The Effects of Orienting Activities, Cueing, and Practice on Learning of Computer-Based Instruction

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ABSTRACT **The purpose of this research was to study the effects of cognitive and behavioral orienting activities and practice on student learning of cued and uncued information. The subjects were 54 ninth-grade students: 28 boys and 26 girls. The instructional content for the study was based on the voyages and discoveries of spacecrafts. A significant difference was found between practiced versus nonpracticed items, high- versus low-ability students, and for cued versus noncued items. In addition, significant interactions were found between orienting activities and cueing, orienting activity and practice, and orienting activity by cueing by practice.**

The importance of practice during instruction has been emphasized by several researchers. Whereas practice per se appears to be of little inherent value (see, for example, Gagne, 1962; Dressel, Schmid, & Kincaid, 1952), practice based upon explicit or general relationships with intended learning provides important support for learning. The early work of Thorndike (1931, 1932), for example, equated practice with reinforcement, suggesting that learning is systematically shaped through practice. For different reasons, contemporary cognitive theorists also support the value of practice during instruction. Both Anderson (1980) and Mayer (1978) have developed cognitive models that support the role of practice in reducing inhibition, improving responsiveness to related instruction, and enhancing retention.

The incorporation of pre-instructional orienting activities designed to heighten receptiveness to subsequent instruction has also been advocated (Hannafin & Hughes, 1986). Advance organizers, a variation of cognitive orienting ability, are thought to provide cognitive anchoring mechanisms through which individuals assimilate instruction (Ausubel, 1978; Mayer, 1979), focus attention selectively (Derry, 1984), and alter the manner in which information is processed (Spiro, 1980). Explicit behavioral orienting activities are believed to aid intended learning of cued content but to limit learning of incidental, uncued information (Duchastel & Brown, 1974; Kaplan & Simmons, 1974; Reynolds & Anderson, 1982). Activities that are integrative require greater integration of new with existing knowledge and often facilitate the learning of both cued and uncued lesson information (Glover, Bruning, & Plake, 1982; Glover, Plake, & Zimmer, 1983; Klauer, 1984). Whereas the effects of orienting activities in isolation have been supported, contradictory findings have also been reported—particularly when the activities are employed in the presence of more powerful instructional variables (Barnes & Clawson, 1975; Hannafin, Phillips, Rieber, & Garhart, in press).

Although some design strategies may be effective when employed in isolation, their effects are often subsumed by other powerful techniques. Rarely have multiple instructional strategies been combined in an attempt to measure their relative value in a comprehensive instructional system. The purpose of this study was to examine the effects of orienting activities and practice on the learning of cued and uncued information presented via computer-based information. Main effects were predicted for orienting activities, cueing, and practice. Interactions, moderated principally by the enhanced power of practice, were also predicted.

Method

Subjects

The subjects were 54 ninth-grade students: 28 boys and 26 girls. All students were volunteers but were representative of typical ninth graders.

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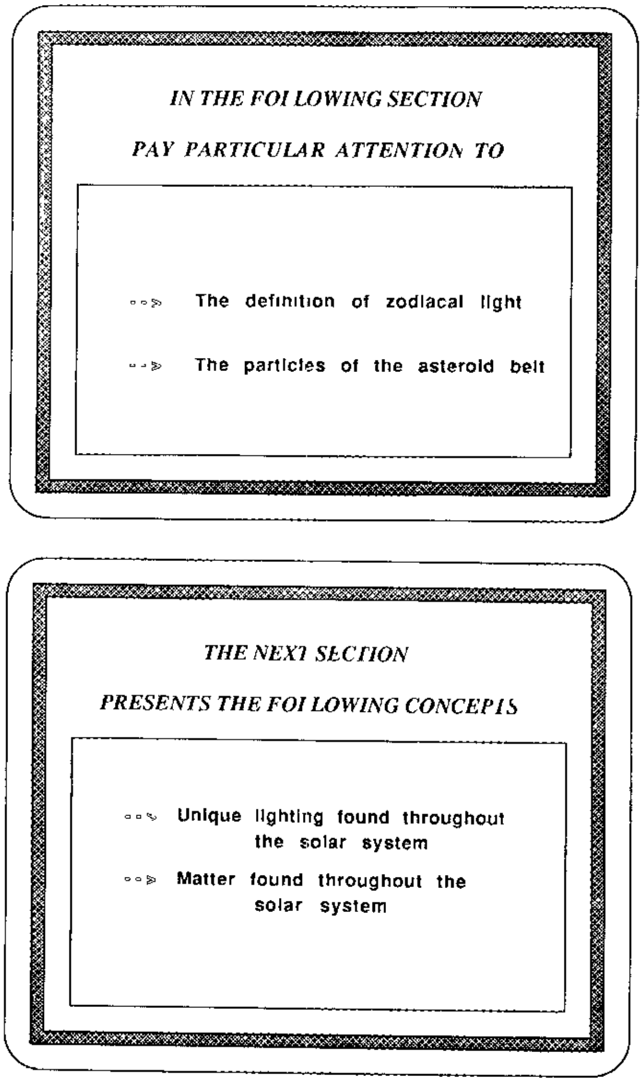

