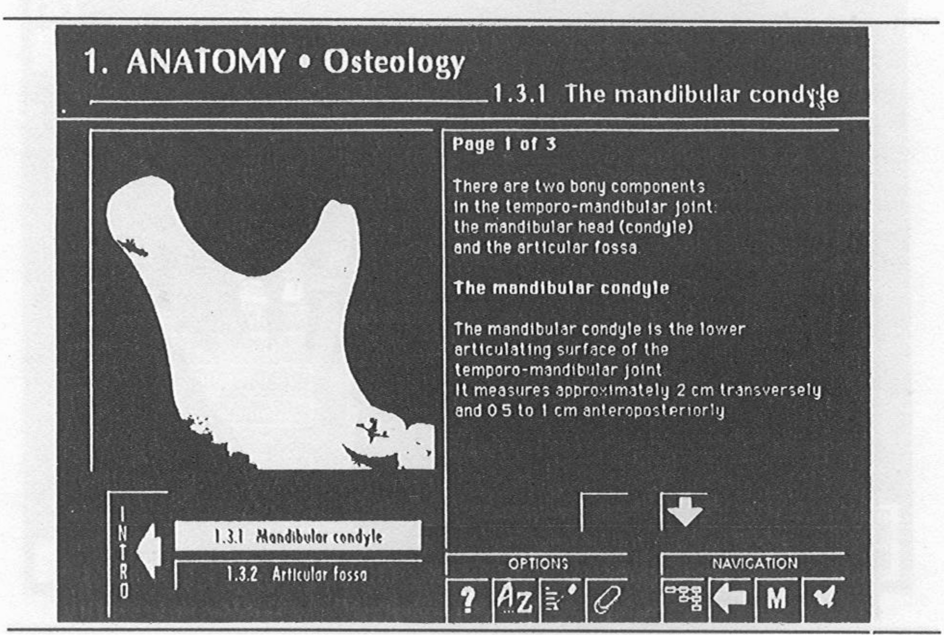
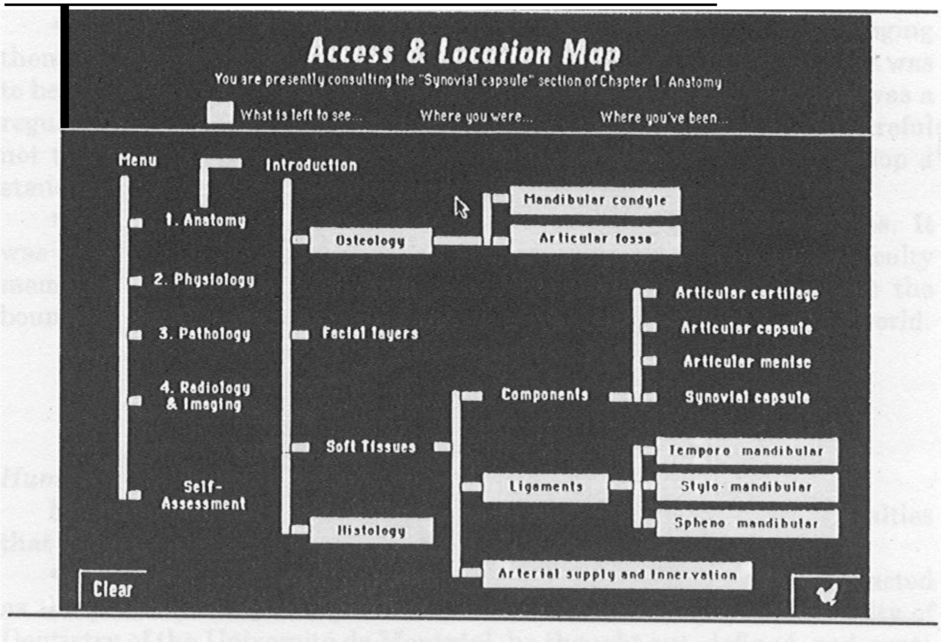


FIGURE 17.
TMJ -Access and Location Map



Different types of quizzes are provided in the Self-assessment section to test the knowledge acquired in the tutorial. Two content questionnaires, one Multiple Choice (Figure 18) and the other requiring Short Answers (Figure 19) are provided. There is also one visual Multiple Choice questionnaire, based on dissection room material and x-ray images. A FileMakerPro template has been created to produce the questions and answers included in the questionnaires. Once they are completed, external files are exported which are then read by the self-assessment module. This particular facility allows easier management of quiz material, and facilitates the modification of the contents of the questionnaires as desired.

OBJECTIVES

As a research and development project, the primary objectives were as follows:

✍ To design and develop computerized teaching or learningtools. Subject-matter was selected from Dr. Demijian's own teaching and research material, and prepared to be developed into computerized documents.

✍ To search for, test, select and evaluate the different tools necessary produce high quality documents. Keeping in mind that a wide variety of media can be used to communicate information, whether visual or audio, still

FIGURE 19.
TMJ — Mu/tip/e Choice Questionnaire in the Se/f-Assessment Section

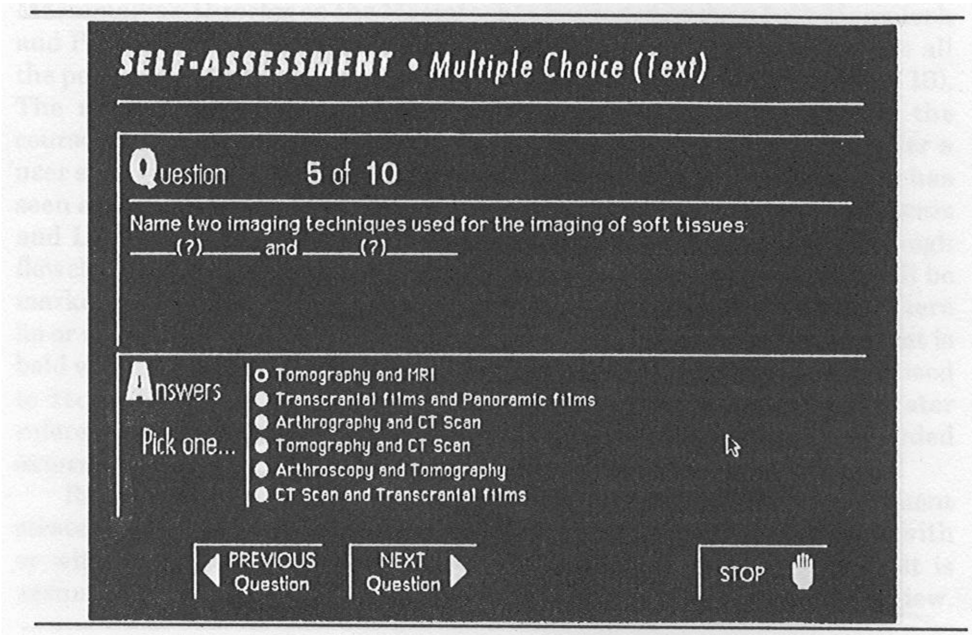
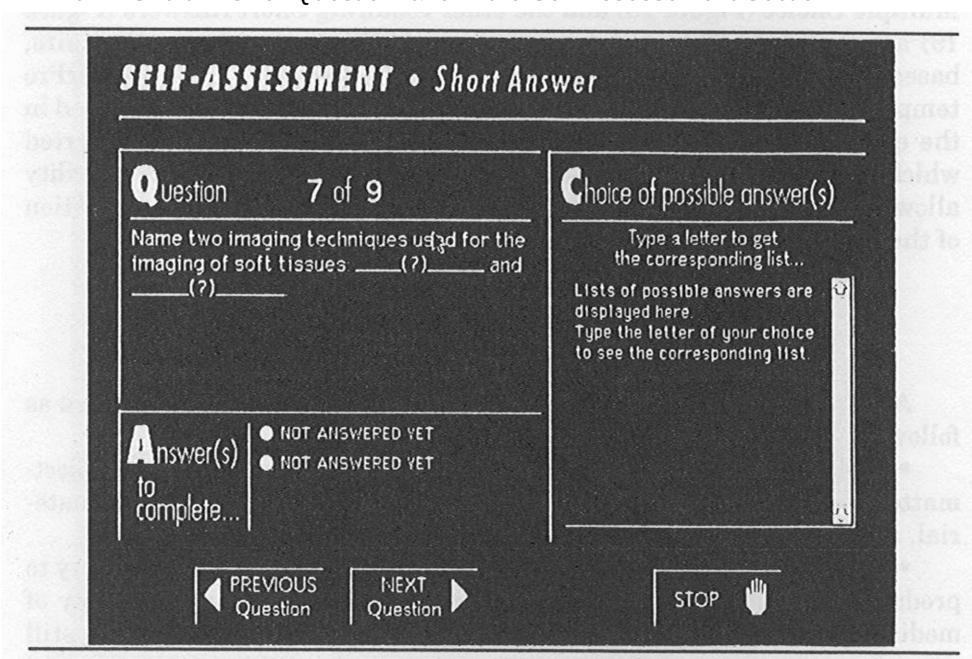


FIGURE 19.
TMJ — Short Answer Questionnaire in the Self-Assessement Section



or animated, textual or graphic, we needed to find the appropriate hardware and software to capture and incorporate the necessary media into the courseware in an efficient manner.

✍ To assess the implications of producing such tools, as well as managing them, in terms of human and technological resources. Even if this project was to be terminated at a known point in time, we wanted to work as if it was a regular activity of a permanent service inside the faculty. We had to be careful not to get caught by the “one shot deal” syndrome, in order to develop a standard and practical procedure to produce interactive documents.

✍ To promote technology-based learning inside Dentistry Programs. It was important to expose people to our work; not only students and faculty members within our own environment but also individuals outside the boundaries of the school, in other learning environments around the world.

RESOURCES

Human Resources

Many people were involved in the course of this project, with specialties that complemented one another.

✍ ***Project Director and Content Expert.*** He managed the project, and acted as the primary content expert. A professor of Anatomy at the Faculty of Dentistry of the Universite de Montreal, he thought out, defined, and wrote the content of the courseware. Other experts were also consulted when necessary.

✍ ***Multi-media Specialist.*** An industrial designer by training, his tasks were: provide support to the expert for the preliminary gathering and organization of the information; evaluate the human and technical resources needed; conduct instructional, interactive and navigational design; conduct analysis for the scripting on the Macintosh platform; interface design; production of the Macintosh versions; supervision of the production for the PC versions. In parallel to the actual production of the courseware, he managed the Macintosh network and the production of support material, such as the user's booklet, brochures, and disk labels. He also participated actively in public events to promote the courseware at conferences and expositions.

✍ ***Authoring Programmer.*** Responsible for the production of the PC versions of the courseware, using Toolbook and Authorware Professional.

✍ ***Programmer.*** Responsible for the production of the Electronic Encyclopedia on Maxillo-facial, Dental and Skeletal Growth including the development of the relational database with db Vista, and the front-end for the PC version with Toolbook.

✍ ***Medical Illustrator.*** Responsible for the production of medical illustrations of subjects difficult or impossible to photograph.

✍ ***Scanning Technicians.*** To digitize the x-rays (over 5000) to be included in the Electronic Encyclopedia, we required the services of the equivalent of one full time technician for a year and a half.

✍ ***Programming Consultant.*** Some part of the courseware development required the services of a programming consultant, mainly to develop and produce external functions for the Macintosh versions (XFCN), and to assist in their development for the PC versions (DLL).

✍ ***Translators.*** Having taken care of the English and French translations ourselves, we required the services of two Spanish speaking dentistry students to produce the Spanish versions of three courses. Their work was of course verified and adjusted by Spanish speaking content experts.

✍ ***Technical Support.*** Using new technologies one inevitably must rely on various sources of technical support including hotlines provided by software developers and hardware manufacturers, after sales support services from the dealers, and exchange of information through the Internet network.

Technological Resources

Having to develop for both Macintosh & PC/Compatible platforms, we organized and structured the department to maximize the exchange and transfer of information among people and workstations.

An ethernet network was first implemented to link all workstations. Two file servers were included on the network: one dedicated for Macintosh development, the other linking all platforms (Macintosh, PC/Compatible and UNIX). Considering the large number of documents that would be created and manipulated, a backup scheme was organized to prevent any loss of data.

Through the development stages, many different configurations of workstations were used to ensure compatibility between courseware and hardware: various peripherals, accessories, and various CPU performance and clock speed (MHz) were integrated. On the Macintosh side, we used a IIsi as the lower end, up to the Quadra 900 for higher performance. As for the PC/Compatible platform, it ranged from an aging IBM 386 running at 20 MHz, to more recent 486 models running at up to 66 MHz. Many peripherals were intentionally acquired from different manufacturers to diversify the stations' configurations, thus giving us more chance to experiment and to detect and address any incompatibility of platforms with our documents.

As with most multi-media documents, our courseware needed to incorporate various types of information presented in as many different media: artwork, photographs, slides, x-rays, video, sounds. The following peripherals were used to acquire that information: reflective and transparency scanners, slide scanners (Figure 20), 35mm digital camera, 8mm S-VHS video camera, microphones, CD-ROM players.

Once a unit of courseware was finally completed, meaning that the English, French and Spanish versions of both Mac and PC platforms were finished and verified, all documents were written to a compact disk (Figure 21), in hybrid format, tested, and if necessary, sent to a production plant for mass reproduction.

