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The Ohio State University, 1987
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THE EFFECTS OF INDUCTIVE AND DEDUCTIVE TEACHING STRATEGIES IN COMPUTER-BASED LANGUAGE LESSONS ON THE PERFORMANCE OF HIGH SCHOOL STUDENTS IDENTIFIED AS BEING FIELD-DEPENDENT OR INDEPENDENT

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the Graduate School of the Ohio State University

By

Thomas A. Claerr, B.A., M.A.

The Ohio State University

1987

Dissertation Committee:
Edward D. Allen
Diane Birckbichler
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Approved by
Edward D. Allen
College of Education
To my wife Christine
whose patience and understanding
made this project possible.

"Le coeur a ses raisons
que la raison ne connait pas."
Pascal

Se la Eternulo ne konstruas la domon
Tiam vane laboras super ĝi
ĝiaj konstruantoj.

Psalmo 127:1
La Santa Biblio
(Tradukita de Lazaro Ludoviko Zamenhof)
ACKNOWLEDGEMENTS

I would first like to thank my adviser, Dr. Edward D. Allen, whose dedication to his students and to his profession are an inspiration to all who know him. At all stages of my doctoral work—from application to the program through the final stages of the dissertation—Dr. Allen has shown extraordinary helpfulness, wise counsel, and unbounded kindness. A special thanks to his wife, Dr. Virginia Allen, for sensible advice in Dr. Allen's absence and for patiently relaying telephone messages.

I would also like to express my deep appreciation to the other members of my committee, Dr. Gerard Ervin and Dr. Diane Birckbichler, who gave encouragement as well as valuable insight, and whose cheerful cooperation in promptly reading drafts made working long-distance less disagreeable.

I wish to mention the indispensable friendship of my fellow doctoral students, in particular Jung Sook Kim, Richard Gargan, Frank "Pete" Brooks, and Randi Cohen, whose emotional support and shared experiences made this adventure truly enjoyable.
I am also grateful to the many colleagues and professional contacts who in various ways contributed to this project. From Oakland Schools I particularly thank Dr. Aaron Stander, head of the English Division, who gave advice on administrative procedures and personal encouragement; Dr. Robert Kramp who provided outstanding research assistance; and Dr. Carolyn Gilbreath who supplied articles and ideas. My deepest appreciation goes to my colleagues in the public school, especially to Nancy Nash, Chair of Foreign Languages at Rochester-Adams High School, whose comradeship and comments on drafts were especially valuable; to Carol Wilson, Chair of Foreign Languages at Seaholm High School, who kindly offered her school for the experiment and who expertly handled administrative details; to Mary Stefano, teacher of Spanish at Seaholm, whose friendship and common sense were highly appreciated; and to Carl Meade, teacher of French at Seaholm, who kindly lent his students for this study.

I would also like to thank Joseph Hansen, Chair of Foreign Languages at Detroit Country Day, for sharing his knowledge of computer programming; Karen Miller, a steadfast companion from the outset of this project, who gave valuable perspective on the psychological aspects of the study; and Raman Sarin, computer specialist, who expertly assisted with programming of the student lessons. I am grateful as well to the secretaries, Bonnie McNeil and Florinda Rosen at Oakland
University, Madalen Papp at Henry Ford Community College, and Karen Sobul at the Ohio State University, who provided professional assistance with word processing and administrative tasks.

A tribute to those who contributed to this project would be incomplete without an expression of special gratitude to those who, while not directly involved with this study, helped give form to my life and career. Among those are Shirley Schaus, my longstanding friend and confidant, whose counsel and observations gave perspective to my personal and career goals; Jeanne Gilleland, a very special person whose passion for language teaching and enthusiasm for life have continued to be an inspiration; Dr. Charlotte Evans, Chair of Modern Languages at Central Michigan University, whose encouragement and professional guidance were especially appreciated; and Dr. Roberto Herrera who served as my mentor during my years as a student and instructor at CMU.

Finally, I wish to thank my family: my wife Christine, who lent financial and emotional support during many years of school, always patiently awaiting my return from class or the library, and even helping with her professional typesetting skill; my mother, who provided a quiet place to study, with meals, coffee, and conversation included; my sister Judy for commentary from a college teacher's perspective; and my sister Kathy and brothers Bob and Dave for their friendship and emotional support.
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41. (March, 1984).

"The role of songs in the teaching of Spanish," Proceedings
of the Northeast Ohio Language Teachers Association
Conference, Cleveland, OH., October, 1983. ERIC ED
254 100.

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CHAPTER I
THE PROBLEM

Introduction to the Problem

The past twenty years have seen rapid advances in the use of computers for educational purposes. The older computer-assisted instructional systems operate with powerful mainframe computers where each student works at a terminal linked to and entirely dependent on the mainframe computer, which may be on the same campus or thousands of miles away. A well known example is the PLATO system at the University of Illinois. A newer development is the smaller minicomputer system that typically services about 120 terminals, usually all on the same campus. But educational computing has begun to have widespread influence only in the past several years with the development of a new vehicle for the delivery of computer-assisted instruction (CAI): the inexpensive, yet versatile microcomputer.

The microcomputer is entirely independent, needing only a power supply to access information stored on diskettes,
although it can also be linked to computer networks or to mainframe computers. The importance of this revolution in educational computing has been recognized by many educators. Wyatt (1982), for example, writes:

Without exaggeration, it can be said that microcomputers have completely changed the rules by which the field of educational computing operated. These inexpensive new devices heralded the start of an era in which educational institutions could realistically look forward to using CAI and other forms of educational computing as a major element in their curricula. At a stroke, the way was cleared for CAI to make an impact on a much wider section of the educational community. (p. 3.)

Although there has been much research into CAI in the past twenty years, until recently much of it has focused on the effectiveness of the medium compared to traditional methods and materials. Many of these studies have shown CAI to be as effective as teacher-conducted learning, and as CAI becomes more widely accepted by the teaching profession, attention is already shifting from the means of delivery to the nature of the teaching material itself and to the best way of utilizing the unique features of CAI. The chief advantage of the computer in education is its capability for individualizing instruction and tailoring the lesson to each student (Burger, 1985).

Because the computer can so easily allow the student and instructor to control how the material is presented, CAI has begun to attract the attention of proponents of
holistic theories of education that regard the educational process from the point of view of the student rather than solely from that of the teacher. Such theories stress that the learner's needs must be taken into account if maximum learning is to take place (Stevens, 1984). Some researchers contend that effective use of any instructional method depends on a learning situation where the method of presentation matches the way of learning and the relevant personality characteristics (i.e. learning style) of the student (Morin, 1983). Learning styles may be defined as the cognitive, affective, and physiological behaviors that serve as indicators of how learners perceive, interact with, and respond to the learning environment (Burger, 1985).

Field Dependence/Field Independence

Cognitive style is perhaps the most important element of a student's learning style, since it describes the way that a learner perceives and processes the information to which he is exposed (Burger, 1985). Among the cognitive styles that have been identified as significant to the learning process, field dependence/independence has been the most extensively studied and has had the widest application to educational problems (Witkin, 1977; Betres, 1984). Field dependence/independence (FD-I) refers to individual differences in ways of perceiving, organizing,
and analyzing information and experience. Field dependence indicates a tendency to rely on external frames of reference in cognitive activities, whereas field independence suggests reliance on internal rules or strategies for processing information (Witkin, 1977).

Some studies of CAI in interaction with learning styles have researched field dependence/independence to find which instructional treatment is best suited to a particular cognitive style. Certain studies on the interaction of the structuring of lesson and FD-I have indicated that the performance of field dependent (FD) students can be improved when tasks are structured for them (Martin, 1983), while field independent (FI) students prefer exploratory learning, using trial and error to refine hypotheses (Carrier, 1984). If this is true, then in order to maximize learning for students with FD or FI cognitive styles, CAI lessons should ideally match their learning style.

In examining second language learners, Hatch (1974) has categorized FI students as "data gatherers" and FD students as "rule formers" (Hansen, 1982). FI students have been shown to perform better on analytic tasks that require inductive reasoning (proceeding from examples to internal rule formation); FD students, on the other hand, perform better in deductive reasoning where an external rule is presented first and carried out in successive tasks (Webb, 1985). Nevertheless, such noted educational theorists as
Gagné, Ausubel, and Bruner disagree on the best sequence for presenting concepts, and whether to present rules first or examples first still has not been answered conclusively (Lahey, 1981).

Inductive/Deductive Presentations

In recent years, educational research has identified a number of models for adaptation of instruction to the students' cognitive styles. One of these is the dichotomy of inductive versus deductive modes of presentation. The inductive method has been defined as teaching "based on the presentation to the learner of a sufficient number of specific examples to enable him to arrive at a definite rule, principle, or fact" (Horak, 1978, p.3). Deductive teaching, by contrast, has been defined as a method that "proceeds from rules or generalizations to examples and subsequently to conclusions or to the application of the generalizations" (Horak, 1978, p. 3). The comparison between these two methods of presentation has been described in various terms in the literature, some having a slightly different focus or emphasis but within the same general parameters. These terms include example/rule vs. rule/example, discovery vs. expository learning, high structure vs. low structure, and freedom vs. constraint (Andrews, 1984).
The results of studies on the value of one of these modes of instruction over the other fail to support overwhelmingly either inductive or deductive presentations (Brown, 1980). However, when the cognitive style of the student is taken into consideration, the literature from a variety of educational fields reasonably supports the contention that the field independent student is more likely to achieve success with the inductive method (IND), while the field dependent student is more likely to achieve success with the deductive method (DED) (Douglass, 1978).

In an experiment with physics students, Andrews (1984) discovered that FI students outperformed FD students in the inductive mode while the reverse was true in the deductive mode. Douglass (1978) reported similar findings in an experiment with biology students. In a study of FD/FI students with inductive and deductive presentations Horak (1978) observed an apparent contradiction in that FD students seemed to perform better with the IND mode of presentation. Abraham (1985) made a similar observation with deductive and inductive lessons in English as a Second Language. However, as Horak states, the achievement of the FD students with the inductive method might be traceable to the social interaction that this treatment afforded them. FD students have been shown to prefer personal interaction, which is an inherent element in teacher-delivered inductive material where the teacher interacts with the students to
help them discover the underlying principle or rule. For this reason Raschio and Lange (1984) proposed using a controlled medium such as the computer for both deductive and inductive lesson presentations to minimize the confounding factor of teacher interaction that has affected the results of studies such as those of Horak (1978) and (subsequently) Abraham (1985).

**Importance of the Study**

The growth in computer assisted instruction has given a new dimension to research of the interaction between learning styles and mode of presentation. A computer-delivered lesson eliminates some troublesome variables present in a teacher-delivered presentation such as bias, halo effect, teaching style preference, and other factors related to personality and human interaction. Use of a computer to deliver the treatment variables of inductive and deductive lessons should result in more generalizable data, with fewer variables that are unaccounted for in the design.

Field dependence has been shown to be a significant factor in a student's learning style (Witkin, 1977). In regards to the second-language learner, research has shown that field dependence/independence plays an important role in the level of achievement (Hansen, 1982, Naiman, 1978).
When considering the mode of presentation, the deductive/inductive model is one of the prominent models for adapting instruction to a certain learning style, according to theorists such as Ausubel, Gagné, and Chastain.

Numerous studies of the interaction of inductive/deductive (IND/DED) modes of presentation and field dependence/independence indicate that there is a significant effect in the matching of FD/I cognitive style to IND/DED modes of presentation (Douglass, 1978, Andrews, 1984, Horak, 1978, Hansen and Stansfield, 1982). A number of studies have been done using computer delivered lessons (Martin, 1983; Morin, 1983; Carrier, 1984; Burger, 1985; Webb, 1985) and some have dealt with the language learning process (Hansen and Stansfield, 1980 and 1982; Stevens, 1983); however, a survey of the literature revealed no studies that combine the variables FD/I and IND/DED in a language learning task using computer-delivered lessons.

Certain researchers have cited the need for research with this particular combination of variables (Martin, 1983; Raschio and Lange, 1984). Raschio and Lange (1984), for example, stated that "more studies observing the learner in interaction with the various modes of presentation on the computer must be performed to gain a better assessment of the effects of the computer and the particular modes of presentation have on a given cognitive
style." (p. 24). Citing a lack of research with these variables, Rashio and Lange suggested a study be done "that investigates the effects of inductive and deductive CAI presentations of a foreign language upon the cognitive dimension of field dependence/independence" (p. 24).

Overview of the Study

This research study investigated the interaction of the variables of FD/I cognitive style and IND/DED modes of presentation using the medium of computer-delivered language lessons. FD/I was measured by use of the Group Embedded Figures Test (GEFT) developed by H.A. Witkin. This test is a widely accepted psychological measure whose reliability and validity have been well established (Witkin, 1977; Goodstein, 1978). This instrument requires the subject to perceive and trace a simple geometric shape embedded within a larger, more complex drawing. The GEFT score indicates one's ability to locate relevant information within, or separate from, the overall context or field, and thereby identifies the subject's degree of field dependence or independence (Hansen, 1982.)

