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ABSTRACT

Research literature pertaining to the use of instructional organizers is reviewed, and a comparative analysis is made of their effectiveness with computer-based instruction (CBI). One of the earliest forms of instructional organizer is the advance organize , first proposed by David Ausubel (1960, 1963) which is meant to facilitate the retention of meaningful verbal information. Other instructional organizers include the graphic organizer, a tree diagram that introduces new material, and the pictorial graphic organizer, which can be presented to students or developed with their assistance. Research pertaining to the use of instructional organizers in CBI has not been extensive. The two theoretical approaches that have guided this work are those of the generative learning hypothesis and schema theory. Evidence for the success of instructional organizers has not been consistent, and it appears that no single theoretical approach is sufficient in itself to predict the effectiveness of instructional orienting techniques and to guide their design. Further research is needed on the application of generative learning and schema theory to CBI. Four tables summarize research results. (Contains 78 references.) (SLD)

Title:

The Effectiveness of Instructional Orienting Activities in Computer-Based Instruction

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Introduction

The low cost and accessibility of the microcomputer has placed the power and flexibility of computing into the hands of the individual and opened a world of instructional possibilities. Among these are the capabilities offered by computer-based instruction (CBI) and of interactive multimedia such as computer-based interactive video (CBIV) in particular. While the use of CBI has been extolled for its capability to individualize instruction, interactive multimedia combines the power of the computer to support student interaction with the richness of the various audio and visual media.

According to Jonassen (1984), the major advantage of CBIV (and CBI in general) is that it is both adaptive and interactive. He defines adaptive as "the ability to adapt or adjust the presentation sequence, mode or sign type to meet a variety of instructional requirements..." and interactive as "that the program engages the learner to participate in a variety of ways that utilize learner responses..." (p.21). For Hannafin (1989), interactivity is more detailed, encompassing 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.

CBI, 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 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 "O" 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, pg. 239). Included in this category are attention-gaining techniques, lesson objectives, pre-questions and advance organizers, which the authors consider to be "a variation of cognitive orienting ability" (Hannafin, 1987, p.48).

It is this category of orienting activities that may suggest methods for alleviating the problem of disorientation and cognitive overload in CBI. Tripp & 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 instructional organizers 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

One of the earliest forms of instructional organizer was the advance organizer first proposed by David Ausubel (1960, 1963). The advance organizer 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). While introduced as an advance organizer, the structured overview graphic organizer is unlike the former 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

Ausubel and his associates (Ausubel, 1960, Ausubel & Fitzgerald, 1961, 1962, Ausubel & Youssef, 1963), provided some of the most-cited research supporting the effectiveness of the technique. Ausubel (1960) tested the learning of undergraduates from a 2500 word passage on metallurgy and produced statistically significant results in favour of the group receiving an expository advance organizer. Ausubel & 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 & Fitzgerald (1962) also conducted a second study to compare 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 & 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.

These studies appear to have demonstrated that advance organizers do facilitate learning. A recent detailed analysis of these four studies (McEneany, 1990), however, has revealed a number of problems and calls into question these results. 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 definition 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). McEneany (1990) was not the first to dispute the effectiveness of advance organizers. Hartley & Davies (1976) reviewed the technique as a part of a broader overview of pre-instructional strategies and, in spite of conflicting evidence, concluded that advance organizers did facilitate both learning and retention. They also claimed that a major problem lies in the design and writing of advance organizers because there were no procedures nor operationally defined steps for generating them. Ausubel, however, has disputed this on several occasions (e.g. Ausubel, 1978, Ausubel, Novak & Hanesian, 1978), claiming that sufficient guidelines can be found in his articles and books.

Barnes & Clawson (1975) were less generous. They rated 32 studies using a "voting technique" based on whether the results were statistically significant or not. Non-significant results prevailed 20 to 12 leading the investigators to a negative conclusion. They also differentiated among the studies according to length of study, ability and subject type. In each case, the count favoured non-significance. The Barnes & Clawson (1975) review, however, was itself strongly criticized on methodological grounds (Ausubel, 1978, Lawton & Wanska, 1977, Mayer, 1979a).

The Advance organizer and assimilation encoding theory

Mayer (1979a) reinterpreted Ausubel's subsumption theory in terms of his own assimilation encoding theory and reported a series of nine studies supporting his contention. 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. It 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 advance organizer literature. Using only published studies which contained either an advance organizer group and a control group or a post organizer group, Mayer rated 27 studies according to three questions:

1. Is the material unfamiliar, technical or lacking a basic assimilative context?
2. Is the advance organizer likely to serve as an assimilative context?
3. Does the advance organizer group perform better than the control group on a test?

