THE EFFECTS OF PRESENTATION MODE AND COGNITIVE STYLE ON IMMEDIATE RECALL OF MAP INFORMATION

by

Linda Brown Reardon

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APPROVED:

D. M. Moore, Chairman

L. J. Weber

J. F. Moore

D. E. Hinkle

J. K. Burton

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Blacksburg, Virginia

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INTRODUCTION

An ever-expanding body of research indicates that individuals differ in how they process information, and that there are numerous dimensions of these individual differences (Corno & Snow, 1986; Messick, 1976; Snow, 1977). The idea that a learner may not only have a preferred strategy, but also one that is more individually effective, has become an essential tenet of instructional design.

One individual difference characteristic which may affect the design of instruction is cognitive style (Goldstein & Blackman, 1978; Kogan, 1970; Messick, 1984). The field-dependence-independence cognitive style continuum has often been suggested as having implications for instructional design (Ausburn & Ausburn, 1978), as it involves perceptual and problem-solving abilities, breaking up or disembedding a stimulus field, structuring a field, ignoring or suppressing information that is irrelevant, and dealing with high information load, all of which are relevant to the instructional process.

In this study, the organization and amount of information contained in complex instructional visuals were manipulated to determine whether such manipulations influence learning effectiveness and whether the manipulations are differentially effective, depending on the level of field dependence of the student.

Need for the Study

There are many factors which can affect the amount and arrangement of information contained in visuals, including the nature of the instructional task and the individual processing characteristics of the learner. Although many studies have dealt with interaction of medium and learner (Clark, 1983; Clark & Salomon, 1986; Jamison, Suppes, & Wells, 1974; Levie & Dickie, 1973; Salomon & Clark, 1977, offer reviews of many such studies), there is still a lack of evidence concerning the use of specific attentional or organizing devices (instructional supports), deliberately designed and employed to take advantage of or compensate for a particular cognitive style. In reference to field dependence-independence, instructional designers have yet to consider fully the implications of such factors as the complexity of information contained in an instructional visual, to what extent organization should be controlled by the presentation or by the viewer, and whether dividing a complex visual into a series of lower-information-level visuals may be successful in improving learning effectiveness.

Planned dividing and sequencing might organize or direct a learner's scanning strategy, or allow the learner to process information in smaller amounts, thus taxing short-term memory abilities less. By separating competing stimuli, such dividing might also increase cue salience or noticeability. On the other hand, too much sequencing might fail to challenge the learner sufficiently due to an inadequate level of complexity (and thus a low interest level), or it may cause the information to lose its contextual relationship. In determining an appropriate level of complexity, the characteristics of the learner should be considered.

In the present study, the learners investigated were four-year college students. Once fairly homogeneous, college populations are becoming increasingly diverse; students possess differing aptitudes, interests, and backgrounds. In higher education, as in other settings, there is an urgent need to develop instruction that meets the needs of individuals. In this increasingly visual society, students are inundated with visual information. Many areas of study require students to deal with visually complex material such as maps, technical drawings, diagrams, and blueprints. The strategies required in order to encode these types of material include being able to attend selectively to parts of the layout, to relate parts to the whole, to ignore irrelevant information, to grasp relationships among the elements, and, often, to remember the spatial layout of the visual.

An area of cognitive style which seems relevant for dealing with such material is field dependence-independence (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962). Learners who are characterized as field independent are seen as more actively engaged with the learning task, and as analytical. They are able to deal with complex information by organizing, breaking up a stimulus field, and restructuring it when necessary. Field dependent students are more global in perception, more passive as learners; they see what is noticeable over what is relevant, and accept a stimulus field as given

(Goodenough, 1976; Witkin, Moore, Goodenough, & Cox, 1977). These students may have difficulty processing complex visual information unless it is presented in such a way as to compensate for specific processing deficiencies related to field dependence.

Using field dependence-independence as a clue to processing style may improve learning by suggesting selective use of specific design variables in the development and presentation of instructional visuals. It seems reasonable that a dividing of information, manipulated by the designer in order to organize scanning behavior and reduce complexity, may result in a visual presentation that is more effective for a field dependent learner. The field independent learner, because of his or her more active approach, may benefit by leaving the visual intact.

Purpose of the Study

The purpose of this study was to determine whether learning from complex visuals may be affected by manipulation of those visuals according to the following criteria:

1. The information in a single complex visual is divided or sequenced into a series of visuals, but is not condensed or otherwise simplified.

2. The information is divided in order to organize attending and processing behaviors of the learner.

3. The visual sequence maintains a clear and obvious organizational structure, along with its relationship to the overall context by means of techniques such as common outlines or overlays.

The cognitive style field dependence-independence was examined to see if it is related to performance on complex visual learning tasks to be undertaken by a college-level sample. As an Aptitude-Treatment-Interaction (ATI) study, this research considered the effects of the presentation mode on learning, the effects of cognitive style on learning, and the interaction between the two. Thus, the research questions that were considered for this study were:

1. Does dividing of the visual information normally contained in *one* visual into a *sequence* of visuals to provide the learner with a more manageable amount of information at one time affect performance on a visual learning task?

2. Do students classified as field dependent or field independent differ in performance on a learning task that employs complex visuals?

3. Is there an interaction across design format (divided vs. intact visuals) with field dependence-independence?

In addressing these questions the study should suggest whether breaking up information into a sequence, when applied to the presentation of complex visuals, may be useful in individualizing instruction for college students according to cognitive style differences.

Definition of Terms

The following terms are defined as they are used in this study:

1. cognitive style -- "individual variation in modes of perceiving, remembering and thinking, ... distinctive ways of apprehending, storing, transforming and utilizing information" (Kogan, 1970, p. 244).

2. complex visual -- for this study, one whose visual elements may be divided into at least two conceptual "subgroups".

3. field dependence -- cognitive style orientation whereby the individual relies on external referents. For this study: lesser cognitive restructuring ability and a global inclination in perception and intellectual functioning.

4. field independence -- cognitive style orientation whereby the individual functions with a higher level of autonomy, maintaining the ability to overcome an embedding context and to impose structure; an articulated mode in perception and intellectual functioning.

5. field dependent -- operationally defined for this study as an individual who scores from 1-10 on the Group Embedded Figures Test.

6. moderately field independent -- operationally defined as an individual who scores from 11-15 on the Group Embedded Figures Test.

7. field independent -- operationally defined as an individual who scores from 16-18 on the Group Embedded Figures Test.

8. instructional support -- manipulation of design variables of instructional material in order to improve cue salience. Examples are organizational patterns, sequencing, and visual indicators such as arrows, circles, and color highlighting.

9. Intact visual -- one which has not been modified by dividing, simplifying, or any other manipulation.

10. Additive visual -- for this study, a visual which is divided into a sequenced build-up of the pictorial and verbal elements, lessening the amount of information encountered at once.

11. Part-by-Part visual -- a visual divided and presented as a sequence without building up to the whole, further lessening the amount of information encountered at one time.

Organization of the Study

Chapter II is a review of the literature pertinent to the areas of field-dependence-independence and the design of instructional supports relevant to the learning strategies of the two cognitve style orientations. Chapter III contains the proposed research design and experimental hypotheses. The analysis and results are presented in Chapter IV. Conclusions and suggestions for further research are found in Chapter V.

Chapter II

REVIEW OF LITERATURE

In support of this study, literature in the areas of field dependence-independence and instructional design has been reviewed, and relevant studies are discussed here. Specifically, the following topics are considered: individual differences as a subject for research, the field dependence-independence cognitive style continuum, field dependence-independence and learning, field dependence-independence as a factor in the design of instruction, manipulations which provide external organization, and map-learning: factors and strategies.

Individual Differences as a Subject for Research

Questions about how students learn from visual media, and how visuals may best be designed and presented for instructional purposes have been addressed for a number of years, and remain an issue (Ausburn & Ausburn, 1978; Dwyer, 1972, 1978; Levie & Dickie, 1973; Winn, 1982). Designers and producers of visual instructional media must be concerned with a number of considerations including the nature of the instructional task, the teaching and learning strategies to be employed, and the individual characteristics of the learner. Students differ not only in ability, but also in interests, goals, learning rate, motivation and learning style. One format may be more effective than another for a particular individual.

The lack of significant results in past media research may have resulted in part from the failure to consider these individual differences in learner response (Salomon & Clark, 1977). According to Snow and Lohman (1984, p. 347), the existence of such differences is "the most longstanding, well-established fact in educational psychology." The application of research on individual differences to the instructional design appears to be a promising avenue for improving instruction, and indeed, a number of such studies have been carried out. One category of research involves developing two or more instructional formats that are differentially effective, depending on the learner's particular aptitude. These are known as Aptitude-Treatment-Interaction studies, or ATI for short. The goal of such studies is a disordinal interaction, whereby one treatment is superior for one level of the tested attribute, and the second treatment better matches the second orientation.

While the results have often been inconclusive or disappointing, in some cases due to faulty methodology (Bracht, 1970), it still seems reasonable to assume that this type of research design is appropriate for instructional media research (Ausburn & Ausburn, 1978; Cronbach & Snow, 1977; Snow & Lohman, 1984). Some of the most promising areas of individual difference research involve cognitive style. The term *cognitive style* has been employed to describe strategies or modes of perceiving, organizing, and processing stimuli. Cognitive style is concerned with the process rather than the content of learning, with the "how" rather than the "what" of information processing. While cognitive styles vary from individual to individual, they tend to remain relatively stable over time and are generally considered difficult to alter. A number of cognitive styles have been identified and studied (Goldstein & Blackman, 1978; Kogan, 1970; Messick, 1976). Some of these tend to overlap in concept, particularly as defined by different investigators. Generally cognitive styles are said to differentiate between simple and complex modes of structuring, and among levels of differentiation and integration (Goldstein & Blackman, 1978).

The Field-Dependence-Independence Cognitive Style Continuum

By far the most extensive research has been done in the area of field dependence-independence, first identified by Witkin and his associates (Witkin & Asch, 1948; Witkin, Lewis, Hertzman, Machover, Meissner, & Wapner, 1954; Witkin et al., 1962). Witkin began systematic research in 1942 on individual differences in perception. He was first interested in factors which cause an individual to maintain the proper orientation toward the upright in space (Witkin et al., 1954).

In his research, Witkin noted that certain individuals relied heavily on the outside environment for perceptual cues, even as they conflicted with internal cues. Others were easily able to separate essential information from a surrounding visual field. Witkin identified two bipolar orientations, labeled field dependence and field independence, respectively, and established a continuum, with individuals found along all points.

Quite a few tests have been developed to measure field dependence-independence. Those developed by Witkin and his associates include

1. The Rod and Frame Test (RFT) -- This test consists of a lighted square frame which may be pivoted either to the left or right. Within the frame is a lighted rod which may be moved independently of the frame. The rod and frame are shown to the subject in a completely darkened room. The subject instructs the examiner as to which direction the rod should be moved to make it vertical. Those who more accurately indicate the true vertical are considered more field independent.

2. The Body Adjustment Test (BAT) -- Here, a chair and small room are used, each of which may be tilted on its axis. In the first trials, the room and chair are tilted to the same side, after which they are tilted to opposite sides. While the room remains in a tilted position, the subject directs the movement of the chair to the position he or she perceives as upright. Those subjects who can better discern the true vertical are considered more field independent.

3. The Embedded Figures Test (EFT) -- The third test is a two-dimensional one. It is supposed to relate to the first two in that it requires the suppression of a surrounding field. The EFT is based on the Gottschaldt Hidden Figures Test (1926). Simple geometric figures are hidden or embedded within complex ones. The subject is shown the simple figure, and then it is removed. He or she then

must find the simple figure hidden in a complex one. Facility in performance of this task is considered to indicate a greater level of field independence.

While the concept of field dependence-independence was first applied to perceptual orientation, further evidence indicated that it pertains to intellectual functioning as well. This expanded concept was referred to as the articulated-global dimension. Describing the field independent or articulated individual, Witkin defined such a person as able to separate items from their backgrounds, impose organization on an unorganized field, and develop a new organization for a previously organized one (Witkin et al., 1962, p. 14). Field dependence-independence was then viewed as the perceptual component of this articulated-global dimension.

The concept eventually was broadened even further to include personality differences, and from this extension has emerged the differentiation construct, employed to define self-consistent functioning across domains of perception, intellectual functioning, and personality (Witkin & Goodenough, 1981). Goldstein and Blackman (1978, p. 175) describe the more differentiated person as one who perceives a field as discrete, maintains internalized standards and specialized defenses, and has a "definite sense of body boundary."

In the most recent conceptual revisions, field dependence-independence is defined as the "degree of autonomy of external referents" (Witkin & Goodenough,1981, p. 48), where cognitive restructuring ability (which is based on internal referents) and interpersonal competency (based on external referents) are at bipolar points on the continuum. According to Witkin and Goodenough: "It now seems possible that what we earlier designated as articulated-global field approach consists of two separate though related functions: reliance on vestibular or visual field referents and cognitive restructuring" (1981, p. 47). They thus question whether "the essence of performance in both tests of perception of the upright and tests such as the EFT is competence in disembedding" (1981, p. 47). Goldstein and Blackman (1978) reviewed 16 reports on correlations between versions of the RFT and EFT. They found correlations generally in the .30 to .65 range. Linn and Kyllonen (1981) performed a comprehensive factor analysis in which embedded figures measures loaded on a cognitive restructuring factor, and the RFT loaded on a factor which they label "familiar field." Thus the focus of any research study involving field dependence should be clearly identified. Most studies which employ embedded figures tests are actually looking at the cognitive restructuring component of the differentiation construct. That is the focus of this study.

Field Dependence-Independence and Learning

Left to their own devices, field dependent and independent individuals approach learning in different ways. Goodenough (1976) and Witkin et al. (1977) have reviewed the literature and offered several conclusions about learning and field dependence. First, field independents, being more analytic in approach, tend to actively engage a stimulus complex, analyzing it if it is organized, bringing structure to it when it lacks organization. In many instructional situations, the ability to analyze and structure aids in learning. The field dependent individual, however, takes a more passive approach, accepting the field as given, experiencing it in a more global, diffuse manner. This passive approach means that field dependents tend to notice those cues in a stimulus field which stand out or are more salient. When the stimulus is arranged so that the salient cues are also relevant, then the field dependent may experience little difficulty. In fact, if a learning task is clear, well-structured, and low in complexity, then there may be no real difference in performance between the two orientations. However, in situations where cue relevance and saliency are in conflict, the performance of field dependents seems to suffer. The field independent, who samples more fully from the available salient *and* non-salient cues, performs more successfully (Goodenough, 1976).

Witkin suggests that the strategies which arise from cognitive style orientation may be somewhat more malleable than the styles themselves. For example, a field dependent will adopt a hypothesis-testing approach when the instructional situation is set up to elicit such a response, although he or she normally takes a more intuitive route to concept attainment.

In their reviews of the literature on field dependence-independence and learning, Witkin et al. (1977) and Goodenough

(1976) have described one mode as not necessarily superior to the other for learning, emphasizing the adaptive value of each orientation. However, much research indicates otherwise. Davis and Frank (1979) suggest that field independent learners possess memory efficiency superior to field dependents, and also possess the ability to perform combinatorial analyses, defined as the ability to "systematically generate all possible combinations and permutations of a set of elements (Flavell, cited in Davis & Frank, 1979). Witkin et al. (1962, p. 99) had admitted the presence of memory deficiencies in field dependent youngsters, and concluded that they were the result of the lack of registration of material due to poor structuring, or in their words, "susceptibility to retroactive inhibition of intrinsically unorganized material." Berger and Goldberger (1979), in searching for a relationship between short-term memory and field dependence, obtained results that indicated a correlation between field dependence and the ability to recall information, rather than a lack of initial registration of the stimulus. This would support the contention that field independents are better able to focus their attention on the relevant aspects of a task. Another opinion holds that field dependence is a manifestation of limits on working memory, whereby an individual is unable to use working memory efficiently to "extract relevant information from a given context" (Nahinsky, Morgan, & Oeschger, 1979, p. 490). A study by Robinson and Bennink (1978) also provided evidence of differences in working memory between field dependents and field independents, but only when information load is high.

Even more prominent in the literature than studies linking memory efficiency with field independence are those which raise the issue about its relationship to general intelligence and other ability factors (Cooperman, 1980; Vernon, 1972; Zigler, 1963). Complicating matters is the fact that tests of field dependence are ability-type tests; that is, there is correct and incorrect response, high and low performance, with high performance being associated with field independence. Kogan (1980, pp. 248-249) maintains that the field dependence-independence dimension "has most of the properties of an ability....it is...conceptually confusing to have a social skill indexed by a deficit in spatial disembedding." Witkin has acknowledged that there is necessarily some relationship between certain aspects of general intelligence and field independence, but maintains that the relationship only applies to specific areas of intelligence. For instance, Goodenough and Karp (1961) completed a factor analysis comparing the EFT and The Wechsler Intelligence Scale for Children (WISC) subtests. Two and possibly three of the subtests appeared to tap the same or similar abilities as the EFT. These were designated as an "analytic factor," based on their common property of overcoming an embedding context. Karp's 1963 study showed similar results. These authors suggested that performance on tests of embeddedness was not related to a Verbal

Comprehension or an Attention-Concentration factor; others disagree.

In a review of 20 studies, Goldstein and Blackman (1978) found correlations in the .40 to .60 range on verbal and performance tests. Witkin et al. (1977) cited their own review of 29 studies showing a correlation of .18 between vocabulary tests and tests of field dependence-independence. Vocabulary tests, along with other verbal scales, are examples of Cattell's (1971) designation *Gc* , or crystallized intelligence. Some researchers have suggested that field independence is instead fluid ability, or *Gf* (Cronbach & Snow, 1977), which encompasses non-verbal reasoning and is measured by some spatial and figural tests (Snow, 1980, p. 35); or perhaps it is spatial visualization ability (Cronbach & Snow, 1977, p. 382; Stasz & Thorndike, 1980, p. 20). In factor analyses, the EFT tends to group with other spatial tests.

The Scholastic Aptitude tests (SAT) are measures of ability that have been found to correlate positively with the GEFT. Witkin himself stated that "...field dependence theory would lead us to expect some relationship between GEFT scores and mathematical competence." (Witkin, Moore, Oltman, Goodenough, Friedman, Owen, and Raskin, 1977, p. 201). In a longitudinal study of a large college-level sample, SAT scores were compared with embedded figures test scores, and correlations of .24 for men and .38 for women were found for the Math SAT. Correlations were lower for the verbal test (.08 and .22, respectively). In both cases, a higher correlation existed for women. Other studies reported by Witkin et al. (1977) also showed a higher correlation between math ability and GEFT performance than between verbal ability and GEFT, and a nonsignificant relationship between measures of field dependence and grade point average. The evidence does seem to indicate that there are significant relationships between measures of field dependence and various ability measures, with higher ability corresponding to the field independent orientation.

Field Dependence-Independence as a Factor in the Design of Instruction

It has been theorized that field dependents and independents learn equally well when the information load and/or complexity level is low. Differences appear as complexity increases, with field independent learners outdistancing their more field dependent peers. Thus, providing structure and organization for field dependent learners seems to be most important when the material is complex.

Complexity, when applied to visual media, has held different meaning for different researchers. To Davis and Klausmeier (1970), it indicated the amount of irrelevant information. Dwyer (1978) and others (Canelos & Taylor, 1981; Canelos, Taylor, & Gates, 1980; Wise, 1984) have examined complexity as level of realism; that is, a photograph would be considered more realistic than a line drawing of the same subject since it inherently contains more visual information, and thus would also be more complex. Dwyer has found the use of such realism to be most appropriate when the student has sufficient time to process the added features, as with self-paced instruction.

Canelos et al. (1980) examined visual complexity (level of realism) as it relates to field dependence. As part of their experiment they required students to draw the human heart after viewing either a line drawing, a colored illustration, or a photograph. Since this task required students to deal with spatial information, predicted to be more difficult for field dependents because "each part would be recalled in terms of its relation with the set of all possible parts" (Canelos et al., 1980, p. 68), it was hypothesized that field dependents would be most successful when shown the simplest of the visuals (the line drawings). Complexity here proved to be a non-significant variable. The argument by Canelos and his associates was perhaps flawed by their use of complexity as level of realism in regard to field dependence. One might question whether there are real differences in organization or structure between a line drawing and a photograph of the same subject, even when there is more detail in the photograph.

Wise (1984) also designated level of realism as complexity, and while he determined in his study that line drawings were generally superior to photographs for learning, he found no differences between field dependent and field independent learners on a drawing test. (He had selected this particular task because he believed it would require disembedding.) However, field independents were superior on a comprehension test. These results led Wise to conclude that field dependence-independence played an insignificant role in visual information processing. His use of a median split for field dependence level may have obscured some differences, but again level of realism and level of complexity may not be the same thing.

A better way of examining visual complexity might be to consider conceptual and spatial relationships. In his 1984 study, Fleming looked at complex and simple text material which consisted of picture-word combinations. He wanted to know how attention was influenced by learner characteristics, specifically field dependence-independence, and by the layout of the materials. In order to do this he examined eye-movement data. Complexity was a significant variable for all students. There was a significant correlation between cognitive style (GEFT score) and the number of transitions (looking from one section to another) for complex materials only. Fleming found that field independents made a larger adjustment (fewer transitions with the simple material; more with the complex) than the field dependents. They also looked longer and more often at the pictorial areas on the complex pages than did the field dependents. According to Fleming, complexity was the strongest aspect in determining learner strategy.

Wachtel (1968) performed an experiment in which field independent male college students were better able than their more field dependent peers to identify parts extracted from complex visual designs. In Wachtel's study, extreme field dependents and field independents were selected via a group embedded figures test. The complex visual designs had been labeled with nonsense names. Both groups were able to identify and label the complete designs from memory, but the field independents were superior in attaching the correct labels to parts extracted from the designs. Wachtel concluded that field independents have a "specific capacity to isolate part aspects of a stimulus" (1968, p. 204), an idea that is relevant to the present study.

The literature tends to support the use of instructional supports: design devices which direct attention, emphasize, provide cues, and give organizational assistance to the learner (Allen, 1975; Clark, 1978; Dwyer, 1978; Fleming, Knowlton, Blain, Levie, & Elerian, 1968; Fleming & Levie, 1978; Gagné, 1977; May, 1965). Widely used forms of instructional support include underlining, bold face, circling, and arrows, but may also include organizing features such as dividing and sequencing of information. Fleming et al. (1968) concluded that learning could be predictably facilitated or hindered according to the structure of the message, and Fleming and Levie (1978) have suggested that by using "appropriate spatial arranging or temporal grouping, processing demands may be diminished (1978, p. 56). Winn, too, advocates "the use of visual forms that express semantic and logical relationships spatially through layout" (1982, p. 13).