FIGURE 20.
Hardware (Scanners) for Capturing Visual Material

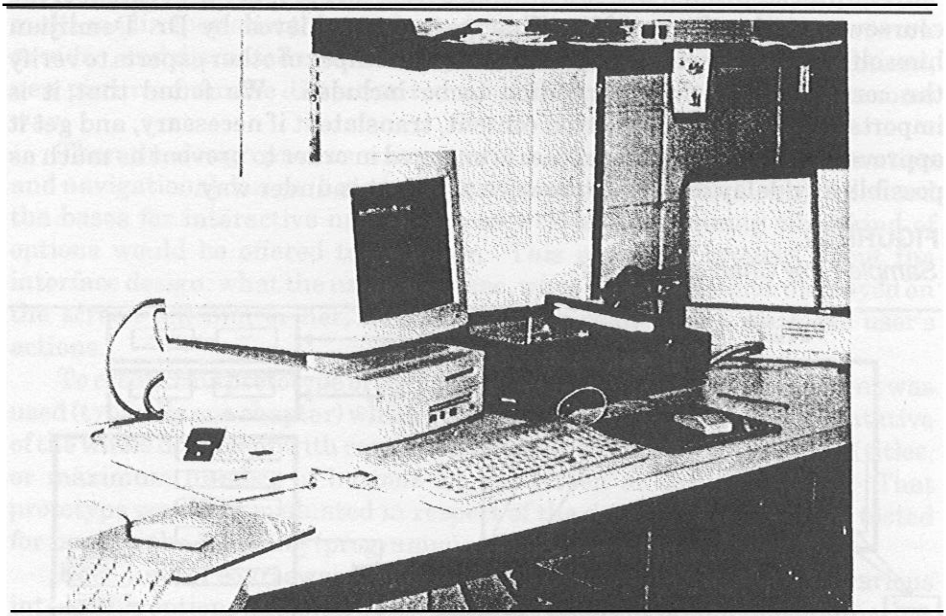
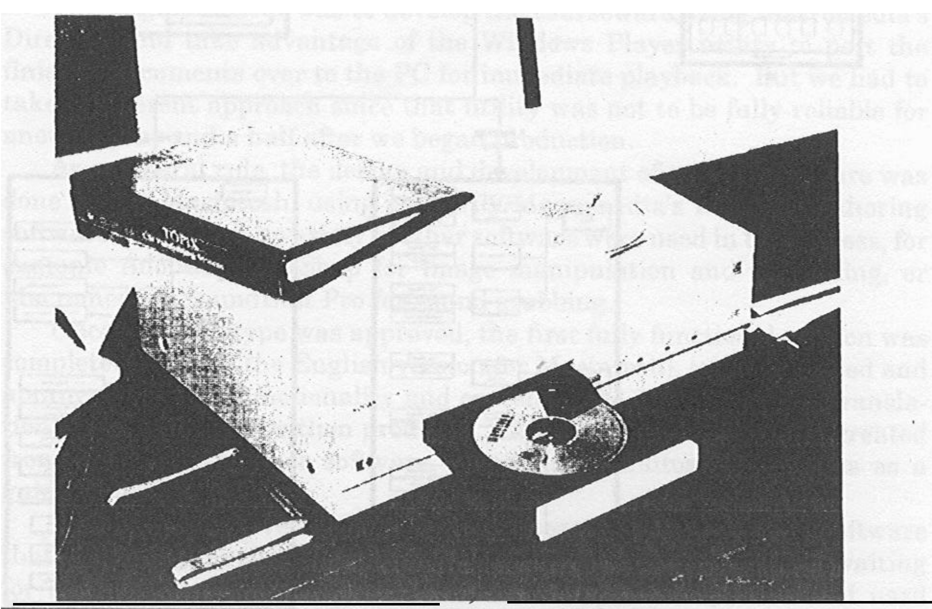


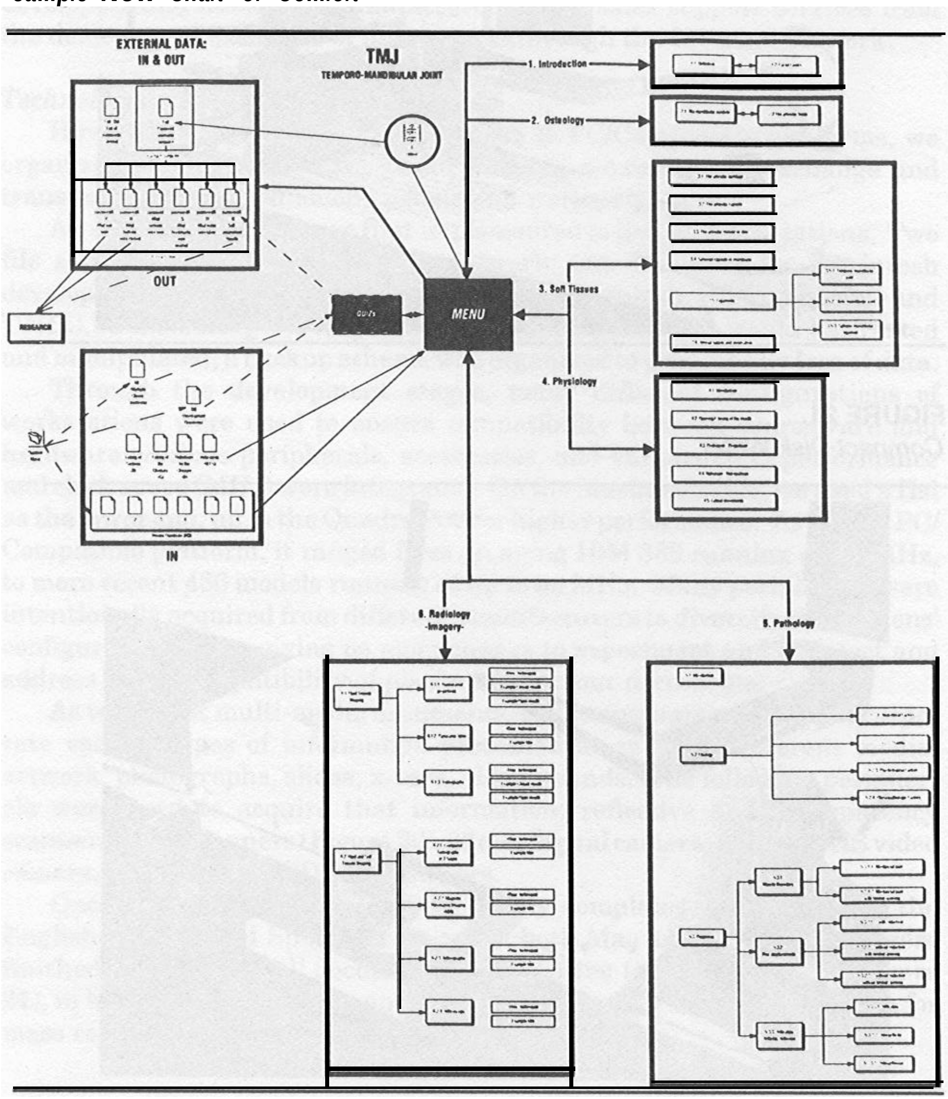
FIGURE 21.
Compact Disk Writer



DEVELOPMENT, DESIGN & PRODUCTION

The first step taken was to define, structure and prepare the content of the courseware-to-be (Figure 22). That part was achieved by Dr. Demirjian himself, the content expert, with the occasional input of other experts to verify the correctness of the information to be included. We found that it is important to finalize the written content, translate it if necessary, and get it approved before the design process is engaged in order to prevent as much as possible any delay in production once a project is under way.

FIGURE 22.
Sample Now Chart of Comfort



Once approved, the content was given on paper to the multi-media specialist. Private tutoring sessions were provided for him so that he could assimilate as much as possible the nature of the material. The expert and the multi-media specialist then evaluated existing media such as slides, artwork or video, and discussed new media to be obtained, like medical illustrations, new pictures from the dissection room, or 3-D models to be animated in some way.

Then the design process was put into motion, starting with information and navigational design (based on the information flowchart), which defined the bases for interactive navigation, as well as determining what kind of options would be offered to the user. This naturally brought about the interface design: what the user would see, what would the items displayed on the screen tell him or her, how those items would react upon the user's actions.

To create this prototype of the courseware, a small part of the content was used (typically one chapter) which provided typical situations representative of the whole document with respect to, for example, maximum length oftitles, or maximum number of buttons on the screen at the same time. That prototype was then evaluated in respect of the design objectives, and tested for bugs in the scripting (programming).

Each unit of courseware was used as a new opportunity to test various interactive options and interfaces, to try out different production approaches (hardware and software) and to determine the best way to produce multi-platform, multi-language courseware.

Tools

The original intent was to develop the courseware using Macromedia's Director, and take advantage of the Windows Player utility to port the finished documents over to the PC for immediate playback. But we had to take a different approach since that utility was not to be fully reliable for another year and a half after we began production.

As a general rule, the design and development of each courseware was done on the Macintosh, using primarily Macromedia's Director authoring software. Of course, a variety of other software were used in the process, for example Adobe's PhotoShop for image manipulation and retouching, or Macromedia's SoundEdit Pro for sound grabbing.

Once the prototype was approved, the first fully functional version was completed (usually the English version for Macintosh), tested, verified and approved as to its functionality and content. The other versions (translations) for the Mac were then produced, while the PC versions were created from scratch with other software, using the Macintosh documents as a guideline.

To create the PC versions, we had to choose another authoring software that would come as close as possible to Director's performance, while waiting for Macromedia to improve their Windows Player utility. We first used

Toolbook, but its lack of visual or special effects kept us on the lookout for another solution. Then we tried Authorware, because of its cross-platform transferability. The original documents were developed with Authorware for the Macintosh, then transferred to the PC and re-opened with Authorware for Windows. The transfer results were good, but we were dissatisfied with Authorware's overall speed, its restricted scripting environment, and its lack of visual effects (again we were comparing it to the Director version on the Macintosh). It's positive aspect was its built-in functions and variables which prove to be very useful when creating a document to be used as an evaluation tool, like a self-assessment, questionnaire or quiz. But since it was possible to achieve the same thing with Director, we were still not fully satisfied.

When Macromedia released a reliable version of the Windows Player in September 1993, we re-oriented our strategy toward developing a Mac version transferable over to the PC, for immediate playback. It meant changing some design aspects, because of minor incompatibilities between platforms, but we felt it was worth it because the overall result was very acceptable, and there were important savings in production time.

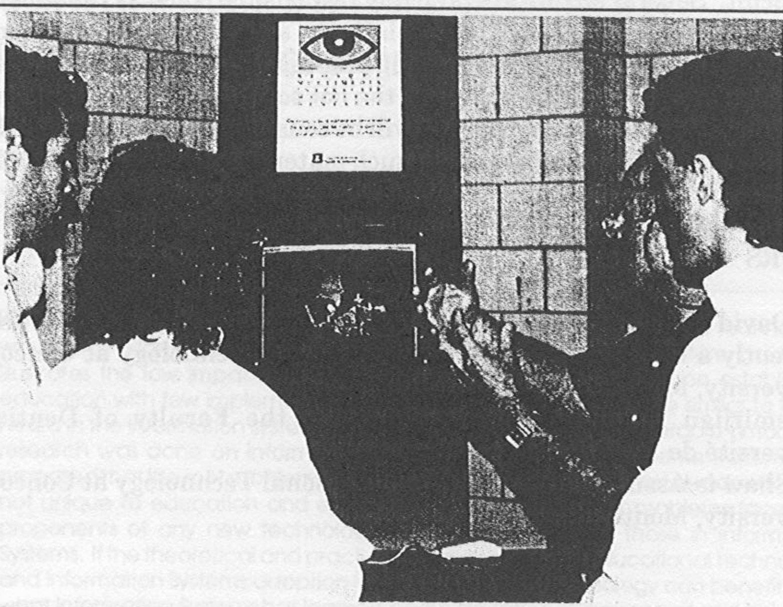
Finally, these efforts brought us to emphasize the use of Director first to design and develop the prototype, then to use it with the Player software (for both Mac & PC) to produce the tutorial part of the courseware. At the same time we retained Authorware as a tool to develop the self-evaluation modules, again for both platforms.

Promotion

Once we had some documents to work with, we started promoting the idea of using these as learning tools in the curriculum, using different approaches.

- Dr. Demirjian started using the courseware in the classroom as part of his teaching material. The documents are displayed to the class with a Macintosh IIci, equipped with an overhead projector and a color LCD projection panel.
- We also designed a kiosk, to be installed in the corridors of the Faculty of Dentistry, so that students and faculty members could be exposed to our work and access it whenever they felt like it. That kiosk is also used to demonstrate its possibilities in special events taking place in Montreal, like conventions and expositions (Figure 23).
- A few computers (Macs & PC's), were also made available to students to use these documents in a more comfortable setting, with technical support for the unfamiliar users.
- Having access to the Internet network gave us the opportunity to make our work known all over the world. Demonstration packages were made available to anybody using the network, for them to download and evaluate. The network even turned out to be one of the best ways to promote our documents right here in Montreal!
- Finally we produced a brochure, or catalogue, of our documents with all the necessary descriptive and technical information. This catalogue is distrib-

FIGURE 23.
Interactive Kiosk



uted to individuals, students and professionals, universities, and libraries, all over the world.