The second variable, the mode of presentation, was represented by two computer-delivered grammar lessons of the artificial language Esperanto. The deductive lesson gave the grammar rule together with examples and practice
items. The inductive lesson did not present the rule, but rather provided a statement telling the student to look at the examples to see how the language was being used, and then to do the practice items. At the end of the four lessons a post test was administered to the students by computer. Post-test results were statistically compared to learning style and type of lesson presentation to determine the effects of these variables on learning. A questionnaire administered before the computer lessons provided additional data (sex, age, GPA, attitude towards computers and language learning, grade, experience with languages and computers, last language grade) to be compared with the other variables and test results. A pre-test was administered to determine if lack of knowledge of English grammar terms affected the results of the experiment.

The null hypotheses were:

1. There is no significant difference in the performance of field dependent and field independent students.

2. There is no significant difference in achievement for either deductive or inductive lessons.
3. There is no significant difference in the performance of students whose cognitive style is matched to lesson mode: field dependent (FD-DED) to deductive and field independent to inductive (FI-IND).

Operational Definitions

CAI

computer-assisted instruction. Instruction that uses the computer as a medium of instruction and is interactive (accepts a student's response and provides feedback). Strictly speaking CAI refers to the use of computer software that assists in teacher-directed instruction, but in the United States is often used to refer to all types of instruction that utilize computer software (Cabeceiras, 1986).

CBI

computer-based instruction. Instruction that uses the computer program as a self-contained unit not necessarily requiring supplementary teacher delivered instruction. A term more commonly used in Britain, but also used in the United States to refer to a stand-alone tutorial lesson such as the one used in this study (Cabeceiras, 1986).

cognitive style

"the characteristic ways in which individuals conceptually organize the environment" (Betres, 1984, p. 2). Cognitive style is a component of learning style.

deductive/inductive presentation (DED/IND) refers to mode of lesson presentation in which inductive teaching is "based on the presentation to the learner of a sufficient number of specific examples to enable him to arrive at a definite rule, principle or fact" and deductive teaching is a method "that proceeds from rules or generalizations to
examples and subsequently to conclusions or to the application of generalizations" (Good, 1959).

<table>
<thead>
<tr>
<th>field dependence/ independence</th>
<th>(FD/I) a dimension of cognitive style relative to which people may be placed along a continuum on the basis of the ease with which they perceive items as discrete from their backgrounds. A field dependent person perceives his world globally, while a field dependent person perceives it analytically and is more likely to impose organization on ambiguous stimulus material (Horak, 1978).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Embedded Figures Test</td>
<td>(GEFT) A measurement of cognitive style where a subject's task is to locate previously seen geometric figures embedded in a larger, complex figure. Yields a score of 0 to 18, with the higher score indicating a tendency towards field independence (Hall, 1980).</td>
</tr>
<tr>
<td>learning styles</td>
<td>&quot;the cognitive, affective and physiological behaviors that serve as indicators of how learners perceive, interact with and respond to the learning environment (Keefe, 1979, p. 2).</td>
</tr>
<tr>
<td>match-mismatch effect</td>
<td>a term used to describe the effect on learning of matching a cognitive style with an appropriate learning situation. May refer to a match of teacher cognitive style to student cognitive style or, as in this study, to a match of cognitive style to a mode of lesson presentation that theory indicates may improve learning. In this study a &quot;match&quot; is FD-DED and FI-IND.</td>
</tr>
</tbody>
</table>
Assumptions

Identification of students by the GEFT test as being field dependent/independent reflects the several assumptions. First, it is assumed that FD/I is an all-inclusive yet mutually exhaustive categorization of one dimension of cognitive functioning. This means that although in the real world a measure of field dependence would place a given student somewhere on a continuum of the scale, for purposes of this study the continuous scale will be divided at the mean and all students will be categorized as being either field dependent or field independent, according to the half of the scale in which their score fell. Since it is assumed that the GEFT is a valid and reliable test, it is also assumed that the GEFT will accurately place all students on a continuum somewhere between the extremes of the two fields.

It is also assumed that the CAI lessons created for this study are reasonable approximations of deductive and inductive teaching strategies, and that the language lessons contain a task that is not unduly biased towards either field independent or field dependent learning styles. However, this factor must be taken into account when analyzing the data.
Limitations

A significant limitation of this experiment involves the treatment variable of inductive vs. deductive modes of presentation. Although every effort was made to compose lessons that closely reflect the customary definitions of inductive and deductive presentations, some adaptations were necessary because of the inherent limitations of presentation by computer.

The inductive lesson was particularly affected by these adaptations. For example, in a teacher-presented lesson, the inductive mode would consist of presentation of numerous examples of the concept being taught, reinforced by visual clues (pictures, objects, gestures, pantomime, etc.) (Allen, 1977). In this computer-presented lesson, by contrast, the number of examples was limited by the length of text that could be printed on the screen of an Apple IIe (approximately 20 lines of text). In addition, visual clues were not used because of the difficulty of programming graphics and representing the concepts using visuals.

Another characteristic of inductive presentation is spontaneous assistance by the teacher, which guides the students to appropriate conclusions (Allen, 1977). In the computer lesson, this feature was represented by an
introductory statement that told the student to look for how the language was used in the sentences, and feedback that was limited to short positive or negative comments, with the right answer supplied after two unsuccessful tries.

Although these may be serious limitations when compared to a teacher-delivered inductive lesson, this study assumed that the inductive CAI lesson in this experiment is an accurate representation of the inductive mode of presentation since it contained the essential element of inductive teaching: presentation of concepts using examples, without a statement of rule or principle before the examples. The lesson was closely modeled after a sample lesson provided by Hammerly to illustrate an inductive presentation of similar grammar concepts using his artificial "Spikian" language.

The GEFT test has been criticized as measuring cognitive disability rather than learning style (Hall, 1980), i.e., that a result indicating field dependence may reflect a subject's inability to discern obscure figures rather than measuring a type of cognitive functioning. Despite this criticism, many years of research support the value of the GEFT in indicating learning styles.

Witkin (1977), the author of the GEFT, cautions that "in areas where good student performance requires highly specialized skills, the availability of these skills may
overwhelm cognitive-style match-mismatch effects."

Language learning is probably one of these areas of highly specialized skills. For this reason a lesson that was rather non-language dependent was chosen, i.e., the grammar concepts being taught were discrete, and use of the concepts was not related to the semantics and syntax of the rest of the sample sentence. In addition, the grammar suffixes which carried the grammatical concepts were different enough from western-European language suffixes that they would not be subject to guessing. Thus the effects of global language skill and prior knowledge were minimized.

Finally, one must keep in mind that the GEFT was not designed to measure language learning styles and therefore may not be ideally suited for use in language learning studies.

As in most educational studies, this research is of limited generalizability. This is because the sample was not totally random, but rather was dependent on the availability of a group of language students in the school that agreed to participate in this study. Secondly, because Esperanto is derived from natural Indo-European languages (i.e., the grammar and vocabulary used are similar to those encountered in learning languages from this group), care must be taken in generalizing the findings of this study to the students of non-Indo-European languages.
Generalizability is also limited by the fact that the descriptive data show that the sample population may be above average in years of language study and GPA, and had a very positive attitude toward language study (Appendix E).

Finally, a significant confounding factor could be the likelihood of interaction between cognitive style and use of the computer medium. Certain studies suggest that FI students are more adaptable than FD students to CAI because of their strong analytical skills (Martin 1983). The background information that was gathered (especially on prior use of CAI) and the attitude questionnaire provided helpful indications of trends regarding these factors.
CHAPTER II
REVIEW OF RELATED LITERATURE

Overview

Two learning variables that have been of great interest to educational theorists for many years are learning style and method of presentation. This study examined the interaction of these variables in a relatively new context: computer-assisted instruction. This chapter will summarize recent theory on one factor of learning style, field dependence/independence, and one mode of presentation, inductive/deductive, both of which have a rather extensive research base going back at least twenty years. Studies which have examined the interaction of these two variables are numerous, although definitive conclusions relating to the best match of cognitive style to mode of presentation are still in the process of being developed (Lahey 1981). This is especially true in the context of computer-assisted instruction, where relatively few studies have been conducted on interaction between these variables (Burger 1985, Stevens 1984, Raschio 1984, Martin 1983).
Cognitive Styles

Recently the influential educational psychologist Gagne (1980) claimed that there is a "general shift in emphasis toward cognitive psychology in human learning . . . . The acceptance of cognitive processing as an idea that must be dealt with in theorizing about human learning is a welcome change." (p. 7) The change he referred to was a change from the behaviorist theories that had dominated education (contemporary with the audio-lingual era of language teaching) for about 25 years (Chastain, 1976 p. 132). The new cognitive theory of learning, set forth by Ausubel (1968) emphasized that meaningful learning involves the integration of newly learned material into the learners cognitive network.

Psychologists have discovered that there is a wide variability in the way individuals approach a learning situation. The term used to describe this idiosyncratic manner of learning is called "learning style." Keefe (1979) defined learning styles as "the cognitive, affective, and physiological behaviors that serve as indicators of how learners perceive, interact with, and respond to the learning environment" (P. 4) The terms "learning style" and "cognitive style" have often been used synonymously although they definitely are not the same. Learning style, in fact, is a broader term which includes cognitive style. Cognitive style refers to that aspect of learning known as
"cognitive" which is defined as "the individuals intellectual operations by which knowledge is gained about ideas or perceptions" (Chastain, 1976 p. 74). Cognitive includes all internal processes activated during perceiving, comprehending, practicing, organizing, storing, recalling, transferring, and manipulating information (Chastain, 1978).

As each learner has an individual learning style, so he or she has a particular cognitive style. Cognitive style has been defined as "the way in which learners process information. It includes thinking, problem solving, and memory" (Burger, 1985, p. 21). Some theorists define it more broadly by including prior knowledge, learning aptitude, and affective factors, reasoning that these also affect how a person processes information (Chastain, 1976). This is logical since a person's cognitive style is determined by the way he internalizes his total environment, and since that internalization involves physical and affective domains, these merge with the cognitive domain in cognitive style (Brown, 1980). Cognitive styles have been shown to be stable traits in adults (Witkin, 1971), however some would argue that individuals show general tendencies toward one style or another, but that differing contexts will evoke differing styles in one individual (Brown, 1980). Brown (1980) suggests that "perhaps the person who is more intelligent
and more successful in learning is the person who is 'bi-cognitive'—one who can manipulate both sides of a cognitive style continuum.

Chastain (1976) states that "The evidence is overwhelmingly in support of cognitive styles in learning." Brown (1980) believes that "such styles can contribute significantly to the construction of a unified theory of second language acquisition. A list of all the cognitive styles that have been identified would be very long indeed. Ausubel (1968, p. 171) identified at least 18 different styles. Among the 5 most prominent styles, because of their comprehensiveness and utility, are field dependence/independence, reflectivity/impulsivity, tolerance/intolerance of ambiguity, differentiation/indifferentiation, and external/internal locus of control (Keefe, 1979, Chastain, 1976, Brown, 1980). However, among the many cognitive styles that have been identified as being significant in the learning process, field dependence/independence has been the most extensively studied and has the widest applications to educational problems (Witkin, 1977, Betres, 1984).

Field Dependence/Independence

Field dependence/independence refers to individual differences in ways of perceiving, organizing, and analyzing information and experience. Field dependence
indicates a tendency to rely on external frames of reference in cognitive activities, whereas field independence suggests reliance on internal rules or strategies for processing information (Witkin, 1977). Witkin, the foremost researcher of field dependence-independence, suggests that the best way to begin to understand this dimension is to describe the actual situations used to identify individual differences in this dimension (Witkin, 1976).

Witkin's program of research had its beginnings in 1948 with laboratory studies to determine how people locate the upright as quickly as they do. Unexpectedly, they found that subjects performed markedly different on the various tasks given, and individuals were consistent across tasks. This suggested that people have preferred ways of integrating information which they used in the act of perception (Witkin, 1981). Witkin (1981) explained that the perception of the upright is ordinarily determined by two sets of experiences working together. First, the field around us, perceived through vision, provides a framework for determining the upright. Second, gravity, perceived by internal senses, provides another indication of the upright. In ordinary experience the external field and the pull of gravity coincide in direction, and the outcome is the same whether either determinant alone, or both together are used as referents.
One research strategy Witkin and his associates adopted was to separate these two standards experimentally (A practical motivation for these experiments was to understand how aviators determine the upright while in acrobatic flight). This separation was accomplished in two situations, the body adjustment test (BAT) and the rod-and-frame test (RFT)--by tilting the visual framework and leaving the gravitational pull on the body unaltered. In the RFT the subject was seated in a darkend room and viewed a luminous square frame within which was a luminous rod both of which could be tilted independently. When the frame was tilted, subjects differed markedly in their ability to determine the upright depending on which referent they used--external field or internal gravitational referent. The resulting hypothesis was that the individual differences represented differences in the tendency to use the external visual field or the body itself as a primary referent (Witkin, 1981).