The literature on sequencing and size of step historically addressed these concepts as they pertained to programmed instruction (e.g., Briggs, 1968; Schwen, 1970; Tobias, 1973). Schwen (1970) looked at size of step in programmed instruction in relation to field dependence as measured by the Hidden Figures Test (HFT): he tested a small-step programmed learning task versus a large-step one with analytic (field-independent) and global (field-dependent) students. In the small-step program generalizations were presented one at a time followed by learner response. In the large-step program, all of the material was presented before a response was required. When he measured retention, he found that for the small-step program there were no significant differences between the two groups, but on the large-step program the analytics outperformed the globals. This corresponds with studies previously mentioned showing differences between field dependents and field independents with high information loads but no difference with low information loads.

A recent study involving size of step was conducted by Jennings and Dwyer (1985). They looked at reduced step size as a means of facilitating student achievement. This was done by increasing the number of visuals in a presentation from 37 to 47, thus decreasing the amount of information in each visual. This manipulation was significantly more effective for the overall learning task and, specifically, for a drawing test, but only during immediate recall.

However, no attempt was made to relate this to an individual difference variable such as field dependence.

Studies involving the use of other types of instructional supports with field dependence-independence include Elliot's (1976) attempt to match instructional designs to analytic and global orientations for a third-grade geometry concept-learning task. His pilot study revealed that matching field dependence with color highlighting of relevant attributes and sequential structure was not effective. He reversed the match, using randomly drawn lots to determine sequencing and abolished the emphasis on relevant attributes for field dependents. Performance was improved in the hypothesized direction. Elliot's results are unexpected based on the characteristics of field dependents brought out in research. Elliot's sample consisted of third graders. Perhaps developmental aspects interfered, or perhaps his particular task did not require external structuring. One finding should be noted: field dependents who received the low-information-density presentation achieved significantly higher test scores than those receiving the high-information-density presentation.

If field dependents learn more efficiently under low information loads, the tendency might be to simplify material by leaving out certain cues, particularly when designing instructional visuals. This technique has not proved especially successful. As Dwyer cautions, "One possible solution to increase the effectiveness of visualization is to limit or reduce the amount of information presented by the visual...the process of reducing detail may also unintentionally eliminate detail which would have been considered as primary learning cues for some learners" (1978, pp. 157-158).

One technique for reducing information load is called *compression*, a method where the background is covered, suppressed or removed so that the learner will not be distracted by irrelevant information. The results of two studies with compressed visuals (Dickie, 1969/1970; Hessler, 1972/1973) indicate that compression does seem to aid field dependents somewhat, but it appears to be more advantageous to field independents. Dickie (1969/1970) developed slide sets to teach the procedure for threading a 16mm projector. He screened out backgrounds on one slide set, with the result that all learners required less time in self-instruction using the compressed visuals, but there was no apparent relationship between field dependence and the technique.

Hessler (1972/1973) also found that, following a visual compression treatment, field independents improved their performance to a greater degree than field dependents. Both Dickie and Hessler classified their subjects on the basis of their performance on the Thurstone and Jeffrey Closure Flexibility Test, with Hessler using upper and lower thirds, and Dickie using extreme groups of 20 each from a large original population (900). There is some question as to whether tests of closure flexibility are legitimate replacements for the Witkin Embedded Figures Test. One reason for the above results may be that the literature on field dependence indicates that an essential feature of disembedding is the presence of an organized field to be broken up. When the field is a pattern, or other unorganized features merely serving as a distraction, then a different factor is thought to be involved (Karp, 1963; Witkin et al., 1977).

Manipulations that Provide External Organization

Other aspects of organization and field dependence were considered by Grieve and Davis (1971), Fleming et al. (1968), and Satterley and Telfer (1979). These studies provide evidence that external organization and structuring of the learning task may be helpful to field dependents, but that field independents seem to do as well or better without such aid. Satterley and Telfer constructed English lessons concerning word structure. Following Ausubel's theory that advance organizers aid in structuring material and thus would enhance performance of field dependents, the authors designed a treatment whereby the relationship between the ideas presented by the organizer and the specific information to follow was "explicitly demonstrated" (Satterley & Telfer, 1979, p. 171). That is, specific references were placed at fixed positions within the lesson to draw learners' attention to ideas in the organizer. Satterley and Telfer had formed their groups using scores from an embedded figures test by Gardner, Jackson, and Messick (1960). They stratified their sample into three groups of 60 each: field dependent, intermediate, and field independent groups. In measuring retention, Satterley and Telfer found that their hypothesis was supported: field dependents scored higher with this treatment, and field independents, with a treatment using no advance organizers. Field independents scored higher overall, but the performance of field dependents approached that of the independents with the supplemental "advance organizer" treatment.

An experiment conducted as part of a broader study on message structure (Fleming et al., 1968) compared the performance of students high or low in flexibility of closure (as measured by the Hidden Figures Test) on recall of hierarchical word lists. When students were asked to begin with superordinate categories and move to subordinate ones, the performance of those high and low in closure flexibility was similar. When asked to remember from subordinate to superordinate, the performance of lows suffered. This experiment seems to illustrate that lows have trouble breaking a "normal" set and has been cited by Goodenough (1976) and Witkin et al. (1977) as evidence that field dependents tend to accept the organization of a field as given rather than imposing their own structure. It also appears to support Coward and Lange's (1979) finding that field dependents can recognize and deal with existing organization as well as field independents, but are less able to impose organization. Once again, caution is in order in interpreting these results, as flexibility of closure has not been proved to be interchangeable with field dependence.

Ordering of material on a larger scale was investigated by Grieve and Davis (1971). Their study compared an expository teaching method with a discovery method for which the content was a geography unit. The two teaching methods were compared for field dependents and field independents. Outcome measures were factual knowledge and transfer skills in using similar materials. Results were insignificant when a median split was used to form the groups. When the sample was reduced to extremes on field dependence, under re-analysis, a significant disordinal ATI appeared, but for boys only. That is, field-independent males performed better with expository, and field-dependent males with the discovery method. Goodenough (1976) suggests that in this case *both* methods are highly structured. Rather, results may be related to field independents' ability to generalize, and field dependents' greater success with smaller amounts of and more specific information. Also, the discovery method perhaps introduced additional material of greater perceptual richness. Since it was externally structured by the teacher, the additional material might have benefited the field dependent students.

An often-cited experiment by Salomon (1972) involved an elaborate attempt to manipulate visual material to compensate for individual differences in visual processing ability. The task required learners to remember and list details from a painting by Breughel. Three treatments were arranged: (a) the painting was shown in its entirety, (b) first the entire painting, then details were shown individually, and (c) a zooming-in on the details with motion picture film was employed to simulate a scanning strategy. Students high in cue attendance (attending to detail) did best when the painting was shown intact. Those low in cue attendance responded best to the zooming-in technique. This treatment seemed best to imitate a successful searching strategy. However, the high ability students were able to initiate and carry out their own scanning strategy, resulting in greater success when shown the entire painting at once.

In another finding, the detailed slide series proved ineffective for all of the groups. Salomon reasoned that the abrupt change from an overall view to detail destroyed the relationship between the elements and their context.

Heidt (1977), analyzed Salomon's experiment and suggested that it might have implications for the design of instruction for field dependent and independent learners. He assumed that the investigated trait "cue attendance" is a close equivalent to field dependence; however, in another study (1974, p. 505), Salomon correlated EFT performance with his measure of cue attendance, and the relationship was not especially large (r= .27 to .37). Nonetheless, Salomon's method for manipulating the visual material to supplant or compensate for individual differences merits exploration. Heidt emphasized the importance of isolating details while retaining overall relationship to context. However, he believed that this linking to context should be achieved through motion, such as with the zooming-in treatment employed by Salomon. It seems that the linking function might also be accomplished by other methods.

Map Learning: Factors and Strategies

Maps, as learning materials, have been studied by a number of researchers (Kulhavy, Schwartz, & Shaha,1982; MacEachren,1982; Shaha, 1982; Shimron, 1978; Stasz & Thorndike, 1980; Sutherland & Winn, 1987; Thorndike, 1979). A map is a complex combination of verbal and visual cues. MacEachern defined map complexity as "the degree to which the combination of map elements results in a pattern that appears to be intricate or involved" (1982, p. 32), and he saw such complexity as a potentially adverse influence on its effectiveness. Yet, since it is an outgrowth both of the nature of the location that is mapped, and the symbolism used, level of complexity is only partially controllable by the designer. Thus both understanding how map information is processed and discovering methods of manipulating such information to bring about increased learning are of importance to the instructional designer.

Paivio (1971) categorized the processing of map-like information as parallel rather than sequential, as with verbal information. Shaha (1982) reasoned that while persons may store the image of a map intact, there is some process of breaking down the information into sub-elements in order to learn and recall it.

Shimron (1978, p. 11) discussed ways in which map information might be recalled, including direction (north, south, east, west), proximity of elements, item categorization, and "overall mental integration." In an experiment that exhibited some aspects of the present study, he presented maps divided by conceptual categories. As a control he presented maps sectioned into thirds. Those who studied the sectioned maps significantly outperformed those who learned the maps by categories. Neither of his groups saw the entire map at any point, and individual learner differences were not considered. Shimron surmised that all of a map's schemes need to be integrated mentally, which would intuitively seem to be the case. However, he did not provide any link to the overall context of the map in his treatments. In a similar vein, Kulhavy, Schwartz, and Shaha (1982) addressed the importance of an interpretative framework (boundaries, grids, outlines) for placing features in a spatial context. They developed a map that used a street grid as an organizational aid for remembering correct placement of map features. The map was divided into a number of pages, which the learners saw sequentially. Each successive page included an additional block of features. For one treatment features were added randomly, for another they were grouped conceptually. The pattern of grouping of features made no difference to the outcome; however, it appeared that the learners did encode the grid as an organizational aid, before dealing with the rest of the map features.

Sutherland and Winn (1987) in another map experiment found that as the number of elements increased, successive processing (learning a list of verbal map-element labels in the correct order) diminished. However, simultaneous processing (in this case remembering the correct placement of a set of visual map elements) first leveled off and then improved. Sutherland and Winn speculated that this occurred as learners became able to employ a chunking strategy (grouping elements and learning them in sets).

It is somewhat difficult to directly relate the results discussed here to the present study because of the nature of the maps. Generally these experiments have used experimenter-developed maps that were little more than a set of discrete elements scattered around a page. There was little integration of features, as one might find on a "real" map. It is this integration of features that may require disembedding.

More relevant to the present study is the work of Stasz and Thorndike. A 1979 paper by Thorndike offered a detailed analysis of the procedures subjects use to encode map information. Of particular interest are the sampling heuristics identified: (a) attentional heuristics: limiting the information attended to at one time, (b) encoding heuristics: integrating current information with other information from the map plus knowledge already in memory store, and (c) control heuristics: handling competing encoding and attentional procedures (selection of appropriate heuristics).

Successful map learners tended to use systematic or stochastic sampling of the map elements (poor learners were unable to focus their attention on one area), used pattern encoding and relation encoding (poor learners could not think of their techniques for encoding), and continued with a particular strategy until it achieved its purpose. The poorer learners frequently abandoned strategies prematurely

Stasz and Thorndike, continuing their examination of map learning, speculated that, due to the "visual complexity of the stimulus," and the "unstructured learning situation," differences between field dependent and field independent individuals might have implications for learning from maps, They hypothesized that field independent learners would have greater success with map learning because they would be able to organize the information of the complex visual into subsets which they might then learn sequentially (1980, p. 9). Stasz and Thorndike suggested that field dependents might be overwhelmed by the visual complexity and thus randomly study the map, rather than employ organizing strategies to make the task manageable. Their ideas were supported by their study: high GEFT scorers tended to be good map learners; one of the successful strategies reported was partitioning, either spatially (dividing the map into smaller areas), or by focusing on conceptual categories (such as roads and geographic features). Stasz and Thorndike did not examine how the task might be altered to fit differences in processing strategy related to cognitive style, but their conclusions seem to suggest that a sequencing strategy controlled by the instructional designer might be appropriate to compensate for field dependents' difficulty in dealing with complexity and high information load.

Summary

Several conclusions arise from a review of the literature on field dependence-independence and instructional design. There are definite distinctions in how the two orientations approach learning. Field independents have been characterized as analytic, able to organize material that is inherently unorganized, able to restructure material when necessary, and able to disembed information from an embedding context. These abilities which comprise the cognitive restructuring component of field independence will be emphasized in this study.

Field dependents, on the other hand, are able to recognize organization, but tend to accept it as given. They respond to cues based on noticeability over relevance. They are less able to break a normal organizational set. With well-designed instructional materials their learning should not be hindered. In spite of its uncertain relationship to general intelligence and individual ability factors, field dependence-independence currently seems a relevant, less value-laden variable than IQ for use in designing individualized instruction. The question becomes, how does one design visual instruction to take advantage of cognitive style differences?

Studies have shown that field independents are better able to deal with complex visuals because they are able to organize their own sequential learning strategies to reduce the amount of information which they must deal with at one time. Field dependents tend to be overwhelmed by complexity and are less able to invoke such strategies. There is evidence, however, that this need not always be the case. The performance of field dependents matched that of field independents on a programmed learning task when smaller steps were used. Similar design features may be incorporated into complex visuals in order to match the learning style of field dependents. In doing this, it is important to distinguish between simplification (where detail is reduced), and low information density (which may be accomplished by dividing and sequencing). Nowhere in the literature is there evidence that field dependents achieve more with less information per se (and thus fewer perceptual cues). However, the division of complex structured visual information into a logical, organized sequence may direct attention, organize scanning behavior, and allow the learner to deal with smaller amounts of information at one time. In their study on map learning, Stasz and Thorndike (1980) showed that field independents can generate their own organizing strategies. Providing them with complex visuals in an intact state seems preferable to possibly interfering with their preferred strategies by imposing an external sequencing pattern.

A design strategy suggested by past research would consist of smaller amounts of information presented at a time to provide low information density and high cue salience for the field dependent individual. The actual amount would be determined by the content structure of the complex visual. This allows the learner to focus on manageable amounts and makes each portion sequentially a salient cue, assuring that the student is not overwhelmed by competing stimuli. It is also important to provide a logical ordered sequence so that the field dependent learner is not required to determine the appropriate order. Finally, a link to context should be maintained by the instructional design of the visual sequence as an aid in structuring the material.

Chapter III
RESEARCH METHODOLOGY

The purpose of this study is to investigate the relationship between the field dependence-independence cognitive style continuum, and performance on a map-learning task employing three format variations: a Part-by-Part sequence, an Additive sequence, and a non-sequenced Intact format. These hypotheses are based on the research questions generated in Chapter I:

Research Hypotheses

1. There is no difference in performance on a test of immediate recall following a presentation consisting of Intact visuals, a presentation of Additive sequential visuals, or a presentation of Part-by-Part sequential visuals.

2. There is no difference in performance on a complex visual learning task between field-dependent, moderately field-independent and field-independent students.

3. There is no interaction between visual design format (Intact, Additive, or Part-by-Part) and the cognitive style variable field dependence-independence.

Research Design

A posttest-only, 3 X 3 research design was used (see Figure 1). The independent variables were presentation format and cognitive style (field-dependence-independence as measured by the GEFT). The three levels of the independent variable "presentation format" were (a) Intact, (b) Additive sequential, and (c) Part-by-Part sequential. The dependent variable was immediate recall of visual and verbal information as measured by a two-part objective test.

Rationale for the Three Treatment Formats

Following evidence that field-independent learners deal more successfully than field dependents with complex information and high information load, map presentations were devised for this study to attempt to match the learning characteristics of each style orientation. The question to be considered was, would field dependents be better able to process visual material that is complex or high in information load if it is divided in such a way as to reduce information level and complexity, but not to alter the total amount of information presented? In addition, since field dependents are less able to analyze and organize material, the presentation should retain a clear organizational structure. The manipulation should be such that the learner is directed by the presentation to look sequentially at the visual elements, concentrating specifically on one element at a time without having to suppress competing salient cues.

Level of Field Dependence	TREATMENT		
	Intact	Additive	Part-by-Part
Field Dependent			
Moderately Field Independent			
Field Independent			

Figure 1: Research Design

Rationale for the Intact Treatment

Given a reasonable amount of time, it was assumed that the field-independent learner could process the information in a complex, intact visual without intervention from the instructional designer, since he or she should be able to organize scanning strategy, selectively ignore competing stimuli, and internally formulate a learning strategy. However, the Intact format might have overwhelmed the field dependent, and he or she might not have employed a systematic learning strategy. If the field dependent successfully learned material in this format, it could be because the level of complexity was not too great, and the level of organization was adequate.

Rationale for the Additive Treatment

This treatment was an intermediate one in that a building up of the visual elements occurred; thus, there was more separation of the component parts than with the Intact treatment, but less than with the Part-by-Part treatment. If a clear organizational pattern is more important to field dependents than is cue salience, then their performance might have been better with the Additive treatment. This treatment should have, however, favored the moderately field-independent student, as the high field independent may not have been challenged adequately by it.

Rationale for the Part-by-Part Treatment

In this treatment was found the highest degree of separation of the visual elements, as each set of conceptually related elements was shown in turn, followed finally by the intact map as an organizational aid. It was predicted that field dependents would achieve the highest posttest scores following this treatment, as it would allow them to focus on details, without having to suppress competing cues, and then they might scan the whole for conceptual relationships. This treatment should have proved less successful for field independents, in that by externally providing a strategy, it might have somehow interfered with their own internal strategy formation. If field dependents were not more successful with this treatment, it might be because organizational relationships were lost due to the high level of separation of the elements. If field independents scored higher following this treatment, it might have been due to superior memory efficiency (e.g., Davis & Frank, 1979).

Preliminary Test and Pilot Study

Before carrying out a pilot study, a preliminary field test of the experimental materials was undertaken. Four volunteers agreed to try out the materials under timed conditions of 2 1/2 minutes per test, with the visual test administered first. They found that looking at the visual test first, with its incorrect visual excerpts, produced interference and made the written test too confusing. They also felt that they needed more time to complete the tests. After their experience it was decided to administer the written test first and then the visual test, and to increase the time from 2 1/2 to 3 minutes for each test section. The pilot study was then initiated based on these changes.

For the pilot study, the experimental task was administered to 36 students in an Audiovisual Methods class at Virginia Tech. Each participant was presented with all three maps, in random order, with a different treatment for each map. However, since the maps differed in level of difficulty, it was felt that the analysis might be awkward. It was decided to administer all three maps in one format per treatment group for the actual experiment. Following an informal item analysis, some test questions were revised. The time limits, format, and map designs were retained with no changes. Some names on the maps were changed, as it was believed that they were too obvious or too simple to learn using mnemonics. However, some that had been questioned were retained, based on the reasoning that in real-life learning situations, content varies considerably in the ease with which it may be related to previous experience by each individual learner.

While a complete analysis of the pilot study data was not attempted, test scores were examined. There seemed to be a broad enough range of scores on both the posttest and the GEFT to provide variance (19 to 52 out of a possible 60, and 3 to 18 out of a possible 18, respectively). The reliability for the posttest in the pilot study was .80, based on the KR-21 formula.

Also as a part of the pilot study, the participants were asked to evaluate the presentation for mechanics, clarity, length of task, time allowed, and difficulty level. There were twelve questions; mean responses ranged from 2.65 to 3.37, where 3 was the optimum choice, and 1 to 5, the range of choices. It was concluded that these responses did not indicate problems with these areas, thus it was decided to proceed with the experiment.

Participants

Participants in the study were college students at a large public university, both undergraduate and graduate. These students were enrolled in Audiovisual Methods and Educational Psychology classes at Virginia Tech and completed the experiment as a course requirement. There were 92 participants in the study. Testing was done during the spring, summer, and fall quarters of 1985. Twenty-five males and 67 females took part in the experiment. Ages ranged from 19 to 38.

Materials and Equipment

The following materials were used in the study. (Copies of 2 through 4 may be found in Appendices A through E).

1. Instructions for the map learning task in three versions, one for each treatment

2. Map Learning Task booklet, three versions, one for each treatment

3. Test Booklet containing the verbal and visual posttests

4. Overhead transparencies showing a sample map, sample written test questions, and sample visual questions

5. Personal Data sheet, including evaluation form

6. Group Embedded Figures Test

Equipment used was an overhead projector to project the sample map and questions, and a timer to time the map learning task and the posttest.

Instruments

GEFT

The measure of field dependence used in this study was the Group Embedded Figures Test (GEFT), (Witkin, Oltman, Raskin, & Karp, 1971). It is a variation of the original Embedded Figures Test (EFT) which can be administered to groups rather than individually. Like the original EFT, the GEFT requires subjects to find a simple geometric figure embedded within a complex one. The GEFT consists of 25 such figures. It is divided into sections of 7, 9, and 9 items, with time limits of 2, 5, and 5 minutes respectively. The first section is for practice only and is not scored. The number of simple figures traced correctly on the second and third parts makes up the raw score which can range from 0 to 18. The more figures found and correctly traced, the more field independent the subject is assumed to be.

Posttest

The posttest consisted of a visual identification portion and a written portion, both testing immediate recall of map information. There were 10 questions of each type per map, making a total of 60 questions for the entire test. The visual test was made up of sets of map excerpts from which the subject was to select the one which was an accurate portion of the map he or she had just studied. The map excerpts were small portions, 1 3/8 inches square, in 1:1 proportion with the original maps. There were five excerpts for each question. The distractors were developed in several ways. Some were portions of an entirely different map. Some were altered visually and/or verbally. The written test was also a multiple-choice test, with four choices per question concerning knowledge of locations, names, directions, spatial relationships, and applications. The reliability of the posttest was calculated at .76, using the KR-21 formula.

Personal Data Form

The Personal Data and Evaluation form asked for age, sex, major, SAT scores, grade point average, and college class level. There were five opinion questions about the map learning task, which had been extracted from the larger set used in the pilot study, and a question about strategies employed in remembering the map information.

Description of the Experimental Task

Students were shown three maps of fictitious locations and asked to learn and remember the information as completely as possible within a time limit of 3 minutes per map. After looking at each map, they were given a test of immediate recall. There were three different map treatments. The difference among the presentations was in the manner in which the map information was sequenced (Figure 2).

Treatment 1 (Intact): The entire map was shown as one visual. Students were thus left to determine their own strategies for learning the maps.

Treatment 2 (Additive Sequence): The information was divided conceptually and presented in a sequence that built up to the entire map. This lowered the amount of information that was encountered at one time. The student was forced to look at the information in a systematic fashion: first, land boundaries; then geographic features and landmarks; then roads, railroads, and cities.

Treatment 3 (Part-by-Part Sequence): The map information was divided conceptually in the same manner as Treatment 2. However, each subset of map elements was shown separately in a sequence. Since this treatment did not show completely the spatial relationship among the sets of elements, the entire map was also shown last during this treatment as an organizational aid.