Conclusion

This experience has proven to be very positive from a research and development point of view. The expectations were largely surpassed, due mainly to the fact that new possibilities were constantly uncovered as we progressed through each new project, allowing us to experiment further.

Though vary well received by undergraduate students, it took a long time to get some basic recognition from other faculty members, administrators, and practicing health professionals. And it will surely take more time to see some kind of real implementation in the curriculum ofundergraduate studies as well as for continuing education. That time frame will depend mostly on how many experts will come forward and invest themselves to produce new subject-matter for development of more titles.

Once a critical mass of titles is available, both on fundamental and clinical aspects, we expect interest in using multi-media instructional materials will increase. At the moment, production of such computer-based materials in the field of dentistry owes much to the commitment and vision of a relatively small number of developers. It is not yet market driven.

Even with the involvement of well-established specialized people in the marketing field, we found that commercial distribution of such materials is very difficult. Several factors are probably responsible, such as the product's novelty, its specialized aspect, the relatively small number of potential buyers, and the difficulty of integrating the material with other faculty's curricula. We look forward to a point in the not so distant future when usage of interactive multi-media courseware will be considered a standard teaching and learning strategy. Development of such material will then be more easily justified.

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Educational Technology Adoption and Implementation: Learning from Information Systems Research

Karen Lee Jost
Scott L. Schneberger

Abstract: Many educational academics believed that educational technology would play a large part in educational reform. A survey of the literature, however illustrates the low impact that educational technology has had on established education with few implementation successes. These remarks are similar to those heard in the information systems field during the 1980s. A considerable amount of research was done on information systems adoption and implementation. It is proposed that the root problems and issues in Educational Technology adoption are not unique to education and educational technology-but problems faced by proponents of any new technology and, in particular. by those in Information Systems. If the theoretical and practical parallels between Educational Technology and Information Systems adoption hold. Educational Technology can benefit from what Information Systems has learned about adoption. Conceptual and historical similarites between educational technology and information systems are explored IS adoption theory and research is explained. and recommendations for ET adop: tion and implementation are discussed.

Résumé: Un grand nombre d'universitaires experts en éducation ont cru que la technologie éducative jouerait un grand rôle dans la réforme pédagogique. Une étude de la documentation écrite sur le sujet a toutefois révélé qu'elle a eu peu d'impact sur l'éducation traditionnelle et peu de succès dans l'application de ses principes. Ces remarques rappellent d'ailleurs cellesqui ont été faites au cours des années '80 sur les systémes d'information.

La recherche effectuée sur l'adoption et l'application des systèmes d'information est considérable. Nous pensons que les problèmes fondamentaux et les questions portant sur l'adoption de la technologie éducative ne touchent pas seulement l'éducation et la technologie éducative mais sont des problèmes qui confrontent les tenants de toute nouvelle technologie et, en particulier, les tenants des systèmes d'information. Si les parallèles théoriques et pratiques établis entre l'adoption de la technique éducative et des systèmes d'information tiennent, la technique Educative peut bénéficier de ce que les systèmes d'information ont appris à propos de cette adoption,

Les similarités conceptuelles et historiques entre la technologie éducative et les systèmes d'information sont étudiées ici: la théorie de l'adoption et la recherche en systèmes d'information sont expliquees; et, les recommandations pour l'adoption et l'application de la technologie éducative font l'objet de discussion.

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INTRODUCTION

Educational reform is a leading topic in socio-political debate, and was one of the key issues in the latest U.S. presidential election. Many educators envisioned educational technology (ET) becoming a large part of that reform. Heinich (1970), for example, foresaw a major role for educational technology as a tool to support teachers, as a replacement for teachers and a conduit for directly educating students, and/or as a means to forming a partnership with teachers whereby technology delivers routine instruction and teachers focus on planning and educational management. Indeed, interest in educational technology and some practical successes during the last 50 years led educational technology to become a unique academic and professional field. The field has academic departments and courses, professional organizations, journals and conferences, academic professionals who identify themselves as educational technologists, and of particular significance, a considerable amount of scientific research. One could easily assume that with so much interest in educational improvements, with so much potential for educational technology as part of the expanding information age of technology, and with all of the research within the field of educational technology, deep and broad improvements in established education would have resulted.

Many educational technologists, however, lament what they perceive to be few implementation successes and a decidedly low impact of educational technology on established education (Reigeluth, 1989; Winn, 1989; Gentry and Csete, 1991; Heinich, 1991). Educational technology is said to be an applied field, yet its knowledge, based on empirical research, is not applied by practitioners to the degree expected.

Many authors, publishing within the field of educational technology, have analyzed the problem and blamed a wide range of factors. Some view teachers themselves as the culprits; citing the idea that teachers are threatened by perceived professional irrelevance that would cause them to naturally resist educational technology (e.g. Heinich, 1991). Other authors blame simple bureaucratic inertia and lack of educational funding (Gentry and Csete, 1991). While there have been many accusations concerning weak adoption of educational technology in general education, some educational technologists criticize research as a malefactor, it is either too descriptive and not prescriptive enough (Clark, 1989), it is based on too many confusing or conflicting theories (Ross and Morrison, 1989), the research simply lacks external validity to everyday situations (Reigeluth, 1989), or that it fails to take advantage of related research in other fields (Clark, 1989).

The problem of innovation and adoption (and ruminating self-examination) is not, however, unlike what occurred in the information systems (IS) field during the early 1980s before the widespread proliferation of personal computers and readily available commercial software packages. A considerable amount of information systems research and writing has been done on who, what, when, where and why (or why not) information systems are adopted, including research on why some information systems are adopted but then not used. It is unlikely that the problems with the adoption of educational technology innovations are entirely unique to education and educational technology. Instead they include problems commonly faced by proponents of any new technology. As stated by Fullan (1993), "change of all kinds has certain generic properties in complex societies" (p. vii).

This paper concentrates on the ***how*** problems of educational technology adoption. It presumes the validity of educational technology research on effective and efficient innovations and focuses instead on the adoption and implementation process and its factors. This paper outlines and compares the conceptual definitions of educational technology and information systems and relates the histories of ET and IS adoption. It outlines and explains information systems adoption paradigms, models, and frameworks and suggests similarities and differences between IS adoption/implementation and educational change. Finally, this paper discusses educational change and what can be learned from information systems adoption models.

DEFINITIONS

One of the immediate issues in discussing the educational technology adoption problem is the varying definitions of educational technology. The Association for Educational Communications and Technology (AECT) defines ***educational technology*** as:

> a complex, integrated process involving people, procedures, ideas, devices and organization, for analyzing problems, and devising , implementing, evaluating and managing solutions to those problems, involved in all aspects of human learning. (AECT, 1977, p.59)

Others define educational technology as a methodology or set of techniques (Cleary et al., as cited by Gentry, 1991), a "body of knowledge" (Dieuzeide, 1971, p.1) and as procedures and devices (Silverman, as cited by Gentry, 1991).

Instructional technology (IT), a phrase frequently used interchangeably with educational technology, often carries two connotations, The definition stated by the Presidential Commission on Instructional Technology (1970) includes both the view of instructional technology as:

> the media born of the communications revolution which can be used for instructional purposes along side the teacher, textbook, and blackboard. (p.19)

and as:

> a systematic way ofdesigning, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communications, and employing a combination of human and non-human resources, to bring about more effective instruction (p.19).

Engler (1972) similarly defines instructional technology within two categories, the first as "hardware- television, motion pictures, audio tapes and discs, textbooks, blackboards, and so on" and secondly as:

> a process by means of which we apply the research findings of the behavioral sciences to the problems of instruction. (p. 59)

One should not view these definitions of educational technology (and instructional technology) as nebulous, contradictory or exclusive definitions, but rather as inclusive definitions to bound the area of interest. By combining the essence of the definitions above (and others cited by Gentry, 1991), this paper defines ***educational technology*** as:

> the application of people, devices, knowledge, and procedures for efficient and effective education.

This definition, resulting from combining the varying ET and IT definitions has a clear correlation with a common textbook definition of ***computer-based information systems (e.g.*** Davis and Olson, 1985; Laudon and Laudon, 1993):

> devices (usually computer hardware and software-based), people, and procedures for organizing, storing, accessing, and maintaining information.

The definitions of educational technology and information systems identically focused on devices, people, knowledge, and process suggest a theoretical linkage between ET and IS application and adoption. The problems and issues associated with adopting information systems appear to have direct bearing on the problems and issues with adopting educational technology. Information systems research on adoption, therefore, would seem to offer rich insight and direction for fruitful educational technology adoption research. If the theoretical and practical parallels between ET and IS adoption hold, what information systems has learned about IS adoption may be what educational technology can benefit from in the future.

EDUCATIONAL CHANGE AND TECHNOLOGY ADOPTION: A SUMMARIZED HISTORY

Fullan (1991) identifies four distinct historical phases in educational change: adoption (1960s), implementation failure (1970-77), implementation success (1978-82), and intensification versus restructuring (1983-90).

Fullan's first phase (adoption) came largely as a result of Soviet success in launching a satellite in 1957 (years before the U.S.). The subsequent "Sputnik crisis" led to large-scale curriculum innovations, technologically-oriented instructional systems, and the advocacy of inquiry-oriented and student-centered instruction. In the rush to meet the crisis, according to Fullan, the emphasis was on how many innovations could be adopted, the more the better as a mark of progress. During this period instructional systems were researched and developed. Significant federal funding for R & D laboratories, mandated evaluation of federally funded educational projects, and the redefinition of audiovisual instruction to include instructional development and technology gave the field of educational technology increased visibility and credibility with educators.

During the 1970s however, innovation got a bad name. According to Fullan, the 1960s' innovations had been adopted haphazardly with little follow-through, leading to pronounced implementation failures. By the end of the 1970s nevertheless, there were some significant, well-documented successes that provided important frameworks and theories for comprehensive educational reforms. The comprehensive reform movements that began in 1983 (as a result of the watershed document *A Nation at Risk* by the National Commission on Excellence in Education) took many approaches, including the use of educational technology.

The advent of microcomputers in the 1980s appeared to offer the dawn of a new era with computer-based instructional systems. The wide availability of relatively inexpensive desktop computers, the capabilities of computer-driven media, and the inherent ease of developing, using, and improving software, provided a ready vehicle for applying educational technology. By 1989, 76,395 of the 79,693 U.S. public schools had two or more microcomputers, averaging about 20 per school (Quality Education Data, 1989). Their use, however, was primarily for administrative and clerical applications and not for the process of teaching and learning. The most common educational use of microcomputers was limited to teaching computer literacy (Ely, 1991). Higher education was not reported as any better; the average U.S. university, in terms of its use of information technology in teaching, was substantially behind the typical elementary and secondary school (Newman, 1989 as cited by Ely 1991).

THE INFORMATION SYSTEMS ADOPTION PROBLEM A BRIEF HISTORY AND COMPARISON TO THE ADOPTION OF EDUCATIONAL TECHNOLOGY WITHIN EDUCATION

Although electronic computers were used for military purposes in the 1940s the public application of computers for information processing began in 1954 when one of the first computers was installed to process payroll at a large U.S. corporation (Davis and Olson, 1985). There have been three generally recognized eras in Information Systems adoption.

The first era was from 1954 to about 1964 when computers were used for accounting and clerical applications in major organizations. Information systems were expensive and very difficult to use. Few people understood how they worked, even fewer knew what to do with them. There was a wealth of research and theory that predicted enormous benefits from computers in everyday business and personal life, but potential users and those in management positions could only wonder at the futuristic predictions while continuing traditional work habits. With considerable simplification, this era roughly equates to the adoption of educational technology innovations in education prior to 1983.

During the second era, from around 1965-1980, the breadth of applications expanded due to improved general purpose programming languages. Major businesses saw computers as a strategic weapon, or at least an image maker, and management began to see the potential ***efficiency*** benefits from computers. There were large investments in computers and one-of-a-kind application software. Computers were ensconced within glass "throne rooms" tended to by computer specialists who were intermediaries to users of computed data. Users still did not understand computers or their potential, but they began to be exposed to the effects of computing. People were mostly forced to adapt to computers and, increasingly, to depend on them for record keeping as well as finance and accounting. These systems were designed by computer specialists who tended to oversell capabilities, had little understanding of user needs, and increasingly built systems that either did not work, went way over budget, or users would not use. Management perceived the importance of computers, but not how to apply them. As the chief strategist for a major U.S. bank said:

> [Computer] technology is our top strategic concern, not because it outweighs everything else, but because we are unsure what to do with it. Although we have a strategy for the marketplace, the technology issues seem to be eluding us. We can't seem to grasp the bigger picture (Parsons, 1983).

Information systems academics and professionals bemoaned the dirth of effective IS applications taking advantage of empirical research, while management complained that IS research was not practical enough or relevant.

This second IS era seems to correlate with the present state ofeducational technology research, development, and adoption. During the 1980s educational technologists also foresaw the importance of the use of technology in education. Educational software increased in availability and became more "user-friendly." Innovators have, however, made mistakes similar to IS designers. Educational programs and products have often been designed by specialists who do notunderstand the user (teacher) or the classroom learning environment. These innovations, therefore, are not implemented as the designers intended. Thus, while the use of technology has grown, it has not dramatically impacted on educational practice in general. Most educators like their IS counterparts in the second IS era, still do not seem quite sure of what to do with the technology.