He listed the results as percentages and claimed statistical significance for only three studies. He concluded that, when used, there was usually a small but consistent advantage for the advance organizer group. He also claimed that advance organizers more strongly aided performance when material was poorly integrated, that they more strongly aided inexperienced learners and that they aided transfer more than specific retention of details.

Meta-analyses of Advance Organizer Research

The summary reviews discussed previously have used a variety of techniques: the traditional literature summary (Hartley & Davies, 1976), an either/or voting technique (Barnes & Clawson, 1975), and a question-based voting technique (Mayer, 1979b). Such reviews have been strongly criticized as overly subjective (e.g. Wolf, 1986). Two later reviews of the advance organizer research literature , however, use meta-analysis, a technique which permits quantitative reviews and syntheses of the research issues (Wolf, 1986). One frequently cited meta-analytic technique is Glass' (e.g. Glass, McGaw & Smith, 1981) effect size statistic (E.S.) which allows the comparison of studies which vary in design, sample selection and setting in order to form conclusions.

The first meta-analysis (Luiten, Ames & Ackerson, 1980), examined 135 studies yielding 110 E.S. (Table 1) for learning (posttest within 24 hours of the treatment) and 50 E.S. for retention (posttest 24 hours and after). They calculated a mean E.S. of 0.21 for learning, indicating that the average subject receiving the advance organizer treatment would perform better than 58% of the control group individuals. The mean E.S. for retention was 0.26. Their conclusion was that advance organizers had a small, facilitative effect upon learning as well as retention. The effect on learning, however, runs contrary to Mayer's predictions based on assimilation encoding theory as well as Ausubel's subsumption theory. Luiten et al. (1980) also found advance organizers effective for all ability levels but especially for high ability learners (a mean E.S. of 0.23) which also contradicts both Ausubel and Mayer.

The second meta-analysis (Table 1), by Stone (1984), more closely followed Mayer's model. Stone included only studies with a control group or a post organizer and those in which a posttest was administered one week or later after the treatment. She listed 112 different E.S. from 29 studies. Stone reported an overall mean effect size of 0.66 which indicates that advance organizers facilitate the long term retention of new, unfamiliar material. However, she also compared true advance organizers, those which acted as subsumers (presented at a more general or abstract level), to those which were at the same level as the material-to-be-learned. The mean E.S. for the subsuming organizers was 0.75 while the mean for organizers taken from the material was 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 Compa rison 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

Has the research published since these reviews provided any further evidence to demonstrate the effectiveness of advance organizers? A comparison of several more recent studies (1984 - 1992) of advance organizers reflect the same inconsistent results (Table 2[1]). One study (Corkhill et al., 1988) consisted of 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.

Of the six, three experiments used advance organizers without some additional activity such as paraphrasing. The mean effect sizes for these experiments are 3.75 for the cue condition (re-reading the organizer before the test of learning) and 2.24 for the no cue condition. While it can be argued that the cue condition might have added a practice effect to the presumed subsumption function of the advance organizer, the no cue condition (reported in Table 2), represents the use of advance organizers as specified by Ausubel and Mayer. Furthermore, the measure of learning in all three experiments tested retention. An average effect size of 2.24, therefore, is strong evidence for the facilitating effect of this instructional technique.

Other recent studies, however, produce much less convincing evidence. Another study by Corkhill (Corkhill, Bruning & Glover, 1988) compared the effects of concrete and abstract advance organizers on students' recall of prose. The concrete organizer was hypothesized to function as a comparative advance organizer, while the abstract organizer was expected to function 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 are strongly conflicting since they provide support for comparative but not expository advance organizers, while both should facilitate learning and retention.

A study by Lenz, Alley & Schumaker (1986) investigated the effects of a regular teacher's delivery of an advance organizer prior to each lesson on Learning Disabled (LD) students' retention and expression of information from a given lesson. Student 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

[1] Note: Those studies concerned with the use of advance and graphic organizers in CBI (e.g. Kenny, 1992, Tripp & Roby, 1990, 1991, Carnes et al., 1987) are included in Tables 2 and 4, but will be discussed in a later section.

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.

Kloster & Winne (1989) conducted a study with 227 eighth grade mathematics students who were randomly assigned to one of 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. 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.