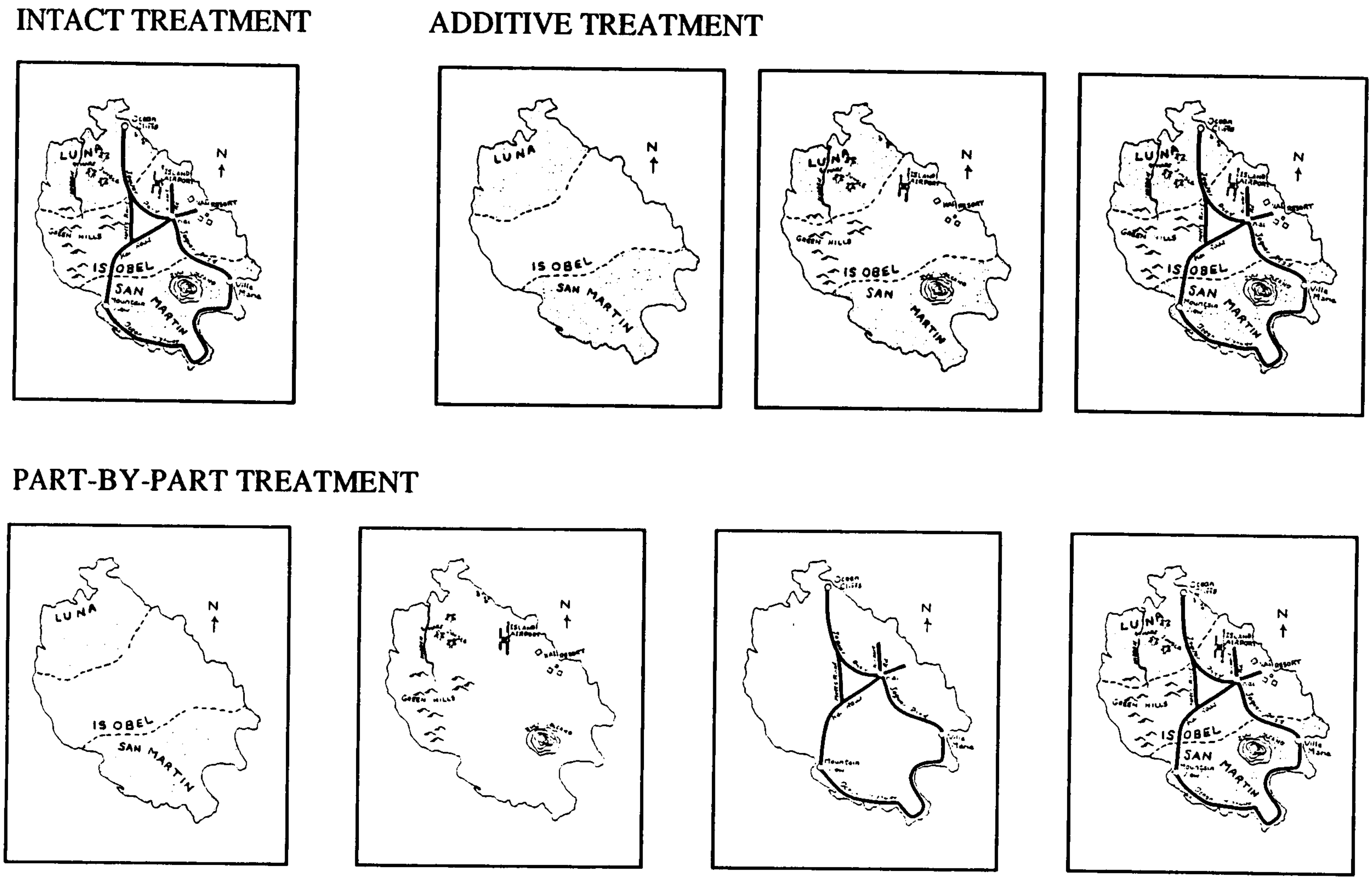


Figure 2: Map presentation formats

Description of Maps:

The three maps developed by the experimenter were titled Tropical Island, Western State, and Small County, respectively. Each map was divided into three geographic areas: either counties, provinces or townships. Each map contained four to seven roads, railroads, and cities, along with four to seven landmarks and geographic features, which were depicted in a symbolic form. All pertinent features were labeled. In an effort to approximate more closely a real-life learning situation, nonsensical names were avoided, and labels varied in the ease with which they could be associated, or remembered mnemonically.

The original maps were drawn by the experimenter in black ink on 11 x 14 inch paper and reduced to fit on 8 1/2 x 11 inch sheets. Titles and other graphics, the verbal test, plus the visual-test layout were created on a Macintosh computer using the MacPaint program. All items were then photocopied and compiled into "Map Learning Task" and "Test" booklets.

Paper copies were used rather than other visual formats for two reasons. First, the students would presumably be able to see the material equally well no matter where seated, given adequate visual acuity and lighting. Second, flexibility was gained: the order of the materials could be varied within the same treatment group in order to minimize bias from fatigue or practice effects. Indeed, the order of the maps was varied from booklet to booklet; thus there were three map booklet versions (A, B, and C) for each treatment. These booklets contained blank sheets between each map or map portion so that students could not see through from one page to the next.

Objectives of the map learning task

The overall objective of the map learning task was that, after studying the map for the given time, the student would be able to reproduce it accurately. As evidence, he or she should be able to identify correct portions of a map as opposed to altered ones consisting of changes in spatial relationships among map elements, redefined boundaries, omission or addition of map elements, changes in names or any other rearrangement of the map information (visual test). In addition, he or she would be able to select correct routes, directions, names and applications based on map knowledge (written test).

Procedure

Six experimental sessions were held, two for each treatment. Students self-selected the session they would attend by signing up in advance. Treatments were randomly assigned to each session, thus the uneven numbers of subjects per treatment. All sessions were held in the same classroom, and lasted approximately one hour. Students were told only that they would be taking part in an experiment concerning learning from high-information-level visuals.

The GEFT was administered first; pencils and booklets were passed out, and directions were read to the group. This test took approximately 20 minutes. Then envelopes containing the rest of the experimental materials were distributed. These were shuffled and distributed randomly. This was done to assure a random distribution of map order. The task was then explained in more detail and an example of the type of map to be dealt with was shown using an overhead projector. Additionally, two sample questions of the type on the posttest were shown and answered as a group.

The students were then instructed to open their envelopes and remove the materials. They were first referred to the Map Learning Task booklet. They were told that they would be given 3 minutes to learn the map, and then would take the tests on that map. For the Intact treatment, the students simply studied the single map visual for 3 minutes. For the Additive treatment, there were three visual map subsets, and the 3 minutes were divided into 30, 60, and 90 seconds; for the Part-by-Part treatment there were three subsets plus the complete map; the timing was 30, 30, 30, and 90 seconds, respectively. When the 3 minutes were up, the students were asked to close the Map Learning Task booklet, and open the test booklet to the first blank sheet marked "1". They were then given 3 minutes to complete the verbal portion of the test, and a separately timed 3 minutes for the visual portion.

The experiment continued with the students returning to the Map booklet to study the second map in the same manner as the first, taking the second set of tests, and finally doing the third map and test set. The experimental task took approximately 30 minutes. When the experiment was complete, the participants were asked to fill out the Personal Data and Evaluation sheet and place everything back in the envelope. When they finished, the materials were collected, and the students were dismissed.

Analysis of Data

The three experimental hypotheses were tested for statistical significance using a two-way analysis of variance. Hypothesis One was concerned with the main effect for presentation mode; Hypothesis Two concerned the main effect for cognitive style, and Hypothesis Three concerned the interaction of presentation mode and cognitive style.

Previous research has indicated that measures of field dependence-independence correlate positively with math SAT, and to a lesser degree with SAT Verbal scores. Since field independence is apparently related to math ability, these scores were requested from participants in order to compare them with the GEFT scores, to see if a relationship would be found for the present sample. Participants were asked to explain the strategies they employed for learning the maps. Demographic data including age, sex, major, and GPA were also obtained. In order to help determine whether the experimental treatment groups were similar in makeup, the demographic variables and the SAT math and verbal scores were compared for the three treatments, using one-way analyses of variance. Results of all analyses are detailed in Chapter IV.

Chapter IV

DATA ANALYSIS AND RESULTS

This chapter details the results of a study to determine the relative effectiveness of three formats for presenting map information to learners who are classified as field dependent, moderately field independent, or field independent. These students' immediate recall of the map information was tested by a multiple-choice 60-item test containing both verbal and visual questions. The students were classified according to their scores on the GEFT into three levels of field independence, a cognitive-style measure.

The three map formats were the following:

1. Intact, in which the maps were shown complete in one visual.

2. Additive, where the map's visual information was presented in a building-up sequence culminating with the entire map.

3. Part-by-Part, in which the map was divided conceptually and a portion was shown at a time.

A 3 x 3 research design was established for the study, with immediate recall as the dependent variable, and presentation mode and field-independence level as the independent variables. Ninety-two subjects completed the experiment. These were divided as equally as possible based on their GEFT scores into a three-way split. Scores from 1 to 10 made up the field dependent level, from 11 to 15, the moderately field independent level, and from 16 to 18, the field independent level. Divided in this manner, there were 29 field dependents, 30 moderates and 33 field independents. The overall mean GEFT score was 12.35. By selecting the experimental session they would attend, students unknowingly also selected the treatment which would occur, as treatments were randomly assigned to available time periods. The number of subjects receiving each treatment was unequal. There were 30 participants who received the Intact treatment, 36 for the Additive, and 26 for the Part-by-Part.

The literature suggests that math ability often correlates at a low but significant level with GEFT scores. In a summary of 13 studies reporting this statistic, the average was .29 (Witkin et al., 1977). Another Witkin article (Witkin, Moore, et al., 1977) reported correlations of .24 for men and .38 for women. To determine whether this would be true for the present study, a Pearson Product-Moment Correlation was computed between GEFT scores and Math SAT scores, grade point average (GPA), and Verbal SAT scores. GPA has not generally been found to relate to Embedded Figures performance. There have been low, usually non-significant correlations between GEFT and Verbal SAT. As expected, Math SAT scores were the only one of these variables to be significantly correlated with GEFT scores in this study, $r=.33$, $p< .01$. The correlation between GPA and Verbal SAT was non-significant, $r = -.09$, $p = .223$.

While it was assumed that the sample represented a typical college-level population, there was a chance that the treatment groups might differ in some aspect that might differentially affect their posttest scores. One-way analyses of variance were run comparing age, GPA, SAT scores, and GEFT scores for the three treatment groups. Group means for these variables are shown in Table 1. (Twenty-two students failed to report Math SAT; 23, Verbal SAT; and 2 did not report GPA.) In comparing means for Math SAT scores, the figure for the Part-by-Part treatment group appeared significantly higher; this was confirmed statistically, $F(2, 67) = 3.53$, $p < .05$. None of the other comparisons were significant, including GEFT scores, the stratifying variable. However, since math ability differed among the three treatment groups, and might have differentially affected performance on the dependent variable, it was necessary to provide a control; this was done by analysis of covariance. In this analysis, Math SAT was not a significant covariate, $F(2, 67) = .057$, $p = .813$. There were 22 missing cases for Math SAT scores. Since the covariate was not significant, the primary analysis (a two-way ANOVA) proceeded, using data from all 92 participants, under the assumption that while Math SAT scores were unequal among the groups, this did not have a significant effect on posttest performance. As for other potential confounding variables, due to the nature of the experimental materials (maps developed specifically for this study), it was assumed that prior knowledge would not be a significant factor since each student worked with his or her own set of materials. For the same reason, seating arrangements were not considered a factor.

Table 1

Means and Standard Deviations: Age, GPA, SATV, SATM and GEFT by Treatment

Characteristic	Treatment		
	Intact	Additive	Part-by-Part
n	30	36	26
Age			
M	22.90	21.67	23.23
SD	3.00	2.78	4.52
GPA			
M	2.55	2.61	2.76
SD	.52	.51	.62
SATM			
M	549.00	525.17	596.00
SD	86.27	73.86	105.21
SATV			
M	523.96	515.33	525.33
SD	97.26	73.86	71.20
GEFT			
M	13.40	11.53	12.27
SD	4.52	5.08	4.85

N = 92

Testing the Null Hypotheses

A level of .05 probability was set for all statistical tests in the study. A two-way analysis of variance was employed using the least squares regression approach. This is a recommended procedure when cell sizes are unequal and disproportionate, as was the case in this study (Hinkle, Wiersma, & Jurs, 1979).

Null Hypothesis One

There is no difference in performance on a recall objective test following a presentation consisting of Intact visuals versus a presentation of Additive sequential visuals or a presentation of Part-by-Part sequential visuals.

Means for the treatment groups were 40.47 for the Intact group, 41.28 for the Additive group, and 38.88 for the Part-by-Part group. Cell means are shown in Table 2. While the mean scores were highest for the Additive treatment, the differences were statistically nonsignificant; thus Null Hypothesis One was retained. There is no evidence from this study that any one of the three map presentation formats is superior.

Table 2

Cell Means: Posttest Scores by Field Dependence Level

Level of Field Dependence	Treatment: Intact	Treatment: Additive	Treatment: Part-by-Part
Field Dependent			
M	34.40	37.29	37.30
SD	9.94	7.79	10.18
n	5	14	10
Moderately Field Independent			
M	42.00	43.50	40.00
SD	6.08	5.93	4.43
n	14	10	6
Field Independent			
M	41.27	44.08	39.80
SD	7.68	6.37	7.55
n	11	12	10

Note. Maximum score = 60

Null Hypothesis Two

There is no difference in performance on a complex visual learning task between field-dependent, moderately field-independent, and field-independent students.

The means for each cognitive-style level were as follows: field dependent, 36.79; moderately field independent, 42.10; and field independent, 41.85. There was a significant difference for cognitive style (Table 3), indicating an association between level of field independence and posttest performance, $F(4, 83) = 4.64$, $p < .05$. Higher GEFT scores were associated with higher posttest scores. The results of a Tukey Multiple Comparison test (for unequal ns) indicated that the significant differences occurred between the field dependent and moderately field independent groups ($Q = 3.96$, $p < .05$), and between the field dependent and field independent groups ($Q = 3.77$, $p < .05$), but not between the moderately field independent and the field independent groups. Since there were differences in posttest preformance according to field dependence level, Null Hypothesis Two was rejected.

Null Hypothesis Three

There is no interaction between visual design format (Intact, Additive, or Part-by-Part) and the cognitive-style variable field dependence-independence.

The interaction effect as shown by the analysis was not significant.

Table 3

Summary ANOVA

Source	df	SS	MS	F	p
Field Dependence Level	2	509.87	254.94	4.64	.012
Treatment	2	128.52	64.26	1.17	.316
Interaction of Field Dependence Level by Treatment	4	78.90	19.73	.36	.837
Error	83	4561.36	54.96		
Total	91	5280.55	58.03		

A single design format was not found to be superior for a particular cognitive style. Therefore, Null Hypothesis Three was retained.

Additional Analysis

Examination of the mean posttest scores by field-independence level showed that the scores for the Part-by-Part treatment were clustered more closely than those of the other two treatments. It appeared that this treatment had resulted in smaller score differences among the three cognitive-style levels. It was decided to further analyze the mean scores for the cognitive styles in order to determine the source of the significant differences which had occurred for cognitive style. The Scheffé procedure was used to answer the question, "for which of the treatments was there a significant difference in posttest means according to cognitive style-level?" The results indicated that the only presentation mode which had resulted in significant differences was the Additive treatment, $F(4, 83) = 6.60$, $p < .05$.

Student Perceptions of the Experimental Task

Following the experiment, students were asked to rate the learning task and test according to five criteria. Each item was compared by treatment using a one-way analysis of variance to see if there were significant differences among the treatment groups in their perception of the task. There were no significant differences among the three treatment groups in their responses to the

Evaluation. Means and standard deviations for the entire sample, and for each of the treatment groups are shown in Appendix F. A response of "3" indicated the difficulty level was about right. Higher numbers meant "too much", i.e., too difficult or too long; lower numbers signified "not enough", i.e., "too easy" or "not enough time."

The final question on the Personal Data sheet was designed to elicit response as to how the students went about learning the maps. Students were asked if they used any special tricks or strategies to help them remember the map information. If so, they were to explain briefly what they did. Forty-two of the 92 participants described their strategies. In all cases, group means for the posttest were higher for those who responded than for the others (see Table 4). Mean GEFT scores of those who answered also tended to be higher. Those who scored in the high (field independent) range on the GEFT were twice as likely to report a strategy as those who scored in the low (field dependent) category.

Almost two-thirds of the participants in the Intact treatment reported a strategy. For the Additive treatment these numbers were almost reversed, with one-third responding. Nevertheless, those in the Additive group who responded scored an average of 3.5 points higher on the posttest than those who did not. For the Part-by-Part treatment, figures were more nearly equal among the reporting and non-reporting students. A summary of the student comments by treatment and field independence level is found in Appendix G.

Table 4

Students Who Verbalized a Map-Learning Strategy Versus Non-Respondents

	Treatment					
	Intact		Additive		Part-by-Part	
Strategy?	yes	no	yes	no	yes	no
n	19	11	12	24	11	15
GEFT Mean Scores	15.00	12.45	11.50	11.54	13.63	11.27
Posttest Mean Scores	41.47	38.73	43.75	40.25	39.64	38.33

Summary

An experiment to determine the relative effectiveness of three map presentation formats was performed using a sample of students at Virginia Tech. The cognitive-style continuum, field dependence-independence was also examined, focusing on its potential as a diagnostic tool for designing individualized visual learning materials. The learning materials in this study were a trio of maps, created by the experimenter as a complex visual format employing both visual symbolic and verbal information. No significant differences were found among three methods of presenting the map information: two treatments where the information was sequenced, and one where the information was left intact. However, when posttest scores were compared with GEFT scores, there was a difference in map learning based on cognitive style, with greater success shown by middle and high scorers on the GEFT, or those characterized as being more field-independent (higher in cognitive restructuring ability). Finally, there was no interaction exhibited between the treatments and cognitive style. That is, field dependent learners did not find one treatment more effective, nor did field independents. The implications of these results, limitations of the study, and suggestions for further research are discussed in Chapter V.

Chapter V

SUMMARY AND DISCUSSION

An increased interest in individual differences among learners and how best to approach these differences in developing learning strategies and supporting materials has led to active experimentation and inquiry concerning the role of cognitive-style variables. Cognitive-style measures are promising as they seem to indicate *how* an individual processes information. Field dependence-independence has been examined more closely than other cognitive styles, no doubt because it describes characteristics which are so directly applicable to the learning process. Measures of field dependence such as the GEFT employed in this study are arguably tests of ability. In fact, the aspect of field dependence-independence that is tapped by the GEFT has been identified as cognitive restructuring ability. There is certainly a strong visual-spatial element in field dependence-independence (Goodenough & Karp, 1961; Linn & Kyllonen, 1981). For this reason researchers have attempted to design visual instruction according to the characteristics of field-dependent and independent learners, hoping to capitalize on strengths and compensate for weaknesses.

In this study, visual information in the form of maps was presented in three design formats designed to take advantage of particular cognitive-style orientations. These three formats consisted of (a) intact maps, (b) maps sequenced by concept, with a building of information toward the whole, and (c) maps sequenced by concept with each portion shown individually.

The first research question asked whether one of these alternative design formats would be superior for learning information from maps. The second question considered whether the cognitive style field dependence-independence played a role in map learning. Past studies had indicated that learners who were higher in field independence were better map learners. Finally, would there be an interaction between treatment and cognitive style? Would field-dependent students learn more effectively from one of the design formats, and field independents from another?

Review of Experiment

Ninety-two students, both undergraduate and graduate at Virginia Tech, took part in an experiment to determine the relative effectiveness of three map presentation formats on immediate recall. The three formats were titled Intact, Additive, and Part-by-Part. The sequencing of information on the maps was as follows:

Intact

Step 1: complete map

Additive

Step 1: map outline with political divisions

Step 2: map outline with political divisions + geographic features

Step 3: map outline with political divisions + geographic features + cities, towns, roads, and railroads (complete map)

Part-by-Part

Step 1: map outline with political divisions

Step 2: geographic features

Step 3: cities, towns, roads, and railroads

Step 4: complete map

The Intact treatment was conceived as requiring the greatest amount of strategy selection and active processing by the learner. The Additive was seen as a "mid-level" treatment, where the information was not broken up to the same extent as the third treatment, the Part-by-Part. It should be noted that as a part of each of the treatments, the students saw the entire map, in order to provide a sense of context.

The three treatments were randomly assigned to groups. All sessions were identical, except for treatment. All students first took the Group Embedded Figures Test to establish their field independence level. Then the experimental task was explained, sample maps and questions were shown using overhead transparencies, and the task proceeded. Finally demographic information and a brief evaluation were submitted. Data from the 3 X 3 research design were analyzed using analysis of variance. The dependent variable was immediate recall of map information as evidenced by a visual-verbal posttest, and independent variables were treatment (map presentation format) and cognitive style (field-dependent-independent modes). The only statistically significant variable was cognitive style. Students who were classified as field independent tended to score higher on the map-learning posttest. Previous studies have shown a relationship between map-learning ability and field independence, which was confirmed by this experiment (Stasz & Thorndike, 1980; Shaha, 1982).

Students were asked to evaluate the instructional task, and to describe the strategies they used for learning the maps. Forty-two of the 92 did describe their strategies, and these were fairly evenly divided among visual and verbal strategies. Participants in the Intact treatment were twice as likely to describe a strategy as those in the other treatments. Students who recorded their strategies scored higher on the posttest and had higher GEFT scores than those who left this question unanswered.

Discussion

This study was undertaken to find out if visual learning materials could be manipulated in such a way as to make them easier to learn for students categorized as field dependent, moderately field independent, or field independent. Previously, researchers (Ausburn & Ausburn, 1978; Heidt, 1977) have suggested breaking up or sequencing information as ways to reduce complexity and provide an externally dictated structure.

Since field-dependent learners are generally characterized as passive and less able to break up and restructure an organized field, as well as less able to deal with complex information than their field-independent counterparts, it seemed reasonable that a form of manipulation which provided structure and separated complex information into more manageable amounts would aid learning by field dependents. There was a trend for field dependents to score higher with the two sequenced treatments than with the Intact, but it was not statistically significant.

For the moderate and high field independents, mean scores were slightly higher for the Additive treatment, but again the differences were not statistically significant. It is possible that several factors may have contributed to the nonsignificant outcome for the treatment variable. First, there is a chance that for this type of complex visual, performance cannot be easily altered by dividing and sequencing manipulations--if performance is influenced more by ability factors than strategy selection, for example. Or perhaps an appropriate instructional format simply was not found. It seems likely that an important factor was the small size of the sample. The types of differences that show up in ATI studies often require large samples before significant differences are revealed (Cronbach & Snow, 1977).