The third era began with the advent of microcomputers around 1980. The entire mindset of users adapting to computers was reversed as powerful applications that ***adapted to users*** were mass-produced and were made commercially available. Moreover, non-procedural programming languages allowed non-programmers to write software specifically tailored to their needs, conditions, and location. Simultaneous communication innovations that digitally tied computers together allowed the full potential (widely predicted by researchers in the 1940s) of computers and IS to overcome time and distance. For most industries, information systems was no longer a service, or simply a medium for information; it had become the core impetus for an entire ***r-e-engineering*** of organizational processes. The second era issues about ***what*** can be done with information systems became third era ***how*** issues as new, practical applications spread. Information systems researchers began to struggle just to keep up with IS practice, let alone perform research that was not obsolete before it was published.

This third IS era parallels current trends in educational technology in the 90s. The third ET era exists in the literature and in isolated settings. The full potential of computer and communications technologies has yet to be utilized within the educational system as a whole. True organizational change has occurred in a limited number of specific school settings.

Given the theoretical and practical parallels between educational technology and information systems, educational technology should explore information systems research on adoption and implementation for insights and guidance.

INFORMATION SYSTEMS ADOPTION THEORY AND RESEARCH

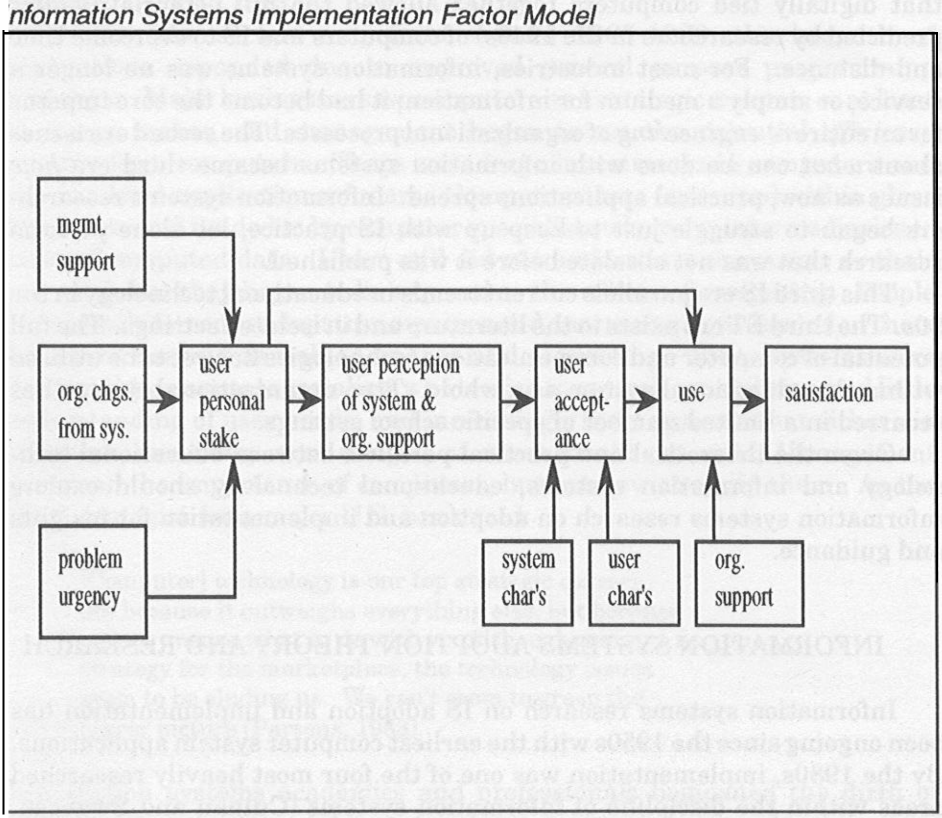
Information systems research on IS adoption and implementation has been ongoing since the 1950s with the earliest computer system applications. By the 1980s implementation was one of the four most heavily researched areas within the discipline of information systems (Culnan and Swanson, 1986). Two basic adoption paradigms were used for research: factors and process.

Factor Paradigm. The factor paradigm, the dominant paradigm in information systems implementation research, sought to identify and relate the many factors involved in IS implementation success, the what behind successful adoption. Six key variables have been identified from scores of empirical research and analysis efforts:

1) organizational need and support
2) user personal stake in success
3) user assessment of system and organizational support for it
4) user acceptance of system
5) use of system
6) satisfaction (Lucas, Ginsberg and Schultz, 1990).

These factors are linked into a generic model for IS implementation as shown in Figure 1.

Figure 1.
Information Systems Implementation Factor Model



In this model, management support for a system, organizational changes required as a result of the system, and the urgency of the problem the system is supposed to address combine to affect the user's perceived stake in the system's adoption. User stake, in turn, influences user perception about the system (how efficiently and effectively it works toward the user's goals) as well as the organizational support behind the system (e.g., corrective maintenance, improvement, supplies). The user's perception of the system and its organizational support in turn directly affects the user's acceptance of the system, in addition to the technical characteristics of the system and the characteristics of the user. User acceptance, overt organizational support, and the user's personal stake in the system then determine how (or whether) the system is used. Experience using the system then directly determines satisfaction with the system from a user and organizational standpoint. Also generally believed to be important factors (but not empirically confirmed with strong data or consistently among researchers) are: user knowledge of the system purpose, user decision making style, user job characteristics, user/designerjoint system development, and user knowledge of the system (Lucas, Ginzberg and Schultz, 1990). Underlying the entire model is the assumption that user acceptance and use are voluntary; the model changes considerably when system use is mandatory.

Under the IS factor implementation model, adoption and successful implementation largely depend on:

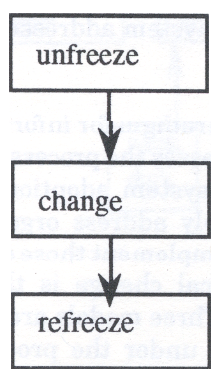
1) gaining support and commitment from the user's management (e.g., funding, job re-design, organizational changes, rewards and incentives, operational support and training);
2) seeking out potential users as early adopters who have a significant personal stake in the problem the system is designed to address, directly involving them in the design process, designing the system to target their technical needs as well as personal characteristics, and focusing attention on their adoption and early use; and
3) ensuring that the system addresses user personal stakes in system use.

Process Paradigm. This paradigm for information systems adoption and implementation research addresses the process of organizational change and management support behind system adoption. This paradigm takes the standpoint that systems simply address organizational and user change needs and provide a vehicle to implement those change needs. Therefore, ***how*** one implements a technological change is the key in this paradigm to successful adoption and use. Three models are prevalent in the IS adoption and implementation research under the process paradigm: ***technological imperative, organizational imperative, and emergentperspective*** (Keil, 1991).

The ***technological imperative model*** is based on the sociological assumption that external forces (the environment) cause internal changes, namely technological changes, to user behavior. In consonance with innovation theories, this model revolves around two change process factors: the technological advantage the system provides a user in performing his or her functions, and the system's ease of use. Together, these process factors determine system use. To promote adoption, management ensures that the system provides technological advantages (or at least that the benefits outweigh the detriments) and that the system is technologically easy to use, Management's agents to this end are IS specialists who are trained in systems, the organization, how to elicit requirements, and how to appropriately design systems for the users. This model is consistent under voluntary or mandatory use situations.

The organizational imperative model assumes that people are causative decision makers in anticipation or in response to environmental changes. Successful adoption and implementation therefore depend on successfully managing the decision making and implementation processes. This model, primarily based on the change and innovation work of Lewin (1947), consists of three phases. According to this model, successful change depends on ***unfreezing*** a situation by creating a climate or motivation for change. The second phase consists of the actual ***change*** based on analysis, design, development, implementation and training for a system and the organizational changes that must accompany the system. The final phase requires ***refreezing*** by institutionalizing the new system (with resulting organizational stability). This model (as shown in Figure 2) emphasizes that an organization with stable political, personal, and social coalitions must first be disturbed before change can be accepted. Although there are many roles (e.g., the user, management, IS developers), management plays the key organizational role in directing the change process.

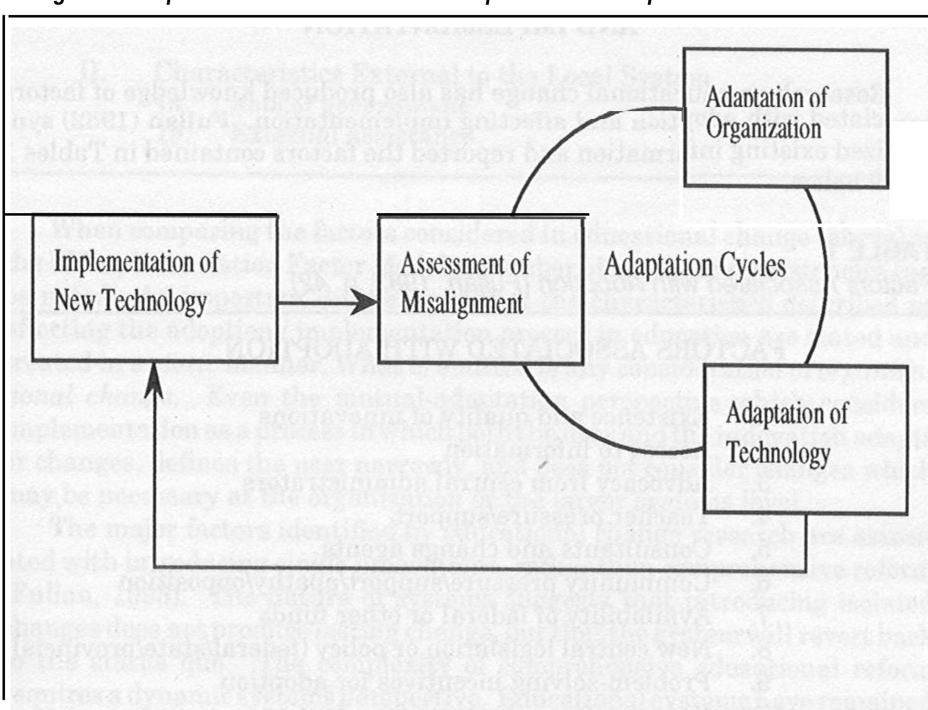
Figure 2.
Organizational Imperative Model for IS Adoption and Implementation



The key to adoption according to this model, therefore, is management awareness of the need for change, awareness and support for a change vehicle (the system with attendant personnel, data, process and organizational structure changes), determination and follow-through on changes, and institutionalization of the changes. While this model is associated more with mandatory than voluntary IS adoption, it can apply equally to both situations. Based on the managerial approach to implementing the change, management can serve as a catalyst to user change as well as an orchestrator.

The final model under the process paradigm is the ***emergent perspective model*** that assumes people and technologies interact in unpredictable ways. What is important is perpetually adjusting that interaction in response to uncovered barriers to success, as shown in Figure 3 (Leonard-Barton, 1988). The important point of this model is that there must be mutual adaptation of technological systems and the organization (including the organizational structure, its management, support, and the users). Change is assumed to be the norm, whether from internal or external environmental forces. No technological system, the model presumes, can ever satisfy all organizational needs forever and will therefore require continual, incremental changes. Likewise, no organization can remain static in light of technological changes or opportunities provided by systems.

Figure 3.
Emergent Perspective Model for IS Adoption and Implementation



The key to adoption in this model is the initial deployment of a new technology, followed by orchestrated monitoring and adaptation. Management and users must be willing to innovate and to take risks on the initial adoption and implementation with the understanding that problems will occur. Management and users must also be willing to invest resources (e.g., time, personnel, budgets) to identify and analyze implementation problems. Most importantly, they must be willing to continually implement technological and organizational changes in a perpetual cycle of change, analysis, and correction. Leonard-Barton (1988) views the initial implementation of a new technology as an extension of the invention process and the mutual adaptation process as occurring at multiple levels within the organization. She argues that “the successful management of technology transfer from developers to users requires that managers recognize and assume responsibility for both technical and organizational change” (p. 253). In organizational terms, this is conflict management, an essential feature of organizational management that entails managerial processes, structure, and content.

These information systems adoption and implementation paradigms, models, factors and processes provide ample suggestions for how to increase and improve successful educational technology implementation in education, as well as provide plentiful opportunities for research.

EDUCATIONAL CHANGE THEORY AND RECOMMENDATIONS TO EDUCATIONAL TECHNOLOGY ADOPTION AND IMPLEMENTATION

Research on educational change has also produced knowledge of factors associated with adoption and affecting implementation. Fullan (1982) synthesized existing information and reported the factors contained in Tables 1 and 2 below.