Figure 1.—Sample Behavioral and Corresponding Cognitive Orienting Activities

Materials

Instructional content. Instructional content was selected to be motivational, but unfamiliar to students. The lesson was based on material published by the National Aeronautics and Space Administration (1981) dealing with the Pioneer and Explorer spacecrafts that journeyed to the outer reaches of the solar system. Technical material was reworded or clarified to be understood by typical ninth-grade students.

The instruction was divided into six sections. Each section was devoted to a different aspect of space flight and was introduced by a related, high-interest graphic in order to maintain student interest.

The instructional sequence began with a computer graphic depicting a spaceship launch. The next frame included an orienting activity that contained two cues related to the subsequent behavioral or integrative cognitive terms. An example of a behavioral and the corresponding cognitive orienting activity is shown in Figure 1. The average number of instructional frames per section was 5, with individual sections consisting of 4 to 7 frames.

Practice questions were then embedded at the conclusion of each section. The information related to one of the practice questions was cued initially by one of the orienting activities; the content of the other question was not cued by the orienting activity. The questions were in multiple-choice format and contained one correct answer and three distractors. Upon entering the answer, the student received immediate feedback either confirming a correct response or providing a correcting sentence informing the learner of the correct answer. The lesson was not repeated. Feedback was only given related to the specific practice question. The amount of instruction was identical for all students.

The design of the lesson was based upon the software design model of Gagne, Wager, and Rojas (1981). Frame protocol was consistent so that familiar computer displays were available during the instruction. All text was double spaced and the instructional material was broken into thematically related sections, separated by transitional graphic frames, to smooth the flow of the lesson and to minimize abrupt shifts in procedures.

Design

The study employed a completely crossed 2 × 2 between-subjects design with two other factors crossed within subjects. The between-subjects experimental treatments included orienting activity (Behavioral, Cognitive) and ability (Hi, Lo). Students were classified as Hi or Lo in ability based on a median split of verbal intelligence estimate on the Iowa Test of Basic Skills (ITBS). The within-subjects factors included two levels of content cueing (Cued, Not Cued) and two levels of practice (Practiced, Not Practiced).

Recall Measures

A 28-item posttest was used to measure recall of information presented during the lesson. The posttest yielded measures associated with each level of the within-subjects measures. Fourteen posttest questions were cued via the orienting activity; the other 14 questions were not cued. Seven of the cued items were practiced using parallel items during the lesson; the remaining cued items were not practiced. Of the 14 lesson items that were not cued, 7 were practiced using parallel items during the lesson, and 7 were not practiced. This breakdown resulted in the following measures: Cued and Practiced, Cued and Not Practiced, Not Cued but Practiced, and Not Cued and Not Practiced. The split-half reliability coefficient of the 28-item multiple-choice posttest was .66.

Procedures

Students were randomly assigned to an orienting activity group. At the outset of the lesson students were advised to study lesson frames carefully and were instructed in the procedures of both the lesson and computer. The students were also told that help could not be provided during the lesson except to pronounce unfamiliar words. During the lesson, student responses were stored for subsequent analysis.

Upon completion of the lesson, the posttest was administered immediately. The test was presented via computer, but no response feedback was provided. Again, student responses were evaluated for correctness and stored for subsequent analysis. Students were then instructed to signal the investigator that the lesson had been completed.

Results

The means and standard deviations for each dependent measure are included in Table 1. A mixed-effects analysis of variance was conducted. The ANOVA source data are contained in Table 2.