The results did indicate that field-independent learners are more adept overall than field dependents at learning map information. The differences in mean posttest scores among cognitive style levels were most evident, however, in the Additive treatment. In some of the research cited in the literature review (e.g., Dickie, 1969/1970; Hessler, 1972/1973), manipulations designed to aid field dependents, actually were more beneficial to field independents. This might have been the case for the Additive treatment. With their more active approach, field independent learners were better able to take advantage of a format where the information level was not too great, but the relationship among the conceptual categories was pronounced. In spite of designing lower information load and smaller size of step into the Additive treatment, perhaps its level of complexity was still better adapted to the field-independent orientation.

The general superiority of field independents on the experimental task may be related to attributes discussed in Chapter II: greater organizational ability, ability to structure and restructure and break up a field, along with superior attentional capability. It may also be due in part to the visual-spatial ability component of field independence or to superior memory efficiency (Linn & Kyllonen, 1981; Berger & Goldberger, 1979; Davis & Frank, 1979). Visual memory, which here was not studied directly, correlated with the GEFT in Stasz and Thorndike's research (1980). (It makes sense that visual memory would play a part; after all accurate performance on the GEFT requires the student to remember the simple figure while searching for it.) The flexibility of field independents has been emphasized by Davis and Cochran (1982), Frank (1983), and Fleming (1984). It takes longer for field dependents to shift attention. Perhaps the time limits imposed in this experiment affected performance by field dependents, in that they could not shift attention at their own pace.

In any examination of why field dependents on the whole were unable to match the performance of field independents, other factors must be considered including the fact that the posttest was somewhat different in format from the learning task. Small sections from the maps were shown in the visual portion of the posttest, whereas the maps had been divided conceptually during the learning task. Dealing with these differences in format may have been more difficult for field dependents, because not only did the learning task require restructuring, but also, the posttest. Fleming (1984) found field-independent learners to be more adaptive, a requirement for completing the tests after seeing the maps in a different format. If this were strongly influencing performance, however, one might have expected the field dependents to do better with the Intact treatment, and this was not the case.

There are other possible influences which were not investigated in this study. Perhaps the anxiety level of field dependents was higher as they undertook the task. Since all students had just completed the Group Embedded Figures Test prior to the map task, they surely had some idea of how they fared, which might have induced anxiety in some of the students. The subject matter itself (fictitious maps) could have been somewhat frustrating; some of the students may have lacked motivation to learn something that was not "real"-- they may have felt it was a waste of time.

There is still uncertainty as to how to categorize field independence. Is field independence general (or *verbal*) intelligence as Cooperman (1980) and others (Vernon, 1972; Zigler, 1963) maintain? This study would seem to indicate that it is not. Cooperman found significant correlations between field independence and Verbal SAT scores. This research tended to reconfirm Witkin's (Witkin, Moore, et al., 1977), with low, non-significant (negative) correlations for Verbal SAT. Also, like Witkin's study, grade point average was not really related to GEFT performance. In fact there was also a very slight negative correlation between GPA and GEFT. Field dependence-independence may be, as Wise (1984) believes, more than one ability.

One interesting aspect of this experiment was the response to the question on the evaluation concerning strategies employed. Students were more likely to report a strategy if they received the Intact treatment. Almost two-thirds of these students described how they went about learning the map information. This treatment, of course, required the most active response from the learner. Only one-third of the Additive group reported a strategy. This is probably because an external strategy was provided for the students in the Additive condition.

Limitations of the Study

The results of this study apply to similar samples from a college student population. A larger sample might have more accurately reflected treatment differences. This researcher assumed that self-reported information including SAT scores was correct, but the possibility of inaccuracies in such information should not be discounted. The ability to generalize to the general population is limited by the fact that GEFT scores were skewed toward the high end of the continuum, although the entire range of scores was represented. In retrospect, it appears that a split of highs and lows, 1-10 for low and 11-18 for high, might have better represented the two cognitive-style orientations; however, this would have produced groups that were quite unequal in size. Sex as a variable was not considered in this study, although there have been sex differences reported in past cognitive-style research (e.g., Grieve & Davis, 1971). The present sample was predominantly female, thus the results should only be considered representative for a sample of similar composition.

The maps used in this study were experimenter-developed learning materials, designed specifically for this study. As such, their validation has been somewhat limited. It is also true that in order to construct a controlled experimental setting, there is sacrifice as far as "real world" applicability.

These results apply to immediate recall only; higher-level learning, long-term memory effects, or delayed learning effects may be different. This was a brief learning task; results may be different for other types of map-learning routines (for example, a case where the learner rehearses, does a self-check, quits for awhile, then returns to the task).

Recommendations for Future Research

How to divide visual information optimally for individual learners is an important consideration in instructional design, one that has not been thoroughly resolved. The results of this study indicate that cognitive style plays a role in learning from visuals, but they do not provide conclusive evidence about how to manipulate visuals during the design process to provide greater effectiveness for individual differences. Questions arise such as "are there better ways of dividing information for optimal learning?" Would a breaking-down instead of building-up, for example, be more effective? This would allow the learner to see the overall organization before dealing with the parts.

One might even ask if it is necessary to manipulate the visual at all, or would some sort of training in strategy selection be more efficient? Shimron (1978) had some success with simply dividing a map into thirds. Such strategies as having the student cover part of the visual and reveal increasing amounts would require no manipulation of the material by the instructional designer. Perhaps instead it would be more effective to provide alternative learning experiences for field dependents that would not rely heavily on spatial ability.

For future research, more emphasis might be placed on the student's self-reported learning strategies, and preferred learning modes. A study similar to the present one, but without time constraints (rather, using time as a variable) might provide insight;

i.e., would field dependents' performance match that of field independents', given more time?

More studies on scanning strategies are needed. The following are some of the questions that might be considered: Are all parts of a map attended to equally; if not, what effect is had on learning; are there ways to compensate for uneven attending behavior; does what is learned about maps also apply to other types of diagrams and charts where a spatial layout is employed, and visual information is combined with verbal labels?

A worthwhile follow-up study to the present one would work with individual learners rather than groups. By the design of the visual stimulus, the student would be given the opportunity to determine his or her own sequencing strategy. Time to mastery would be a variable, and reporting of strategy selection would be emphasized. Delivery systems such as interactive video might be further investigated in concert with the manipulations used in this study This would allow the learner freedom to make his or her own choices as to presentation format from numerous possible combinations of overlays and sequencing effects.

References

Allen, W. H. (1975). Intellectual abilities and instructional media design. AV Communication Review, 23 , 139-170.

Ausburn, L. J., & Ausburn, F. B. (1978). Cognitive styles: Some information and implications for instructional design. Educational Communications and Technology Journal, 26, 337-354.

Berger, E., & Goldberger, L. (1979). Field dependence and short-term memory. Perceptual & Motor Skills, 49, 87-96.

Bracht, G. H. (1970). Experimental factors related to aptitude-treatment interactions. Review of Educational Research, 40, 627-641.

Briggs, L. (1968). Learner variables and educational media. Review of Educational Research, 38, 160-194.

Canelos, J. & Taylor, W. (1981). A networking information processing strategy and the learning of field dependents receiving visual instructional information. Journal of Experimental Education, 50, 42-46.

Canelos, J. J., Taylor, W. D., & Gates, R. B. (1980), The effects of three levels of visual stimulus complexity on the information processing of field-dependents and field-independents when acquiring information for performance on three types of instructional objectives. Journal of Instructional Psychology, 7, 65-70.

Cattell, R. B. (1971). Abilities: Their structure, growth and action. Boston: Houghton Mifflin.

Clark, R. E. (1978). Five promising directions for media research. In J. W. Brown (Ed.), Educational Media Yearbook, (pp. 99-103). New York: R. R. Bowker.

Clark, R. E. (1983). Reconsidering research on learning from media. Review of Educational Research, 53, 445-459.

Clark, R. E., & Salomon, G. (1986) Media in teaching. In M. C. Wittrock (Ed.), Handbook of Research on Teaching (3rd ed., pp. 464-478). New York: MacMillan.

Cooperman, E. W. (1980). Field differentiation and intelligence. Journal of Psychology, 105, 29-33.

Corno, L, & Snow, R. E. (1986) Adapting teaching to individual differences among learners. In M. C. Wittrock (Ed.), Handbook of Research on Teaching (3rd ed., pp. 605-629). New York: MacMillan.

Coward, R. T., & Lange, G. (1979). Recall and recall-organization behaviors of field dependent and field independent children. Psychological Reports, 44, 191-197.

Cronbach, L. J., & Snow, R. E. (1977). Aptitudes and instructional methods. New York: Irvington.

Davis, J. K., & Cochran, K. F. (1982). Toward an information processing analysis of field independence. New York: Paper presented at the annual meeting of the American Educational Research Association. (ERIC Document Reproduction Service No. ED 221 551)

Davis, J. K., & Frank, B. M. (1979). Learning and memory of field dependent-independent individuals. Journal of Research in Personality, 13, 469-479.

Davis, J. K., & Klausmeier, H. J. (1970). Cognitive style and concept identification as a function of complexity and training procedures. Journal of Educational Psychology, 61, 423-430.

Dickie, K. E. (1970). Effects of compressing visual information and field dependence on acquiring a procedural skill. Dissertation Abstracts International, 31, 662A.

Dwyer, F. M. (1972). A guide for improving visualized instruction. State College, PA.: Learning Services.

Dwyer, F. M. (1978). Strategies for improving visual learning. State College, PA.: Learning Services.

Elliot, C. A. (1976). The effect of instructional designs matched to individual differences in cognitive styles on concept learning: A trait-treatment interaction study. Los Angeles: University of Southern California. (ERIC Document Reproduction Service No. ED 122 973)

Fleming, M. L. (1984). Visual attention to picture and word materials as influenced by characteristics of the learners and design of the materials. Dallas, TX: Paper presented at the annual meeting of the Association for Educational Communications and Technology. (ERIC Document Reproduction Service No. ED 243 420)

Fleming, M. L., Knowlton, J. Q., Blain, B. B., Levie, W. H., & Elerian, A. (1968). Message design: The temporal dimension of message structure. Bloomington, IA: Indiana University. (ERIC Document Reproduction Service No. ED 023 294)

Fleming, M., & Levie, W. H. (1978). Instructional message design. Englewood Cliffs, NJ: Educational Technology Publications.

Frank, B. M. (1983). Flexibility of information processing and the memory of field-independent and field-dependent learners. Journal of Research in Personality, 17, 89-96.

Gagné, R. M. (1977). The conditions of learning (3rd ed.). New York: Holt, Rinehart, and Winston.

Gardner, R. W., Jackson, D. N., & Messick, S. J. (1960). Personality organization in cognitive controls and intellectual abilities. Psychologcal Issues, 2 (4, Whole No. 8).

Goldstein, K. M., & Blackman, S. (1978). Cognitive styles: Five approaches and relevant research. New York: John Wiley & Sons.

Goodenough, D. R. (1976). The role of individual differences in field dependence as a factor in learning and memory. Psychological Bulletin, 83, 675-694.

Goodenough, D. R., & Karp, S. A. (1961). Field dependence and intellectual functioning. Journal of Abnormal and Social Psychology, 63, 241-246.

Gottschaldt, K. (1926). Uber den einfluss der erfahrung auf die wahrnehmung vin figuren 1, uber den einfluss gehaufter eingragung von figuren auf ibre sichtbarkeit in umfassenden konfigurationen. Psychol. Forsch., 8, 261-317.

Grieve, T. D., & Davis, J. K. (1971). The relationship of cognitive style and method of instruction to performance in ninth grade geography. Journal of Educational Research, 65, 137-141.

Heidt, E. U. (1977). Media and learner operations: The problem of a media taxonomy revisited. British Journal of Educational Technology, 8, 11-26.

Hessler, D. W. (1973). Interaction of "visual compression" and field-dependence in relation to self-instruction and transfer. Dissertation Abstracts International, 33, 6235-A. (University Microfilms No. 73-12735)

Hinkle, D. E., Wiersma, W., & Jurs, S. G. (1979). Applied statistics for the Behavioral Sciences. Boston: Houghton Mifflin.

Jamison, D., Suppes, P., & Wells, S. (1974). Effectiveness of alternative instructional media: A survey. Review of Educational Research, 44, 1-67.

Jennings, T., & Dwyer, F. (1985). The instructional effect of different cueing strategies in facilitating student achievement of different educational objectives. International Journal of Instructional Media, 12, 8-20..

Karp, S. A. (1963). Field dependence and overcoming embeddedness. Journal of Consulting Psychology, 27, 294-302.

Kogan, N. (1980). A cognitive-style approach to metaphoric thinking. In R. E. Snow, P-A. Federico, & W. E. Montague (Eds.), Aptitude, Learning and Instruction: Vol. 1. Cognitive process analyses of aptitude (pp. 247-272). Hillsdale, NJ: Lawrence Erlbaum.

Kogan, N. (1970). Educational implications of cognitive styles. In G.S. Lesser (Ed.), Psychology and Educational Practice (pp. 242-292). Glenview, IL.: Scott, Foresman.

Kulhavy, R. W., Schwartz, N. H., & Shaha, S. H. (1982). Interpretative framework and memory for map features. American Cartographer, 9, 141-147.

Levie, W. H., & Dickie, K. E. (1973). The analysis and application of media. In R. M. W. Travers (Ed.), Second Handbook of Research on Teaching (pp. 858-882). Chicago: Rand McNally.

Linn, M. C., & Kyllonen, P. (1981). The field dependence-independence construct: Some, one, or none. Journal of Educational Psychology, 73, 261-273.

MacEachren, A. M. (1982). Map complexity: Comparison and measurement. American Cartographer, 9, 31-46.

May, M. A. (1965). Enhancements and simplifications of motivational and stimulus variables in audiovisual instructional materials. Hamden, CT. (ERIC Document Reproduction Service No. ED 003 169)

Messick, S. (1984). The nature of cognitive styles: Problems and promise in educational practice. Educational Psychologist, 19, 59-75.

Messick, S., (Ed.). (1976). Individuality in learning: Implications of cognitive styles and creativity for human development. San Francisco: Jossey-Bass.

Nahinsky, I. D., Morgan, M. S., & Oeschger, D. E. (1979). Cognitive strategies, field dependence, and the abstraction process. Journal of Research in Personality, 13, 490-504.

Paivio, A. (1971). Imagery and verbal processes. New York: Holt.

Robinson, J. A., & Bennink, C. D. (1978). Field articulation and working memory. Journal of Research in Personality, 12, 439-449.

Salomon, G. (1972). Can we affect cognitive skills through visual media? an hypothesis and initial findings. AV Communication Review, 20, 401-422.

Salomon, G. (1974). Internalization of filmic schematic operations in interaction with learners' aptitudes. Journal of Educational Psychology, 66, 499-511.

Salomon, G., & Clark, R. E. (1977). Reexamining the methodology of research on media and technology in education. Review of Educational Research, 47, 99-120.

Satterley, D. J., & Telfer, I. G. (1979). Cognitive style and advance organizers in learning and retention. British Journal of Educational Psychology, 49, 169-178.

Schwen, T. M. (1970). The effect of cognitive styles and instructional sequences on learning a hierarchical task. Dissertation Abstracts International, 31, 2797A-2798A. (University Microfilms No. 70-23, 380)

Shaha, S. H. (1982). *Cognitive processes functional in spatial recall*. Los Angeles: California University. (ERIC Document Reproduction Service No. ED 228 271)

Shimron, J. (1978). Learning positional information from maps. *American Cartographer*, *5*, 9-19.

Snow, R. E. (1977). Individual differences and instructional theory. *Educational Researcher*, *6*, 11-15.

Snow, R. E., (1980). Aptitude processes. In R. E. Snow, P. A. Federico, & W. E. Montague (Eds.), *Aptitude, Learning and Instruction: Vol. 1. Cognitive process analyses of aptitude* (pp. 27-63). Hillsdale, NJ: Lawrence Erlbaum.

Snow, R. E., & Lohman, D. F. (1984). Toward a theory of cognitive aptitude for learning from instruction. *Journal of Educational Psychology*, *76*, 347-376.

Stasz, C. M., & Thorndike, P. W. (1980). The influence of visual-spatial ability and study procedures on map learning skill (Research report no. N-1501-ONR). Santa Monica, CA: Rand.

Sutherland, S., & Winn, W. (1987, February). *Effect of the number and nature of features and of general ability on the simultaneous and successive processing of maps.* Paper presented at the meeting of the Association for Educational Communications and Technology, Atlanta, GA.

Thorndike, P. W. (1979). *Heuristics for knowledge acquisition from maps*. (Rand Note N-1193-ONR) Santa Monica, CA. (ERIC Document Reproduction Service No. ED 184 948)

Tobias, S. (1973). Sequence, familiarity, and ATI in programmed instruction. *Journal of Educational Psychology*, *64*, 133-141.

Vernon, P. E. (1972). The distinctiveness of field independence. *Journal of Personality*, *40*, 366-391.

Wachtel, P. L. (1968). Style and capacity in analytic functioning. *Journal of Personality*, *36*, 202-212.

Winn. W. (1982), Visualization in learning and instruction: A cognitive approach. *Educational Communications and Technology Journal*, *30*, 3-25.

Wise, R. E. (1984) The role of field independence in visual information processing. International Journal of Instructional Media, 11, 133-140.

Witkin, H. A., & Asch, S. E. (1948). Studies in space orientation IV: Further experiments on perception of the upright with displaced visual fields. Journal of Experimental Psychology, 38, 762-782.

Witkin, H. A., Dyk, R. B., Faterson, H. F., Goodenough, D. R., & Karp, S. A. (1962). Psychological Differentiation. New York: John Wiley & Sons.

Witkin, H. A., & Goodenough, D. R. (1981). Cognitive styles: Essence and origins. New York: International Universities Press.

Witkin, H. A., Lewis, H. B., Hertzman, M., Machover, K., Meissner, P. B., & Wapner, S. (1954). Personality through perception. New York: Harper.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 47, 1-64.

Witkin, H. A., Moore, C. A., Oltman, P. K., Goodenough, D. R., Friedman, F., Owen, D. R., & Raskin, E. (1977). Role of the field-dependent and field-independent cognitive styles in academic evolution: A longitudinal study. Journal of Educational Psychology, 69, 197-211.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A. (1971). A Manual for the embedded figures tests. Palo Alto, CA: Consulting Psychologists Press.

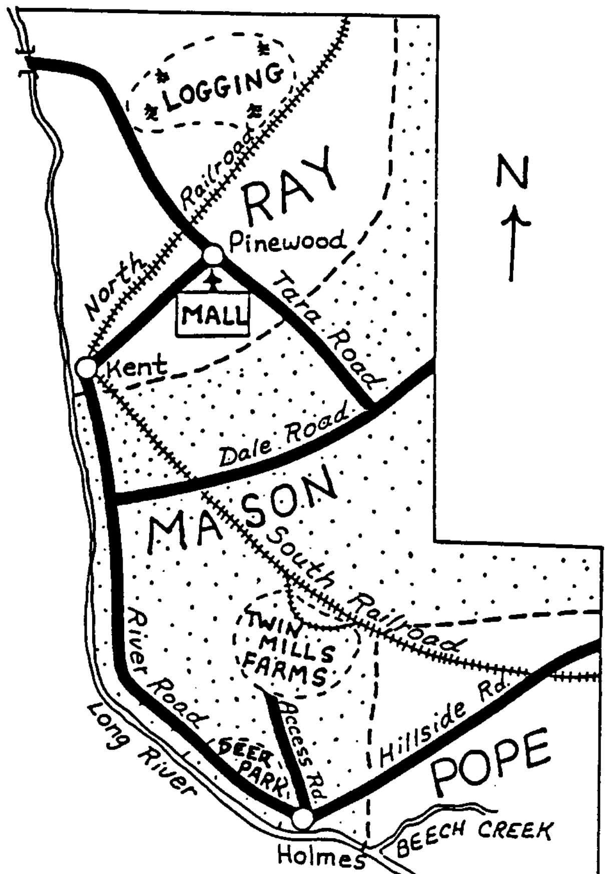
Zigler, E. A. (1963). A measure in search of a theory. Contemporary Psychology, 8, 133-135.