TABLE 1
***Factors Associated with Adoption (Fullan, 1982, p.** 42)*

FACTORS ASSOCIATED WITH ADOPTION
1. Existence and quality of innovations
2. Access to information
3. Advocacy from central administrators
4. Teacher pressure/support
5. Consultants and change agents
6. Community pressure/support/apathy/opposition
7. Availability of federal or other funds
8. New central legislation or policy (federal/state/provincial)
9. Problem-solving incentives for adoption
10. Bureaucratic incentives for adoption

TABLE 2
Factors Affecting implementation (Fullan, 1982, p. 56)

FACTORS AFFECTING IMPLEMENTATION
A. Characteristics of the Change
1. Need and relevance of the change
2. Clarity
3. Complexity
4. Quality and practicality of program (materials, etc.)
B. Characteristics at the School District Level
5. The history of innovative attempts
6. The adoption process
7. Central administrative support and involvement
8. Staff development (in-service) and participation
9. Time-line and information system (evaluation)
10. Board and community characteristics
C. Characteristics at the School Level
11. The principal
12. Teacher-teacher relations
13. Teacher characteristics and orientations
D. Characteristics External to the Local System
14. Bole of government
15. External assistance

When comparing the factors considered in educational change (above) to the IS Implementation Factor Model, a number of apparent consistencies can be noted. An important difference is that the characteristics described as affecting the adoption / implementation process in education are stated and treated in a static manner. What is omitted is any consideration of ***organizational change.*** Even the mutual-adaptation perspective which considers implementation as a process in which both the user and the innovation adapts or changes, defines the user narrowly, and does not consider changes which may be necessary at the organization or the larger systems level.

The major factors identified by educational change research are associated with introducing single innovations, rather than comprehensive reform (Fullan, 1993). The nature of systems suggests that introducing isolated changes does not produce lasting change, but that the system will revert back to the status quo. The complexity of comprehensive educational reform requires a dynamic systems perspective. Educational systems have remained as relatively closed systems. Too much isolation exists both within schools and between schools and their environment. This isolation is an additional barrier to educational change.

Successful corporations, such as the Hanover Insurance Company (Hampden-Turner, 1992), and schools that have been successful in achieving major reform (Louis and Miles, 1990; Rosenholtz, 1989) are systems which learn from their environments. Successful organizations are continually changing and adapting, The vast majority of schools, however, have attempted to adopt isolated innovations into a conservative system that remains the same.

Schools that will be successful at serving a diverse and changing student body, must interact with and learn from their environment through collaborations and partnerships (Fullan, 1993). From past research we have learned that comprehensive change is a complex process that cannot be totally preplanned. Each change causes numerous consequences, including many which can not be anticipated. We can again learn from studies of other types of organizations. In a study of business computing, Attewell (1992) reconceptualizes the diffusion of technology in terms of organizational learning, skill development, and knowledge barriers. He notes important differences when dealing with complex technologies which can inform the diffusion of technology in education.

Despite similarities to information systems, educational technology adoption research and practice should also bear in mind that educational systems have a characteristic rarely seen in general organizations used in information systems research. Educational systems are professional bureaucracies with a unique organizational structure, unique coordinating and controlling apparati, user roles and culture, communication channels, flow of decision making and authority, and situational factors. For example, information systems factor research consistently reveals management support as the most important, overriding factor in IS adoption and implementation success, but the role of management in a professional bureaucracy is small, existing mainly to provide resources to the professionals (i.e., educators), resolve conflicts among the professionals, and liaise with the external environment. In a professional bureaucracy, a successful decision to adopt an innovation will not be made by the administration alone, it will be made and carried out by individual professional educators. This characteristic, however, does not negate ET application of IS adoption models, it only suggests that the factors and processes for successful educational technology adoption will likely have different relative weights than the factors and processes in successful information systems adoption.

Educational systems are also social systems. As such there exists a variety of stakeholders insisting on having a voice in organizational change and/or instructional changes. The challenge is in learning from the different perspectives and working together rather than polarizing and working separately on opposing goals.

There also exists an important difference between the use of new information systems and the implementation of new programs, products, or technologies in education, at the level of the teacher. The way that a teacher implements and adapts an instructional innovation is affected by his or her personal constructs concerning learning and instruction (Jost, 1992). In addition, classroom instruction includes social interactions and constructions that influence both teachers' thought processes and actions.

User acceptance and use has consistently been identified as essential to information systems adoption. Given the professional bureaucracy structure of the educational system, professional educators rightly have the authority and discretion to adopt or not adopt innovations for teaching; they are hired because of their expertise in education. An important way to improve success should be adopted from the IS factor model: directly involving users in the design process and designing systems that target their needs and characteristics. Without consideration of the user, support and incentives, widespread user acceptance by existing educational professionals is unlikely to occur. In professional bureaucracies, attrition or replacement is the most common means of organizational changes, in addition to changing the standards of who can newly enter the profession, changing what individuals learn in training for the profession, and re-educating those professionals who are willing to be re-educated (Mintzberg, 1993).

Be-educating must take into consideration the issues of conceptual change and role changes as well as technical and curricular competencies. Leonard-Barton (1988), in case studies concerning the introduction of technology into the operations of large corporations, found that extensive investment was sometimes made in supporting hardware but not enough in training, or in training but not in education. "Training did not equate with education and people needed 'know-why' as well as 'know-how'" (p. 262). Research on educational change parallels these findings. When teachers learn the outward appearances of an innovation (procedures) without understanding the underlying philosophy, no real change occurs because the intended innovation has not been implemented.

Education systems and educational change involve complex and dynamic interrelationships. We must expand our understanding of mutual adaptation to include changes in the innovation, the teacher, the organization and the system. Successful change, particularly change involving sophisticated and pervasive uses of technology, requires both bottom-up and top-down involvement and support. Education systems must become learning organizations composed of inquiry-oriented individuals and environments that support collaboration and problem-solving.

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Authentic Activity as a Model for Appropriate Learning Activity: Implications for Emerging Instructional Technologies

David G. Lebow
Walter W. Wager

Abstract: In this paper, we discuss the implications of authentic activity as a mode1 of learning, particularly in the design of computer-based simulations and project-based learning activities. We first address the characteristics of real-life problem-solving situations, educational simulations, and authentic learning activities. We then identify three key guidelines in the design and development of authentic learning activities: (a) support the learner in establishing a learning enterprise. (b) insure that the learner practices what is essential for the transfer situation, and (c) base design decisions on values consistent with constructivist principles of teaching and learning. In our view. authentic activity represents a holistic and generative process of learning and motivation. Authentic learning activities place emphases on self-directed learning and on development of metacognitive abilities necessary to support it.

Résumé: Dans cet article nous étudions les implications de l'activité authentique comme modèle d'apprentissage, notamment dans la conception de simulations informatisees et dans les activités d'apprentissage a l'intérieur d'un projet. Nous nous penchons d'abord sur ce qui caracterise les situations de solution de problemes reelles, les simulations educatives, et les activités authentiques d'apprentissage. Nousidentifionsensuite troislignesdirectricesclés pour la conception et le developpement d'activites authentiques d'apprentissage: a) le support de l'apprenant dans l'etablissement d'un projet d'apprentissage, b) l'assurance que l'apprenant met les éléments essentiels a la situation de transfert en pratique, et c) des décisions sur les valeurs de conception de base compatibles avec les principes constructivistes de l'enseignement et de l'apprentissage. Nous pensons que l'activite authentique represente un processus holistique et generatif de l'apprentissage et de la motlvation. Les activités authentiques d'apprentissage mettent l'accent sur l'apprentissage auto-dirige et sur le développement d'aptitudes métacognitives nécessaires a son support.

Today, interest in learning through authentic use is widespread as the theory base for situated learning matures and as innovations in computer-based multi-media systems outstrip the development of theory-based instructional strategies (Dick, 1991). Beginning with Dewey (1972) and the progressive educators of the 1920s and 1930s theorists have argued that learning should take place in meaningful contexts where students work cooperatively to solve everyday problems. More recently, this idea has provided the basis for a number of educational approaches including cognitive apprenticeship (Brown, Collins, & Duguid, 1989), project-based learning (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991), theme-based learning (Wager, 1994), guided microworlds (Rieber, 1992), computer-supported intentional learning environments (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989), and reciprocal teaching (Brown & Campione, 1990).

At the same time, the availability of powerful low-cost computers has stimulated interest in the design and development of simulations. Simulations have long been used to deliver instruction in schools, military, industrial, and other educational settings on the basis that they increase the ability of participants to apply what they have learned in the classroom to the real-world or transfer situation.

It is an often-stated conviction that producing transfer is the main job of education. Yet, an increasing body of research shows that the way students learn something in school often results in students knowing something but failing to use it when relevant. Brown et al. (1989) have concluded that this condition, originally identified by Whitehead (1929) as the problem of inert knowledge and also referred to as a transfer problem, occurs because classroom learning environments generally lack the contextual features ofreal-life problem-solving situations. With this problem in mind, Brown et al. have proposed that "understanding is developed through continued and situated use" (p. 33). They have further suggested that cognitive apprenticeships should be designed that immerse students in the culture of traditional academic domains by engaging students in authentic activity.

In this paper, we discuss the implications of adopting authentic activity as a model for appropriate learning activity, particularly in the design of computer-based simulations and project-based learning activities. The term "model" as used in this context is meant in the sense of something worthy of imitation and not in the scientific sense of a theoretical model of learning or instruction. We suggest, however, that there is much more to transforming the conventional classroom into an authentic learning environment than simply incorporating features of real-life situations into school work. Use of computer-based simulations and reality-centered projects does not insure that students will assume a positive orientation to learning or derive the benefits of in-context learning. Much additional support is required to strengthen the learners' tendencies to engage in intentional learning processes and to help them progressively assume responsibility for learning.

The following discussion is divided into three sections, organized around the following three questions that also serve as headings for the sections:

a) What characteristics of real-life problem-solving situations are different from problem solving in school?
b) What characteristics of educational simulations are most important?

c) What characteristics of authentic learning activity are most important'?

Question 1. What characteristics of real-life problem-solving situations are different from problem solving in school?

A primary principle of the cognitive apprenticeship framework is that understanding develops through application and manipulation of knowledge within the context of the ordinary practices of the target culture-in other words, through authentic activity. This principle represents the primary rationale for using authentic activity as the model for appropriate learning activities. It extends various cognitive theories of transfer that emerged from information processing theories of human learning and memory in the 1970s (e.g., Bransford & McCarrell, 1974). These theories stimulated thinking about developing educational practices to enhance far transfer and, more particularly, transfer from school learning to real-world situations (Royer, 1979). As Brown et al. (1989) suggested, conventional classroom tasks frequently lack the contextual features that support transfer from the school setting to the outside world. For advocates of situated approaches to learning, the provision of authentic activity in schools is a way to increase cognitive engagement, support meaningful learning, and facilitate transfer.

Table 1 summarizes differences between real-life problems and problem-solving activities typical of actual practitioners versus problem solving typical of students in school that are particularly relevant to the design of authentic activities. The differences identified in the table are further elaborated below.

TABLE 1
Real-Life Versus In-School Problem Solving

Real-Life

1. Involves ill-formulated problems and ill-structured conditions.
2. Problems are embedded in a specific and meaningful context.
3. Problems have depth, complexity, and duration.
4. Involves cooperative relations and shared consequences.
5. Problems are perceived as real and worth solving.

In-School

1. Involves "textbook examples" and well-structured conditions.
2. Problems are largely abstract and decontextualized.
3. Problems lack depth, complexity, and duration.
4. Involves competitive relations and individual assessment.
5. Problems typically seem artificial with low relevance for students.

1) Real-life problems are frequently ill-formulated and conditions are ill-structured. Understanding develops through experience in multiple case contexts and from multiple perspectives within the same context. In school (and more generally in the design of instruction), performance requirements are simplified and the learning situation is well-structured (Spiro, Feltovich, Jacobson, & Coulson, 1991).

2) In real life, skill practice is embedded in performing some larger task at hand that justifies developing the skills in the first place (Brophy & Alleman, 1991). The larger task serves as an integrating structure or enterprise that helps organize new information and lends meaning and purpose for learning. Individuals assume responsibility for establishing and monitoring their goals and strategies when the reasons for performing procedures, even tedious ones, are understood within the context of a broad, global task environment (Honebein, Duffy, & Fishman, 1994). In school, teachers often assign students to low-level work involving recognition and reproduction of memorized information or practice of isolated skills, without providing links to a larger functional context (Doyle, 1986). All too often, the primary enterprise for students is to pass tests rather than apply new knowledge and skills in meaningful ways.

3) Real-life projects frequently have depth, complexity, and duration (Berliner, 1992). When people engage in active and generative problem-solving activities that involve personal values and beliefs, they experience a feeling of ownership over the activity and its goals and thus, the tendency to engage in intentional and self-regulated learning processes is enhanced. "School activities" generally lack depth, complexity, duration, and relevance to the real world. Teachers and students are constrained by requirements to cover "essential" content.

4) In real life, the intelligence to solve a problem or perform an activity is often distributed across a group of peers, a learner-mentor system, and/or an electronic performance support tool (EPSS), or other form of cognitive technology (Pea, 1993). The quality of interactions among participants is frequently of primary importance in undertaking a project or accomplishing a goal. In school, teachers serve as authoritative sources of all information rather than as guides or information managers. Relationships between students are predominantly competitive rather than cooperative, as individualistic modes of learning and assessment are generally the norm. When group activities do occur, students are usually judged exclusively on what they can do on their own.

5) In real-life, all problems do not have previously known solutions or just one possible explanation. When people work collaboratively on solving real-life problems, they share in substantive conversation, which has a different quality from conventional school talk (Newmann, 1991). An individual's orientation toward learning is qualitatively different when learning is embedded in the context of achieving personally relevant and valued goals versus working for a grade or some distant, future goal. In school, problems are often

artificial and of no particular interest to the students. Students who see no relevance in the problems, also see no relevance in the knowledge and skills required to solve them.