A study (Tajika, Taniguchi, Yamamoto & Mayer, 1988) using pictorial advance organizers with fifth grade Japanese mathematics produced similar, and stronger, results. Mayer (1979a, p. 382) indicated that an advance organizer could be a "short set of verbal *or visual* [emphasis added] information". Students were randomly assigned to one of four groups: (1) an integrated pictorial advance organizer, which presented two geometric figures divided into component parts in an organized manner, (2) a fragmented pictorial advance organizer, which presented the same shapes but in a disorganized way, (3) a group which received extra reading time and (4) a control group which merely read the passage. They studied the organizers immediately before reading a 550 word passage about an imaginary land emphasizing geometric shapes. Students took a free recall (learning) test after reading the passage and a delayed recall test one week later. Effect sizes were highest for the retention test as predicted by Ausubel and Mayer.

Finally, four studies (Carnes, Lindbeck & Griffin, 1987, Tripp & Roby, 1990, 1991, Kenny, 1992) used advance organizers with computer-based instruction and achieved mixed results. These are discussed in the section, "Instructional Organizers with CBI".

Overall, based on the reviews and recent studies discussed above, the research evidence concerning any facilitative effect of advance organizers upon learning and retention is quite confusing. Much of the evidence appears positive, and yet, it is clearly quite variable. Effect sizes for the more recent studies range from -1.02 to 2.04 for measures of learning 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 would 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, 1990), one likely source of error is treatment fidelity. Much of this variability may reflect the lack of clarity of what an advance organizer is.

Table 2

A Comparison of Effect Sizes for Recent Advance Organizer Studies

Study	Learning	Retention
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	---
Lenz, Alley & Schumaker 1986		
After teacher training	1.03	---
After student training)	2.93	---
Kloster & Winne (1989)	---	
Comparative Organizer	---	- 0.15
Expository Organizer		- 0.18
Gilles (1984)	0.015	0.33
Doyle (1986)	0.74	1.03
Tripp & Roby (1990)	1.25	---
Tripp & Roby (1991)	0.33	---
Carnes, Lindbeck & Griffin (1987)	0.49	0.14
Tajika, Taniguchi, Yamamoto & Mayer (1988)		
Fragmented Pictorial	0.078	1.49
Integrated Pictorial	2.04	4.08
Kenny (1992)		
Adv. Org. > Partic. Graph C g.	0.45	0.95
Adv. Org. > Final Form Graph Org.	- 1.17	- 0.45
Mean	0.76	1.16

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) provide two alternate explanations. They suggest that, rather than to necessarily increase discriminability between prior learning and new material, concrete (comparative) advance organizers furnish ideational anchorage in terms already familiar to the learners, that is, to provide meaning by association with existing schema. Further, 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 jury still appears to be out on the advance organizer and the theory on which it is based. 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

As discussed above, the graphic organizer was first presented as a structured overview (Barron, 1969) and meant as a variation on the advance organizer. Since it is not (e.g. Alverman, 1981), the question arises whether there is evidence that this form of organizer 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 4). 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 as predicted by assimilation encoding theory. 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 - again predicted by Mayer's theory.

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). Since a true control group was not used in this study, effect sizes were calculated using the outlining group as a control.

Table 3

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

And last, Carr & Mazur-Stewart (1988) found that a vocabulary 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.

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 the use of teacher-constructed participatory pictorial graphic organizers in regular classrooms (grade eight history, grade twelve English literature). The results indicated a stronger effect for learning than for retention. Two studies (Hawk, McLeod & Jeane, 1981, Hawk & Jeanne, 1983, cited in Hawk, McLeod, & Jonassen, 1985) reported statistically significant results in favour of participatory pictorial graphic organizers. However, insufficient data was 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, Carnine & Kameenui (1986) compared several techniques for informing sixth grade reading students of content information, including 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.

Alvermann (1988) investigated the effects of a final form graphic organizer (the filled in version) designed to induce tenth grade social studies 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 merely 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.

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
Darch, 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 (1992)		
Participatory Graph. Org. > Adv. Org.	- 0.45	- 0.95
Final Form Graph. Org. > Adv. Org.	1.17	0.45
Mean	1.09	0.48

Finally, studies by Kenny, Grabowski, Middlemiss & Van Neste-Kenny (1991) and Kenny (1992) 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.