Appendix A

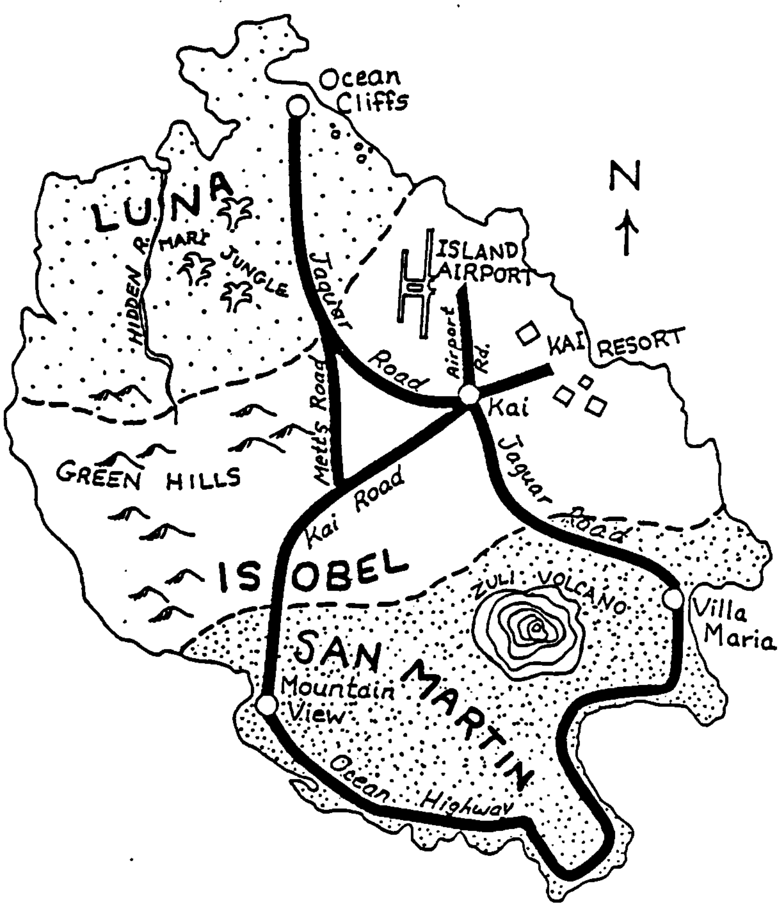
MAP LEARNING TASK BOOKLET: INTACT TREATMENT

MAP LEARNING TASK

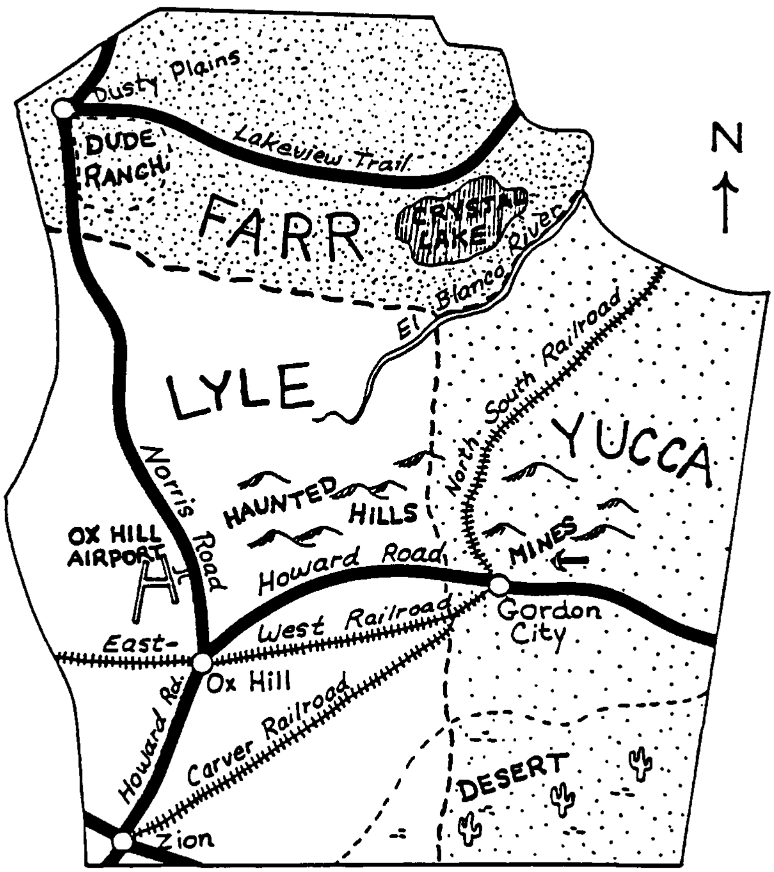
SMALL COUNTY, consisting of three townships



TROPICAL ISLAND, an island composed of three provinces



WESTERN STATE, a state composed of three counties

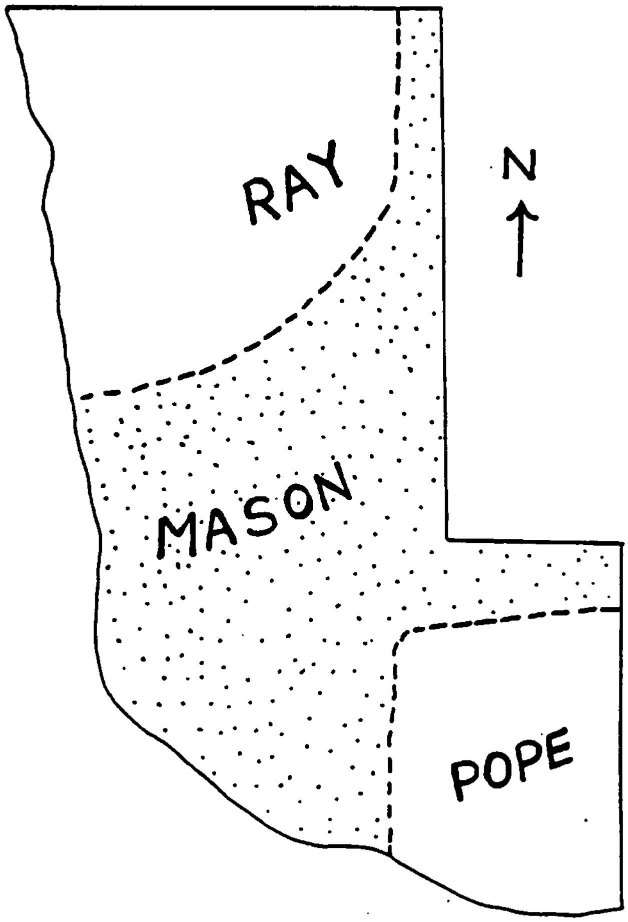


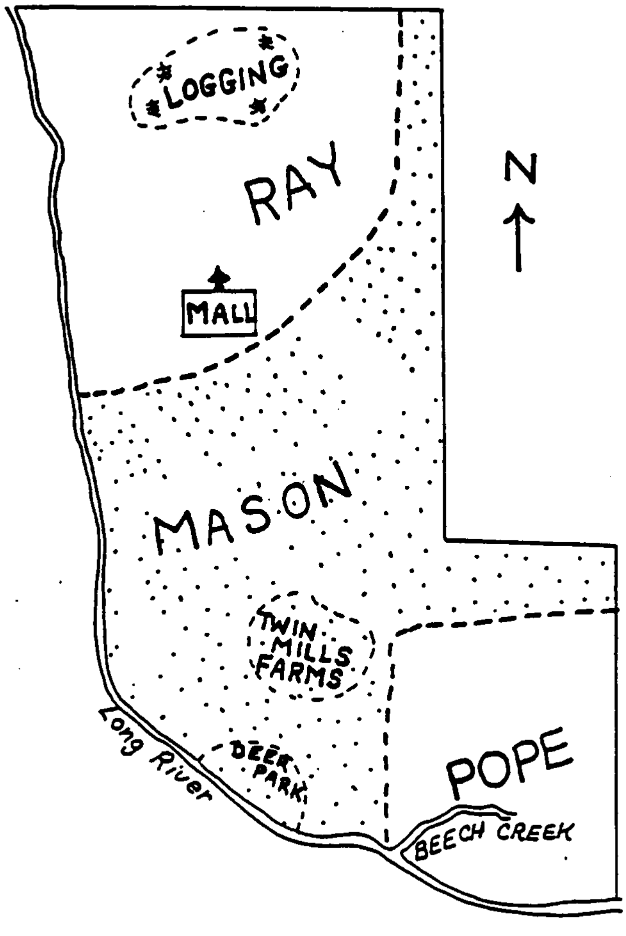
Appendix B

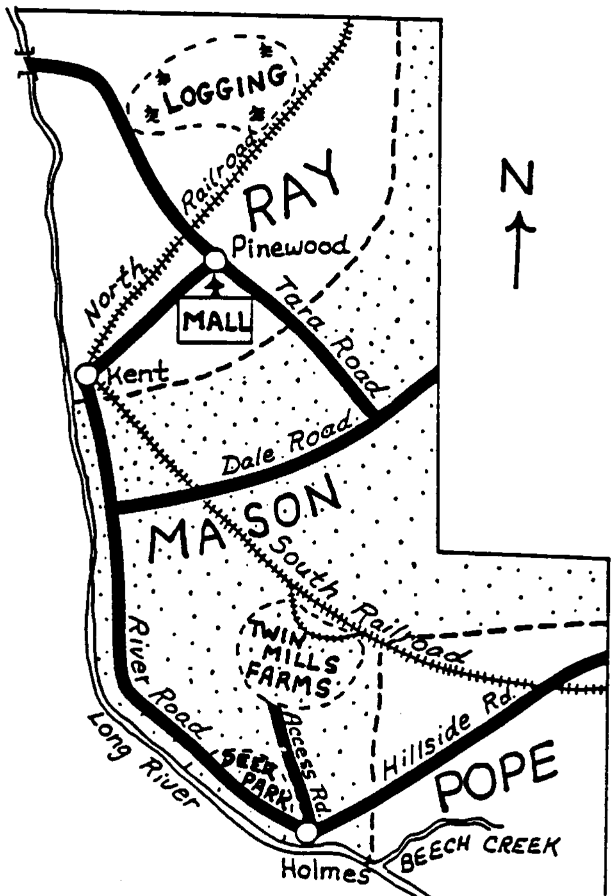
MAP LEARNING TASK BOOKLET: ADDITIVE TREATMENT

MAP LEARNING
TASK

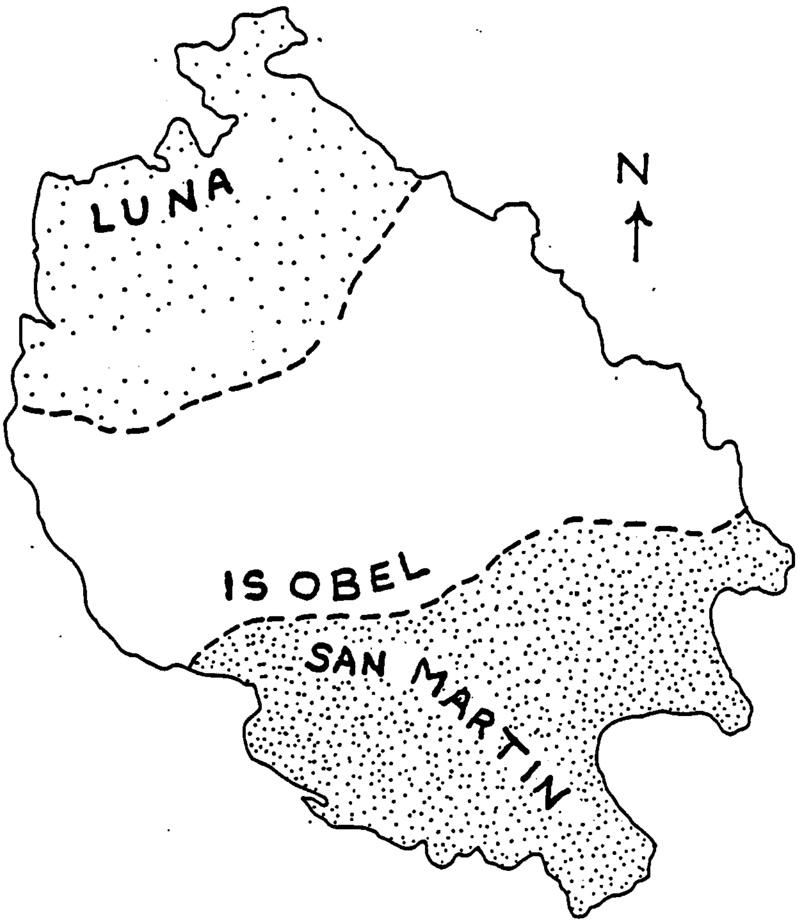
SMALL COUNTY, consisting of three townships

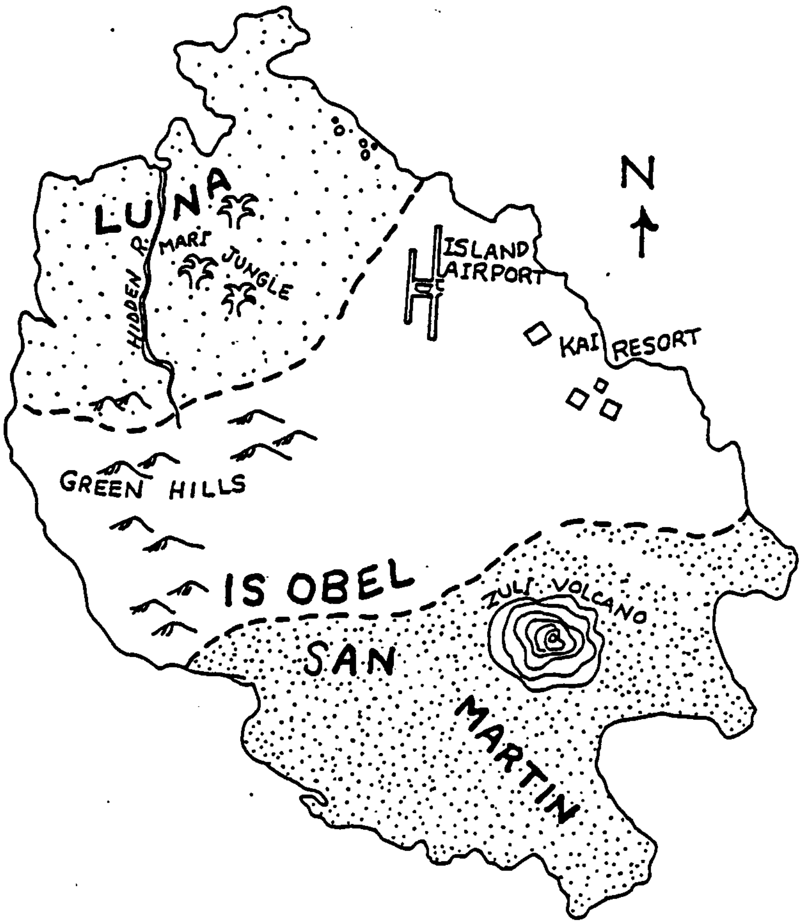


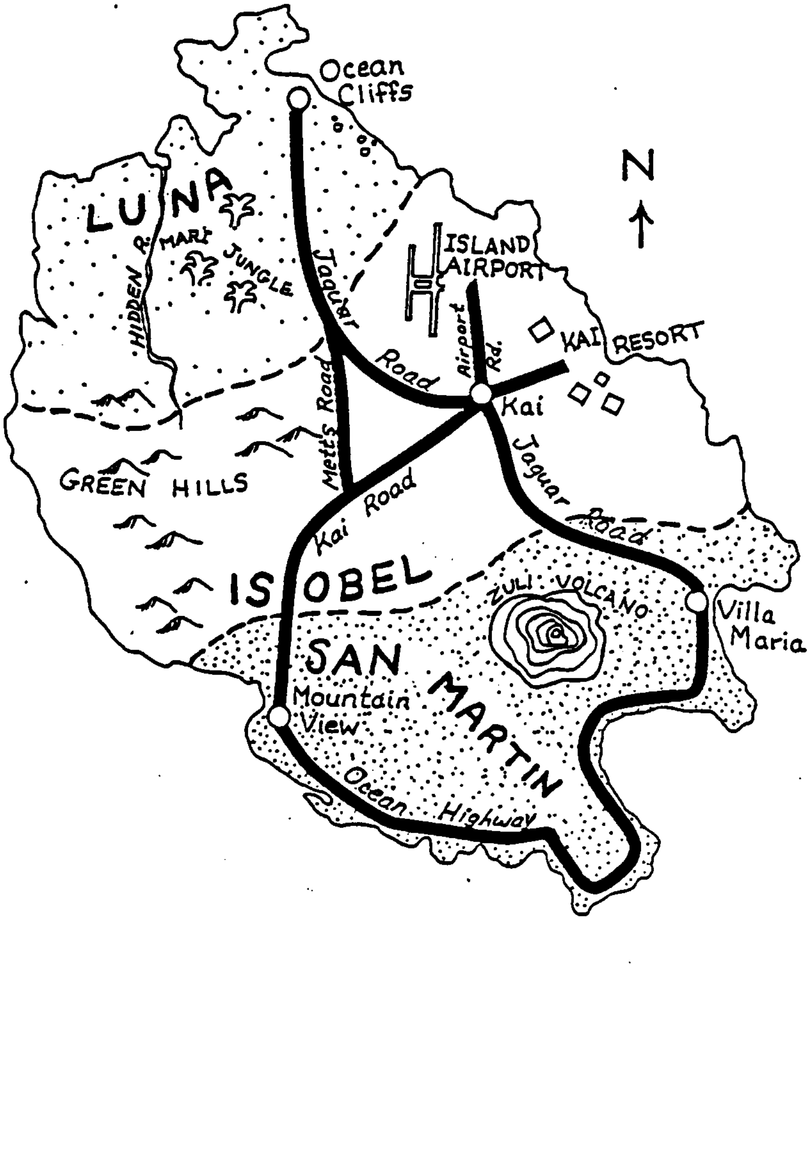

LOGGING
RAY
MALL
N
MASON
TWIN MILLS FARMS
DEER PARK
Long River
POPE
BEECH CREEK


LOGGING
North Railroad
RAY
Pinewood
MALL
Tara Road
Kent
Dale Road
N
MASON
South Railroad
TWIN MILLS FARMS
River Road
Long River
SEER PARK
Access Rd.
Hillside Rd.
POPE
BEECH CREEK
Holmes

TROPICAL ISLAND, an island composed of three provinces

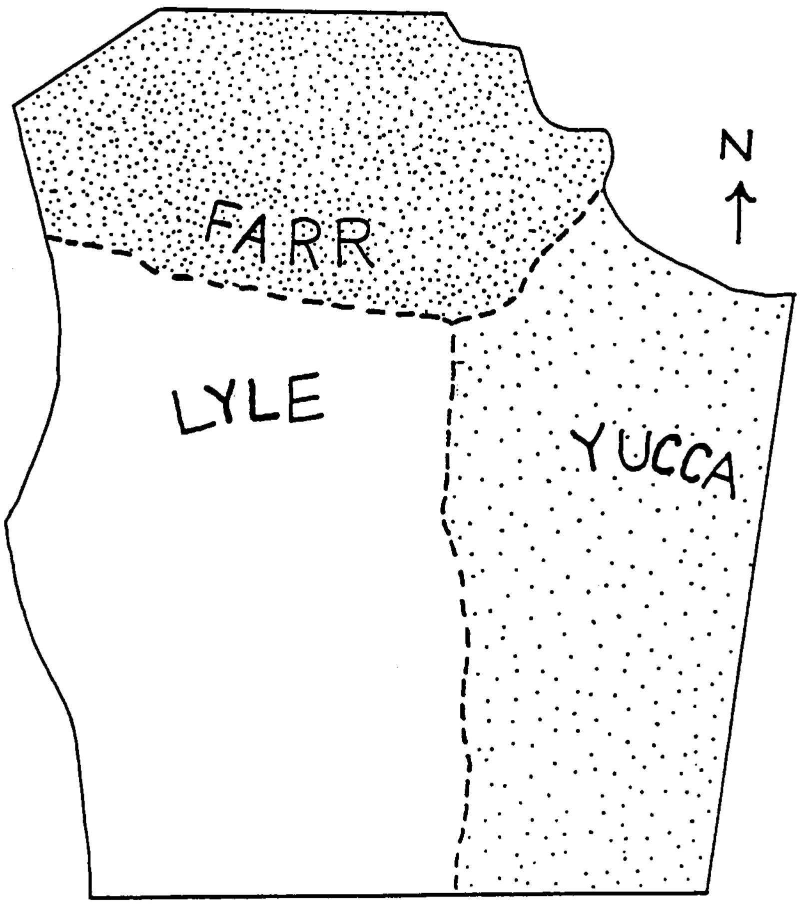


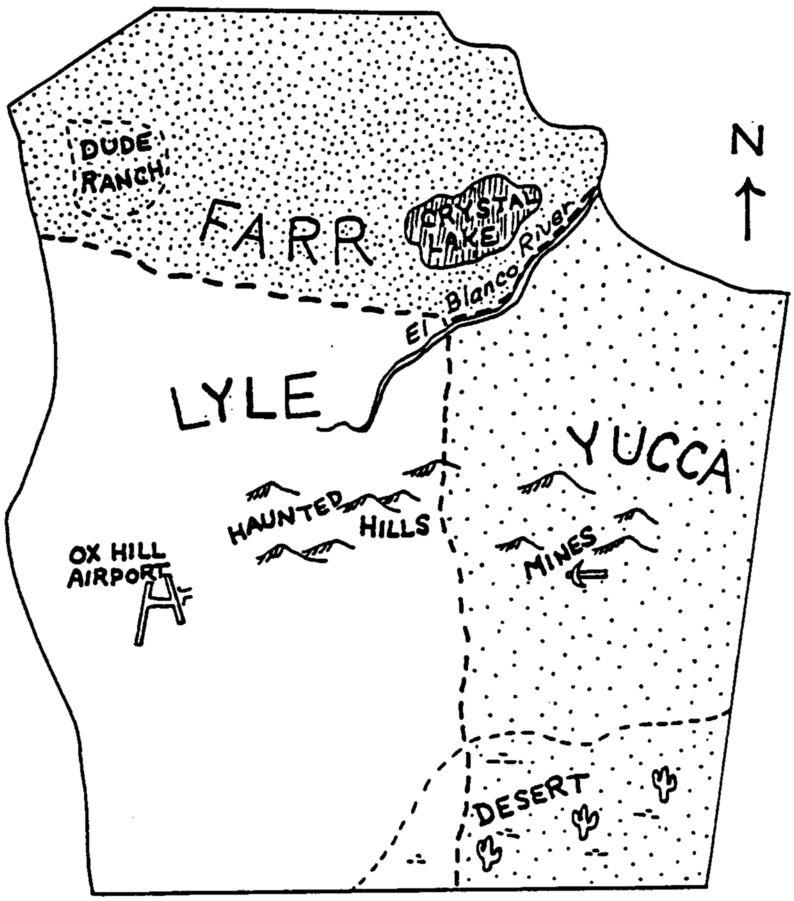

N
LUNA
HIDDEN R.
MARI
JUNGLE
ISLAND
AIRPORT
KAI RESORT
GREEN HILLS
IS OBEL
ZULI VOLCANO
SAN
MARTIN



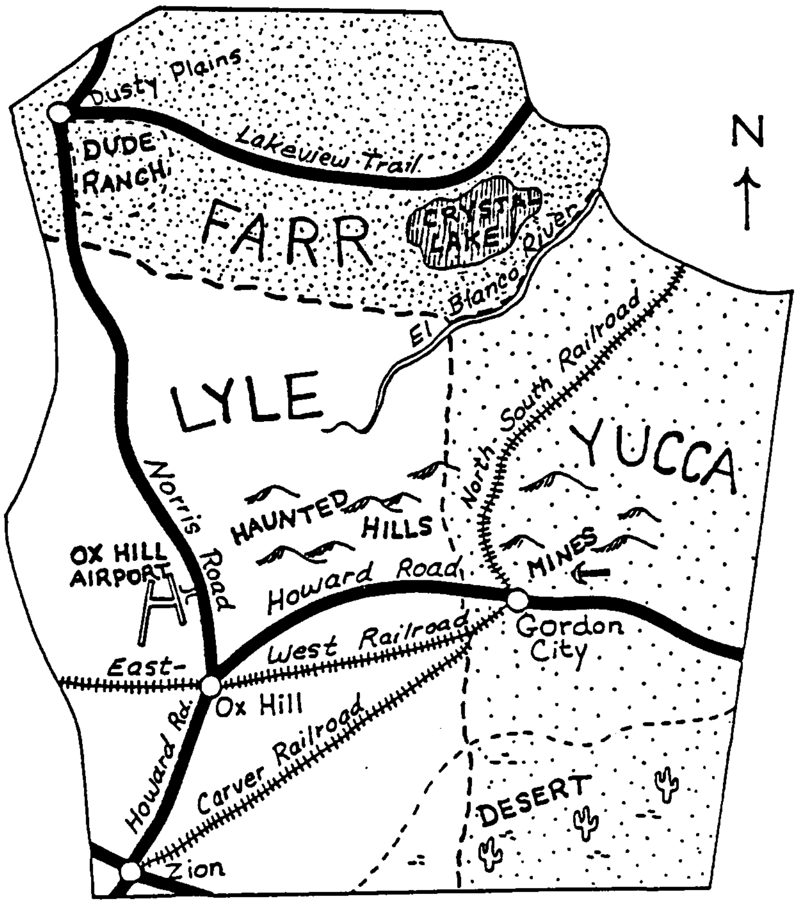
Ocean Cliffs
LUNA
HIDDEN R.
MARI
JUNGLE
Jaguar
ISLAND AIRPORT
N
Airport Rd.
KAI RESORT
Road
Kai
Mett's Road
GREEN HILLS
Kai Road
Jaguar Road
ISOBEL
ZULI VOLCANO
Villa Maria
SAN MARTIN
Mountain View
Ocean Highway