The next major step was to test whether other perceptual tasks could also involve separation of an item (a rod) from an organized field (a frame). An example of such a task is The Embedded Figures Test (EFT) in which the subject is shown a simple figure and then required to find it hidden in a complex design (See Figure 1) (Witkin, 1977).
It was found that the same subjects who had difficulty separating the simple figure from the complex design were the same ones who could not separate the rod from the frame—in other words, were field dependent. People who were field independent in orientation tests found it easy to locate the simple figure from the complex design. Field dependence/independence was thus seen to be a perceptual-analytical ability that is consistent throughout an individual's perceptual functioning (Witkin, 1981).

The group embedded figures test (GEFT) is an adaptation of the EFT to be used in a group setting. It consists of a text booklet containing 25 complex figures plus two sample figures. On the back cover are eight simple figures identified by a letter. The instructions are for the subject to find a specific simple figure in each of the complex figures, and trace it with a pencil. The booklet is scored by the examiner visually comparing the traced figures with those on the provided scoring key. The test is divided into three parts of 7, 9, and 9 items. The first part is practice and is not scored. The number of figures correctly traced on the last two parts constitutes the raw score on the GEFT with a range of 0-18, the higher the score the more field independent the subject is. The GEFT test is regarded as being a well researched instrument with good reliability and construct validity (Goodstein, 1978).
Field Dependence/Independence and Language Learning

Because of its wide application to perceptual tasks, the cognitive style of field dependence/independence has been investigated in many different contexts, and language learning is no exception. Witkin (1981) mentions a study by Messick and French (1975) which found first order factors for speed and flexibility of closure in both spatial and verbal materials. Witkin (1981) also observes that verbal-analytical tasks may be analogous to visual disembedding tasks, especially in verbal disembedding tests which require the subject to focus primarily on individual letters. For example, the subject may be required to find hidden words in a sentence by combining the last several letters of one word with the first few letters of the following word. It is interesting to note that according to Witkin (1980) verbal disembedding ability shows a very small \( r = .14 \) relation to verbal comprehension constructs. Thus, the disembedding ability is due more to the field independence factor than to general verbal ability.

One of the most prominent studies of cognitive styles and language learning has been conducted by Naiman, Frolich and Stern (1978). In a detailed cross-sectional study of French grammar usage by middle and high school English speakers, they attempted to identify the strategies and techniques of good language learners. They used a battery of personality and cognitive style tests (including the
GEFT) as well as interviews and attitude questionnaires to identify possible characteristics of successful language learners. Naiman stated that:

We hypothesize that the more successful language learner is the one who is able to focus on those language stimuli relevant to the language learning task at hand, and to disregard the inappropriate ones [field independence], whereas the less successful language learner will be distracted by irrelevant cues which produce an overall effect of noise. He is dependent on the field and cannot select the proper cues for attention (p. 30).

Two specific observations were made concerning cognitive styles:

(a) Learners with different cognitive styles may be predisposed to different language learning processes . . . (b) Different classes of variable--personality, cognitive style, attitude, learning strategy--may be of varying importance at different stages of language learning and in different learning environments. p. 101.

Naiman (1978) further suggests that it would be useful to test the effectiveness of individualized language learning by grouping students according to common cognitive style factors and learning preferences. He concludes by stating that his study found evidence that "such features as tolerance of ambiguity, field independence, and extroversion have some bearing on language learning." (p. 102).

Perhaps the greatest body of experimental research on field dependence-independence and language learning has been done by the Hansen and Stansfield team. One study (Hansen, 1980) tested the relationship between field
dependent/independent cognitive styles as determined using the GEFT and Spanish achievement. It was found that field independence is associated with a higher level of achievement in college Spanish courses, particularly in discrete-point examinations of Spanish grammar. Evidence suggested that "the ability of a more field independent person to organize, analyze, and structure both perceptual and symbolic material is at work in learning the linguistic system of another language." (p. 24).

Another study (Hansen, 1982) examined the role of field dependence/independence in college level Spanish courses and confirmed the results of the above-mentioned study that field independent students displayed a significantly higher level of achievement and that the students' field dependent/independent cognitive style played a greater role in achievement than did the cognitive style of the teacher. A third study (Stansfield, 1983) of field dependence/independence and Spanish Cloze Test performance confirmed that field independence is positively related to second language test performance. An interesting conclusion of Stansfield's study is that since a second language cloze test requires the subject to predict the appropriate word to fill in the gap by using a hypothesis-testing strategy, it could be related to a field independent cognitive style. They conclude that in that case a cognitive style bias would be operating in cloze performance that would lessen
the validity of this instrument as a test of general language proficiency. Stansfield stated that field dependent persons have more difficulty analyzing information to solve a problem, but that according to Witkin (1977) it is possible to train field independent persons to utilize an analytical hypothesis-testing approach in appropriate situations.

In a study in ESL Lynn Hansen (1984) (not the same Hansen as cited above) validated the results of Stansfield (1983) that field independence is positively related to cloze-test performance. An interesting observation was that the lower achieving groups showed a significant relationship between cognitive style and cloze test performance, while the high achievers did not.

In a study of affective cognitive and social factors in achievement in an elementary level bilingual French program Tucker (1976), using the GEFT test, found that field independence contributed significantly to performance on a standardized achievement test. A conclusion was that the study of individual student variation should occupy an increasingly prominent role in the evaluation of second language programs.

Brown (1977) found that field dependence correlated quite highly with language proficiency of adult ESL learners and hypothesizes that this may be due to the fact that dependent persons tend to be more socialized, empathic
and sensitive to the feelings and thoughts of others, and these traits, in turn, aid in acquiring language in a natural setting where communication with others is the primary method of learning. He adds that field independence has been shown to correlate positively with achievement in the classroom and that this type of learning involves analytical tasks such as drills and grammar tests that tap the analytical skill of field independent students (Brown, 1980). He concludes that field dependence/independence could be contextualized and variable, so that its effect on language learning could depend on the task and context.

In a study of the relationship of cognitive style, aptitude, and general intelligence to Spanish language proficiency tasks at the secondary level Parry (1984) found that performance on discrete point and integrative language tasks was associated with the cognitive attributes of field independence, reflectiveness, sharpening, and flexible control. Since field independence accounted for variation in only selected criterion tasks, it was concluded that different foreign language tasks require different modes or styles of cognitive functioning.

Computer Assisted Instruction and Cognitive Styles

With the relatively recent arrival of computer-assisted instruction on the educational scene, some researchers have examined field dependence/independence (FD/I) to measure
its effects on learning through this medium. In a study "Cognitive Styles and Their Implications for Computer-Based Instruction," Martin (1983) chose FD/I as one of the three cognitive styles to be tested in an experiment. She found that "studies on the interaction of structuring and field independence suggest that the performance of field-dependent subjects can be improved when tasks are structured for them" (p. 241). Morin (1983) examined learning styles and attitudes and found a number of significant interactions in computer-assisted instruction. She states that "Identifying those characteristics which serve to differentiate individuals who learn under one instructional condition from those who learn best within a different instructional context is imperative in operationalizing individual instruction" (p. 101-102).

Burger (1984) used the GEFT to study the relationships between field dependence/independence, academic achievement, and CAI in an undergraduate medical terminology course. She found that students who had higher grades preferred CAI, but FD/I showed no significant relationship to CAI preference or grade. Other research, however, has indicated that field independent students perform better on CAI because that cognitive style has been associated with analytical thinking and the desire to work alone, which are elements of CAI (Webb, 1985).
Although the implications of cognitive style for performance in CAI are not clear, it is evident that CAI has great potential for adapting instruction to individual styles. Burger (1985) claims that the chief advantage of the computer in education is its capability for individualizing instruction and tailoring the lesson to each student.

Cosky (1980) views cognitive style as a "potentially rich but typically overlooked source of individualization in computer based instruction." (p. 10) He suggests matching instructional activities to the cognitive style of the learner and to the demands of the learning task, yet cautions that it is imperative to know more about the interactions of various cognitive styles. He concludes by challenging the educational community to provide a more nearly individualized computer based instruction by conducting more research in cognitive styles in CBI.

**Inductive/Deductive Presentation**

The potential relation of mode of presentation to cognitive style is readily apparent when one recalls that cognitive style determines the way in which a learner perceives and organizes information that is presented to him or her. We have seen in our discussion of cognitive styles that field independent persons perform better on tasks that tap their ability to separate elements from a
field, analyze them, and arrive at a generalization (also referred to as a rule or principle). Generalization has been found to be a pervading strategy in human learning. Brown (1980) states:

To generalize means to infer or derive a law, rule, or conclusion, usually from the observation of particular instances . . . . Inductive and deductive reasoning are two polar aspects of the generalization process. In the case of inductive reasoning one stores a number of specific instances and induces a general law or rule or conclusion which governs or subsumes the specific instances. Deductive reasoning is a movement from a generalization to specific instances: specific subsumed facts are inferred or deduced from a general principle (pp. 85-86).

Thus, it is logical to assume that a type or mode of presentation that is inductive, i.e. gives a number of examples and requires formation of a general principle, would work better with field independent persons while a deductive mode of presentation, which organizes the information in an expository manner by providing a rule, would work better with field dependent persons who need structure. Thus the dichotomy of inductive vs. deductive modes of presentation has emerged as one of the primary models for adapting instruction to the student's cognitive style. The inductive mode of presentation has been defined as being "based on the presentation to the learner of a sufficient number of specific examples to enable him to arrive at a definite rule, principle, or fact" (Horak, 1978, p. 3). The deductive mode of presentation has been
defined as a method that "proceeds from rules or generalizations to examples and subsequently to conclusions or to the application of the generalizations" (Horak, 1978, p. 3). The comparison between these two methods of presentation has been described in various terms in the literature, some having a slightly different focus or emphasis but within the same general parameters. These terms include example/rule vs. rule/example, discovery vs. expository learning, high structure vs. low structure, and freedom vs. constraint (Andrews, 1984).

Studies on the advantage of one mode of presentation over the other fail to consistently support either inductive or deductive presentation, and educational theorists differ on which mode is to be preferred (Chastain, 1976, Lahey, 1981). For example, Gagné and Bruner favor inductive (discovery) learning while Ausubel favors deductive (expository) learning. Ausubel argues that in the context of second language learning while the inductive approach may be useful in teaching grammatical generalizations to young children or unsophisticated adults who are incapable of understanding abstract syntactic propositions, "the deductive use of grammatical generalizations, on the other hand, is decidedly more efficient in second language learning." (p. 78-79) Gagné (1985), in contrast, favors discovery learning where a student is guided in solving a problem and is led to
discover the generalization himself. He cites a number of studies which indicate there is a greater transferability of the generalizations when they are arrived at by the discovery method.

Although neither research nor theory support overwhelmingly either inductive or deductive presentation, when cognitive style is taken into consideration, the literature seems to support the contention that field-dependent students perform better when tasks are structured for them as in deductive presentation, and field-independent students perform better when they are allowed to do active analysis as in an inductive presentation (Douglass, 1978, Keefe, 1979, Anderson, 1979, Martin, 1983, Andrews, 1984, Raschio and Lange, 1984).

A review of the literature found a number of studies in diverse fields of education that examined the relationship between cognitive style and inductive/deductive lesson mode. We will first examine those studies that are outside of the language field and later discuss those which deal with language learning.

Andrews (1984) conducted a study of the effects of discovery vs. expository presentations of molecule models for physics students. The discovery lesson utilized the Socratic method of guiding the students to appropriate conclusions while the expository lesson used a typical lecture format to explain the concepts. Students were
categorized as having a personality tendency described as dependent or independent by use of the Grasha-Reichmann Student Learning Styles Scales. These scales used student responses to statements such as "I like to work alone" to categorize them as dependent or independent in personality. It was expected that more independent self-directed students would find the open-ended discovery lesson more profitable while those who are more dependent on external structure would prefer the expository lesson. Results showed that the discovery format was superior for both groups of students, but the superiority was markedly greater for the independent students. Also, independent students outperformed dependent students in the discovery format while the reverse was true in the expository format.

In a study using high school biology students taking audio-tutorial lessons, Douglass (1978) found that extremely field dependent students (as measured by the GEFT) performed better when matched with a deductive presentation while extremely field independent students performed better when matched with an inductive presentation.

Betres (1984) conducted a study with 102 middle school students identified as field dependent or independent by use of the Childrens Embedded Figures Test, similar to the GEFT and also developed by Witkin and his associates. The experiment taught selected activities dealing with the
Industrial Revolution in expository and inductive lesson modes. The generalization building activities of the inductive mode proved superior to the expository mode for both FD and FI students, but no significant interaction of cognitive style and lesson mode was found.