Question 2. What characteristics of educational simulations are most important?

The theoretical assumptions underlying the designs of simulations are as varied as the purposes for which they are used and the contexts in which they appear. According to Cunningham (1984), a simulation duplicates some essential aspect of reality for purposes of experimentation, prediction, evaluation, or learning. An educational simulation is designed to increase one's ability to respond appropriately in a real-world or transfer setting. It allows the learner to practice decision-making, problem solving, and/or role playing in the context of a controlled representation (model) of a real situation (Smith, 1986).

From an instructional-design perspective, educational simulations support predetermined learning outcomes by providing users with opportunities to deal with the consequences of their actions and to respond to feedback Within Pea's (1985) framework of distributed intelligence, computer-assisted simulations have the potential to reorganize mental processes by "closing of the temporal gaps between thought and action [and] between hypothesis and experiment" (p. 85). Pea envisions a partnership between computer and student that extends and redefines thinking capabilities and transforms how problem solving occurs. Such effects are made possible by allowing the user to engage in "what-if thinking" where the consequences of different approaches to a problem may be displayed immediately.

In the literature on simulation, the definition offidelity varies depending on the context to which it is applied and the theoretical orientation of the author. For example, in proposing a model for assessing the fidelity of task simulators used in industry, Bruce (1987) identified three criteria: a) physical similarity; b) functional similarity; and c) task commonality. After assigning a value to each category involved, the values are combined to produce a fidelity index for a particular training device. In contrast, Smith (1986) believes that the essential reality factor in a simulation is not its form but the information-processing demands it imposes on the learner. He has called this its "cognitive realism" the degree to which the simulation engages participants in a decision-making or problem-solving process that parallels the mental activities required in the transfer situation.

Oddly enough, research does not support the idea that maximizing realism, or fidelity of a simulation maximizes learning outcomes (Alessi 1987). With this in mind, Reigeluth and Schwartz (1989) recommended that when designing for a novice learner, it is best to start with low fidelity and to add fidelity and complexity progressively. Similarly, Blumenfeld et al. (1991) have proposed that a great strength of simulation for instructional purposes is its potential to allow students active exploration in simplified environments. They believe that when extraneous details are minimized, interactions among variables are easier to notice than in a highly realistic simulation or in the transfer environment itself.

Reigeluth and Schwartz (1989) have described three major elements in the design of computer-based simulations that they believe determine their effectiveness: the scenario, the underlying model, and the instructional overlay. They have suggested that the scenario (the situation and the learner interface with the simulation) and the model (usually a mathematical formula for establishing causal relationships) should duplicate to some degree the essential characteristics of the transfer situation. In other words, the characteristics of the scenario and the model determine whether essential aspects of the transfer situation are represented, although how to identify such essential characteristics is not addressed. Reigeluth and Schwartz have concluded, on the basis of their own analysis of simulations, that the instructional overlay (the features that function to optimize learning and motivation) are generally the weakest aspect in educational simulations.

One element of the instructional overlay that Reigeluth and Schwartz (1989) feel should receive more attention from designers is artificial feedback. Alessi and Trollip (1985) have distinguished between natural feedback that the real-life situation provides, and artificial feedback that the designer builds into the simulation. One of the strengths of simulation for instructional purposes is its potential to shelter learners from costly forms of natural feedback (skidding into a snow bank) and to provide real-time artificial feedback (aural, verbal, or visual instructions to turn in the direction of the skid.)

The simplifying-conditions method proposed by Reigeluth (1993) appears to take advantage of strengths inherent in simulation without sacrificing authenticity of the learning activity. In this method, experts identify (a) a simple case that closely represents a real-world task and (b) the ways in which this “epitome” version of the task differs from more complex versions. Over time, complexity and variations are added systematically to the learning activity with the expectation that the method preserves the potential benefits of in-context learning. Reigeluth has claimed that this is a more holistic way to sequence instruction than the traditional parts-to-whole approach and is compatible with context-based design models.

The ideas that sequencing within a simulation should progress from simple-to-complex and that different levels of fidelity and complexity are appropriate for different levels of learners appear to be inconsistent with constructivist principles held by a number of theorists. For example, Honebein et al. (1994) believe that the learning situation should parallel the transfer environment with all its complexity and messiness. They have argued that the complexity of the learning environment in the early stages of learning should reflect the complexity of the authentic context to the extent practical. Otherwise, when instructional designers simplify the learning environment, they may unwittingly alter the metacognitive and affective demands of the authentic task complex.

Carroll (1990) has suggested that in order to facilitate transfer, promote metacognitive and affective learning, support an adaptive motivational pattern to learning, and encourage a high degree of ownership and personal relevance, educators should provide training on real tasks. Similarly, Spiro Vispoel, Schmitz, Samarapungavan, and Boeger (1987) believe that "case; and examples must be studied as they really occur, in their natural contexts, not as stripped down 'textbook examples' that conveniently illustrate some principle" (p. 181). From this perspective, the role ofinstruction changes from controlling student learning through imposing a simplifying structure on the environment to developing appropriate "scaffolding," including new strategies, tools, and resources that support the student in functioning within the authentic learning context,

Of note, Spiro et al. (1991) have identified two factors that determine when it is appropriate to maintain the complexity of the transfer environment within the learning situation, and when it is more effective to simplify the learning situation. They distinguish between a) well-structured domains versus ill-structured domains; and b) introductory learning versus advanced learning. Whereas instruction that focuses on general principles with application across cases is effective in well-structured domains, such an approach may impede attainment of more ambitious goals in ill-structured domains. To attain high-level thinking skills in ill-structured domains, the learning environment should provide experience in multiple case contexts and from multiple perspectives within the same context.

Theorists hold a variety of viewpoints on when to maintain the complexity of the transfer situation within the learning situation and when to simplify the learning situation. Vygotsky's (1978) concept of the zone of proximal development (ZPD) and Pea's (1985) ideas concerning distributed intelligence appear particularly relevant to this concern. The ZPD represents the limits of an individual's development defined as the distance between independent problem solving and what a person can accomplish under adult guidance or in collaboration with more capable peers (Vygotsky, 1978). Pea has suggested that technology, in Vygotskian terms, can expand zones of proximal development to enable novices to engage in problem-solving activities that would otherwise remain beyond their reach. From this perspective, intelligence may be distributed across a system not only through collaborative efforts but also as a result of the partnership between learner and computer (Pea, 1993). This suggests the following principle: The complexity of the learning situation should not exceed the capacity of the environment to adequately expand the ZPD through both social and technological scaffolding.

Question 3. What characteristics of authentic learning activity are most important?

Examined from a variety of viewpoints, the assumption underlying most traditional educational practices that knowledge is context-independent, appears increasingly difficult to justify. A renewed educational awareness is growing that recognizes the priority of supporting higher mental processes through situated learning and the collaborative construction of meaning. Although educators have long recognized the need to foster higher order thinking skills and positive disposition toward learning, they have disagreed about how to achieve these ends (Resnick, 1989).

The idea that students need to acquire facts and theories as conceptual tools for solving problems in meaningful contexts, rather than for maximizing success on "school" tests, has led to an interest in apprenticeship learning and learning through authentic use (Brown et al., 1989; Pea & Gomez, 1992). Results from cognitive skill research that examine differences between experts and novices support this view. Experts and novices differ in many ways other than the amount of subject matter mastered, including "the organization of knowledge, the ability to process problems in depth, and the appropriateness of the mental model possessed by the learner" (Royer, Cisero, & Carlo, 1993, p. 235).

The notion of authentic activity is based on the idea that the learning situation should help learners develop ways of thinking and acting that characterize the target culture or professional community. This does not mean, however, that design for authentic learning activity is merely a matter of maximizing the similarity of the learning situation to the transfer environment. As is explained through Tripp's (1994) example below, design for authentic learning is also concerned with the values that the learning environment supports and models, and whether the learner practices what is essential for the transfer situation.

Tripp (1994) believes that one way to learn something about instructional design is to analyze proven educational approaches by reverse engineering them and trying to extract some principles. For example, he believes that the instructional model applied in the education of Pacific navigators for over a thousand years represents such a proven approach. Although Pacific Islanders educated their navigators in part through informal situated learning at sea, much of the students' education occurred in a formal instructional context. For example, instruction in wave pattern recognition and star relationships was done on land with substitute media-stick charts, stone canoes, and the interior of a building that served as a kind of low-fidelity planetarium — even though real waves and stars were readily available.

One principle that Tripp (1994) derived from his analysis is as follows: "Reality is not necessarily superior to artificiality. When reality is subtle or complex, substitute media that increase saliency by simplification are more efficient" 3). The neophyte navigator knows in a meaningful way that what he is learning is necessary for his survival. The idea that he is engaged in a learning enterprise, in Gagne and Merrill's (1991) terms, is well established in his mind before he enters the formal phase of training. Thus, in this case, authenticity is primarily a quality of the larger task environment as understood by the learner.

Tripp's (1994) analysis illustrates a fundamental principle of instructional design that emerges from an open-systems view of the learner: The orientation of the individual to learning is part of the learning context Learning orientation encompasses an individual's beliefs about the nature of knowledge and how it is acquired as well as personal goals, expectations, and attitudes. Considered as a whole, these factors influence students' cognitive engagement and the learning activities they employ.

From an open systems conception, human learning is essentially a matter of self-regulation. It is a process of making sense, where external perturbations, anomalies, and errors trigger internal transformations toward reorganization and new understanding (Doll, 1989). With an open systems model of the learner, the role of instruction is to support the process of meaning-making by influencing the thinking processes students use to learn and sustain motivation, rather than controlling external conditions to achieve pre-set ends.

Buchanan (1992) has suggested that since conditions are ill-structured and problems are ill-formulated in many areas of human endeavor, all but the most clearly linear design problems assume a fundamental indeterminacy. Von Bertalanffy's (1967) distinction between open and closed systems is relevant to this view. Closed systems such as cybernetic or feedback systems are open to information but do not exchange matter with the environment. Open systems, on the other hand, such as organisms and other living systems are maintained in a continuous exchange ofcomponents. Instructional design within an open-systems framework recognizes the constructive nature of reality and further requires a shift in preferred metaphor for education from transmission of information to building representations of meaning.' In a sense, an open system is open to possibilities.

Based on our own design experience and on the literature related to constructivist philosophy, higher order thinking, achievement motivation and computer-supported collaborative learning environments we have tentatively identified a set of interrelated values that may guide educators in the design of authentic learning environments. In the face of what Doll (1989) describes as an emerging post-modern agenda for curriculum the traditional ID values of replicability, reliability, communication, and control (Heinich 1984) appear increasingly restrictive. An alternative (and not necessarily mutually exclusive) set of values has emerged including mutual inquiry collaboration, multiple perspectives, pluralism, personal autonomy activity' reflectivity, generativity, authenticity, complexity, personal relevance, self-regulation, ownership, and transformation (Lebow, 1993). These values are supported by a growing body of educational research and theory that advocates holistic and generative approaches to education and the use of technology to assist students in developing higher order thinking skills and important long term dispositions toward learning.

When the design of instruction is guided by such values means and ends become integrated and the desired results and preferred instructional techniques and strategies appear as reflections of the same whole. To put this in other terms, when the transfer task is the model for the learning activity, means support values inherent in ends. For example, to develop interpersonal skills for sustaining cooperative group work is both a goal of instruction and a means to achieve the goal. Students practice group process skills in the context of achieving personally relevant goals. Another goal, to develop the ability to reflect on one's own learning processes, is also a means to self-correction and self-regulation of the learning process. Within an authentic learning activity, instruction is a model for the values that instruction is designed to support, and, in line with the concept of continuous progress, a good test is also a good learning activity. As a result, students experience the relevance of new information, not by being told about its relevance, but by experiencing changes in perceptions, understandings, beliefs, feelings, and capabilities as a function of new information (Bransford, Franks, Vye, & Sherwood, 1989).

Gustafson (1993) believes that the fundamentals of instructional design must change in response to mounting evidence supporting the claims of cognitivists and constructivists. He has suggested that "what we now await is a much greater amount of specific guidance on how to apply cognitivism and constructivism, such as we have for behaviorism" (p. 30). Our current research efforts are pointed in this direction as we develop a set of guidelines that will serve to make the application of constructivist values to the design of instruction more concrete, in two ways. The guidelines will (a) provide information on how to design for higher order thinking skills and positive disposition toward learning and (b) suggest solutions to a variety of classroom management issues that may arise when authentic activities serve as the model for learning activities.

The guidelines initially emerged from a review of literature about how cognitivist and constructivist principles may contribute to the design of complex learning environments, and to an understanding of how to use emerging technologies in education. We are now in the process of refining the guidelines based on results of our own research efforts in examining a prototype computer-supported learning environment for graduate level education.

At this point, we have organized the guidelines into four main categories including collaboration, ownership, meaning, and practice as a framework for communicating our ideas and as a basis for future research. Taking the first letter of each category provides the convenient mnemonic of COMP. Under each category, we have listed a number of tentative goal statements that reflect instructional design principles consistent with constructivist and cognitivist thinking and in line with the values mentioned previously. Although it is beyond the scope of this paper to report on our progress in this area, an example of a goal statement from each of the COMP categories is offered below:

1) ***Collaboration:*** Provide students with opportunities to engage in activities traditionally reserved for teachers by a) shifting from all students learning the same things to different students learning different things; b) creating group problem-solving situations that give students responsibility for contributing to each other's learning; and c) helping students see the value of what they are learning and choose to share that value.