Main Effects

Practice. As expected, a highly significant difference was found between the overall mean scores on practiced versus nonpracticed information, $F(1, 50) = 234.62$, $p < .0001$. Practiced information was recalled at a much higher rate ($M = 12.79$) than nonpracticed information ($M = 8.69$). Practice alone accounted for roughly 79% of the controlled score variance.

Cueing. A significant difference was detected between the overall mean scores for cued versus noncued items, $F(1, 50) = 12.82$, $p < .005$. More cued items were recalled ($M = 11.16$) than noncued items ($M = 10.22$). Cueing accounted for approximately 4% of the score variance.

Table 1.—Means and Standard Deviations for Recall Scores on Posttest

Orienting activity		Practiced: Cued	Practiced: Not cued	Not practiced: Cued	Not practiced: Not cued	Totals: Cued	Totals: Not cued
Behavioral							
Hi	M	6.93	6.33	5.93	4.33	12.86	10.66
(n = 15)	SD	0.26	0.90	1.10	1.11	1.12	1.63
Lo	M	6.14	6.00	4.64	3.64	10.78	9.64
(n = 14)	SD	1.29	0.87	2.09	1.08	2.91	1.73
Cognitive							
Hi	M	6.70	6.60	4.20	4.30	10.90	10.90
(n = 10)	SD	0.48	0.96	1.22	0.94	1.44	1.28
Lo	M	6.27	6.20	3.73	3.66	10.00	9.86
(n = 15)	SD	0.79	0.94	1.43	1.17	1.89	1.68
Totals							
Hi	M	6.84	6.44	5.24	4.32	12.08	10.76
(n = 25)	SD	0.37	0.92	1.42	1.03	1.47	1.48
Lo	M	6.20	6.10	4.17	3.65	10.37	9.75
(n = 29)	SD	1.04	0.90	1.81	1.11	2.42	1.68

Note. Maximum score = 7 for each subscale.

Table 2.—Mixed Effects ANOVA Source Data for Treatment Combinations

Source	df	MS	F	p
Orienting Activity (OA)	1	6.53	2.79	ns
Ability	1	21.93	9.36	.005
OA × Ability	1	1.13	0.48	ns
Error	50	2.34		—
Cueing	1	12.04	12.82	.001
Cueing × OA	1	8.70	9.26	.005
Cueing × Ability	1	0.89	0.94	ns
Cueing × OA × Ability	1	1.16	1.24	ns
Error	50	0.94	—	—
Practice	1	230.22	234.62	.0001
Practice × OA	1	8.02	8.18	.01
Practice × Ability	1	1.15	1.17	ns
Practice × OA × Ability	1	0.29	0.28	ns
Error	50	0.98	—	—
Practice × Cueing	1	2.89	3.68	ns
Practice × OA × Cueing	1	3.48	4.39	.05
Practice × Ability × Cueing	1	0.01	0.00	ns
Practice × OA × Ability × Cueing	1	0.10	0.12	ns
Error	50	0.79		

Ability. As expected, a significant difference was also found between the overall mean scores obtained by Hi versus Lo students, $F(1, 50) = 9.36$, $p < .005$. High ability students recalled more factual information ($M = 20.13$). Ability counted for roughly 71% of the controlled score varience.

Interactions

Orienting activity by cueing. A significant interaction was found between orienting activity and cueing, $F(1, 50) = 9.26$, $p < .005$. This interaction is illustrated in Figure 2. Cueing was most effective for the behavioral orienting activity, while the remaining mean scores were comparable. The interaction accounted for roughly 3% of the controlled variance.

Orienting activity by practice. A significant interaction was found between orienting activity and practice, $F(1, 50) = 8.18$, $p < .01$. This interaction is illustrated in Figure 3. Practice improved scores for both the behavioral and cognitive strategy, but proportionately more for the cognitive strategy. Roughly 3% of the controlled variance was accounted for by this interaction.