Horak's (1978) study of inductive and deductive teaching methods in college mathematics lessons had findings apparently contradicting the results of the above mentioned studies in that field dependent students (as identified by the GEFT) performed better with the inductive method. Field independent students performed equally well under either method. Horak explained the unexpected result by hypothesizing that the field dependent students responded to the social interaction that the inductive lesson afforded them since FD persons have been shown to prefer personal interaction which is present in teacher-delivered inductive lessons where the teacher interacts with the students to help them discover the underlying principle or rule. This same explanation may apply in a similar finding by Abraham (1985) who found that FI students (as identified by the GEFT) performed better with a deductive lesson of ESL grammar (participle phrases) and FD students performed better with an inductive lesson. Abraham also made a statement not found in other literature that "FI students are more adept at learning and using rules than FD students." (p. 691)
We will now turn our attention to literature which examines inductive and deductive modes of presentation in second language learning. Werdelin (1968) assigned students into three groups of 58 students each for a lesson in learning a foreign alphabet. Unfortunately the report does not mention which alphabet or native language were involved. Group A was told the principles of the alphabet and applied it on examples; group B was given most of the examples first, then told the principles, then was given additional examples; group C was given examples only. It was found that group A (deductive method) learned the principles best as measured by ability to apply them immediately, but group C (the most purely inductive) performed better on tests that measured retention and transfer.

In an experimental study Seliger (1975) randomly assigned inductive and deductive ESL lessons on sequence of pre-noun adjectives to adult students. The examples, practice and explanations were the same for both lessons with the only difference being that in the inductive lesson the explanation came at the end while in the deductive it came at the beginning. While no significant difference was found on an immediate recall test, a retention test given two weeks later showed better retention for the students who had the deductive lesson. Seliger hypothesized that presentation of the explanation first allowed the students
of the deductive group were able to establish a "set" for the concepts and maintain that set for a longer period of time than the students of the inductive group.

In a review of the inductive-deductive controversy in second language teaching, Fischer (1979) concluded that "an inductive approach in which the student discovers the grammatical rule for himself may be employed in those cases where the foreign language is similar or dissimilar but simpler than the native language rule." (p. 100-101) But on the other hand, "a deductive approach in which the student is initially given the grammatical rule may be required in those cases where the foreign language rule is dissimilar and of equal or greater complexity than the native language rule." (p. 101) Hammerly (1975) reviewed the deduction/induction controversy and concluded that 80% of the basic grammar points of Spanish or French can be learned inductively, and that the inductive approach leads to better retention and makes learning more interesting.

On the relative advantages and disadvantages of the two types of presentations Allen (1977) states:

The deductive approach is most effective for the presentation of irregular patterns or exceptions to general patterns, for these by their very nature cannot be discovered through analogy. In the hands of a good teacher, the approach can save class time. . . . The drawback of the deductive presentation is that it may become dry and technical. . . . The advantage of the inductive approach is that the students participate in the formulation of the grammatical principle. . . . The disadvantage is that it often takes more time than a deductive presentation. (pp. 85, 90).
Hammerly (1982) states that "certain simple rules can be taught inductively as differential feedback will make the rule clear to the student" (p. 412). He adds that if a rule consists of a mechanical difference between the two languages (for example, number-gender agreement in Spanish and English) efficient inductive learning is possible. To illustrate this idea he includes a sample lesson in the made-up language of "Spikian" which uses simple sentences with cognates and English translation with practice and feedback to illustrate simple grammar concepts. Allen (1977) outlined the general pattern for deductive and inductive presentations as follows:

The deductive presentation of grammar follows this general pattern: 1. Statement of the rule or pattern, 2. Sample sentences that students repeat, 3. Ample opportunity for students to practice the new pattern. . . . The inductive presentation of grammar follows this general pattern: (1) Presentation of examples. (2) Oral or written practice. (3) Generalization or rule that grows out of the previous activity. Either the teacher states the rule or the students formulate it. The rule may be in the native or the target language. (pp. 85, 90).

**Summary**

Field dependence/independence has been identified as a significant variable in relation to both foreign language study and computer-assisted instruction. Inductive/deductive mode of presentation, although in itself not clearly shown to be a significant variable in instruction, when combined with the dimension of field dependence/
independence, the research reasonably supports the contention that a matching of cognitive style to mode of presentation (field independent-inductive and field dependent-deductive) may improve performance. Also the computer has been shown to be an effective and efficient medium for adapting instruction to individual needs. Therefore, this study will use inductive and deductive modes of presentation by computer to test their relative effectiveness on the performance of students indentified as being field dependent or independent.
CHAPTER III
PROCEDURES

Population

The population consisted of high school foreign language students. The artificial-language lessons did not require knowledge of any language other than English. The pre-test and background questionnaire enabled data to be analyzed according to how much previous knowledge of any languages has affected post-test results.

Sample

Students from French and Spanish classes at Seaholm High School and Rochester-Adams High School, public schools in upper middle class suburbs of Detroit, participated in the study. At Seaholm High School the experiment was administered to in-tact classes during the language class period. One Spanish and four French classes taught by a total of three teachers were involved. All students present on the days participated. At Rochester-Adams students from various Spanish classes of one teacher were offered extra credit to remain after school to participate.
in the experiment. Eighteen of the total of 104 students in the study were from Rochester-Adams.

**Pilot Study**

A pilot study was conducted prior to the experiment, using beginning Spanish students at Rochester Adams High School in Rochester, Michigan. The pilot study showed that the computer lessons ran as planned and that all students could finish the computer lesson in less than fifteen minutes. In addition, an informal survey of students afterwards confirmed the assumption that the lessons were at the appropriate level of interest and difficulty for high school language students. Experience administering the Group Embedded Figures Test (GEFT) was gained by giving the test to volunteer teachers, some of whom verified grading results. A licensed educational psychologist who had extensive experience with the GEFT served as consultant and advisor during the planning stages.

**Research Design**

A 2x2 factorial design was chosen to accommodate the primary independent variable, field dependence/independence, and the treatment variable, deductive and inductive lesson modes. Figure 2 illustrates this design.
Although a pre-test was used, the study was not an experimental pre-test/post-test design, since students knew nothing of Esperanto before the instruction. Instead, the pre-test given here was to determine whether lack of knowledge of grammar terms in English was a possible factor in the practice or post-test performance. This type of single treatment experimental design controls for history and maturation threats to validity. The one week interval between pre-test and treatment lesson was long enough to minimize the repeated measures threat to validity. No control group was necessary in this design since the dependent variable was examined in terms of the difference in performance in two contrasting lesson modes: deductive and inductive. To assure as much randomization of subjects as possible, students of each cognitive style were randomly assigned to one of the lesson treatment cells. In order to assure equivalent treatments, the inductive and deductive computer lessons were given to evenly mixed groups of FD and FI students in the same computer laboratory and with the same instructions.
Variables and Instrumentation

The independent variable of field dependence/independence was measured by means of the Group Embedded Figures Test, a well accepted measure of cognitive style whose validity and reliability have been satisfactorily established (Witkin, 1977). This instrument requires the subject to perceive and trace a simple geometric shape embedded within, or separate from the overall context or field, and thereby identifies the degree of field dependence or independence (Hansen, 1982).

The dependent variable observed was achievement in language lessons written and programmed by the researcher on floppy disks using the Apple Super Pilot Tutorial Authoring Language. Super Pilot (acronym for Programmed Inquiry, Learning, or Teaching) was chosen because it is a true programming language rather than an authoring system or template and thus allows creative flexibility in educational programming (Sanders, 1985). In addition, Super Pilot is especially well suited to language manipulation and is recommended for tutorials for foreign language lessons (Sanders, 1985). Super Pilot can match a response with an anticipated answer or identify combinations of letters embedded in any response. It also allows jumping within the lesson for purposes of review. PILOT is available in the public domain as well as from the Apple company in the copyrighted Super Pilot program.
The CAI treatment lessons taught four grammar concepts in the artificial language Esperanto, which was created in 1887 by Ludwig Zamenhof, a Polish oculist, and is now the most widely known of the international planned languages (Large, 1985). Esperanto was chosen for this study because it is a near-perfect fusion of grammar and vocabulary from the languages most commonly taught in U.S. schools: Romance Languages such as French, Italian, Latin, and Spanish, as well as Germanic languages (including English) and Slavic languages (Pei, 1961). Thus the results of the experiment would be generalizable to students of these western European languages of the Indo-European group. Esperanto also offered the possibility of using cognate words, simple spelling (similar to Spanish or Italian), and a sentence structure that can be identical to English. These features minimized the interference from the confounding factors of language aptitude and prior knowledge, which were outside of the main focus of the lesson (word suffixes that carried the grammatical concepts). Language aptitude was accounted for because the similarity of syntax and vocabulary would diminish the importance of skill in these areas for comprehension of the sample sentences. The potential confounding factor of prior knowledge was eliminated because the suffixes that signified the grammar concepts were different enough from
those used in western European languages that the student would have very little chance of inferring the correct suffix without seeing a rule or examples.

The treatment variable was the mode of presentation, either inductive or deductive. It was a fixed, active variable that was integrated into the lesson format (see Appendix C). The content for both lessons was identical, containing the same vocabulary, example sentences, and practice items. The major difference in the two lessons was the presence (deductive lesson) or absence (inductive lesson) of a rule statement. In place of a rule, the inductive lesson had a guiding statement that told the student to look at the examples of Esperanto and their English translations and try to figure out how the language worked. Since inductive learning requires the student to generalize a principle from many examples, the inductive lesson used twice as many examples (an average of six) as the deductive lesson. The presence of more examples is an inherent characteristic of inductive presentation, so that this difference between the treatment lessons was not a threat to internal validity, but rather was part of the treatment variable itself.

The design of the treatment lessons was based on the sample lesson of the artificial "Spikian" language used by Hammerly (1982) to illustrate the guided discovery (inductive) method of instruction. Since this model was
intended for oral presentation, some modifications were necessary for presentation by computer. The kind and amount of feedback was more limited in the computer lessons than in Hammerly's, but the basic format was retained. The lessons in this study taught language concepts that typically occur in beginning level learning of western European languages: formation of plurals, feminization of nouns, the accusative case (direct object), and verb tenses in the past, present and future. The deductive lesson presented the rule first (e.g. "To form the plural of a noun in Esperanto, add a 'j' to the end of the noun") followed by examples and practice. The inductive lesson gave three or more examples and the students were directed to look for the element in the Esperanto sentences that reflected the change in their English translations.

The dependent variable, performance on 8 practice items and 10 post-test items, was measured by having the subjects fill in the blanks in a transformational task. In the practice portion this consisted of a sentence in Esperanto with its English equivalent and below, a second incomplete sentence in Esperanto modeled after the first one (which provided a context and the root vocabulary needed) followed by its English translation (which incorporated the grammar concept being learned). For example, when the task was to add a "j" for pluralization of a noun this practice item was given in both lessons:
La viro visitas la doktoron.
The man visits the doctor.

La ________ visitas la doktoron.
The men visit the doctor.

The correct response was "viroj." Neither the rules nor examples were on the screen when the practice item was given. The fill-in-the-blanks format with English translation was chosen because it best isolated the grammar concepts being taught, and made possible accurate evaluation of the responses by the computer.

A maximum of two tries was allowed during practice before the correct answer was supplied. Practice scores were kept by the computer, which awarded two points for a correct answer on the first try, and one point for a correct answer on the second try. Students were not aware that the practice scores were being recorded. There were a total of eight practice questions and therefore a maximum score of 16 for the practice portion.

The post-test consisted of ten questions that were of the same type as in the practice, with only vocabulary and sentence context changed. A list of basic vocabulary in Esperanto and English appeared at the top of the screen for each question so that students could find the root word, which they then could modify according to the grammar.
concepts presented in the lessons. Vocabulary root words were provided, rather than requiring students to remember them from the lesson, since the object of the lessons was to teach grammar concepts contained in suffixes: requiring vocabulary knowledge would introduce a confounding factor since there would be no way to verify whether a wrong response was due to lack of knowledge of vocabulary or grammar.

In the post-test, a vocabulary of the eight root words needed in the blanks was provided at the top of the screen, and the student was required to alter the root as indicated in the English translation. For example:

actor=aktor  
friend=amiko  
man=viro  
uncle=onklo  
tiger=tigro  
catch=kaptas  
study=studas  
watch=observas

The friends learn the lesson.
La _________ lernas la lecionon.

The correct answer is "amikoj."

For each of the ten post-test questions the computer scored two points for a correct answer and zero points for an incorrect answer. Thus the post-test items were weighted so that they were of the same maximum value per question as the practice items.
Post-test and practice scores were combined when testing for relation with other variables for two reasons. First, it was of interest to the study whether lesson mode and cognitive style had an effect on the process of learning as well as on the end result. Scoring practice items would allow evaluation of students' responses during the hypothesizing process. Secondly, by combining the two scores there would be more measures per student, which would increase internal validity of the experiment.

The descriptive data below, although not tested as experimental variables, provided a context for interpretation of the results of the experiment, as well as guidance for future research. The background data (age, sex, year in school, years of study of languages, home learning of languages, prior use of CAI for school and languages, last language grade, and GPA) was collected one week before the computer lessons by means of a background questionnaire (appendix A). A four-item attitude survey in Likert scale form asked the students to rate how they felt about language learning, use of the computer for schoolwork and for learning languages (appendix A). The first three items were positively stated and the last item was negatively stated to control against an acquiescence response set. A score of one to five was assigned to the values in each item, with the scores of the last item reversed in order. Thus, by totalling all the scores, a score for
attitude towards computers and languages was obtained. A fifth item of the questionnaire allowed the students to make any comments they wished. This item was not subjected to statistical analysis but provided an indication of possible extraneous variables that may be present.