2) Ownership: Support development of reflective self-awareness and other self-regulated learning skills as the basis for assuming personal responsibility for learning by a) providing new structure, process-relevant feedback and sufficient time to support reflection on the learning process and to help learners experience the value of self-monitoring; b) modeling and offering coached practice at self-questioning and other metacognitive skills for developing both executive control of learning activities and critical thinking skills for evaluating intellectual products including one's own; and c) promoting meta-affective skills for increasing ability to concentrate and persevere.

3) Meaning: Support development of a learning versus grade orientation to the academic enterprise and help learners build commitment to their goals by a) embedding the reasons for learning something into the learning situation and helping students learn something in a way that includes experiencing its significance or function; and b) providing opportunities for students to experience how increasing cognitive engagement is tied to achievement of personally relevant goals.

4) Practice: Support development of cognitive flexibility by providing a) problem-solving experience in multiple case contexts and from multiple perspectives within the same context; and b) repeated practice in environments similar to those in which learners will use their problem-solving skills (Spiro et al., 1991).

In summary, authentic activity is consistent with a holistic and generative view of learning and motivation that places emphases on self-directed learning and on development of metacognitive abilities necessary to support it. From this perspective, the traditional split between cognition and affect is seen as an often unproductive application of reductionist thinking. When authentic activity is the model for appropriate learning activity, the perceptions of the learner and the affordances of the environment represent an integral and inseparable context of learner/environment. The implications for instruction are primarily threefold: (a) design must support the learner in establishing a learning enterprise within the larger global task environment (b) the learning situation must afford the kinds of activities essential success in the transfer environment, and(c) the instructional designer should base design decisions on values consistent with constructivist principles of teaching and learning.

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Mediaware Review

The Apple Media Kit Version 7.7

L. F. (Len) Proctor, Editor

System Information and Requirements

Apple Programmers Development Association (APDA)
Apple Computer, Inc.
Order: l-800-637-651 1
Fax: 716-871-6511
Applelink: APDA
Price Range: $1,OOO- $2,000

System Requirements:

- Macintosh IIci or later
- 8 MB of RAM memory
- At least 40 MB hard disk drive (although larger drives are recommended)
- System 7.1 or later
- QuickTimeTM, version 1.6.1 or later
- CD-ROM optional

Program Description

The Apple Media Kit is a cross-platform, multimedia authoring tool. The Media Tool component facilitates the assembly of sound, picture, computer graphics, text and movie files. The AMT Programming Environment is an object-oriented programming language that enables a programmer to add interactivity to a project. The Kit contains Macintosh installation disks, Windows installation disks, documentation, a demo CD containing an electronic version of the Programming Environment documentation, sample Mac and Windows projects and a demonstration version of the Media Tool.

Basic Functions

Media Tool projects use an icon map to structure the user path and the order in which screens are displayed. A library folder is used to hold all the media components that are used to construct the screen. When a completed Media Tool project is saved, the description of objects and their actions can be output to the AMT Programming Environment as a text file. In text form, the code can be edited and enhanced with the Apple Media Language or other standard programming language such as Pascal or C. Conditional branching based on user input can only be achieved within the programming environment.

Documentation

Documentation for the Media Tool has two forms. Getting Started is a tutorial guide that explains the basic operation of the program and the User's Guide provides a reference type, feature by feature explanation. The Programming Environment has both a User's Guide and a Reference Guide. An electronically searchable copy of the programming documentation is also available on the companion CD-ROM. For the Media Tool, the Getting Started Guide presumes that the user has an extensive working knowledge of Macintosh operating conventions. The Programming Environment presumes a basic knowledge of the Macintosh Programmer's Workshop (MPW) shell, programming in C, object-oriented programming, Macintosh programming fundamentals and the Media Tool.

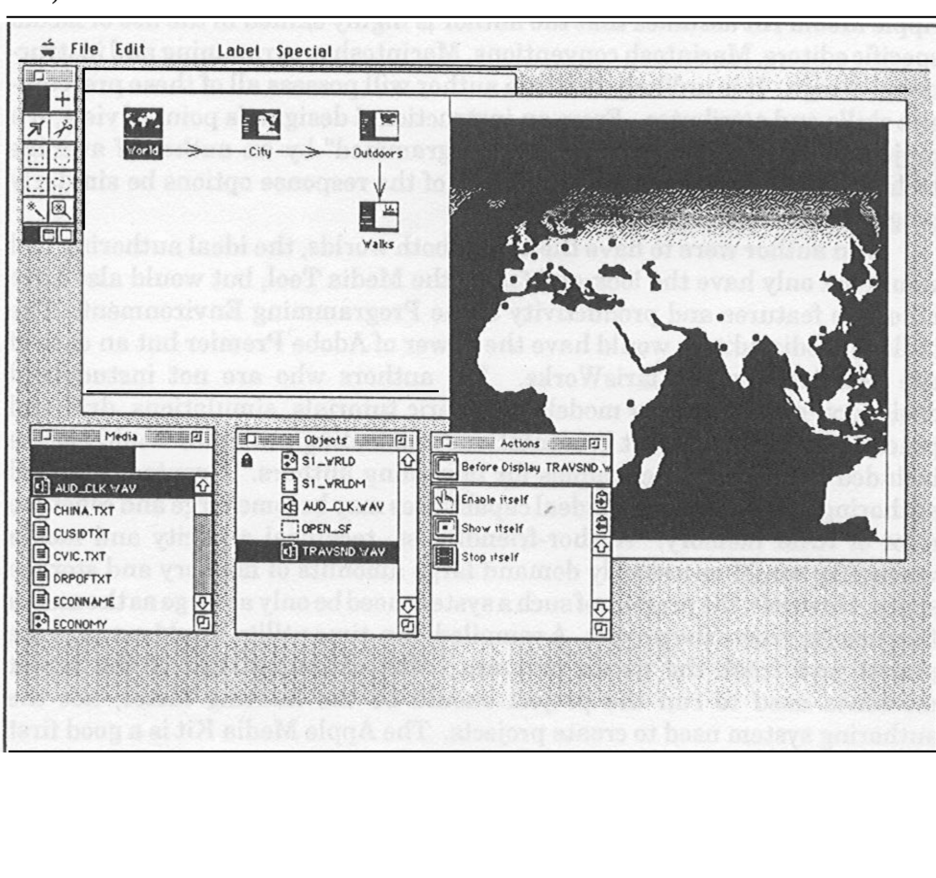
Critique and Recommendations

The Media Tool functions as a media assembly tool because it does not contain any resident media editors. Editing sound, text, picture or movie files has to be done by jumping out of the Media Tool to an appropriate outside editor. In order to use external media editors while the Media Tool is being used, there must be enough RAM memory available to handle each task. Second, if cross platform development is anticipated then MS-DOS file naming conventions must be used when the final editing is done, otherwise, the project may not run properly in a DOS or WINDOWS environment. The necessity of having to buy external editors adds to the cost of the program. Depending of the quality of subsidiary media editors selected, the cost will vary from a few dollars for shareware products to several hundred dollars for full-featured commercial editing programs.

The Media Tool requires a minimum of 3 MB on a hard drive. The documentation suggests that a minimum of 4 MB of RAM memory be exclusively dedicated to AMT, but recommends that the minimum be increased to 8 MB. Given that system files can easily consume another 2 to 3 MB, it is easy to see that if any multi-tasking is required, a minimum of 16 MB of RAM memory will be required for even a modest sized project. Second, because sound, still picture and video files are notorious for their ability to fill up hard disk space, the larger the hard drive available the better. Memory requirements for the Programming Environment are similar. The important point to note here is that while the program will run on smaller machines like the Macintosh IIci, using equipment with limited RAM memory and disk storage capabilities will very quickly limit the size and complexity of projects that can be developed.

Authors who want to start producing projects quickly will find the icon map feature very valuable because it makes thumbnails of all the project screens visible and clearly delineates the paths used to connect these screens. The map feature together with the use of library folder to hold the media components facilitates the rapid prototyping of a project and permits each member of a multi-member development team to input media files. One point to keep in mind however is that if the project contains more that fifty thumbnails, the scrolling speed of the map window becomes very slow. Even though thumbnails can be hidden to increase navigation speed, they still occupy 5 KB of memory. Project editing and revision is easy because as each screen or screen component is drafted, crafted and polished it can be added to the project by simply giving it the same name as the rough draft and adding the finished version to the library after the rough draft has been deleted.

User navigation through a project authored with the Media Tool is achieved by creating hot spots on menus, text elements or symbols. Like HyperCard, the hot spots can be linked to any screen or screens that are specified by the designer in the project map. Navigation commands are activated by the user when the mouse is clicked or moved, or when screens are opened and closed. No author programming, coding or scripting is required to specify navigation paths. The project author simply chooses an object and selects what action is to occur and when from a menu of choices (see illustration).



Once the project producer becomes familiar with the choices available under the menu items, tangible products can be created with a minimal investment of time in learning how to use the features of the Media Tool. Second, by limiting user input to click object responses AMT learning time can also be reduced. On the other hand, if the author wishes to use other forms of user response such as text input or to specify conditional branching based on user input, he or she has no choice but to revert to learning how to program a Macintosh. Unless the author is already an accomplished Macintosh programmer, his/her AMT learning time will quickly expand.

The response time of an AMT project to user is dependent on the complexity of the screen being assembled. This may vary from a few seconds to many seconds. Project response time can be enhanced by compiling code and preloadingpicture and movie files. However, running a project stored on a CD-ROM instead of a hard drive may cancel any gains in response time made by using these techniques. If the performance of the project at run time is judged to be too slow, the designer should consider dividing complex screens into two or more screens. There is a direct relationship between response time and object presentation. Hence, fewer objects on a screen at any one time will result in an increase in the speed of operation.

In conclusion, version 1.1 of the Apple Media Kit is one of the better choices of assembly tools that a multimedia author can select for simple project production. For more complex projects requiring higher levels of interactivity, Apple Media Kit assumes that the author is highly skilled in the use of media specific editors, Macintosh conventions, Macintosh programming and instructional design. It is unlikely that one author will possess all of these prerequisite skills and attributes. From an instructional designer's point of view, if a project navigation hot spot can be "programmed" by an author of average technical skill, why can't the remainder of the response options be similarly programmed from Media Tool menus?

If an author were to have the best of both worlds, the ideal authoring tool would not only have the look and feel of the Media Tool, but would also have all of the features and productivity of the Programming Environment. The built-in media editors would have the power of Adobe Premier but an ease of use associated with ClarisWorks. For authors who are not instructional designers, representative models of generic tutorials, simulations, drill and practice exercises, content presentations and testing examples would also be included in the Kit as examples for beginning authors. Granted, an ideal authoring environment with ideal capabilities may become large and consume a lot of RAM memory. Author-friendliness, technical capacity and media versatility would necessarily demand large amounts of memory and storage space. However, the product of such a system need be only as large as the media files used to create the project. A compiled, run-time utility would manage the project and track the user's progress. The characteristics of the target machines used to run the project should be the limiting factor, not the authoring system used to create projects. The Apple Media Kit is a good first step in this direction. Hopefully, as development continues on this product, it will continue to evolve in an author-friendly direction and eventually have all the capabilities suggested for an ideal authoring system.

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Book Reviews

Diane P. Janes, Editor

Hands on Internet: A Beginning Guide for PC Users, by David Sachs and Henry Stair. Englewood Cliffs, New Jersey: PTR Prentice Hall, 1994, ISBN 0-13-056392-7 (275 pages).

Internet: Mailing Lists, Edward T. L. Hardie and Vivian Neou (Eds.). Englewood Cliffs, New Jersey: PTR Prentice Hall, 1994, ISBN 0-13-289661-3 (582 pages).

Reviewed by Diane P. Janes

To continue my self-imposed mini-series on the Internet, it seemed appropriate to examine two new offerings by Prentice Hall.

Hands on Internet: A Beginning Guide for PC Users asks the question "Are you frustrated by the mass of Internet publications available which lack hands-on, how-to information?". The answer for me was yes. In my job, I am often called upon to give students enough information to send email messages to their professors, or asked by the faculty and staff to help them solve some Internet dilemma they have stumbled upon. The information provided by our campus computing department when I started exploring the Net was unreadable. (To be fair, the material has improved...or is it that I can now understand it?> Our campus librarians got into the act and produced a series of valuable handouts, again useful but missing something. Even the seminars provided by the campus library on using the Internet and specifically Memorial University's own system, did not seem to provide the basic solution to the problem.

Hands on Internet does try and solve the problem. I cannot say the authors were completely successful, but they do make a valiant attempt. The problem: how do you explain the infinite ways available to a user, to get to that point when the computer asks for your username and password. In my laboratory alone, there are two different methods, depending on the computer you use. Add to that my home modem, the terminals in the main computer labs, the terminals in the library and you could and do have confused users.

