The Effectiveness of Instructional Orienting Activities in Computer-Based Instruction

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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.

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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