A pre-test on English grammar terms was given at the same time as the attitude survey and background questionnaire. The purpose of the pre-test was to account for the extraneous variable of lack of knowledge of grammar terms, which could affect practice and post-test results, especially in the deductive lesson where these terms were used. Jeffries (1983), in an investigation of the relationship between knowledge of English grammar terminology and success in French, Spanish, or German at the university level, noted that in most college language texts the essentials of grammar are presented generally in a deductive order although the inductive approach is also used where the context gives a clear and organized presentation. Results of the investigation showed that knowledge of English grammar terminology is a stable predictor of language achievement although the nature of this correlation was not adequately explained by the data.

The pre-test consisted of five tasks in English that corresponded to the grammar concepts of the Esperanto lesson (appendix B). These were pluralization and feminization of nouns, accusative (direct object) endings
and verb tense endings for past, present and future. With three items for each of the five tasks, a maximum score of fifteen was possible.

Procedures

The experiment was accomplished in two stages, one week apart. On the first day, the researcher met the students at Seaholm High School in their classrooms during their regularly scheduled language class. The researcher told the students that they would take part in a very important scientific experiment that would help foreign language teachers design better software lessons. Students were assured that whatever data was gathered would be confidential, and that only anonymous data would be reported. First the background questionnaire and attitude survey were distributed, with the pre-test on English grammar attached. After the GEFT tests were completed, the booklets were collected for grading by the researcher at a later date.

The second stage, one week later, consisted of the computer lesson on Esperanto grammar that included practice and post-test scores recorded by the computer. Response times on the post-test items were also recorded by the computer. This stage of the experiment took place in the computer lab during the regular language class hour. After all students were seated, one per computer, they were given
their pre-assigned treatment lesson disk, either deductive or inductive. When all disks were distributed and inserted into the disk drive, the students were told to proceed with the lesson at their own pace. They were informed that time and test scores were being recorded. Lab assistants and teachers made sure that the students stayed on task and did not help each other or look at one another's screens. As the students finished, they raised their hands as instructed on the computer lesson, and an assistant marked their finishing time on the disk. The disks were collected for later analysis and the students were told not to discuss Esperanto with other students until the next day.

At Rochester-Adams High School all the data were gathered in one day after school (N=18). This one-day procedure was necessary because a given group of students could attend only one after-school session. The questionnaire, pre-test and GEFT were administered first, followed by the computer lessons. The students at Rochester-Adams who took participated in the experiment were not the same ones who attended the pilot study one month earlier.

Analysis of Data

The total scores (combined practice and post-test scores) were subjected to a two-way analysis of variance with interaction to test the null hypothesis of no
interaction effect between the matching of cognitive style to lesson mode (field dependence was matched to deductive presentation and field independence to inductive presentation), and no main effects with the independent variables of cognitive style and lesson mode. The SAS (Statistical Analysis System) package was utilized on an Amdahl V-7B computer at the Ohio State University.

The simultaneous measures (response latencies in the post-test and total elapsed time) and the data from the background questionnaire, attitude survey and pre-test on English grammar terms provided additional descriptive data. Two correlation coefficient tests (Spearman Rho and Kendall Tau B) were conducted on the questionnaire and attitude survey data to test for relation with total score and cognitive style.

In addition, Chi Square contingency tables were used to further analyze the relation between cognitive style and the descriptive data and main experimental variables. Pre-test scores on English grammar terms were plotted and evaluated for possible interaction with the dependent variable. Furthermore, plotting was done on a number of variables to provide perspective on the results of certain correlations.
Summary

This study investigated the effects of deductive and inductive teaching strategies in computer-based language lessons on the performance in practice and post-test of students whose cognitive style was identified as field dependent or field independent. The subjects were 104 high school students of Spanish and French. A 2 X 2 factorial design was used to test for interaction between the independent variables of cognitive style and lesson mode.

In order to understand more fully the context of any results, the following descriptive data was collected by means of a background questionnaire and attitude survey (appendix A): age, sex, year in school, length and type of language study, use of computers for schoolwork and languages, last language grade and grade point average (GPA), and attitude towards language study, computers, and use of computers for language study. This descriptive data, as well as post-test response times and total elapsed time, were tested for correlations which would give a context for interpreting the experimental findings.
CHAPTER IV

RESULTS OF THE STUDY

Analysis of Experimental Data on Field Dependence/Independence, Lesson Mode, and Total Score

H0₁ There is no significant difference in the performance of field dependent and field independent students.

Table 1 shows the mean and standard deviation of total scores (practice plus post-test score) as a function of cognitive style. Out of a total possible score of 28, field independent students scored an average of 6.13 points higher than field dependent students, at a strong significance level of P>.0001.

The null hypothesis is rejected.
Table 1. Means and Standard Deviations of Total Scores as a Function of Cognitive Style.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>48</td>
<td>18.25</td>
<td>0</td>
<td>33</td>
<td>7.22</td>
</tr>
<tr>
<td>FI</td>
<td>56</td>
<td>24.32</td>
<td>8</td>
<td>36</td>
<td>6.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>-5.97</strong>*</td>
</tr>
<tr>
<td></td>
<td>*** P&gt;.0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This finding is consistent with results found in previous research, which indicated that field independent students perform better in foreign language tasks, especially if they involve discrete point grammar items such as in this study (Parry, 1984, Hansen & Stansfield, 1980, Naiman, 1978, Tucker, 1976).

Ho2 There is no significant difference between the mean total scores of the inductive and deductive lessons.

Table 2 shows the mean and standard deviation of total scores as a function of lesson mode. The mean on the deductive lesson was 4.5 points higher than that on the inductive lesson and resulted in a significant difference at a level of P>.0008.

The null hypotheses is rejected.
Table 2. Means and Standard Deviations of Total Scores as a Function of Lesson Mode.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ded</td>
<td>49</td>
<td>23.90</td>
<td>8</td>
<td>36</td>
<td>7.45</td>
</tr>
<tr>
<td>Ind</td>
<td>55</td>
<td>19.40</td>
<td>0</td>
<td>36</td>
<td>7.28</td>
</tr>
</tbody>
</table>

Difference: 4.50***

*** P>.0008

This result indicates that for lessons of discrete grammar points such as those taught in this lesson, where the rules are different from English but relatively simple, a deductive approach is best. This seems to contradict, or at least qualify the opinions stated by Fischer (1979) and Hammerly (1982) who recommend the inductive method for simple, mechanical differences between the native language and the target language. However, a limitation of this study, namely the adaptations of the inductive method to CAI, must be taken into account. The inductive lesson may have performed better with the grammar tasks in this study if it included more graphics, more examples, and more feedback and guidance. Nevertheless, the results show that the deductive approach worked well in this situation.
Ho3 There is no significant difference in the performance of students whose cognitive style is matched to lesson mode: field dependence to deductive and field independence to inductive.

Table 3 shows the mean and standard deviation for the match-mismatch effect. It was hypothesized that a match of field-dependent cognitive style and deductive lesson mode would result in higher scores than field-dependent mismatched with inductive lesson mode. The same was hypothesized for a match of field independence and inductive mode. No significance was found in comparing match to mismatch.

The null hypothesis is retained.

Table 3. Means and Standard Deviations for Total Score as a Function of Interaction between Cognitive Style and Lesson Mode (match/mismatch).

<table>
<thead>
<tr>
<th>Match/Mismatch</th>
<th>N</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>match:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FD-Ded</td>
<td>23</td>
<td>20.78</td>
<td>8</td>
<td>33</td>
<td>7.36</td>
</tr>
<tr>
<td>FI-Ind</td>
<td>30</td>
<td>22.30</td>
<td>8</td>
<td>36</td>
<td>6.79</td>
</tr>
<tr>
<td>mismatch:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FD-Ind</td>
<td>25</td>
<td>15.92</td>
<td>0</td>
<td>29</td>
<td>6.37</td>
</tr>
<tr>
<td>FI-Ded</td>
<td>26</td>
<td>26.65</td>
<td>15</td>
<td>36</td>
<td>6.49</td>
</tr>
</tbody>
</table>
An examination of the differences between the means shows a very slight advantage for matching field dependent cognitive style with deductive mode compared to a mismatch, but the opposite is true for field independent cognitive style. (Table 4)

<table>
<thead>
<tr>
<th>MATCHED</th>
<th>FI-IND</th>
<th>MEANS</th>
<th>MEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD-DED</td>
<td>20.78</td>
<td></td>
<td>22.30</td>
</tr>
<tr>
<td>FD-IND</td>
<td>15.92</td>
<td></td>
<td>26.65</td>
</tr>
<tr>
<td>Difference</td>
<td>4.86</td>
<td></td>
<td>-4.35</td>
</tr>
</tbody>
</table>

The absolute values of the differences are approx. equal. Thus the advantage of match with FD is nearly canceled by the advantage of mismatch with FI.

Note that while matching resulted in higher scores for the field dependent students, the opposite was true for field independent students. This is may be due to the superiority of the deductive lesson, which caused both groups of students to score well with that mode. However, the possibility exists that the field independent students may perform better with rules, as Abraham (1985) suggests. Another possible explanation for field independent students doing well in the deductive mode may be that, as Naiman (1978) states, certain language tasks
lend themselves better to a certain cognitive style; thus field independent students may perform better than field dependent students on the discrete point grammar tasks presented in this study, regardless of the method of presentation.

Although there is no significant difference for the match-mismatch effect, a Tukey's Multiple Comparisons of means between groups reveals significance at the P>.05 level (Table 5).

<table>
<thead>
<tr>
<th>DIFFERENCE BETWEEN MEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATCH</td>
</tr>
<tr>
<td>FD-DED</td>
</tr>
<tr>
<td>MATCH</td>
</tr>
<tr>
<td>FI-IND</td>
</tr>
<tr>
<td>FD-DED</td>
</tr>
<tr>
<td>FD-DED</td>
</tr>
<tr>
<td>FD-IND</td>
</tr>
<tr>
<td>FD-IND</td>
</tr>
</tbody>
</table>

*** P>.05

It is apparent that the greatest difference in the means was between field dependent students with the inductive lesson and field independent students with the
deductive lesson. There is no readily apparent explanation for this surprisingly large difference. Perhaps, as suggested before, field independent students are able to function well with rules in learning discrete-point grammar. This is a strong possibility here since their analytic ability would be supplemented by the advantage of having the rule stated. In contrast, the field dependent students may be distinctly disadvantaged by the inductive format, which requires analysis in separating the grammatical elements in the sentence examples. In fact, the field dependent person's difficulty with inductive format could be the reason for other researchers' belief in the match-mismatch effect. That is, the extreme difficulty of the field-dependent mismatch with inductive method, when measured together with a field-independent mismatch, may mask the possibility that field-independent students are not disadvantaged by a "mismatch" but rather function well in either format. Indeed, this study has shown this to be the case since field independent students scored highest in a mismatch situation. Thus there may not exist a match-mismatch effect for both cognitive styles, but only for field-dependent persons who are taught inductively. As noted earlier, the extreme disadvantage of field-dependent students in this situation may have been diluted in other studies where their personal interaction with the teacher counterbalanced their lack of analytical skill.
Summary of Findings for Experimental Variables

Table 6 shows a plotting of the scores for the independent variables, showing the number of observed scores at each value. The total number of observations (number of students) is 104. Note that from this plot it is apparent that the field independent students out-performed the field dependent students, and that the deductive lesson resulted in higher scores for each group.
Table 6. Plot of Number of Scores Observed at each Value of the Total Score

**Plot of Total*Group**

**Legend:**
- A = 1 Obs.
- B = 2 Obs.
- C = 3 Obs.
- D = 4 Obs.
- E = 5 Obs.
- F = 6 Obs.
- G = 7 Obs.
- H = 8 Obs.
- I = 9 Obs.

---

<table>
<thead>
<tr>
<th>Total Score</th>
<th>Group Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Dep-Ded</td>
</tr>
<tr>
<td>5</td>
<td>Dep-Ind</td>
</tr>
<tr>
<td>10</td>
<td>Indep-U</td>
</tr>
<tr>
<td>15</td>
<td>Indep-I</td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>
The results of a two-way analysis of variance with interaction are summarized in Table 7.