WESTERN STATE, a state composed of three counties





DUDE RANCH
FARR
CRYSTAL LAKE
El Blanco River
LYLE
YUCCA
HAUNTED HILLS
OX HILL AIRPORT
MINES
DESERT
N

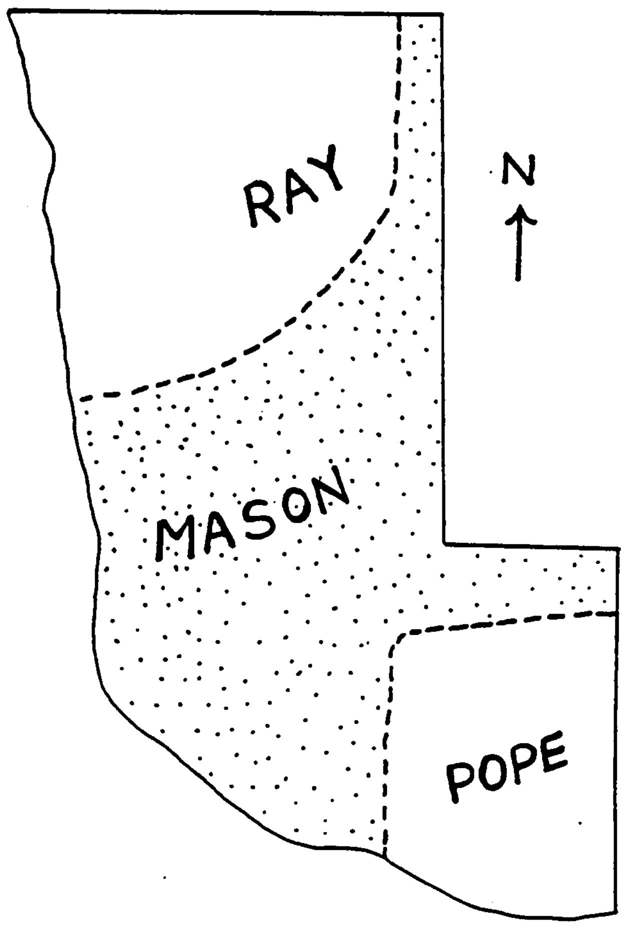

Dusty Plains
DUDE RANCH
Lakeview Trail
FARR
CRYSTAL LAKE
El Blanco River
North South Railroad
LYLE
YUCCA
Norris Road
HAUNTED HILLS
OX HILL AIRPORT
Howard Road
MINES
Gordon City
West Railroad
East-
Ox Hill
Howard Rd.
Carver Railroad
DESERT
Zion
N

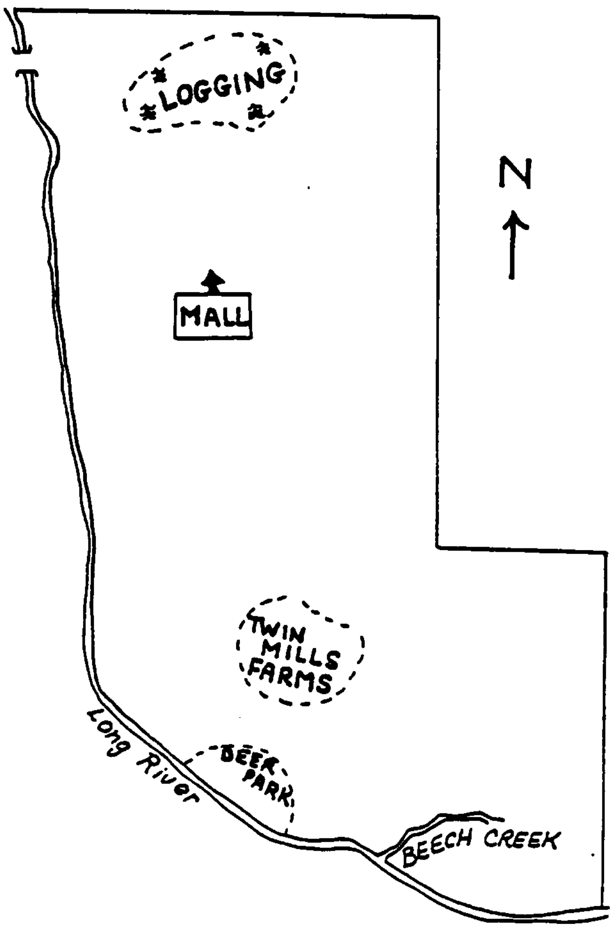
Appendix C

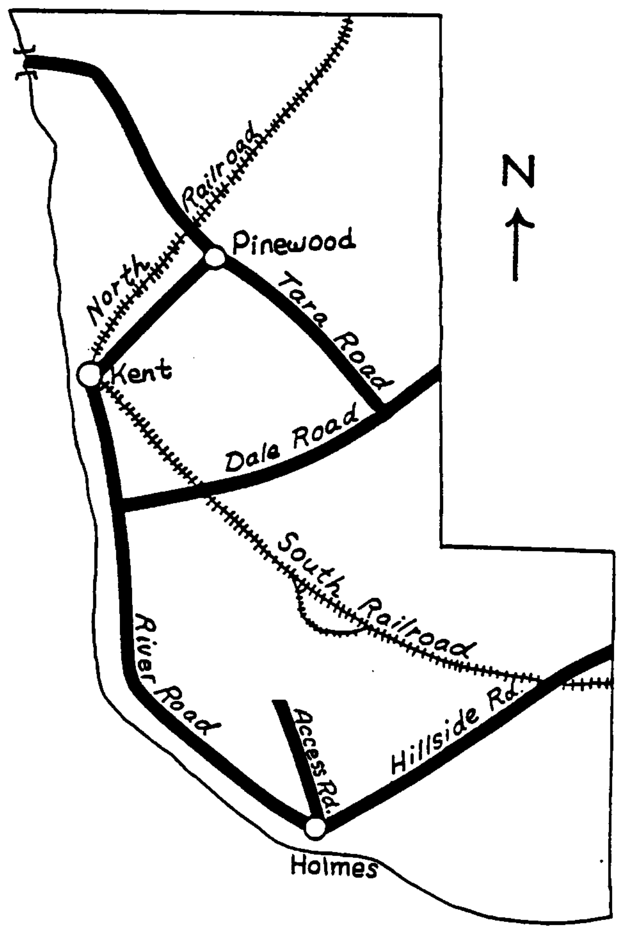
MAP LEARNING TASK BOOKLET: PART-BY-PART TREATMENT

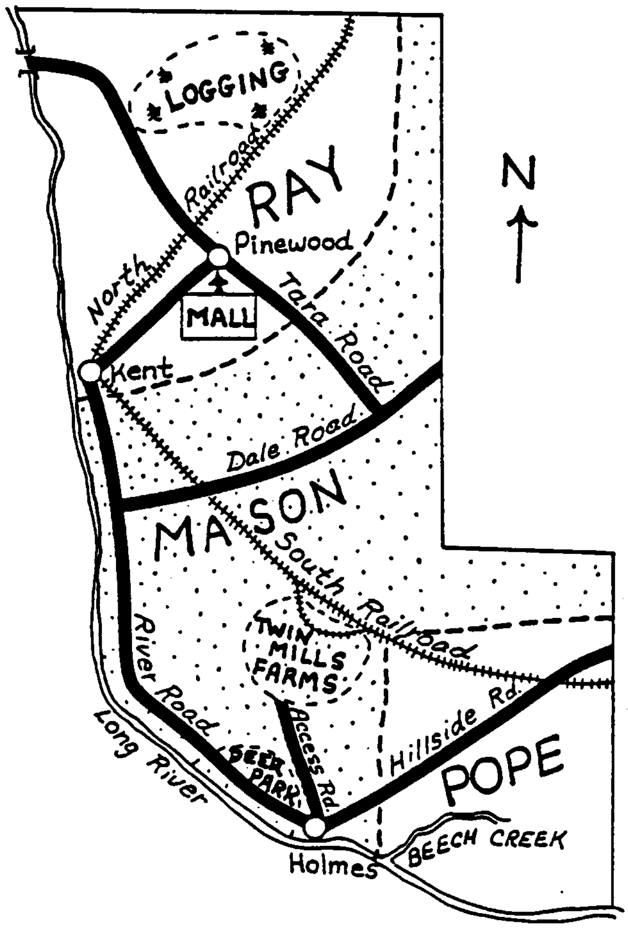
MAP LEARNING TASK

SMALL COUNTY, consisting of three townships

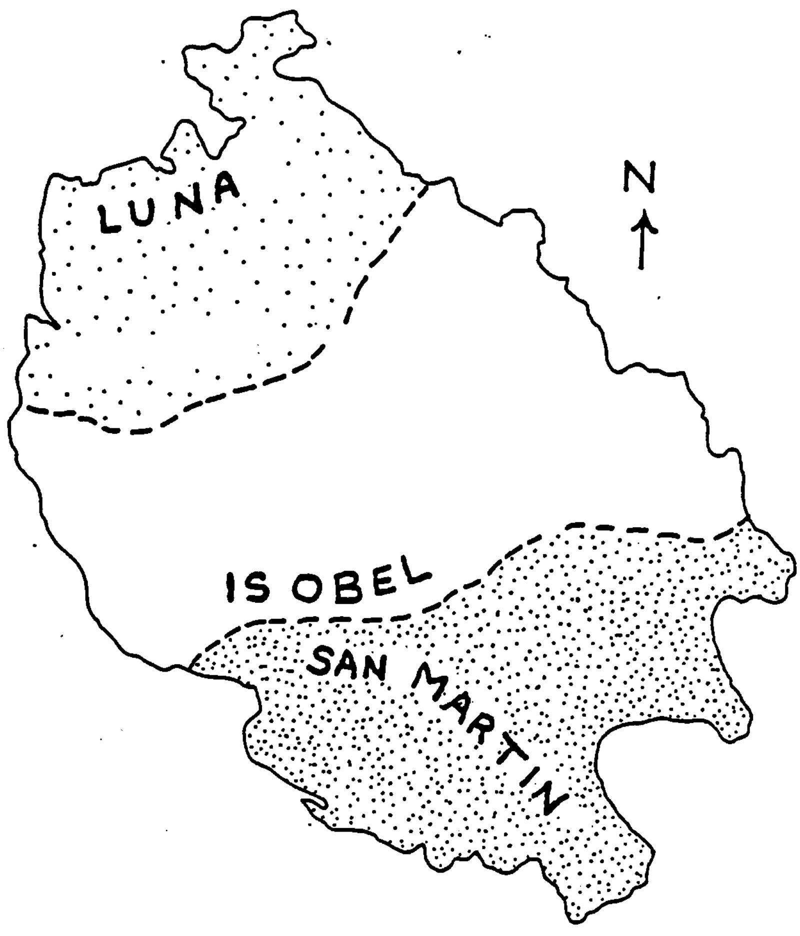


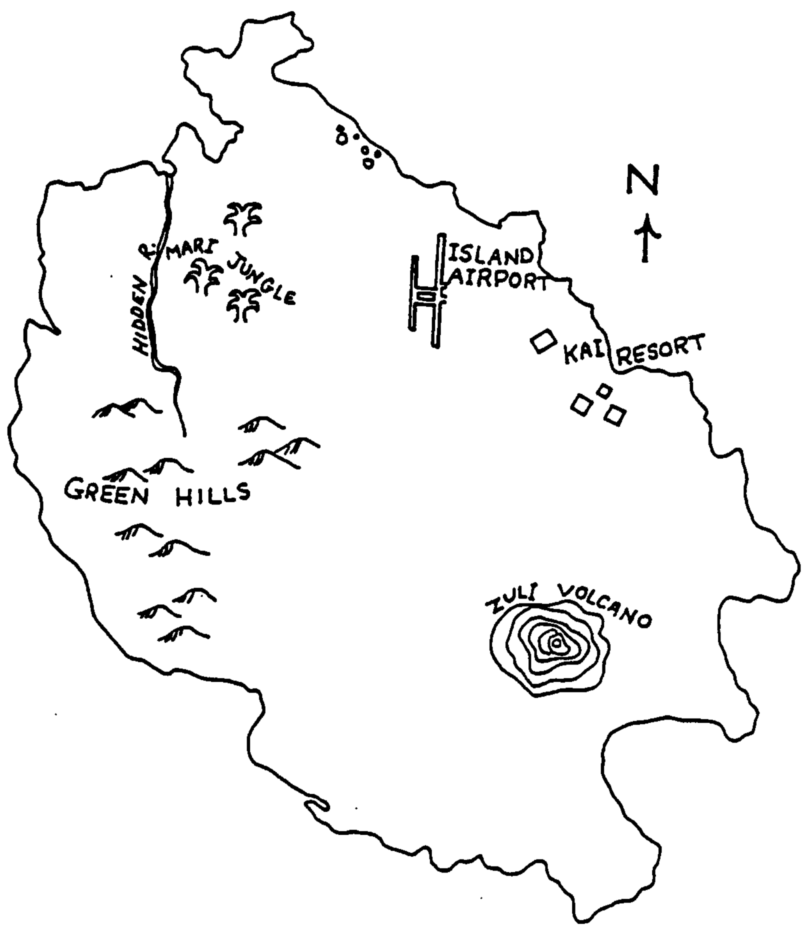

LOGGING
N
MALL
TWIN MILLS FARMS
Long River
DEER PARK
BEECH CREEK

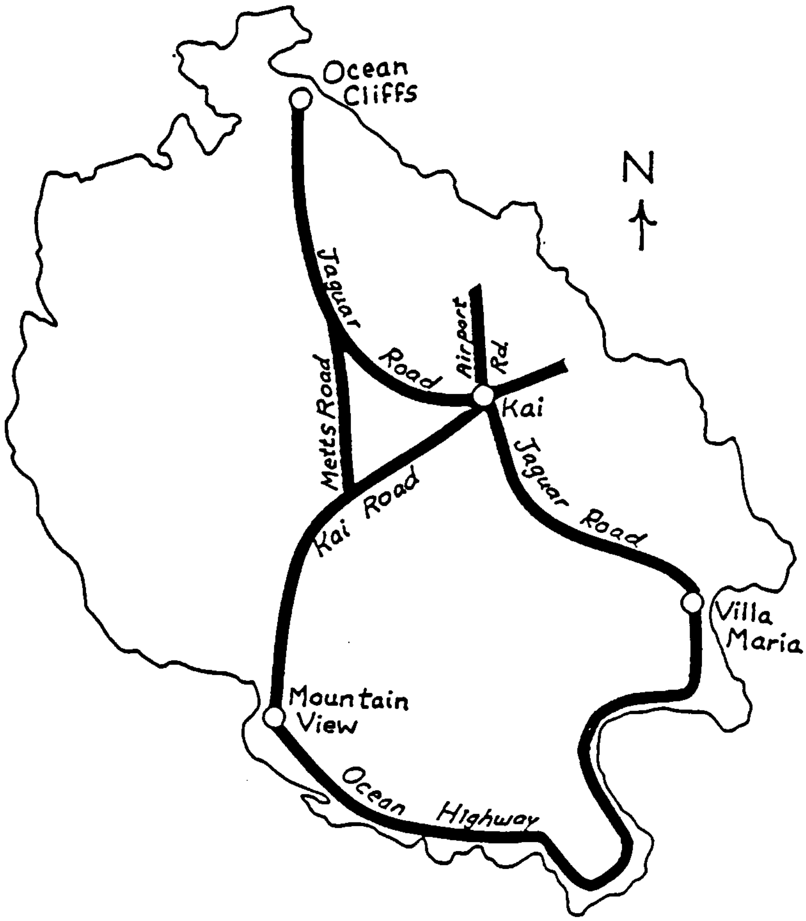

N
North Railroad
Pinewood
Tara Road
Kent
Dale Road
South Railroad
River Road
Access Rd.
Hillside Rd.
Holmes

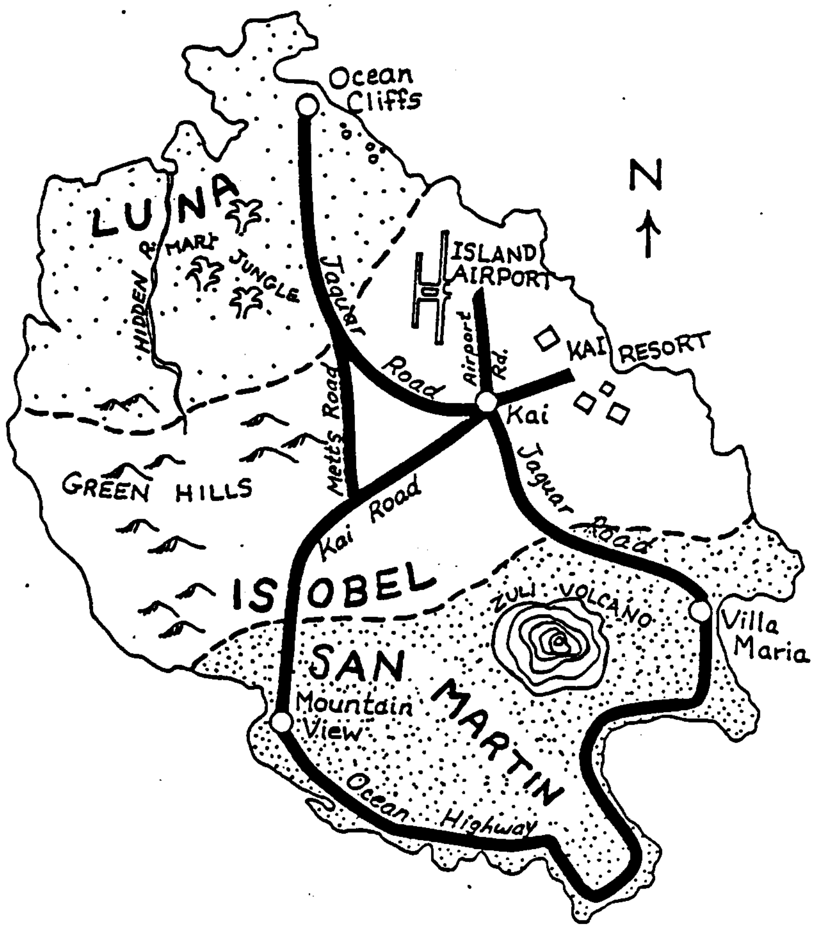

LOGGING
North Railroad
RAY
Pinewood
MALL
Tara Road
Kent
Dale Road
MASON
South Railroad
TWIN MILLS FARMS
River Road
Access Rd.
Hillside Rd.
SEEK PARK
Long River
POPE
Holmes
BEECH CREEK
N

TROPICAL ISLAND, an island composed of three provinces

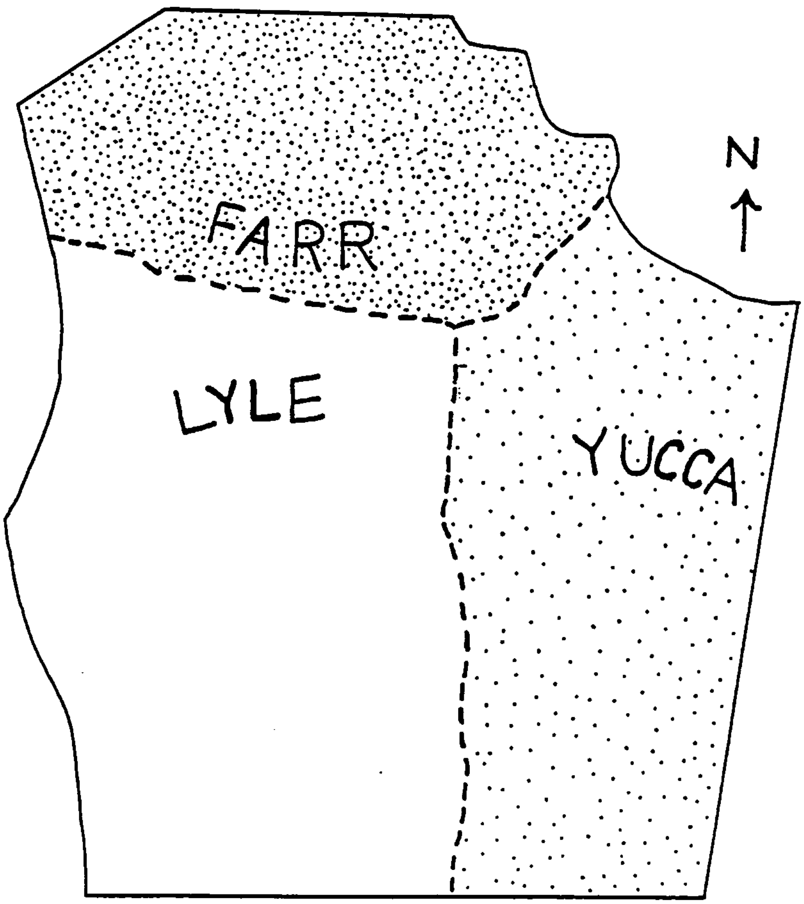


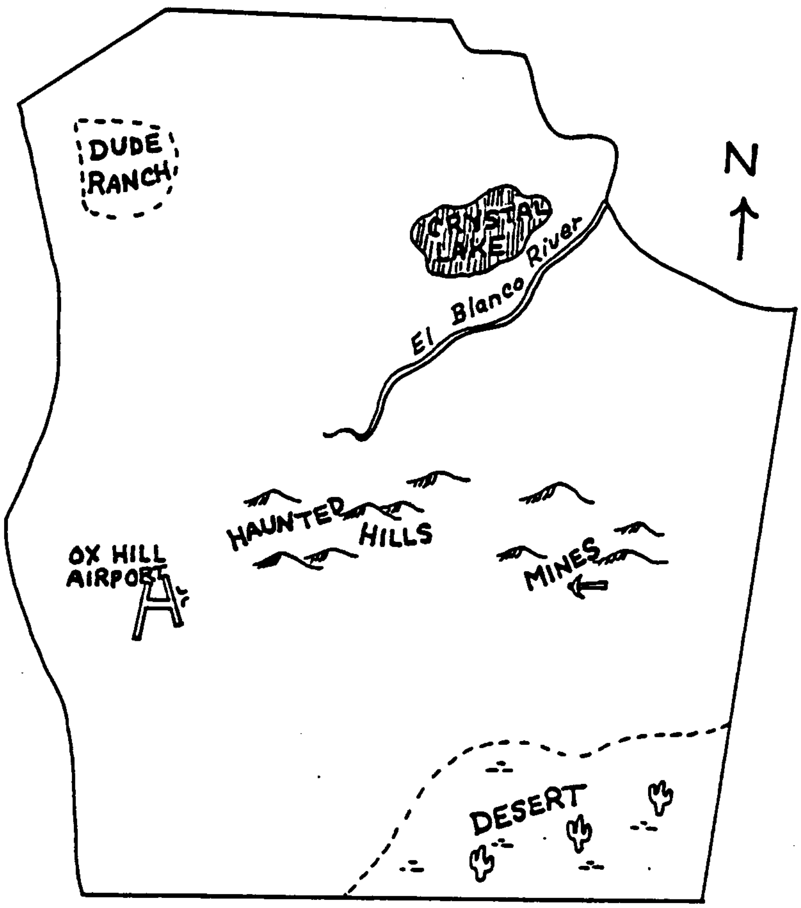

N
HIDDEN R.
MARI JUNGLE
ISLAND AIRPORT
KAI RESORT
GREEN HILLS
ZULI VOLCANO

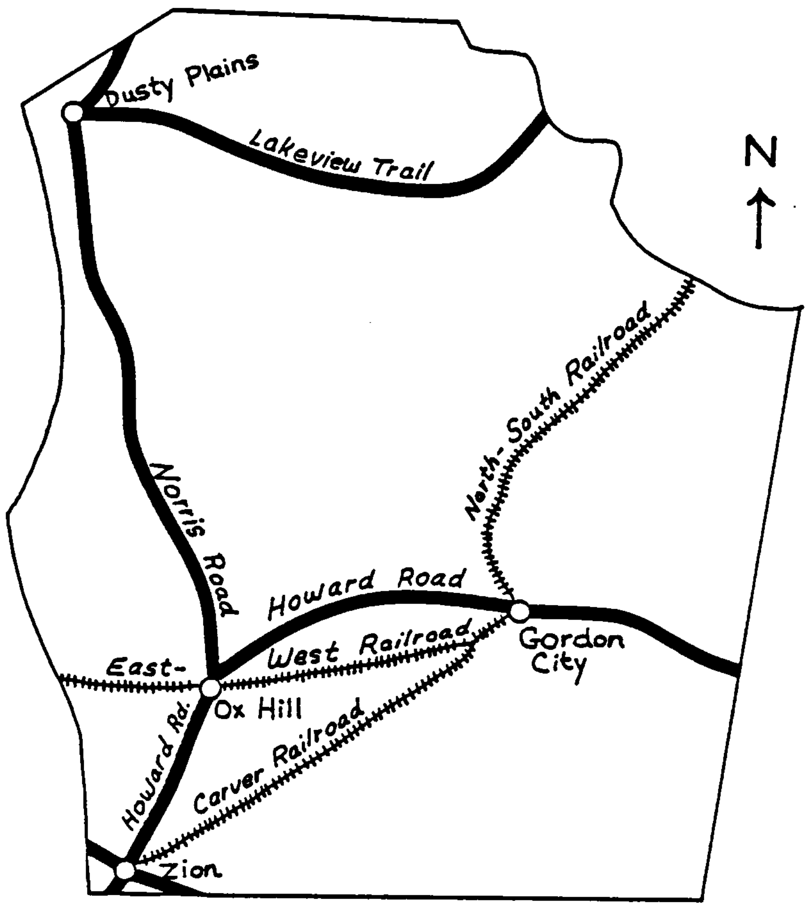

Ocean Cliffs
N
Jaguar Road
Airport Rd
Metts Road
Kai
Jaguar Road
Kai Road
Villa Maria
Mountain View
Ocean Highway