While some of the advance organizer studies reviewed did use visual and oral versions, the vast majority presented a text form. Mayer's characteristics, however, indicated the acceptability of visual organizers. 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 conducted most of the research on this topic, publishing a series of papers on orienting activities in CBI generally and CBIV in particular (e.g. Hannafin, 1987, Hannafin & Hughes, 1986, Hannafin, Phillips, Rieber, & Garhart, 1987). This research is based on the ROPES+ meta-model for designing instructional prescriptions discussed above. In a study on the effect of orienting activities in CBI with university students, Hannafin and his associates (Hannafin, Phillips, Rieber & Garhart, 1987) found that both behavioral and cognitive orienting activities improved factual learning. Their description of the cognitive orienting activity was: "designed to provide an integrative method for establishing meaningful relationships, while also serving as a subsumer of lesson detail" (Hannafin, Phillips, Rieber & Garhart, 1987, p.80). This sounds like an advance organizer. However, the one example they give, "In the next section, you will be presented information about: The importance of studying cultures." (Hannafin, Phillips, Rieber & Garhart, 1987, p.77), seems insufficient according to Mayer's characteristics.

Similarly, Hannafin, Phillips & 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 demonstrated to be a significant instructional component. Again, the example of 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", also seems meagre. Rieber & Hannafin (1988) also studied the effects of textual and animated cognitive orienting activities on learning from CBI. Their subjects were 111 students from a rural elementary school presented with a lesson explaining Newton's laws of motion. Three types of orienting activities (of 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. There was also a control (no activity) group. The orienting activities were presented throughout the lesson before each basic concept. They found no statistically significant effects for any of the orienting activities.

The orienting activities in these studies meet three of Mayer's characteristics for advance organizer construction: (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, one could reasonably argue as well that, for none of these studies, were the cognitive orienting activities of sufficient scope to meet the other two conditions; that is, (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 not true advance organizers. Several studies, however, did use true advance organizers in computer-based instruction. One of these studies was carried out by Carnes, Lindbeck & Griffin (1987) using a computer-based tutorial on kinematics with 100 suburban high school physics students. The advance organizers were "written according to the guidelines of Ausubel et al. (1978)" (p.785) and were presented on screen. 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 & Blanchaer (1986) tested the use of a true 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 was reported to allow the calculation of effect sizes and, hence, this study was not included in the previous table (Table 2).

Tripp & Roby (1990, 1991) reported the use of an advance organizer in two studies with a Japanese-English hypertext-based lexicon. The measure of learning in these investigations was of immediate recall and was, in fact, an assessment of what the investigators viewed as rote learning. The authors reasoned, however, that the advance organizer would convey the structure of the database and, therefore, contribute to meaningful learning. Results of the first study indicated a probability coefficient of $p < 0.171$. Interestingly, despite the low p coefficient, the effect size for the organizer was 1.25, which appears to indicate a lack of power in the study. However, half of the group using the advance organizer also received a visual metaphor. A statistically significant negative effect was reported for the interaction between the two techniques. Tripp and Roby speculated that otherwise the advance organizer could have been expected to have a statistically significant effect upon learning.

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. Comparison of the advance organizer only treatment group mean to the control group mean, however, reveals a much smaller effect size (0.33) than the first study. The second study, though, used a considerably larger number of subjects and, with the increased power, may have produced a more accurate result. Regardless, these studies clearly contradict advance organizer theory since they demonstrated that the technique facilitated rote, rather than meaningful, learning.

Kenny, Grabowski, Middlemiss & Van Neste-Kenny (1991) compared the effects of participatory pictorial graphic organizers to those of the identical final form versions on the learning of third year nursing students from a CBIV program on nursing elderly patients with chronic obstructive pulmonary disease. The group receiving the participatory graphic organizer 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 very slight difference between the two treatments on the retention test (given one week later) and in favour of the final form version (E.S. = -0.07). Unfortunately, considerable unanticipated extraneous note-taking by subjects in both groups confounded the differences in generativity between the two treatments. One interesting, though not statistically significant, result was that the final form graphic organizer group scored almost two points higher (on an 18 question, multiple choice test) on the retention test than on the test of learning. This may provide evidence that a final form graphic organizer behaves in a subsumptive manner akin to that posited for advance organizers.

In a subsequent study, Kenny (1992) then 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, it was the final form graphic organizer which was clearly the most effective treatment, garnering the highest mean scores on both tests of learning and retention. Curiously, 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 $p \leq 0.05$ level for learning (E.S. = 1.17) but was not significant for retention (E.S. = 0.45). The difference between the advance and participatory organizer group means was statistically significant at the $p \leq 0.10$ 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 (See the section "The Generative Learning Hypothesis").

Based on the results of these studies, 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 conflicting. 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 too, however, there is a problem with the underlying theory. 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 & 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). They point out that Wittrock's (1974) generative learning theory incorporates such principles. This 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, generating pictures, etc. (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).