Hands on Internet tries to solve this problem by, as they say, having the reader "learn by example" and "train by doing". They make the reader comfortable by using common language, using bold font to emphasise jargon, and offering an explanation of the jargon within the context of the Internet. Rather than using chapters, the book is organised by what the authors' call sessions. Beginning with the Introduction, the authors attempt to personalise the reader's system by asking the reader questions. Yes answers get led in one direction; No answers in another. This, one hopes would solve the problem of different systems, etc. Yet when I gave this book to several users, the more experienced user found the book beneficial. (I use experienced here, lightly. The user knew how to get into his/her system and log on.) The more novice user became confused early on, until we realised she was using a VAX/VMS account, where the book indicates it will be using a UNIX based system. It took a second look to discover this information.

After the Introduction, ***Hands on Internet*** uses nine sessions (all hands on and conducted while the reader is logged on to the Internet) to teach. Session One deals with logging on to the Internet, what is an account, login names and passwords, password security, making a mistake, directories, and finally "Getting out Gracefully". Session Two explores electronic mail - from what it is to uploading and downloading files. Session Three explores the news groups found on the Internet. (Careful here, Memorial University, as an example, uses a newsreader called TIN on its UNIX system -TIN is not mentioned in this book, that I could find). Session Four discusses contributions to Usenet, rules, posting to groups, flames and automatic signatures. Session Five describes mailing lists. Session Six explores telnet. Session Seven describes file transfer protocol (FTP). Session Eight, called Finding Things, takes the reader through gopher, archie, WAIS, and world wide web practices. Session Nine is a quick reference to all of the previous eight sessions. The sessions are followed by 4 appendices (Where to Learn More, PC Communications and the Disk, Dial-up Internet Services, and The Internet Society) and an Index. The spine of the book is colored to allow the reader quick access to a particular session. Each session ends with a vocabulary and command summary.

Hands on Internet comes with a 3.5" disk that includes "...a fully functional demonstration version of [deltaComm Development, Inc.'s] communications program Telix Lite". Instructions on how to install and use this software and software from LotusWorks, Microsoft Windows and Microsoft Works are included. Discount forms from a number of commercial internet services are also included.

Once over the hurdle of logging in to the Internet on the system you are using, ***Hands*** on ***Internet*** becomes a valuable tool. Its language is clear, jargon explained, step-by-step procedures are used. Caution must be shown by novices so that they will check with their systems administrator, campus computing department, communications software manual or other experienced user to ensure the proper procedures for their own personal system.

The other book reviewed here, ***Internet: Mailing Lists*** is designed for the more experienced user of the Internet - the user who has logged on, who does use email regularly, but who hasn't really discovered, yet, that the Internet is a wealth of information andresearch possibilities.

Internet: Mailing Lists is a relatively simple book. It is part of the SRI International Internet Information Series, published by Prentice Hall. Divided into four chapters, the first three chapters take up the first 15 pages, discussing generally the Internet, BITNET and USENET, types of mailing lists, how to join a mailing list, and how to start your own list. The remainder of the book discusses over 800 mailing lists available for you to explore. The book ends with a request to readers that if they have a list they administer and would like to have it included in the next edition of this book, a template for information to be sent and an email address is included for use. The final section of the book is an index of the mailing lists. It is alphabetical but does include not only the proper name of the mailing list, but subject catagories that will lead you to the appropriate mailing lists.

The book asks "What do deadheads, chess players, science fiction fans and birdwatchers have in common?". Of course the answer is the Internet and its world of special interest groups. Mailing lists can be unmoderated (anything goes), moderated (usually messages are screened before being passed on to the membership on the List, and digest formatted (messages are gathered by the moderators and grouped. Groups are sent out regularly by the moderator to the List membership). According to the editors "There are hundreds of mailing lists covering almost every topic imaginable, allowing individuals with common interests to share their thoughts and discoveries". By adding your email address to a Mailing List, the editors suggest that " . ..participating in a mailing list is closer to being part of a conversation than being the passive recipient of an organization's mail".

Let's look at an example from ***Internet: Mailing Lists.*** Have an interest in discussing the use of computers as an educational tool in higher education? Try CBEHIGH on LISTSERV@BLEKULll. BITNET or LISTSERV@CCl.KULEUVEN.AC.BE (134.58832). Owned by several individuals and the Computer Based Education University Computing Centre, University of Leuven, Belgium, the list entry indicates who would be interested in participating in this list, who to contact if you have materials you would like stored and made available to people reading the list, how to subscribe to the list, and importantly, how to unsubscribe if you find it is not to your needs, how and who to send a message to, and finally, that the list is unmoderated. The owners ask those sending messages to "... .Make sure your messages are intended for public consumption".

If the idea of subscribing to lists as a way to broaden your Internet horizons appeals to you, then this book may be for you. A word of caution. Like all Internet books, it can become quickly out of date as the Internet grows and expands. As well there are some mailing lists that have very particular 'netiquette', that is an expected level of behavior from its members. If you are new to a mailing list, I would suggest passive monitoring (a.k.a. lurking) of the group for a while before posting. This would give you a feel for the group's "corporate culture", if you like. Also look for FAQ's (Frequently Asked Questions). FAQ's are valuable in answering the most basic of questions about the group and avoids the frustration often felt by experienced users who get asked the same questions, over and over, by new subscribers. Enjoy!

REVIEWER

Diane P. Janes, M.Ed., is a Laboratory Instructor with the Faculty of Education, Memorial University and presently serves as Book Review Editor for ***CJEC.***

Multimedia for Learning. Diane M. Gayeski (Ed.). New Jersey: Educational Technology Publications, 1993. ISBN o-87778-250-4 ($29.95 USA)

Reviewed by Brian D. Kerr

Have you ever wondered what exactly is meant by the term multimedia? Are you having trouble with the latest in computer technology acronyms? When you hear people speak of "HyperCard" do you think they are referring to the next step up from "Goldcard?" Have you spent much time lying awake at night pondering the possible applications for interactive technology, or what about virtual reality?

Well, Multimedia for Learning is the book for you! Diane Gayeski and ten other authors examine new perspectives concerning the latest in instructional/learning technology - that of multimedia. This compilation of papers is an attempt to increase our sensitivity toward multimedia. The authors are not only trying to promote a greater awareness of what is actually available - they want to emphasize the possibilities of the learner becoming "a more creative participant in the educational process." According to Gayeski, multimedia technology is key in facilitating a switch from "teaching mode to a full learning culture." Theoretically this will allow the learner to be in control of not only what s/he will learn but how s/he will learn.

My initial response to the book was very positive. It is well written and is quite thorough in its coverage of the subject area in relatively basic and reader-friendly language, given the technical dimensions of the subject matter. The topics discussed range widely. For example, the first chapter written by Gayeski herself, is truly an introduction to the subject - an overview. It even provides a glossary of current terminology. Other chapters provide a guide for developing multimedia; determining what is involved; getting started; and dealing with the various hurdles one might encounter. Chapters such as these are better suited to the beginner, while others may require a little more background knowledge for full comprehension. One author even delves into the latest multimedia platforms complete with some future forecasting. In addition the book provides the reader with insight on how to evaluate multimedia platforms for curricular uses and actual examples of how multimedia technology is being used in the training environment. There are also discussions on current and future possibilities for virtual reality technology.

Although a lack of familiarity with the topic may handicap some readers, the main points of the book can still be understood. The amount of information provided in each chapter is not overwhelming, and for the most part each author is quite effective in conveying the desired enthusiasm. The broad scope of multimedia becomes apparent quite early in the book, and the usefulness of such a tool for instruction is obvious. Clearly, multimedia can be seen as an important aid in designing future instruction and not the reverse, as has been the case in the early years.

In this reviewer's opinion, the only shortcoming of this book can be attributed to the organization of the chapters. A careful examination of the Table of Contents may be required in order to plan the sequence in which the various topics and perspectives will be addressed. As a swimming instructor might warn: " Don't attempt to get in too deep, too early!" Specifically some of the later chapters could be rearranged to follow a more logical progression. Related topics sometimes seem to be separated by unrelated topics.

In conclusion, Multimedia for Learning is certainly a must for those unfamiliar with multimedia and the latest computer hardware/software, but because of its broad coverage and up-to-datedness it will suit pioneers as well.

REVIEWER

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Distance Education: A Practical Guide. Barry Willis (138 p). New Jersey: Educational Technology Publications, 1993. ISBN O-87778-255-5 ($29.95 USA).

Reviewed by Mary F. Kennedy

The Preface of Barry Willis' latest book on distance education emphasizes its practical nature, and its direction at two particular audiences - faculty and administrators. Distance Education: A Practical Guide is certainly not intended for educational technologists, or for those with considerable experience working in a distance education setting. This slim book is written at a very basic, extremely practical level.

That being said, ***Distance Education: A Practical Guide*** is well done. It uses clear and non-jargonistic language, and definitions of new or ambivalent terms are included in the text, as well as in the Glossary at the back. It is attractively laid out with an uncluttered, non-threatening appearance, achieved by the insertion of numerous sub-headings and many sections of prose in list form. It makes frequent use of subheadings in question form, which, despite mixed research findings regarding specific learning results, seem to be very appealing to readers.

Distance Education: A Practical Guide has eight sections or chapters. Section 1 is the introduction and overview, presenting a definition of distance education and arguments for using distance education, with a very brief summary of its historical roots. Section 2 gives a brief overview of research in distance education, which focuses on the areas commonly studied but is scant on findings. Commonly investigated areas such as attrition rates, student motivation, achievement rates, cost-effectiveness, and cognitive styles are summarized. The latter half of this section emphasizes that there is no one best means in terms of distance education, emphasizing that content presentation, or instructional design, rather than delivery system is the key variable. Willis states "Effective distance learning is more the result of preparation than innovation" (p. 22).

Section 3 identifies the key players in distance education and describes very briefly their roles: the students, the faculty, the facilitators, the support staff, and the administrators. There is one proviso worthy of note here -Willis warns that administrators should remain involved, so that growth in the technical infrastructure does not weaken the academic focus.

Sections 4 and 5 focus on faculty development and the instructional development process. He takes a typical approach to inservice for faculty, intimating that in the case of distance education, it should lead to a change in the way the instructor sees the learner. Also noted is the need for institutions to recognize the legitimacy of distance education teaching and reward such efforts. This I perceive as wishful thinking, having worked in a university setting for the past fourteen years, where despite lip service not even face-to-face teaching is valued in terms of the reward system. Section 5 uses a generic instructional development model to emphasize the process of designing instruction from start to finish. One interesting subsection is the focus on qualitative methods in evaluating instruction.

Section 6 deals in a very non-technological way with the tools and technologies of distance education. Willis categorizes these under the headings of voice tools (audio), video tools, data tools (computers), and print tools, and warns throughout against selecting these tools prematurely. He also emphasizes the technological incompatibility of computer hardware/software and ensuing problems.

Sections 7 and 8 are very brief, and they give the impression of not quite knowing where to go from here. Section 7 presents, in five pages, a summary of generalized teaching strategies. There is nothing new, or nothing particularly applicable to distance education in the list. Section 8 looks briefly at the future of distance education and suggests we look to the twenty-five year paper trail at the Open University and Athabasca University to learn from the experience of others.

I found it very difficult to review this book. I was a reader with approximately thirty years of experience in developing instruction, with graduate degrees in educational technology, and with considerable experience working in the distance education milieu. I tried to determine its value to my students as I read (they are mostly experienced teachers enrolled in a Master of Education Program in Educational Technology).

I'm sure that it is too basic to be of any value to them. I therefore must assume that the audience for this book is the novice distance educator with no background in educational technology and not much background in general education/teaching studies. Given that many who eventually work in distance education management and/or course design fit that description, I know there are readers who would find this book worthwhile.

REVIEWER

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Information for Authors

CJEC welcomes papers on all aspects of educational communication and technology. Topics include, but are not limited to: media and computer applications in education, learning resource centers, communication and instructional theory, instructional design, simulation, gaming and other aspects of the use of technology in the learning process. These may take the form of reviews of literature, descriptionsof approaches or procedures, descriptions of new applications, theoretical discussions and reports of research,

Manuscript Categories

Manuscripts may fall into one of two classes: General, dealing with a topic or issue at a general level (although reference to specific instances or examples may be included), and Profiles, dealing with or describing only a specific instance of an approach, technique, program, project, etc. A Profile may be thought of as a descriptive case study.

Most manuscripts dealing with a topic in general should include reference to supportive literature, while manuscripts submitted to the Profile category may or may not. The Editor reserves the right to change the designation of a manuscript or to make a designation, if none has been made previously by the author. Authors interested in determining the suitability of materials should consult past issues of CJEC or contact the Editor.

All manuscripts received by the Editor (either general or profile) will be judged for suitability, contribution, accuracy, etc. by a panel of anonymous reviewers designated at the time of submission. Normally, the review process requires about eight weeks. There are no deadlines for the submission of manuscripts,

Manuscript Preparation

Manuscripts should be typed on 8 1/2 x 1 l-inch ordinary white paper, All materials must be double-spaced, including quotations and references, Include a title page on which appears the title of the manuscript, the full name of the author(s) along with position and institutional affiliation, mailing address and telephone number of the contact author. An abstract of 75-150 words should be placed on a separate sheet following the title page, While the title should appear at the top of the first manuscript page, no reference to the author(s) should appear there or any other place in the manuscript. Elements of style, including headings, tables, figures and references should be prepared according to the ***Publication Manual of the American Psychological Association, 3rd Edition,*** 1983. Figures ***must*** be camera-ready,

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