Orienting activity by cueing by practice. A significant three-way interaction, illustrated in Figure 4, was also found. However, the magnitude of this effect was comparably modest, $F(1, 50) = 4.36$, $p < .05$. This ef-

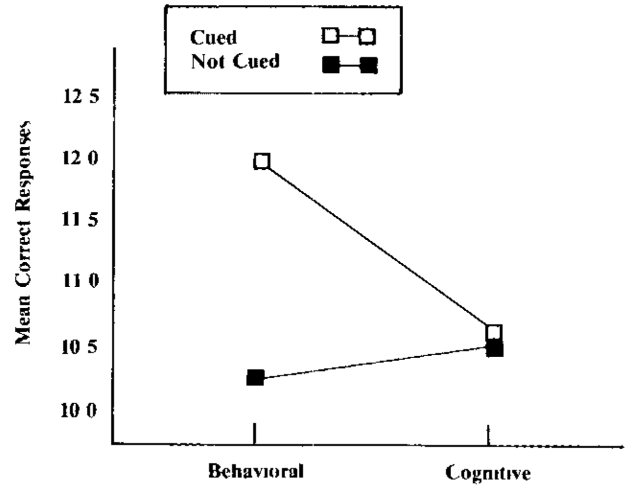

Figure 2 —Interaction Between Orienting Activity and Cueing

fect accounted for only 1% of the controlled variance Both cueing and practice influenced the performance of the behavioral orienting activity group, but not the cognitive orienting activity group

Discussion

The purpose of this study was to examine the effects of orienting activities and practice on the learning of cued and uncued information during computer-based instruction The major findings indicated that practice was a significant component in isolation as well as in combination with other design variables

Practice was by far the most powerful design component in the study As a main effect, practice alone accounted for nearly four-fifths of the controlled score variance among the treatments In a comparative sense, practice was far more powerful than the other design components used in this study This is consistent with

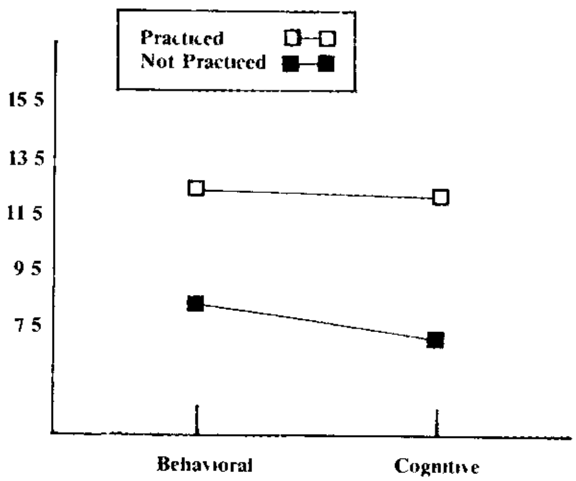

Figure 3 —Interaction Between Orienting Activity and Practice

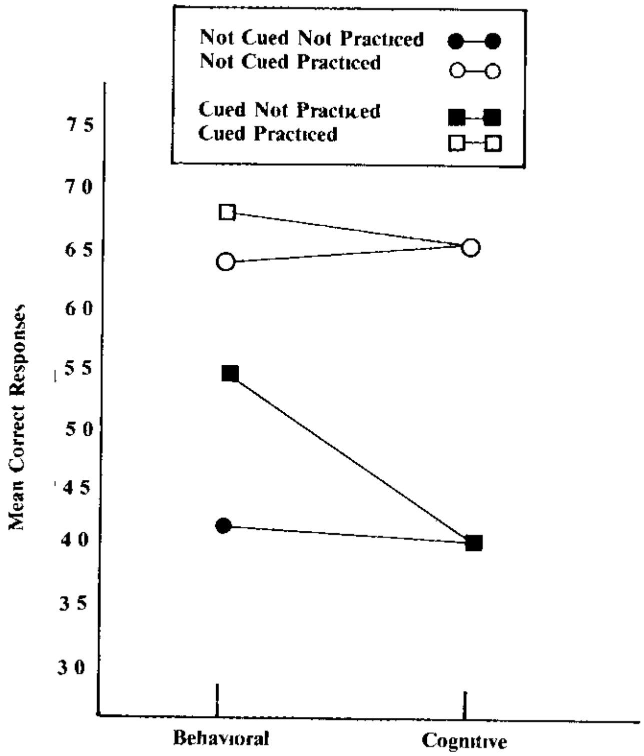

Figure 4 —Interaction Among Orienting Activity, Cueing, and Practice

researchers who have advocated the inclusion of criterion-based practice during instruction (Mayer, 1984) Practice appears to make explicit the intent of the lesson by providing the learner with an unambiguous aid for remembering Practice also seems likely to strengthen relationships among practiced concepts as well as practiced information with prior knowledge (Salisbury, Richard, & Klein, 1986)