Table 7. Two-Way Analysis of Variance with Interaction of Cognitive Style and Lesson Mode Showing Levels of Significance for Difference of Mean Effects.

| PARAMETER                  | ESTIMATED DIFF. | P>|/T/ |
|----------------------------|-----------------|-------|
| MATCH VS MISMATCH          | 0.0508          | 0.8487|
| DEP. VS INDEP.             | 6.1256          | 0.0001***|
| DEDUCT. VS. INDUCT.        | 4.6082          | 0.0008***|

*** P>.001.

The main effects for the variables when considered separately proved to be significant at the P>.001 level. Thus, field-independent students scored significantly higher on both lessons while the deductive lesson yielded higher scores for both cognitive styles. However, when interaction between lesson mode and cognitive styles is considered, analysis of variance showed that the slight advantage noted above for matching cognitive style with lesson mode did not prove to be significant.
In addition to the experimental data analyzed above, four other types of data were collected. These were: simultaneous timing measures (response latencies on the post-test and total elapsed time), pre-test scores on grammar terms in English, a Likert scale survey on attitudes towards computers and language study, and background information. The purpose of the descriptive data was to provide information that may be useful in interpreting the above results. In the case of the pre-test and attitude survey, and certain of the background information such as last language grade, this data gave indications of possible extraneous variables these may have influenced the results. The descriptive data also may prove useful in indicating possible directions for future research, but since these data were not the result of experimental testing of the variables involved, they should not be construed as being reliable for predicting results in replication experiments.

Some of the tests that were conducted on the descriptive data are not reported here. Only those results that proved interesting or were likely to be useful were included. Table 8 summarizes the results of Spearman Rho correlation coefficients between the dependent variable of total score and certain independent variables from the
background information and attitude survey. A Kendall TAU B correlation test was used on the same data and confirmed the results. The variables listed in the positive column all proved to be significantly positively related to the total scores at a P level of .05 or less. Attitude and computer use did not show a correlation with total scores at the P>.05 level. Thus, the students' attitudes towards computers and languages were not significantly related to their performance and neither were their prior experience or lack of experience in using computers.

<table>
<thead>
<tr>
<th>Table 8. Spearman Rho Correlation Coefficients for Descriptive Data as Related to Total Score.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POSITIVELY RELATED at P&gt;.05</strong></td>
</tr>
<tr>
<td>GRADE POINT AVERAGE</td>
</tr>
<tr>
<td>LAST FOREIGN LANGUAGE GRADE</td>
</tr>
<tr>
<td>AGE</td>
</tr>
<tr>
<td>YEAR IN HIGH SCHOOL</td>
</tr>
<tr>
<td>LENGTH OF STUDY OF LANGUAGES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>NOT SIGNIFICANTLY RELATED at P&gt;.05</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQUENCY OF USE OF COMPUTER FOR SCHOOL</td>
</tr>
<tr>
<td>TOTAL ATTITUDE: COMPUTERS AND LANGUAGES</td>
</tr>
</tbody>
</table>
Response Time

Response time for post test was analyzed for relation to lesson mode and no significant difference was found. However, in relation to cognitive style, field dependent students took significantly longer to respond to the test items than did field independent students. (Table 9)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>FD</td>
<td>48</td>
<td>200</td>
<td>90</td>
<td>310</td>
</tr>
<tr>
<td>FI</td>
<td>56</td>
<td>181</td>
<td>106</td>
<td>262</td>
</tr>
</tbody>
</table>

*** p > .0406

In a comparison of the means of match (FD-DED, FI-IND) vs. mismatch of cognitive style and lesson mode, no significant difference was found. Neither was any significant difference found in comparisons between any of the groups of cognitive style and lesson mode.
Total Elapsed Time

As was the case with response time, no significant difference was found for elapsed time in relation to lesson mode. In fact, the total time that each lesson took was very nearly the same. This is an interesting observation, since the literature indicated that one of the disadvantages of the inductive method was that it required more time. The most likely explanation for this discrepancy may be that the inductive lessons in this study did not include sufficient examples or graphic illustration in context. If this is true, it would support the idea that the inductive lesson was deficient in some way, which may account for the lower scores.

Again, as in the case with response time, field dependent students took significantly longer ($P > .0007$) in completing the total lesson (Table 10).

Table 10. Means and Standard Deviations of Total Elapsed Time for Lesson and Post Test in Minutes as a Function of Cognitive Style.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>48</td>
<td>18.56</td>
<td>13</td>
<td>25</td>
<td>3.42</td>
</tr>
<tr>
<td>FI</td>
<td>56</td>
<td>16.38</td>
<td>11</td>
<td>23</td>
<td>2.95</td>
</tr>
<tr>
<td>Difference</td>
<td><strong>1.18</strong>*</td>
<td><strong>1.18</strong>*</td>
<td><strong>1.18</strong>*</td>
<td><strong>1.18</strong>*</td>
<td><strong>1.18</strong>*</td>
</tr>
</tbody>
</table>

*** $P > .001$
This is not surprising given the lower means scores for this group. They may have simply not understood the concepts as well and therefore took more time figuring out an answer in the practice and post test items.

Again, as in the case with response time, no significant difference was found between the mean total times of matched and mismatched groups. However, a General Linear Model Procedure on comparisons between groups showed that the FD-DED group took significantly longer to finish the lesson than either of the field independent groups, but not significantly longer than the FD-IND group. Table C shows the total elapsed times for each group.

| Table 11. Means and Standard Deviations for Total Elapsed Time by Group |
|--------------------------|----------|--------|--------|--------|--------|
| Group       | N   | Mean | Min | Max | S.D. |
| FD-DED A,B  | 23  | 19.04| 13  | 25  | 17.36 |
| FD-IND      | 25  | 18.12| 13  | 25  | 19.60 |
| FI-DED B    | 26  | 16.12| 11  | 23  | 18.77 |
| FI-IND A    | 30  | 16.60| 11  | 23  | 17.52 |

A & B are significantly different at the P > .005 level.

As noted above, the inductive lesson was expected to take longer and this result contradicts that expectation, probably for the same reason as noted above.
Pre-test scores were plotted to see if there was a great enough variation in scores to warrant concern about the confounding factor of lack of knowledge of English grammar terms. As expected, the great majority of the students scored a maximum 15 points, while a few students placed in the 12 to 14 range. Therefore this factor was not judged to be significant enough to affect experiment results since the terms were used in context together with examples in the lessons.

Summary of Findings

Analysis of the experimental data revealed no significant effect for matching of cognitive style to lesson mode. However, field-independent students performed significantly better in both lesson modes than did field-dependent students ($P > .0001$). Also, scores for the deductive lesson were higher than those for the inductive lesson ($P > .0008$). An analysis of comparisons between groups found that there was a large significant difference in the performance of field dependent students in the inductive mode compared to field independent students in either mode.

Correlations on descriptive data yielded some interesting information. Frequency of computer use, attitude toward languages and CAI, and knowledge of English grammar terms had no significant effect on performance. GPA, last language grade, age, year in school, and length
of language study were found to be positively correlated with performance. Total elapsed time and response time on the post test items were shown to be greater for field dependent students but no difference was found in the times for the two lesson modes.
CHAPTER V
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of the Study

The primary purpose of this study was to investigate the effects of deductive and inductive presentation of grammar in computer-delivered lessons, on the performance of students whose cognitive style was identified as being field dependent or independent. In the deductive lesson, the rules for four grammar concepts in the artificial language of Esperanto were presented along with examples and practice. The inductive lesson did not present the rule, but rather told students to look at the samples of Esperanto sentences and their English translation, and try to see how the language worked. Responses for practice and post-test items were scored by the computer. Response times for post-test items and total elapsed time for lesson and post-test were recorded. Additional descriptive data such as age, sex, year in school, experience with languages and computers, last language grade and GPA were collected by means of a background questionnaire. Attitude towards computers and language learning was also surveyed.
A review of related literature suggested that a match of cognitive style to mode of presentation (field dependent-deductive or field independent-inductive) would result in better performance than a mismatch, since field dependence has been associated with the need for structure (as in the deductive lesson) while field independence has been associated with analytical thinking (as in the inductive lesson).

The following procedures were followed. The Group Embedded Figures Test, background questionnaire, attitude survey and pre-test on English grammar terms were administered to 104 French and Spanish high school students. One week later the students were randomly assigned to treatment cells and took either the inductive or deductive CAI lessons and post-test. A 2x2 factorial design accommodated the variables of field dependence and lesson mode. Practice and post-test scores were subjected to a two way analysis of variance with interaction. Correlation tests were run on the descriptive data as well.

The following results were obtained:
--Field independent students performed significantly better than field dependent students in both lesson modes.
--The deductive lesson resulted in significantly better achievement than the inductive lesson.
The field dependent students in the inductive lesson performed significantly below the field independent students in either lesson.

In the descriptive data, two further interesting observations were made: neither amount of experience with computers nor attitude towards foreign languages or the use of computers had any correlation with achievement.

Conclusions

The most important finding of this study was that the expected match of FD-DED and FI-IND did not result in improved achievement. The fact that no significant match-mismatch effect was found in these computer-delivered lessons, suggests that the interaction found in previous studies may have been due to other effects, such as teacher-student sociological or psychological interaction. For example, a teacher who is field independent and prefers the analysis of the inductive mode of presentation may find that field independent students perform better in her class. This apparent "match" of FI-IND (not found in the present study) may be due primarily to the fact that FI students can identify with the personality and way of thinking of the teacher; in other words, the "match" between teacher and student cognitive style may be more significant than the "match" between cognitive style and method of presentation. One purpose of this study was to
test whether previous findings would hold true in computer-delivered lessons where extraneous presentation variables were minimized. Thus, the findings of no interaction in this study should caution acceptance of the results of previous studies where teacher-delivered lessons found a match-mismatch effect.

If it is assured, as this study indicates, that there is no match of cognitive style and lesson mode for field independent students, what theoretical explanations could be offered for the fact that field independent students performed equally well in each lesson mode? According to Ausubel (1968) "inductive problem solving may be considered a subsidiary phase within a generally deductive approach" (p. 55). Thus the FI students may have already available cognitive skills for achievement in deductive lessons, as well as in inductive lessons.

What explanation could be offered for the superiority of the deductive lesson? Brown (1980) suggests that the inductive method is best utilized for superordinate principles, while Chastain (1976) states that deductive works best with discrete grammar items. This could explain why the deductive lesson scores were higher: because the content was simple grammar points that lent themselves to a rules, that is, deductive, approach.

Although no significant difference was observed for matching FD-DED and FI-IND, some very large, significant
differences were found for comparisons between groups. The largest difference was between the means of FD-IND and FI-DED. This indicated that field independent students are capable of achieving well in either lesson mode while field dependent students have great difficulty with the inductive mode. As mentioned in Chapter IV this may be due to the fact that in the inductive mode they are called upon to analyze examples which field dependent persons have difficulty doing. The present interpretation suggests that previous studies that discovered a match-mismatch effect may have actually been observing a strong mismatch effect for field dependent students in the inductive mode rather than a mismatch effect for both cognitive styles. If this is the case, the present results indicate the importance of taking field dependence into consideration when presenting a lesson inductively.

Fortunately, there is research evidence that indicates that the observed disadvantage of field dependent students in inductive learning can be ameliorated by training in analyzing skill. In his recommendations for improvement of cognitive profile Letteri (1985) suggests giving the students training to help them develop better control of analysis of presented information. This skill is then transferred to almost any academic area. Witkin (1977) likewise states that it may be possible to increase cognitive analytical skills by perceptual training in the
manipulation of figure and background field relationships. A module of training such as this, preceding an inductive language lesson, for example, would probably help the field dependent students to overcome some of their weakness in analytic skills and allow them to perform closer to the field independent students.

Another concept for improvement in the performance of all students with inductive lessons, but especially field dependent students, is suggested by a number of theorists and researchers: to add guidance to the inductive presentation of examples. (In fact, guidance may be regarded as a type of "on the spot" training in that it helps the students to organize the information presented to them.) Hammerly (1975, 1982) recommends guided discovery as middle ground in the controversy between deductive and inductive methods. He suggests that it be employed in cases where the student is able to learn without overt presentation of a rule.

Gagné is one of the foremost proponents of the use of guidance with the inductive method. For Gagné (1985), this type of guidance is instructions, whether verbal or modeled, that are externally provided to "guide" or "channel" thinking in certain directions. Guidance may vary in amount or completeness, but always stops short of describing the solution. He states: "As a minimum, guidance of thinking informs the learner of the goal of the
activity, the general form of the solution . . . . Greater amounts have the effect of limiting the range of hypotheses entertained by the learner in achieving solution." (p. 191). He concludes by stating that guidance "has been found to be effective in experimental studies of rule learning although the question of how much or how little guidance is most effective has not yet received a satisfactory answer." (p. 313).

Although in the discussion in Chapter II we noted that Ausubel (1978) argues for the superiority of expository (deductive) teaching, he does provide a convincing argument for use of "guided discovery" learning, which is inductive learning augmented by the type of guidance mentioned by Gagne. Ausubel states that in a discovery learning situation the degree of guidance can range from complete guidance, which is tantamount to reception (deductive) learning, to absence of any guidance whatsoever, which requires completely autonomous discovery.