Advance organizers were developed from Ausubel's theories about meaningful verbal learning while Mayer analyzed the research in terms of assimilation encoding theory. Pictorial graphic organizers, on the other hand, while a derivative of advance organizers, are neither based on subsumption nor assimilation encoding theory. 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). They are referring here to Wittrock's (1974) generative learning hypothesis. Participatory graphic organizers elicit generative activity because they require the learner to actively search a body of material to select information to complete the organizer. True advance organizers, on the other hand, cannot necessarily be considered to be generative activities. They invoke a covert response on the part of learners which may or may not be generative, depending on whether or not they generate meaning between the organizer and their prior knowledge and between the organizer and the material-to-be-learned. The advance organizer does not engage the learner in overt, active learning. Of the instructional organizers considered thus far, therefore, only the participatory form of the pictorial graphic organizer advanced by Hawk, McLeod & Jonassen (1985) and the student-constructed form of structured overview (Moore & Readance, 1984) could be considered, by design, to elicit a generative response from the learner. Perhaps this explains why the research on instructional organizers, and particularly advance organizers, is so variable. Given the difficulty in determining exactly how to construct them, it may be that some investigators unknowingly designed their organizers or some other aspect of their studies such that the learners engaged in generative learning activities.

In fact, Moore & 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, Bruning and Glover (1988) demonstrated the advantage of concrete advance organizers over more abstract ones, suggesting that the former furnish ideational anchorage in terms already 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, 1992) obtained mixed results. Kenny, Grabowski, Middlemiss & Van Neste-Kenny (1991) compared the use of final form and participatory graphic organizers with CBIV and found a mild effect size in favour of the participatory pictorial graphic organizer. Kenny (1992), however, compared nearly identical participatory and final form graphic organizers to an advance organizer, again with CBIV, and found the final form graphic organizer to be the most effective on both measures of learning and retention. The group using the participatory organizer, hypothesized to be the technique most likely to elicit generative learning, 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 normally generative nature of the participatory graphic organizer. In effect, the learners were already engaged in a generative learning activity, one which was quite demanding. In this situation, the normally generative organizer, rather than helping to make learning more meaningful, likely contributed to, rather than alleviated, cognitive overload.

In another study with tutorial courseware delivered by CBIV, Harris (1992) compared the use of learner-generated summaries to the completion of multiple choice questions. 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 & 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 one study (the second), Jonassen & Wang (1992) tested the use of a generative activity with the Hypercard version of their text, Hypertext / Hypermedia. 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. As with the Harris study, the control treatment group was generally more successful, scoring higher on the average, on a test of recall (E.S. = - 0.64) and on 2 of 3 tests of structural knowledge (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.

Clearly, these studies are far from conclusive. Three of these four 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. Is there any theory that will provide guidance? In fact, Borsook & Higginbotham-Wheat (1992) suggest that a number of theories, generative learning among them, may provide insight about how and why hypermedia may work. Perhaps most prominent among these cognitive theories is schema theory (Rumelhart & Orteny, 1977, Anderson, 1977).

Schema Theory and the Hypermap

Jonassen (1989) claimed 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 of information into some form of spatial representation that clarifies the relationships among inherent 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. Since the graphic organizer is one form of spatial representation, schema theory may help explain the effectiveness of the technique. In the study by Kenny (1992), 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 at a higher, more abstract level as is an advance organizer, might be designed to reflect either novice or expert schemata, particularly if the hypermedia is unstructured. To do this, Jonassen (1989), advocated 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 one of the studies described above (the first), Jonassen & Wang (1992) compared the effectiveness of a hypermap to a control treatment consisting of referential links embedded in the cards. As with the other study, the control group outperformed the hypermap group on a recall test. The difference was statistically significant. Tests of structural knowledge acquisition, however, showed no significant differences between the techniques. In the third study, Jonassen & Wang (1992) provided learners with either a control treatment as described above or a graphical browser (or 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 TCU knowledge mapping system (e.g. Dansereau et al., 1979) has been tested.

Like the graphical browser, the TCU 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 TCU 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 text screens 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 has been seen, the research pertaining to the use of instructional organizers in CBI has not been extensive. Much of it has been carried out under the umbrella of 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. Where such organizers have been constructed according to original guidelines, they have been somewhat more successful. Yet the evidence has not been consistent, a result which is perhaps not surprising given the modest results reported in past research. 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. Based on this review, 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. As discussed previously, Borsook & Higginbotham-Wheat (1992) have suggested that a number of theories, generative learning and schema theory among them, may provide insight about how and why hypermedia may work. 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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