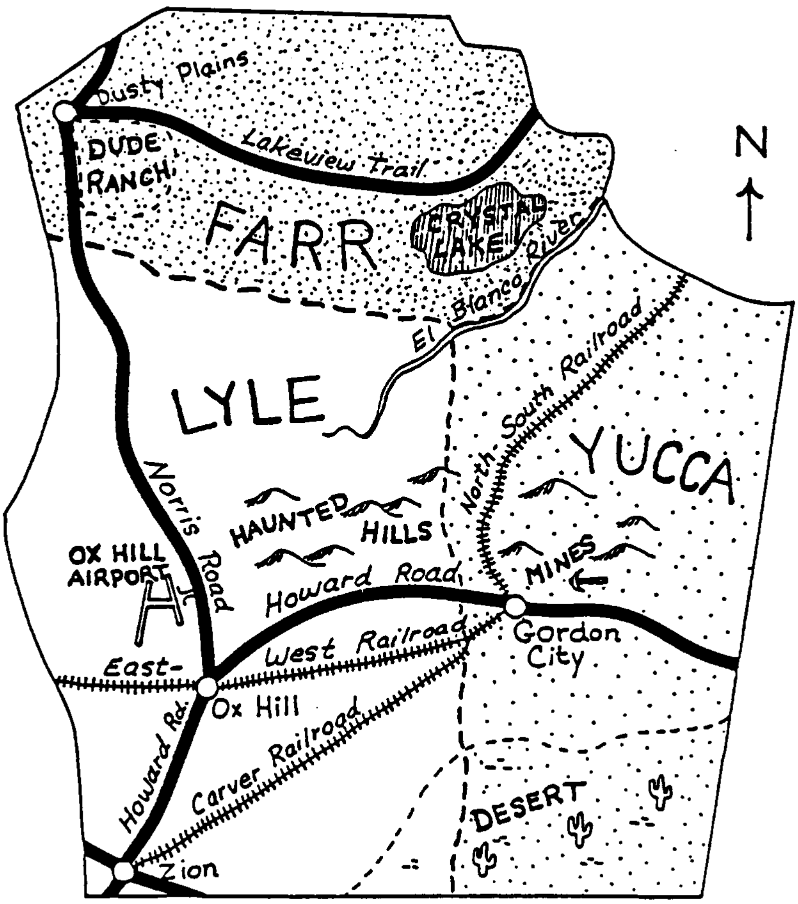

Ocean Cliffs
N
LUNA
HIDDEN R.
MARI
JUNGLE
Jaguar
ISLAND AIRPORT
Airport Rd.
KAI RESORT
Road
Kai
Metts Road
GREEN HILLS
Kai Road
Jaguar Road
ISOBEL
ZULI VOLCANO
Villa Maria
SAN MARTIN
Mountain View
Ocean Highway

WESTERN STATE, a state composed of three counties




DUDE RANCH
CRYSTAL LAKE
El Blanco River
N
HAUNTED HILLS
OX HILL AIRPORT
MINES
DESERT


Dusty Plains
Lakeview Trail
N
North-South Railroad
Norris Road
Howard Road
East-
West Railroad
Gordon City
Ox Hill
Howard Rd.
Carver Railroad
Zion


N
Dusty Plains
DUDE RANCH
Lakeview Trail
FARR
CRYSTAL LAKE
El Blanco River
LYLE
North South Railroad
YUCCA
Norris Road
HAUNTED HILLS
OX HILL AIRPORT
Howard Road
MINES
Gordon City
East-
West Railroad
Ox Hill
Howard Rd.
Carver Railroad
DESERT
Zion

Appendix D

POSTTEST BOOKLET

TEST BOOKLET

PLEASE DO NOT MARK
IN TEST BOOKLET

SMALL COUNTY
MAP LEARNING TEST

1. Dale Road runs through which township?

   1. Ray
   2. Pope
   3. Mason
   4. Pinewood

2. Which road should be taken to get from Holmes to the Mall?

   1. River Road
   2. Access Road
   3. Beech Creek Road
   4. Tara Road

3. What is the shortest route from Kent to Twin Mills Farms?

   1. Hillside Road
   2. North Railroad
   3. River Road
   4. South Railroad

4. Which township is directly north of Mason?

   1. Tara
   2. Ray
   3. Kent
   4. Pope

5. Near which town might one be most likely to build a furniture factory?

   1. Holmes
   2. Hillside
   3. Pinewood
   4. Kent

CONTINUE TO NEXT PAGE

6. South Railroad runs in which direction?

   1. East toward the county line
   2. South to Deer Park
   3. South from Twin Mills Farms
   4. Southeast from Kent

7. Which town is closest to Twin Mills Farms?

   1. Beech Creek
   2. Holmes
   3. Kent
   4. Pinewood

8. Which is the smallest township?

   1. Kent
   2. Mason
   3. Pope
   4. Ray

9. A log cabin and fence are being constructed at Deer Park. The logs are being obtained from the logging area shown on the map. Which is the most direct route for getting the logs to Deer Park?

   1. Tara Road-Dale Road-River Road
   2. North Railroad-Kent-South Railroad
   3. North Railroad-Kent-River Road
   4. Tara Road-Pinewood-Kent-River Road

10. Which roads come together in the northeastern part of Mason Township?

    1. Access Road and Hillside
    2. Tara Road and River Road
    3. Dale Road and River Road
    4. Dale Road and Tara Road

STOP

SMALL COUNTY
PAGE 1

VISUAL TEST. IDENTIFYING EXCERPTS FROM A MAP

For each of the following sets of map sections, select the one that is a correct portion of the map you have just seen.

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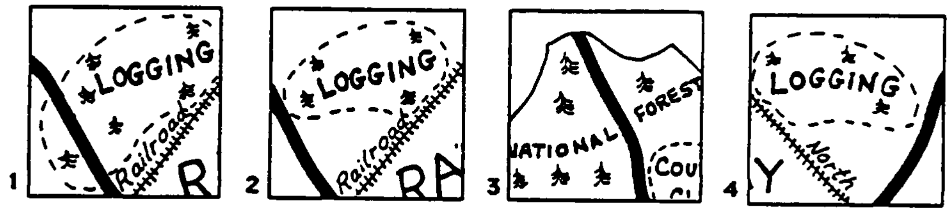

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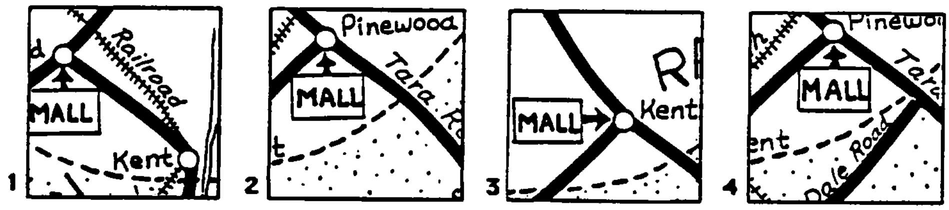

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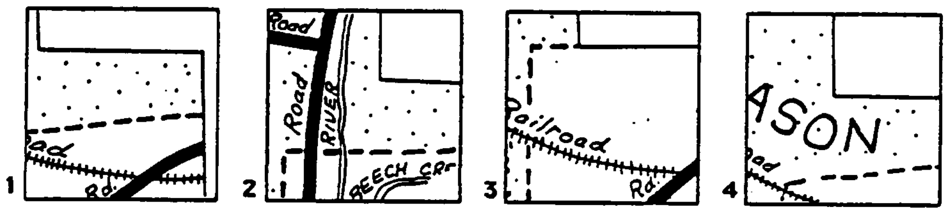

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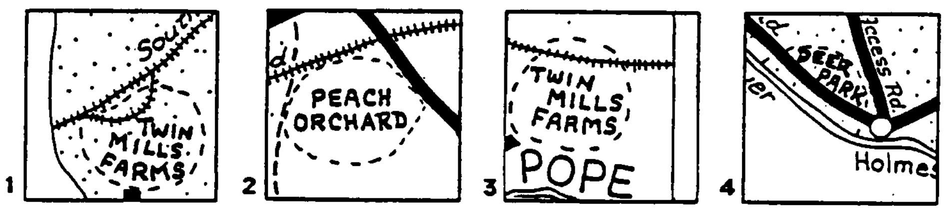

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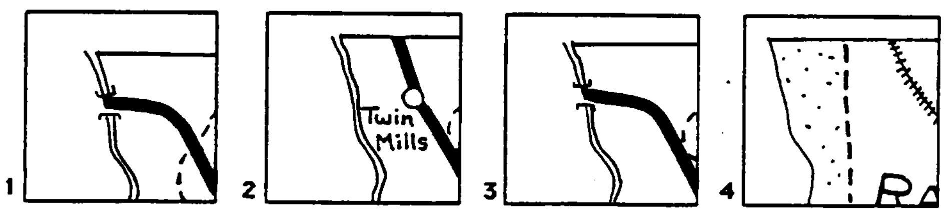
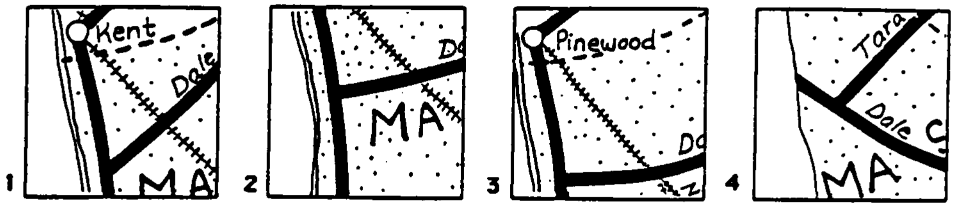


CONTINUE TO NEXT PAGE

SMALL COUNTY
PAGE 2

6



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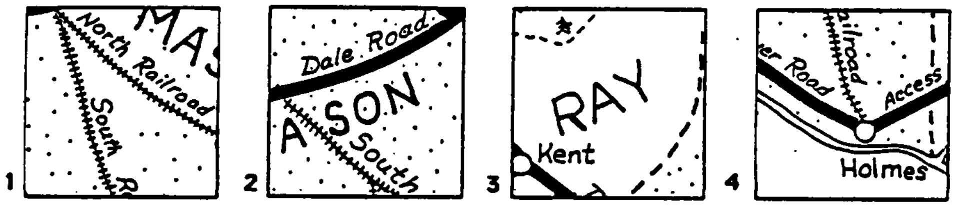

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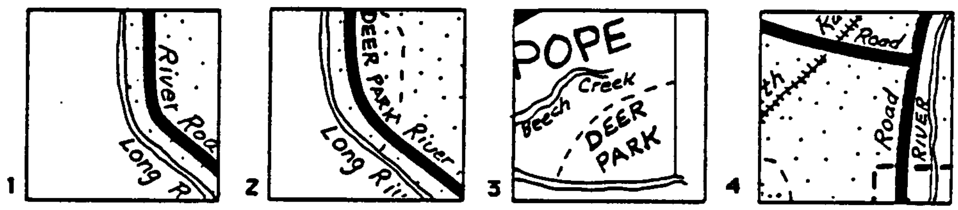

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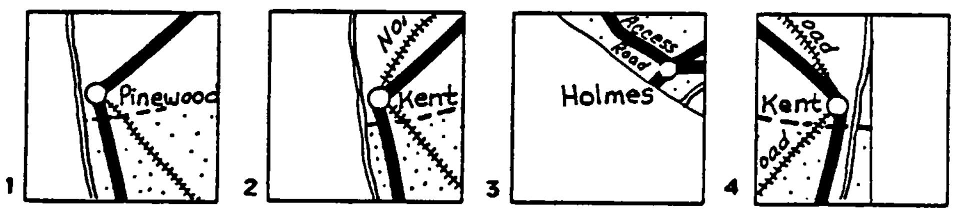

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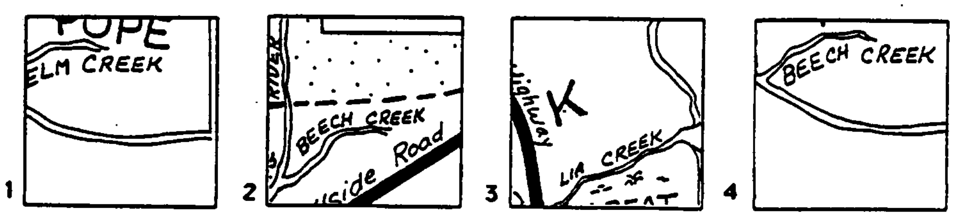

STOP

TROPICAL ISLAND

MAP LEARNING TEST

1. Which city is intersected by the most highways?

   1. Kai
   2. Mountain View
   3. Ocean Cliffs
   4. Villa Maria

2. The Green Hills are located in which province?

   1. Luna
   2. Kai
   3. Isobel
   4. San Martin

3. The Island Airport is what direction from Kai Resort?

   1. East
   2. Northwest
   3. South
   4. Northeast

4. Which road goes from Mountain View to Villa Maria?

   1. Jaguar Road
   2. Metts Road
   3. Kai Road
   4. Ocean Highway

5. A small band of uncivilized natives still lives in an isolated location on the Island. Which of the following is the most likely area?

   1. Eastern Isobel Province
   2. San Martin Province, west of Zuli Volcano
   3. Isobel Province, between Green Hills and Kai
   4. Luna Province, west of Jaguar Road

CONTINUE TO NEXT PAGE

6. The Governors of the Island are meeting to select a new capital city (Ocean Cliffs is the present one). Considering resources, location, development, etc., which city should they select?

   1. Villa Maria
   2. Kai
   3. Kai Resort
   4. Mountain View

7. Which road passes through all three provinces?

   1. Ocean Highway
   2. Kai Road
   3. Jaguar Road
   4. Metts Road

8. Which one of the following is closest to Kai?

   1. Island Airport
   2. Mari Jungle
   3. Zuli Volcano
   4. Green Hills

9. Zuli Volcano is located between two cities. Which are they?

   1. Mountain View and Ocean Cliffs
   2. Kai and Mountain View
   3. Kai and Villa Maria
   4. Mountain View and Villa Maria

10. Which direction is Hidden River from Mari Jungle?

    1. Southeast
    2. West
    3. Northeast
    4. South

STOP

TROPICAL ISLAND
PAGE 1

VISUAL TEST: IDENTIFYING EXCERPTS FROM A MAP

For each of the following sets of map sections, select the one that is a correct portion of the map you have just seen.

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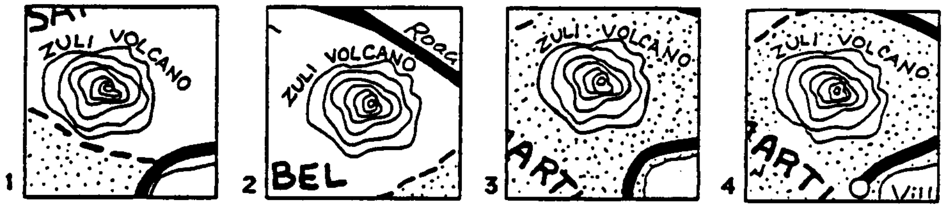

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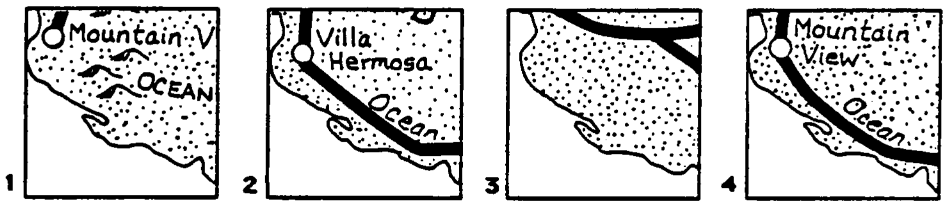

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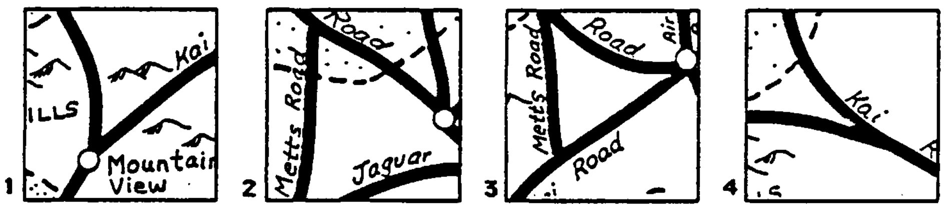

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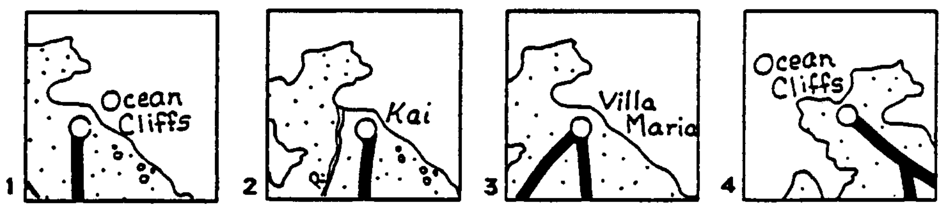

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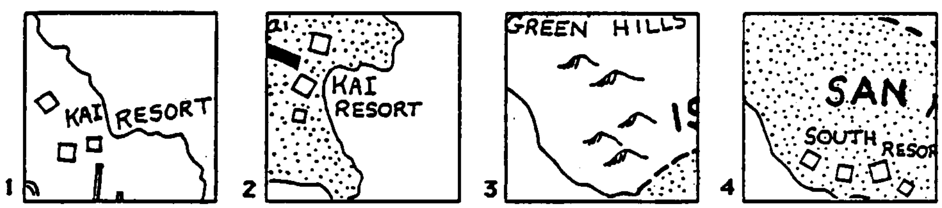

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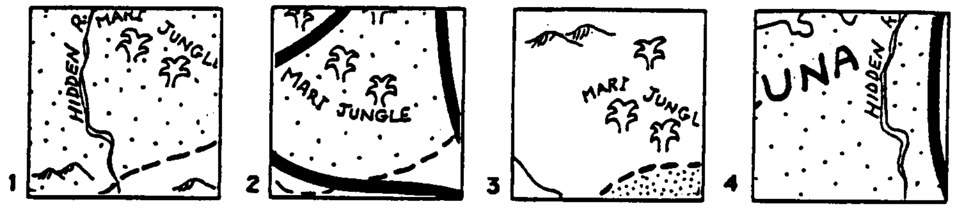
TROPICAL ISLAND
PAGE 2

6



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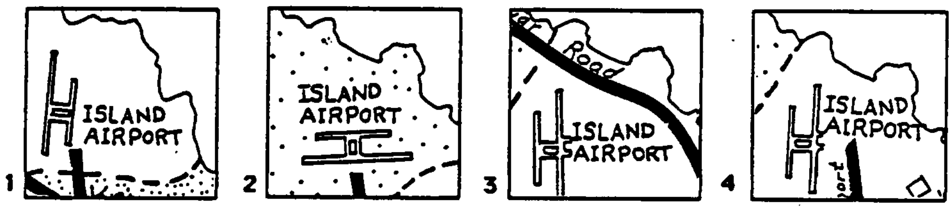

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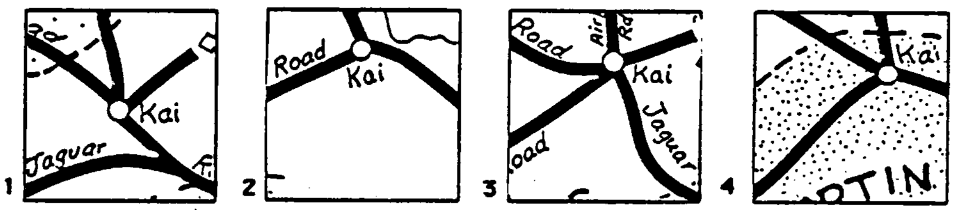

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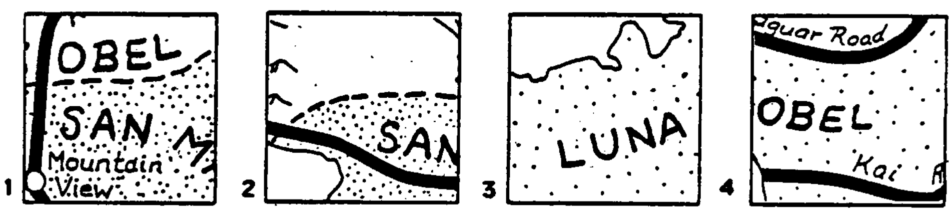

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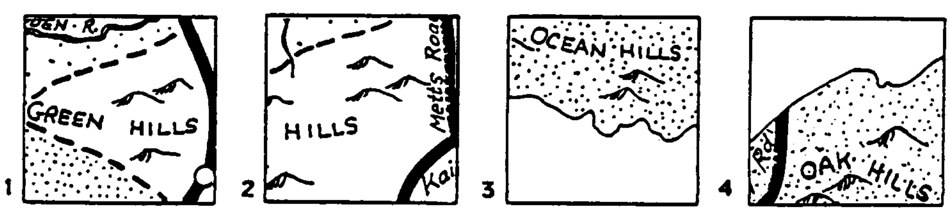

STOP

WESTERN STATE

MAP LEARNING TEST

1. El Blanco River forms a boundary between which two counties?

   1. Farr and Lyle
   2. Farr and Yucca
   3. Zion and Lyle
   4. Ox Hill and Zion

2. The Dude Ranch is which direction from Crystal Lake?

   1. North
   2. South
   3. West
   4. East

3. A visitor arriving at Ox Hill Airport to go to the Dude Ranch should take which road?

   1. Howard
   2. Ox Hill
   3. North-South
   4. Norris

4. A desert is found in which part of the state?

   1. Southeast
   2. Northwest
   3. Central
   4. Southwest

5. Carver Railroad runs in which direction?

   1. Northeast from Zion to Gordon City
   2. East from Ox Hill to Gordon City
   3. North from Gordon City to the State line
   4. West from Ox Hill to the State line

CONTINUE TO NEXT PAGE

6. Which railroad runs through the Haunted Hills in Yucca County?

   1. East-West
   2. Carver
   3. North-South
   4. Pacific and Western

7. Howard Road passes through which town(s)?

   1. Ox Hill and Zion
   2. Zion, Ox Hill and Gordon City
   3. Gordon City
   4. Dusty Plains, Ox Hill and Zion

8. In which county is the greater part of the Desert found?

   1. Lyle
   2. Yucca
   3. Brava
   4. Farr

9. Which area of the State has the water supply <u>and</u> rail service necessary for growing and shipping fruit?

   1. South of Ox Hill
   2. Southeast Farr County
   3. Northern Lyle County
   4. Northwest Yucca County

10. Which city is a mining town?

    1. Ox Hill
    2. Zion
    3. Dusty Plains
    4. Gordon City

STOP

WESTERN STATE
PAGE 1

VISUAL TEST: IDENTIFYING EXCERPTS FROM A MAP

For each of the following sets of map sections, select the one that is a correct portion of the map you have just seen.