Ausubel concludes that:

A review of short-term studies of the role of guidance in meaningful discovery learning leads to the conclusion that guided or semiautonomous discovery is more efficacious for learning, retention, and transfer than is either completely autonomous discovery or the provision of complete guidance . . . . Guidance under these circumstances apparently sensitizes the learner to the salient aspects of the problem, orients him or her to the goal, and promotes economy of learning by preventing misdirected effort. (p. 336-337).
In regards to this study then, we conclude that the inductive lesson may have been too pure a form of autonomous discovery. Achievement superior to that observed in the inductive or even the deductive lesson may occur with a lesson that provided more specific guidance. For example, this guidance could take the form of telling the students where in the sentence or word to look for the suffix that carries the grammatical concept.

Another type of guidance suggested by Gagné (1985) and Ausubel (1978) is to help the learner recall information stored in memory. In the inductive lesson in this study the guidance could be in the form of questions which prompt the students to recall what they already know of foreign language suffixes that serve to carry grammatical concepts. (Note that this is not the same as giving them the rule, as in the deductive lesson.) In this manner the advantages of discovery learning (better retention and transfer) can be retained, while the disadvantages (more time, and as this study indicates, and reduced effectiveness for field dependent students) can be diminished.
Recommendations for Future Research.

In light of the preceding discussion, it is evident that the presence of guidance (or "guidance effect" as it will be referred to here) in the inductive lesson could affect a number of the observations and results obtained in this and other investigations of field dependent-field independent cognitive style and inductive-deductive lesson mode. Results that may have shown a "guidance effect" include the following: a) the poor performance of field dependent students in the inductive lesson, b) lower achievement in an inductive lesson of discrete point grammar, c) longer learning time with the inductive lesson, and d) less retention and transfer in a purely discovery lesson. Therefore, it is recommended that this study be replicated to test for "guidance effect" in three types of lessons: a guided discovery lesson, a pure inductive, and a pure deductive lesson.

In order to adequately test long term retention, a retest would be necessary after an appropriate amount of time. To test transfer, somewhat dissimilar language tasks would have to be devised (such as use of prefixes instead of suffixes only as in this study) to carry grammatical concepts. Also, it would be advisable to increase sample size so that extreme field dependent and field independent cognitive styles could be separated from the sample in
order to discover weaker, but still significant results in the match-mismatch effect and in comparisons between groups.

This study has confirmed the importance of cognitive style in foreign language learning. In order to maximize learning, more research is needed on how to adapt instruction to students' cognitive styles. Although studies such as this one that examine one dimension of cognitive style are valuable and necessary to sort out the variables involved, eventually, as cognitive theory develops, more studies such as those of Letteri, which examine cognitive profiles, will have to be done.

The significant difference in performance on the deductive and inductive lessons warrants further investigation into the factors involved. This research should be done with various types and levels of subject matter, and with global as well as discrete point material. And finally, the relative paucity of all types of research dealing with learner variables and computer-assisted instruction demands further investigation in this area, especially with the manner in which CAI interacts with cognitive style. Another observation of this study, that attitude toward use of computers or amount of use of computers had no relation to achievement, should ease the concern of teachers who hesitate to require all students to use the computer for school learning tasks.
The findings of this study are not definitive. They have, however, given indications of how learning styles can be taken into account when attempting to maximize learning. What the results of this investigation can do is sensitize educators to how the differences in student cognitive style and type of presentation as well as medium of instruction can affect students' learning.
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APPENDIX A
BACKGROUND QUESTIONNAIRE
AND ATTITUDE SURVEY
QUESTIONNAIRE: BACKGROUND INFORMATION

NOTE: This information is needed for statistical purposes only. None of this information nor any test scores will be kept on file under your name. No information you supply will be given out to anyone (including your teacher) without your permission.

1. AGE________
2. SEX (circle one) M F
3. GRADE (circle year in high school) 1 2 3 4

4. Which foreign languages have you studied? (circle those that apply)
   French  German  Spanish  Latin  other _____________

5. How long did you study the language that you know best? (check the closest figure)
   ___ 4 years or more  ___ 3 years  ___ 2 years  ___ 1 year  ___ less than 1 year

6. Did you learn any of the above circled languages from the family at home? yes no

7. How much have you used a computer for classwork? (check the closest figure)
   ___ never  ___ a few times  ___ more than 10 times  ___ very often

8. Have you ever used the computer for your foreign language class? yes no

9. What is your overall grade point average (the average grade of all your classes)? ________.

10. What is the last FINAL GRADE you received in a foreign language class? ________.

ATTITUDE QUESTIONNAIRE

Please put a check anywhere along the line to indicate how you feel about the statement.

1. I like to use the computer for schoolwork.
   / ___________________________ / ___________________________ / ___________________________ / ___________________________ / ___________________________ / ___________________________ /
   strongly disagree  disagree  no opinion  agree  strongly agree

2. I enjoy learning a foreign language.
   / ___________________________ / ___________________________ / ___________________________ / ___________________________ / ___________________________ / ___________________________ /
   strongly disagree  disagree  no opinion  agree  strongly agree

3. I would like to use the computer to help me learn a foreign language.
   / ___________________________ / ___________________________ / ___________________________ / ___________________________ / ___________________________ / ___________________________ /
   strongly disagree  disagree  no opinion  agree  strongly agree

4. Using the computer for doing school work is frustrating for me.
   / ___________________________ / ___________________________ / ___________________________ / ___________________________ / ___________________________ / ___________________________ /
   strongly disagree  disagree  no opinion  agree  strongly agree

5. Are there any comments you would like to make?
APPENDIX B

PRE-TEST OF GRAMMATICAL CONCEPTS
PRE-TEST: GRAMMATICAL CONCEPTS

1. Write the **plural** of these words in the blanks

   paper ____________
   match ____________
   bud ____________

2. Write the **feminine** equivalent of these words:

   actor ____________
   man ____________
   brother ____________

3. Make these words into **feminine, plural**:

   son ____________
   uncle ____________
   boyfriend ____________

4. Underline the **direct object** in these sentences:

   The man catches the fish.
   The students learn the lessons.
   The aunt writes the letters.

5. Label the **time** of the action in these sentences by circling past, present or future.

   The man visited the doctor.  past/present/future
   The teacher will teach the lesson.  past/present/future
   The cat sees the birds.  past/present/future

WHEN YOU HAVE FINISHED WITH THIS PAGE, PLEASE TURN IT OVER AND WAIT UNTIL YOU RECEIVE INSTRUCTIONS ON WHAT TO DO NEXT.
APPENDIX C

PRINTOUTS OF COMPUTER PROGRAM

OF LESSONS
Print of lesson INDUCTIVE

In the next few minutes you will learn to read and write simple sentences in Esperanto. This artificial language was created over 100 years ago so that people from all countries could speak in one language.

Today, people in virtually every country in the world, teachers, lawyers, businessmen, and scientists use Esperanto to communicate with each other.

Now you have a chance to begin learning it too!
To make your lesson in Esperanto more fun, let's imagine that you are about to embark on an adventure to a fantasy country called Esperantoland.

But before you will be permitted to enter, you have to take a test to see how well you can learn their language.

In this computerized lesson you will be given some examples of Esperanto and after some practice you will be given a quiz. You will then receive a rank in Esperantoland according to your level of achievement.

Are you ready? The computer will be recording how long you spend on the lesson, so work fast, but do the best you can to learn Esperanto so you can enter Esperantoland with as high a rank as possible.

Bonshanco!

(Good Luck!)
u: subl

r: LESSON 1 ALCUSIVTE

*viro
u: subl
La viro kaptas la tigron.
La tigro kaptas la virojn.
La patro vizitas la o'leon.
La onklo vizitas la patron.
La o'lon vizitas la patrojn.
La kato observas la muson.
La muso observas la katon.
La tigro observas la muson.

When you think you've seen how it works, press RETURN to continue.

q:m410,10;t (RETURN)
w:999
q:es

t: Now see if you can complete this Esperanto.

q:es

La leono observas la tigron.
La tigro observas la ___________.

When you think you've seen how it works, press RETURN to continue.

r:The * allows for a period.
Right!

No, look at the examples another time and try again.

The answer is "leonon".

*lesson2

*studas

1: Lesson 2.1 PLURAL, INDUCTIVE

Here are some more examples of Esperanto. When you think you've seen how the Esperanto is being used, go on.

La amiko studas la lecionon.

The friend studies the lesson.

La amikoj studas la lecionon.

The friends study the lesson.

La viro kaptas la tigon.

The man catches the tiger.

La viroj kaptas la tigrojn.

The men catch the tigers.

La leono observas la birdon.

The lion watches the bird.

La leonoj observas la birdojn.

The lions watch the birds.

Press (RETURN). The computer will wait 999 seconds for any key to be pressed, then will erase screen and proceed.

Now let's see if you can fill in the blank with the right word.
La viro visitas la doctoron.
The man visits the doctor.
La ________ visitas la doctoron.
The men visit the doctor.

ty: Great! You've got the idea.
tn1: That's not quite right. Let's look at the examples again.

*leono

t: Are you ready for another one?
Let's see how observant you were when you saw the examples. Think hard, then type a word for the blank.

La leono observas la katon.
The lion Watches the cat.

La leono observas la ________.
The lion watches the cats.

ky1: Score3 2
ty: Great. You got that one right!

tn: No, not quite. Try once more.

jn: leono

r: I want student to go to leono if he missed the first try.

tn2: The correct answer is "kato1n".

r: I want program to go on after second wrong answer.

*l:lesson

u: sub1

r: LESSON 3.1 FEMININE, INDUCTIVE

t:

q: O, f. In#, you're doing great! You are now half way through your lesson to enter ESPERANTULAND.

t:

r: REPEAT GRAPHIC OF SHIP, THIS TIME HALFWAY TO ESPERANTULAND

u: sub1

r: Take a look at these new examples of Esperanto and go on as soon as you think you've seen what is happening.

*lernas

u: sub1

r: La virino lernas la lecionon.

r: The woman learns the lesson.

r: La virino lernas la lecionon.
t: La amiko lernas la lecionon.
t: The boyfriend learns the lesson.
t: La amikino lernas la lecionon.
t: The girlfriend learns the lesson.
t: La patro visitas la onklion.
t: The father visits the uncle.
t: La patrino visitas la onklion.
t: The mother visits the aunt.
t: La patrinoj visitas la onklion.
t: The mothers visit the aunts.
t: When you are ready press RETURN.

g:m410,10;t (RETURN)
w: 999
g: es

t: Do you think you have it? Type in the word that goes in the blank.
t:
t: La frato laptas la birdojn.
t: The brother catches the birds.
t: La _______ laptas la birdo.
t: The sister catches the birds.
t: ts:g9,7
a:
   ts:g6,13
m: fratino

k1: Score 4 2
k2: Score 4 1
n2: Score 4 0

ty: Yes, that's it!
tn1: No, not quite. Look at the examples and try once more.
jn1: lernas

r: I want student to go to lernas after first wrong answer.

tn2: Well, the correct answer should be "fratino".
r: I want student to go to following question after the second wrong response or after correct response.

*patron

u: sub1

t: Now let's do another one.
t: Type in the correct form.
t:
t: La studento visitas la patron.
t: The student visits the father.
t:
t: La studento visitas la ________.
t: The student visits the mother.
t:
t: g25,6
t: g0,13

m: patron*

u: sub3

t:
t: ty: Yes, you're right!
t:n1: No, you'd better try again.

j: patron
tn2: The correct answer is "patron".

*ami ko

u: sub1

m: a torinojn

k1: Score5 2
k2: Score5 1
k3: Score5 0
ty: Fantastic!

tn1: No, try again.

jn1: amiko

r: I want student to go back to *amiko
   : if he got the first try wrong

tn2: The answer should be "aktorinojn".

*lesson4

r: LESSON 4.1 TENSES. INDUCTIVE

u: sub1

t:

r: You're making good progress with
   : your Esperanto lesson, In$. Three
   : down, one to go.

r:

t: Look at this final set of examples
   : and then see if you can correctly
   : complete the practice sentences.

*studento

g: m410, 10; t (RETURN)

w: 999

g: es

t: La studento skribas la leterojn.

r: The student writes the letters.

r:

t: La studento skribis la leterojn.

r: The student wrote the letters.

r:

t: La studento skribos la leterojn.

r: The student will write the letters

r:

r:

r:

r:

r:

r:

When you are ready for practice,
   : press RETURN.
See if you can fill in the blank with the correct form of the verb.

La lato observas la birdon.
The cat watches the bird.

La lato _______ la birdon.
The cat watched the bird.

The correct answer is "observas".

Let's do one last practice sentence. Then we'll be ready to go to the test.

La viro kaptas la leonon.
The man catches the lion.

La viro _______ la leonon.
The man will catch the lion.
ty: Right!

tn1: Not quite right. Try again.

jn1: kapta

tn2: The correct answer is "kapto".