The high proportion of variance accounted for by the combination of practice and practice-moderated interactions is noteworthy This finding suggests that although other design features may result in statistically reliable effects, such effects may pale in the presence of practice or be enhanced differentially as a function of practice In this study, for example, the combination of practice and orienting activity yielded a significant interaction, but orienting activity alone was not a significant instructional component Given the widespread evidence suggesting significant effects for orienting activities such as advance organizers and behavioral objectives (e g , Hamilton, 1985, Mayer, 1984, Melton, 1978), orienting activity effects were predicted in this study as well However, when instructional components are combined into the integrated systems of typical computer-based instruction, the effects of such activities are often subsumed (Hannafin, Phillips, & Tripp, 1986) In effect, although orienting activities may influence performance in less powerful or poorly organized lessons, they are often impotent when instruction is supported through powerful features such as practice

In the absence of practice, learning was more efficiently directed through the use of factually specific behavioral orienting devices than more abstract cognitive techniques As students progressed through the lesson, they likely confirmed the relevance of the strategy, became more inclined to use the strategies provided, and built stronger associations within the activity provided the factual nature of practice sessions (based on information that was practiced), and the eventual recall test Students in the cognitive orienting group, however, were unable to confirm explicitly the value of the orienting activity during the lesson Though the activity likely supported learning to a degree, the explicitness of the relationship between lesson orientation and practice was less clear Interestingly however, practice subsumed differences manifested by explicit versus general orienting activities alone In effect practice was important for both orienting activities but most important for the cognitive orienting activity group

Significant effects were also found for cueing as well as the cueing-by-orienting activity interaction In general, cued items were recalled at a higher rate than uncued items Most of this difference, however, was attributed to the influence of the behavioral orienting activity Although the behavioral activity yielded the best performance for cued information, each of the remaining combinations yielded comparable performance This is consistent with findings related to the relationship between orienting activity and practice (Koran & Koran, 1975, Melton 1978, Reynolds & Anderson 1982), which predicts most effective performance for information explicitly cued

This study confirmed the power of practice in the learning of verbal information and supported the interactive effects among orienting activities, cueing, and practice Whereas practice dominated the lesson design components in the present study, it seems reasonable that other complex relationships among practice and related design variables also exist Future efforts to establish the effects of the various components of integrated CBI systems should prove valuable in prescribing empirically validated lesson designs

The cognitive activity, however, neither cued learners to specific criterion elements nor provided apparent support to uncued lesson elements This is inconsistent with research where integrative activities were found to support the learning of both intended and incidential information (Glover, Plake & Zimmer, 1983, Klauer 1984) In effect, a preparatory set was instilled via the cognitive activity, which neither predisposed learners to particular lesson detail nor improved the learning of incidental information Specific behavioral strategies, on the other hand, were most effective for the recall of strategy-specific (intended) learning but provided little support for learning strategy-irrelevant (incidental) lesson information

The modest interaction among practice, orienting activity, and cueing suggests that practice and cueing are most influential for behavioral and least influential for cognitive orienting activities The effects of practice and cueing were incremental for the behavioral orienting activity Practice and cueing were most effective, followed by practice without cueing, cueing without practice and no cueing and no practice Neither practice nor cueing however, were of significant impact for the cognitive orienting activity group These results tentatively suggest that for verbal information, behavioral strategies designed to focus explicitly on intended learning tend to yield the best outcomes when paired with relevant cueing and practice

Several directions for further research are indicated Cognitive orienting activities may be more important for higher level learning tasks than the verbal information learning required in this study To the extent that broader contextual learning is required such as inferential or problem-solving learning, cognitive orienting activities may still prove effective The effects of embedded practice may not be as restricted for higher level learning as for the learning of facts Research designed to compare orienting activity effects across the levels of learning will better define the generalizability of the findings here

If, as proponents suggest, abstract orienting activities better enable learners to form relationships among lesson concepts as well as with prior knowledge, practice might need to be examined as a between-subjects variable rather than as the within-subjects variable employed in this study Practice seems likely to generalize when the nature of the practice is integrative in nature, such as required for higher level learning If so, "spread of activation" (Gagne, 1985) resulting from practice needs to be controlled between subjects

The long-term retention differences resulting from the instructional manipulations used in this study, as well as the subsequent acquisition of related information, also require careful examination Orienting activities that encourage greater depth of processing during encoding might be expected to yield greater retention of knowledge than those that do not Efforts to establish the impact of orienting and processing activities in a more comprehensive framework should be advanced

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