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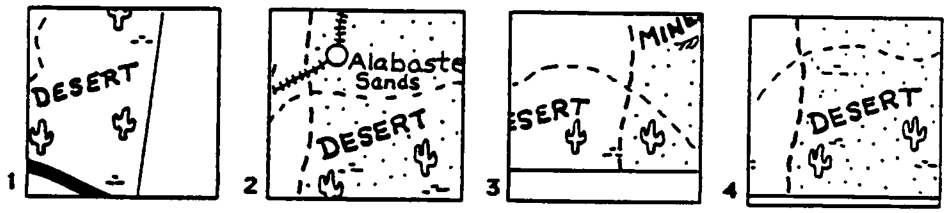

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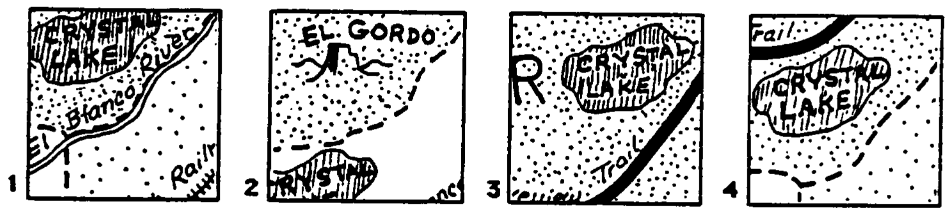

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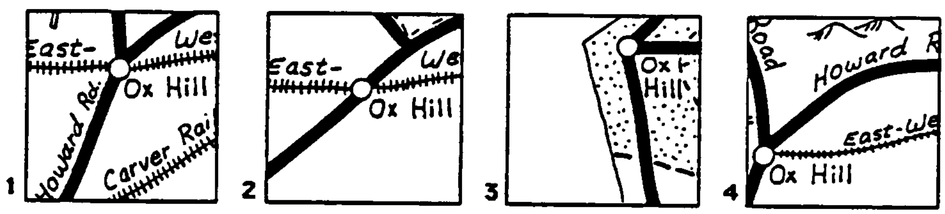

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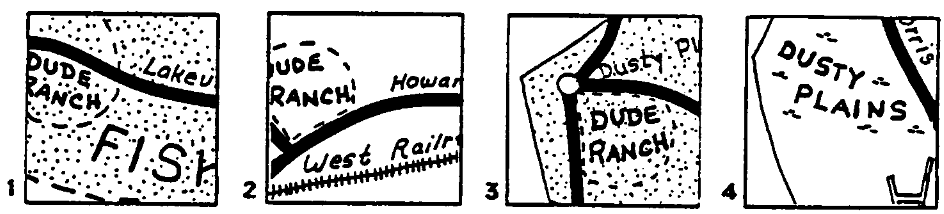

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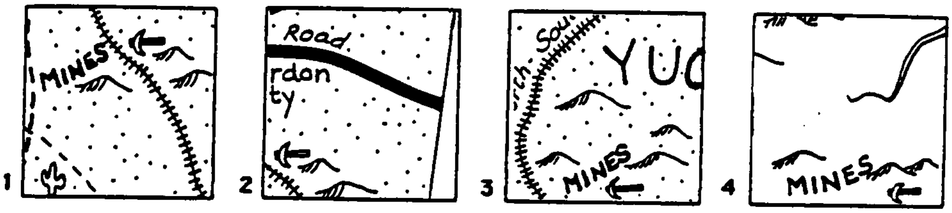
CONTINUE TO NEXT PAGE

WESTERN STATE
PAGE 2

6



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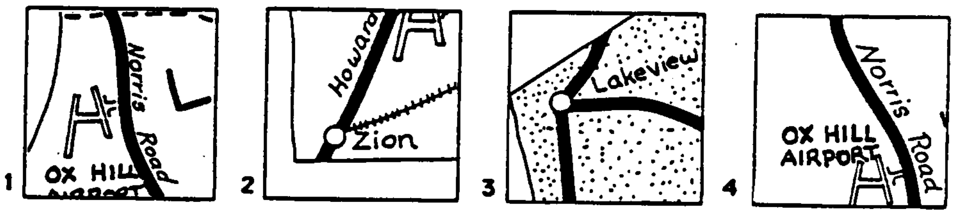

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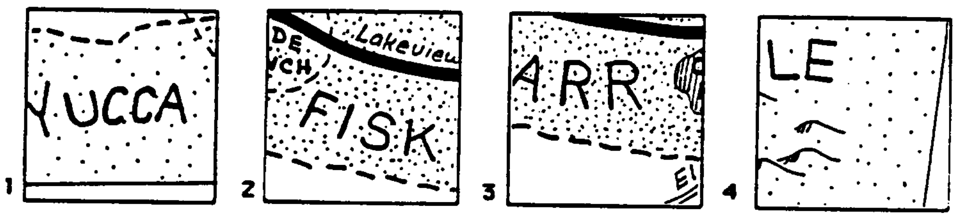

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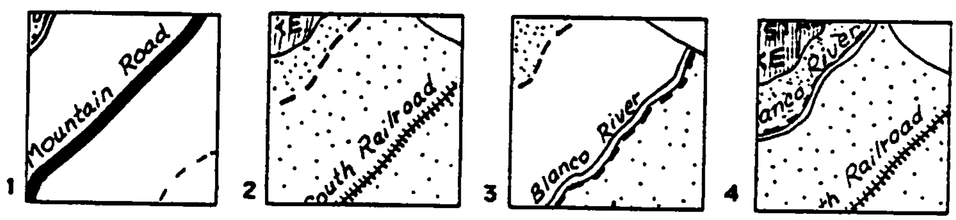

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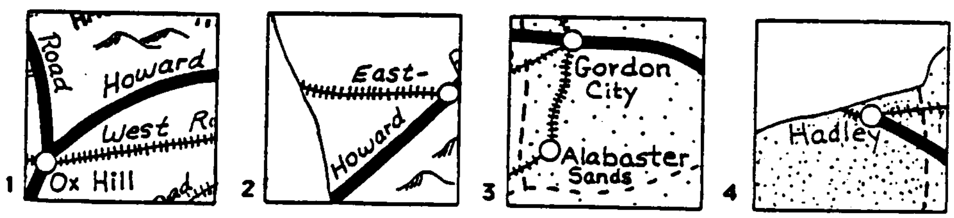


STOP

Number_____

Form A-I

ANSWER SHEET

MAP LEARNING TESTS

Circle the correct number for each question. Make sure you have the right block of numbers for the Map test you are taking.

MAP 1:
Name of Map __________

WRITTEN TEST					VISUAL TEST				
1.	1	2	3	4	1.	1	2	3	4
2.	1	2	3	4	2.	1	2	3	4
3	1	2	3	4	3	1	2	3	4
4	1	2	3	4	4	1	2	3	4
5	1	2	3	4	5	1	2	3	4
6.	1	2	3	4	6	1	2	3	4
7	1	2	3	4	7	1	2	3	4
8	1	2	3	4	8	1	2	3	4
9	1	2	3	4	9	1	2	3	4
10	1	2	3	4	10	1	2	3	4

MAP 2:
Name of Map __________

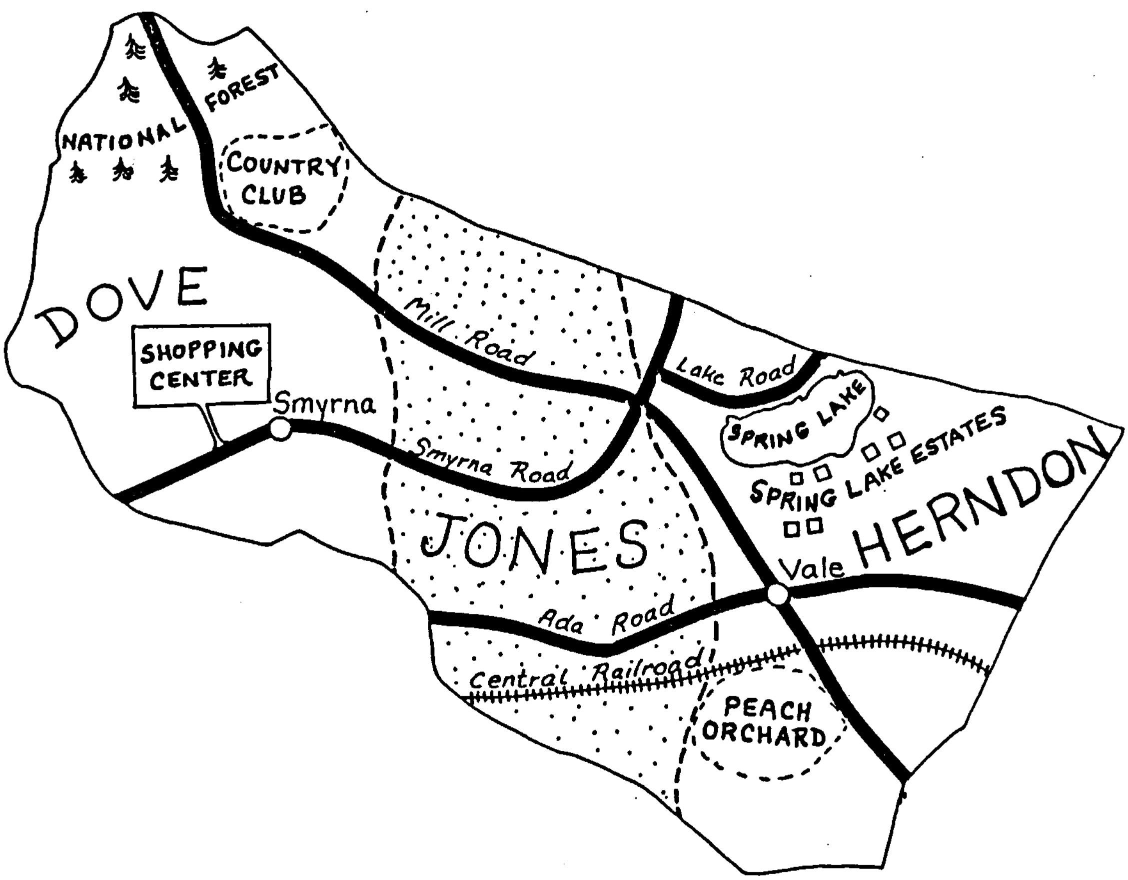
WRITTEN TEST					VISUAL TEST				
1.	1	2	3	4	1.	1	2	3	4
2.	1	2	3	4	2.	1	2	3	4
3.	1	2	3	4	3	1	2	3	4
4.	1	2	3	4	4	1	2	3	4
5.	1	2	3	4	5	1	2	3	4
6.	1	2	3	4	6	1	2	3	4
7.	1	2	3	4	7	1	2	3	4
8.	1	2	3	4	8	1	2	3	4
9.	1	2	3	4	9	1	2	3	4
10	1	2	3	4	10	1	2	3	4

MAP 3:
Name of Map __________

WRITTEN TEST										VISUAL TEST									
1.	1	2	3	4	6.	1	2	3	4	1.	1	2	3	4	6.	1	2	3	4
2.	1	2	3	4	7.	1	2	3	4	2.	1	2	3	4	7.	1	2	3	4
3.	1	2	3	4	8.	1	2	3	4	3.	1	2	3	4	8.	1	2	3	4
4.	1	2	3	4	9.	1	2	3	4	4.	1	2	3	4	9.	1	2	3	4
5.	1	2	3	4	10.	1	2	3	4	5.	1	2	3	4	10.	1	2	3	4

Appendix E

OVERHEAD TRANSPARENCY MASTERS: SAMPLE MAP AND EXAMPLES OF TEST QUESTIONS



Written Test: Example

The Shopping Center is located in which township?

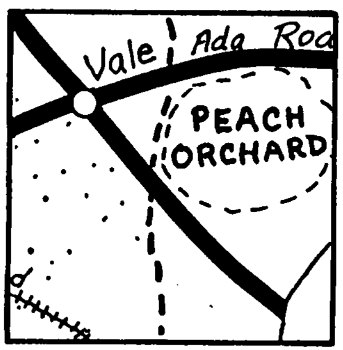
1. Jones
2. Dove
3. Smyrna
4. Herndon

Which direction is Vale from the Peach Orchard?

1. North
2. South
3. East
4. West

Visual Test: Example

1



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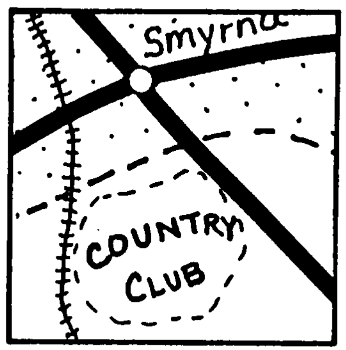

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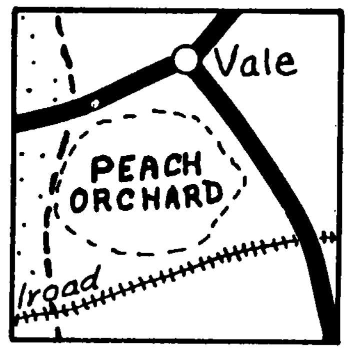

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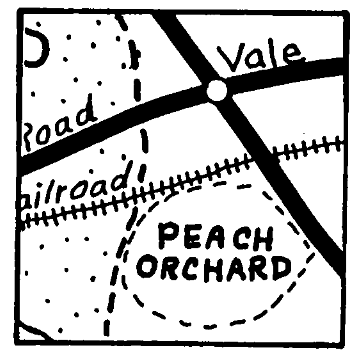

Appendix F

EVALUATION SURVEY BY TREATMENT

SCALE

NOT ENOUGH		ABOUT RIGHT		TOO MUCH
1	2	3	4	5

Question:	Mean Score: INTACT	ADDITIVE	PART	TOTAL
1. Clearness and readability of maps	3.27	3.19	3.15	3.21
2. Difficulty level of learning task	3.30	3.28	3.27	3.28
3. Difficulty of written test	3.30	3.06	3.15	3.16
4. Difficulty level of visual test	3.53	3.42	3.58	3.50
5. Time allotted to learn maps	2.80	2.72	2.69	2.74

Appendix G

MAP LEARNING STRATEGIES GROUPED BY TREATMENT

(GEFT and Posttest scores are in parentheses following comments)

INTACT TREATMENT

I tried to learn the counties, then rivers and railroads, and cities separately. Then how they were connected to each other. Lastly, what were special attractions found in each region. (8, 33)

Not really. Partly I just tried to associate certain things like towns to railroads, names of rivers and roads, and significant things around each other. (4, 34)

Tried to associate names of locations, etc., to more imaginative things. For example, I just watched "All the President's Men," and that helped me associate Howard Road (Howard Hunt) to Gordon (Gordon Liddy) and Liddy to the gold mines. Weird, yes, but it seemed to help. (4, 49)

Used alphabet association; roads, towns correlation. Tried to remember details of rivers/ where crossed, any bridges, etc. (14, 46)

I put all counties, townships in alphabetical order, then everything in them in alphabetical order for a mental list. Then I went from top to bottom and "pictured" everything in my mind--checking off what I could remember and going over all of it again with my eyes closed. (14, 52)

Since each map had only three provinces, I tried to learn the features one province at a time instead of the "state" as a whole. (14, 49)

Noticed relationships of parts; mnemonic devices. (15, 47)

Took first letters of counties and made words. Also routes from city to city. Example: Farr, Lyle, Yucca = FLY. (12, 41)

Tried to memorize major intersections of roads and first three letters of each of the counties. Dots and clear [background] also helped on the visual test. (15, 41)

Memorized one section at a time and then put them together. (15, 39)

Pope, Mason, Ray [townships] for last map task. (14, 41)

Learned major points on maps, then learned the smaller points. (18, 31)

Just tried to group the main characteristics of each area together. (18, 51)

I used the background differences to help remember places and I associated the names of the counties with any single names in that county. (18, 39)

Associations; i.e. relate names of towns to what is located in them to try and help remember them better. (17, 31)

Mnemonics for memorizing how to get [to] places and for directions. (16, 35)

The various textures, etc., helped sometimes. Also I would learn locations alphabetically (of the towns from the top to the bottom, railroads, etc.). (16, 43)

Made sentences with the first letter of each word from north to south--one sentence for cities, another for counties. (17, 40)

I took each county as a separate map--but I don't know how effective this method was. (17, 46)

ADDITIVE TREATMENT

Chunking. (6, 38)

Word association. (4, 33)

Closing my eyes and then checking maps. using first letter to remember towns, creek, etc. (10, 39)

Used sentences beginning with first letter of each county to remember order. (6, 49)

I tried to shut my eyes and remember the pictures while I still had the chance to look at them. (3, 39)

I tried to make up a little story to go with the maps. (11, 45)

I tried to get a mental picture of the map, especially the roads. (15, 50)

Association of names. (17, 42)

Yes, I would associate names of things with things I knew of already, for instance, some of the road names are the same as some roads I know of at home, etc. (16, 51)

I tried to remember names by connecting them with people or places I know. (18, 49)

I remembered the first letter of the names of various locations. (16, 41)

Acronyms for order of counties; pretended I was there: where I wanted to go and where to avoid, quickest routes, roads especially. (16, 49)

PART-BY-PART TREATMENT

Mostly looked for patterns, color, shape and direction, but need more time. (4, 25)

I just tried to get a global view of each map and to memorize sentences such as "the railroad goes from E-W". (10, 34)

I tried taking prior knowledge or correlation to use--like where railroads are usually located, and River Road alongside river, etc. (4, 39)

I tried to memorize everything on the maps from top to bottom so I could keep everything in perspective. (15, 44)

Tried to remember what major regions had what particular items of major inportance in them. (15, 42)

Acronyms to remember the provinces top to bottom. If there were rivers next to jungles I thought how they would flow into the jungles. Common sense--River road next to long river. (17, 33)

I traced the maps (each one) for the entire time and constantly repeated the words (names of counties and townships, etc.) to myself (17, 49)

I used shapes and space relations--but mostly words in relation to each other. very interesting. (16, 35)

Acronyms; i.e., Farr, Lyle, Yucca = FLY. (16, 42)

Associated names with people I already knew. (18, 44)

Linking names of points shown on the map like Ray, Mason, Pope = Ramapo. (18, 49)

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THE EFFECTS OF PRESENTATION MODE AND COGNITIVE STYLE ON IMMEDIATE RECALL OF MAP INFORMATION

by

Linda Brown Reardon

Committee Chairman: David M. Moore
Curriculum and Instruction

(ABSTRACT)

This study investigated the use of varying formats for presenting complex visual information in the form of fictitious maps. There were three treatment formats, two which sequenced the map information by conceptual category (i.e., roads, geographic features, boundaries), and a third which used a normal intact map format. The two sequenced presentations differed in that the first was additive; that is, each visual in the sequence built upon the preceding one by adding a category of information until the complete map was displayed. The second simply displayed one conceptual category per visual.

The cognitive style field dependence-independence was also examined as potentially related to map-learning ability based on the greater cognitive restructuring ability of the field independent orientation. It was predicted that the achievement of field-dependent students would be higher with the sequenced map treatments, and the achievement of the field-independent students

would be higher with the intact map treatment. The research questions were:

1. Does dividing map information into either an Additive sequence or a Part-by-Part sequence affect performance on a map-learning task?

2. Do students classified as field dependent, moderately field - independent, or field independent differ in their performance on a map-learning task?

3. Is there an interaction across visual design format with cognitive style?

The sample for this study was composed of 92 four-year college students. Level of field dependence was measured by the GEFT. The analysis of the 3 X 3 research design was by a two-way analysis of variance with posttest scores (which measured immediate recall of map information) as the dependent variable. Map presentation format and cognitive style were independent variables. Results indicated there was no difference in achievement among the three map presentation formats, but that cognitive style was significantly related to posttest scores; that is, a higher level of field independence was associated with more effective map-learning performance.