*end

is: END INSTRUCT.N

ui: sub1

ts: s2; t2

t: GRATULOJ!

ts: s1; t1

t: (CONGRATULATIONS!)

t:

ts: s1; t2

t:инф

ts: s1; t1

t: You have now finished all four lessons of Esperanto. Now let's see how much you can remember.

t: In the following section there will be ten questions. At the end you will be given your score and a rank in Esperantoland.

t:

th: Press RETURN.

a:

c(al(1)=99): a1(1)=77

l: pre/post.t

e:
*sub1
  g: m410,10:t (RETURN)
  w: 999
  g: es
  e:

*sub2
  g: m410,10:t (RETURN)
  a:
  e:

*sub3
  kyl: Score 2
  ky2: Score 1
  kn2: Score 0
  e:
Print of lesson DEDUCTIVE

d:al(1)
c:al(1)=99
r: your text viewport is set at
r:

*ins1
pr:q
pr:lg
pr:l
d:n$(20)
t:
t:

t: ESPERANTO:
t: The International Language
t:
t: In the next few minutes you will
learn to read and write simple
sentences in Esperanto. This
artificial language was created over
100 years ago so that people from all
countries could speak in one language.
t:
t: Today, people in virtually every
country in the world, teachers,
lawyers,
businessmen, and scientists use Esperanto
to communicate with each other.
t:
t: Now you have a chance to begin
learning it too!

u:sub1

t: To make your lesson in Esperanto
more fun, let's imagine that you are
about to embark on an adventure to a
fantasy country called.
t:
t: ESPERANTOLAND
t:

q::ship
r:WILL DISPLAY GRAPHIC OF SHIP

u:sub1
But before you will be permitted to enter, you have to take a test to see how well you can learn their language.

DEDUCTIVE LESSON begins here.

In this computerized lesson you will be given four rules for making sentences in Esperanto. After each rule you have a chance to practice it.

At the end you will be given a quiz and then you will receive a rank in Esperantoland according to your level of achievement.

ranks

GRAPHIC OF RANKS HERE

Are you ready? The computer will be recording how long you spend on the lesson, so work fast, but do the best you can to learn Esperanto so you can enter Esperantoland with as high a rank as possible.

Bonshanco!

(Good Luck!)

Please type your first name. (Then press RETURN).

a: $n$
Please type your last name. (Then press RETURN).

---New Student---
Name: \$n\$ \$q\$

Above commands will store student's name in system log.

O.k., we can begin.

LESSON 1 ACCUSATIVE

Your first task is to learn how to make a direct object in Esperanto. The direct object is the thing that receives the action of the verb.

The first rule of Esperanto is:

Rule #1: Put an "n" at the end of the direct object.

Here are two examples:

La viro kaptas la TIGRON.
The man catches the tiger.

La tigro kaptas la VIRON.
The tiger catches the man.

When you are ready to go on, press the RETURN key.

Now let's see if you can complete the sentence correctly. If you make a typing error, use the backspace arrow to go back and type again.

Be sure to press RETURN to enter
:your answer into the computer.

*leono

\texttt{g:m410,10; t (RETURN)}
\texttt{w:999}
\texttt{g:es}

\texttt{t: La leono observas la tigron.}
\texttt{t: The lion watches the tiger.}
\texttt{t: La tigror observas la _________.}
\texttt{t: The tiger watches the lion.}

\texttt{ts:g27,4}
\texttt{a: ts:g0,15}

\texttt{m:leono*}

\texttt{u:sub3}

r:THE U:SUB3 COMMAND IS A COMMAND TO SAVE SCORE IN SYSTEM LOG

\texttt{t:}
\texttt{ty: That's right!}
\texttt{tn1: Remember, the rule is:}
\texttt{ : Rule #1: Put an "n" at the end}
\texttt{ : of the direct object.}
\texttt{ : Try again.}
\texttt{jn1:leono}
\texttt{tn2: The answer is "leono".}

*leson2

\texttt{u:sub1}

r:LESSON 2: PLURAL

\texttt{t: Now for the second rule of Esperanto.}
\texttt{t: Rule #2: To make a noun plural,}
\texttt{ add a "j" after the "o".}
\texttt{t: For example:}
\texttt{t:}

\texttt{latiqtro observas la tigror.}
\texttt{The tiger watches the lion.}
If the noun is a direct object, you still put a "j" after the "o" and before the direct object "n":

Example: leccion = lesson

ción = lessons

* viro

See if you can type the correct word for the blank:

La viro visitas la doctoron.
The man visits the doctor.

La ______ visitas la doctoron.
The men visit the doctor.

The correct answer is "viroj".

* kato
t: Are you ready for another one? If the word for cat is "kato" how would you complete this sentence?

```plaintext
La leono observas la __________.
```

The lion watches the cats.

t: ts:27.5

m: katojn

u: sub3

ty: Terrific, you've got it!

```
#1 For a direct object add "n".
#2 For a plural add "j"
```

Try again.

```
#1: kato
```

tn2: The correct answer is "katojn".

*lesson3*

u: sub1

r: LESSON 3 FEMININE

t:

t: O.k., In3, you're doing great! You are now half-way through your lesson to enter Esperantoland.

```
gr: GRAPHIC of ship halfway to land.
```

u: sub1

t: The third rule of Esperanto tells how to make a word into its feminine equivalent.

t: Rule #3. To make a noun feminine add "in" before the "o".

t: For example: patro patrino

t: father mother

t: This rule also applies when a noun is a direct object:
For example:

- man woman
- sub
- If a noun is a direct object, as well as feminine and plural, you use all the rules you've learned on that word:
- Example:
  - ami k0 = friend
  - ami kino = girlfriend (fem.)
  - ami kinoj = girlfriends (fem. & pl.)
  - ami kinojn = girlfriends (fem. & pl. as direct object)

*frato

Let's see if you have it. Type in the word that goes in the blank.

La frato kaptas la birdojn.
The brother catches the birds.

La _________ kaptas la birdojn.
The sister catches the birds.

ts: g6,6
a:
ts: g0,10

fratino

Yes. That's correct.
No, not quite. The rule is:
Rule #3: To make a noun feminine add "in" before the "o".
Go back and do it over.
frato
Well, the right answer is "fratino"
*patron*

g:m410,10:t(RETURN)
w:999
g:es
t: Now let's do another one.
t: Type in the correct form.
t: La studento visitas la patron.
t: The student visits the father.
t: La studento visitas la __________.
t: The student visits the mother.
t:
ts: g26,6
a:
ts: g0,9

m:patr1non
u: sub3

t:
ty: Yes, that's it!
tn1: No, you'd better try again.

*jn*: patron

*ami to*

u: sub1

t: Let's try one more.
t: La amiko visitas la aktoron.
t: The friend visits the actor.
t:
ts: g26,6
a:
ts: g0,9

m: a*torino

u: sub3

ty: Yes, that's perfect.
tn1: No, you must have forgotten to
apply one of the rules. Think hard
and try it once more.

jn1: amiko
tn2: The answer should be "aktorinojn".

*lesson4

r: LESSON 4 TENSES DEDUCTIVE

u: sub1

t: You're making good progress with your
Esperanto lessons, jm1. Three down
and one more to go.

t: Here is the last rule of Esperanto.
t: Study it, then do the practice items.
t: Rule #4: Verbs have these endings to
t: indicate the time of the action:
t:
  - is indicates PAST
  - as indicates PRESENT
  - os indicates FUTURE
t:
t: Examples:
t:   lernis (learned)
t:   lernas (learns)
t:   lernos (will learn)

*observe

u: sub1

t: See if you can do this sentence
correctly:
t:
  La kato observas la birdon.
t: The cat watches the bird.
t:
  La kato _________ la birdon.
t: The cat watched the bird.
t:
  ts: g14, 6
  a:
  ts: g0, 9

m: observe
The man catches the lion.

The man will catch the lion.

Try again.

* The right answer is "observis".

Let's do one last practice sentence.

La viro kaptas la leonon.
The man catches the lion.
La viro _____ la leonon.
The man will catch the lion.

Try again. I now you've got it.
Watch your endings and try again.

The correct answer is "kaptos".

*end

DEDUCTIVE
You have now finished all four lessons of Esperanto. Now let's see how much you can remember.

In the following section there will be ten questions. At the end you will be given a score and a rank in Esperantoland.

Press RETURN.

c(a1:1=99):a1:1=77

I:pre/post.t

*sub1

g:m41v,10:t(RETURN)
w:999
g:es
e:

*sub2

g:m410,10:t(RETURN)
a:
e:

*sub3

kv1:Score 2
kv2:Score 1
kn2:Score 0

e:
Print of lesson

For the following ten sentences, type the correct form of the word needed to complete the sentence in Esperanto.

Try the first one:

actor=aktor  tiger=tigro
friend=amikoj  catch=kaptas
man=viro  study=studas
uncle=onklo  watch=observas

The man catches the tiger.
La viro lapas la __________.

La _________ skribas la lettern.

La __________ lernas la lecionon.

The actress writes the letter.

The friends learn the lesson.
t: 4. The brother watched the bird.
   t: La fratuo _________ la birdon.
   t: ts:g12,2
   a: $b$
   ts:g0,13
   m:is

u: sub3
j(e=99):q1.5
j:test2

r: 5=fem & acc

t: 5. The doctor visits the woman.
   t: La doktoro visitas la _________.
   t: ts:g25,2
   a: $b$
   ts:g0,13
   m:virinon*

u: sub3
j(e=99):q2.1
j:test2

r: 6=tense, future
t:6. The student will study the lesson.

La studento ________ la lecionon.

La studento ________ la lecionon.

La studento ________ la lecionon.

La studento ________ la lecionon.

The girlfriend watch the tiger.

La _________ observas la tigron.

La _________ observas la tigron.

La _________ observas la tigron.

La _________ observas la tigron.

The lion caught the bird.

La leono _________ la birdon.

La leono _________ la birdon.

La leono _________ la birdon.

La leono _________ la birdon.
*q2.4
c:b=9
g:es
r:9=accusative, plural

t:9. The man watches the tigers.
t:
t: La viro observas la __________.
t:
ts:g23,2
a:$b$
ts:g0,13

m:tigrojn

u:sub3
j(e=99):q2.5
j:tes2

*q2.5
c:b=10
g:es
r:10=acc. fem & plural

t:10. The student visits the aunts.
t:
t: La studento visitatas la __________.
t:
ts:g27,2
a:$b$
ts:g0,13

m:onklinojn

u:sub3

*end
g:v:es
ts:g0,3
c:i=10-i

t:Out of 10 questions, you answered

t: #1 correctly.
t:
t: Find the rank below that corresponds to the number you got right. This is the rank with which you enter Esperantoland.
g:::ranks

u::sub1

ks:Post Te

        #1

  c::1=0
  l::BYE

*sub1

g::m410,10;t (RETURN)

a:
  ts::es
  e:

*sub2

g::m410,10;t (RETURN)

a:
  e:

*sub3

u::sub5

c::i=1+1
e(e=99):
e(a1(0,0)=0):
f::1,a1$
c(f=2): g=(b*3)+109
  c(f=1): g=(b*3)+19
c:a2$=a1$(g,3); d=abs(flo(a2$)+1)
c:a2$=str(d); a1$(g,3)=a2$
fo::1,a1$
un::sub4
  e:

*sub4

f::1,a1$
c(f=2): h=(b*3)+154
  c(f=1): h=(b*3)+64
c:a8$=a1$(h,3); e=abs(flo(a8$)+1)
c:a8$=str(e); a1$(h,3)=a8$
fo::1,a1$

  e:

*sub5

ky::Score 2
hn::Score 0
k::Time #(tim(0))
Print of lesson BYE

ts: v0,39,0,23
g: es
t: 
t: Nice going!
t: 
t: See you in ESPERANTOLAND!!
t: 
t: 
t: 
t: PLEASE DO NOT TOUCH THE COMPUTER.
t: 
t: RAISE YOUR HAND AND THE LAB
nt: ASSISTANT WILL TELL YOU WHAT TO DO
nt: NEXT.
t: 
t: 
t: 
t: ts: t2
nt: ADIAU!
t: ts: t1
nt: (good bye!)
nt: *SIT
nt: J: SIT

r: jump to *sit will put computer in a
nt: loop. Student won't be able to do
nt: anything but shut it off. K S command
nt: above has already saved data to system
nt: log.
Print of lesson SYSTEM.LOG

K: END DEDUCTIVE
*HELLO
L: DEDUCTIVE
K:
K: --- New Student ---
K: Name: John R. Student

R: PRACTICE ITEMS SCORES

K: Score 2
K: Score 1
K: Score 0
K: Score 0
K: Score 2
K: Score 1
K: Score 1
K: Score 0
K: END DEDUCTIVE LESSON

R: POST TEST SCORES
R: AND RESPONSE TIMES

L: POST TEST
K: Score 0
K: Time 5.35001
K: Score 2
K: Time 9.4
K: Score 0
K: Time 3.15
K: Score 2
K: Time 3.425
K: Score 2
K: Time 8.05002
K: Score 2
K: Time 24.7248
K: Score 2
K: Time 9.1
K: Score 2
K: Time 3.90001
K: Score 0
K: Time .575
K: Score 0
K: Time .925

R: POST TEST TOTAL
R: AND RANKING

K: Post Test 6
APPENDIX D

DESCRIPTIVE DATA FREQUENCY AND PERCENTAGES
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