PROCEEDINGS of SELECTED RESEARCH PAPER PRESENTATIONS

at the
1984 Annual Convention
of the
Association for
Educational Communications and Technology

sponsored by the
Research and Theory Division
Dallas, Texas

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at the 1984 Convention of the
Association for Educational Communications and Technology
and sponsored by the
Research and Theory Division
in
Dallas, Texas

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PREFACE

For the sixth year, the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is publishing these Proceedings. Papers published in this volume were presented at the national AECT Convention in Dallas, Texas. A limited quantity of this volume were printed and sold. It is also available on microfiche through the Educational Resources Information Clearinghouse (ERIC) system.

REFEREEING PROCESS: All Research and Theory Division papers selected for presentation at the AECT Convention and included in this Proceedings were subjected to a rigorous blind reviewing process. Proposals were submitted to Dr. Philip Brody of the University of Kansas who coordinated the review process. All references to author were removed from proposals before they were submitted to referees for review. Approximately fifty percent of the manuscripts submitted for consideration were selected for presentation at the Convention and for publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

This volume contains two cumulative indexes covering the first six volumes, 1979-84. The first is an author index. The second is a descriptor index. The two indexes will be updated in future editions of this Proceedings.

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TITLE: The Relationship of Field Dependent/Independent Cognitive Styles, Stimuli Variability and Time Factor on Student Achievement

AUTHOR: Christopher I. Atang

THE RELATIONSHIP OF FIELD DEPENDENT/INDEPENDENT COGNITIVE STYLES, STIMULI VARIABILITY AND TIME FACTOR ON STUDENT ACHIEVEMENT

A Paper Delivered at the

Graduate Student Research Session of the

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Dallas Texas, January 21, 1984

by

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1984

Introduction

Concern for the improvement of American education is widely evident today. The National Commission on Excellence in Education (Gardner et al., 1983) stated bluntly that "a tide of mediocrity has devastated public education", and suggested, among other things, that educators must demand the best effort and performance from all students regardless of their backgrounds and orientation.

If educators are to demand the best efforts from all students, we must learn more about cognitive styles. Cognitive styles, especially field dependence/field independence (FD/FI), have recently received much attention, probably because they have been related to many learning abilities and activities. According to Ausburn and Ausburn (1978), almost no research has been conducted on the relationship between cognitive styles and instructional designs. In addition, cognitive styles have not been conceived and studied as a single entity. Rather, a number of different factors or dimensions of cognitive styles have been identified and subjected to systematic theoretical and empirical examination (Ausburn and Ausburn, 1978). Therefore, studies designed to investigate these relationships may be useful to instructional developers and designers.

Related Research

Cognitive Styles

The concept of cognitive style refers to psychological dimensions that represent consistencies in an individual's manner of acquiring and processing information (Ausburn and Ausburn, 1978). Several learning styles have been identified. Each style seems to be related to how the individual processes and learns information. An often studied learning style by educational technology researchers, because of its relationship to mediat instruction, is field dependence/field independence (FD/FI). Witkin and collaborators (1971) discussed FD/FI and indicated that the FD person had difficulty locating geometrical figures in a complex pattern. The FI person, on the other hand, did not have such difficulty locating the same figures.

Color Realism and Visualized Instruction

The question of whether color or black and white images have an effe on increasing the performances of an individual has been investigated by several researchers. In summary, a number of studies relating to the col variable, Otto and Askov (1968) concluded that "the cue value of color in learning is still essentially unclear." Rudisill (1952) indicated that students preferred to view colored instructional materials, but Katzman Nyenhuis (1972) found that color did not improve the learning of materia Travers, quoted in Kemp (1975 p. 23) concluded that while color adds to attractiveness of instructional materials, black and white illustrations were just as effective for instructional purposes, except when the learn involved color discrimination.

Realism theories, according to Dwyer (1976), are based on the assumption that learning will be more complete as the number of cues in learning situation increases. Most instructional materials available to are published in color. An important research question available today not be whether the presence of color in an illustration promotes learnin but whether it may actually deter or hinder learning in a FD or FI stude Does the presence of color make the illustration more complex? Since FD is correlated strongly with one's ability to sift through a series of possible solutions and select the best solution to a problem, in terms of using instructional materials with varying amounts of visual stimuli for instructional purposes, FD/FI and time on task could affect one's ability to distinguish and organize the relevant cues.

<u>Amount of time and learning</u>

The amount of time used to process information may also interact with cognitive style and stimuli variability to affect learning. Carroll (1963) regarded time as the central variable in school learning, and asserted that students differ in the amount of time they need to learn a given set of materials to some set criterion. Anderson (1973), Arlin (1973), and Ozcelik (1973) studied the amount of time students spend in active learning and found that the amount of time spent on learning were highly predictive of the learning achievement of the students.

Statement of Hypotheses

The following hypotheses were generated and tested at the .05 and .01 levels of confidence:

1. There is no significant difference in posttest scores between FD and FI Ss treated with color, B/W and no illustrations.
2. There is no significant relationship between FD and FI, time on task and posttest scores of Ss in the treatment groups.

Subjects

Eighty-five freshman students in the Iowa State University psychology pool agreed to participate in all aspects of the study. Thirty-eight students of the original 132 who participated in the Group Embedded Figures Test (GEFT) chose not to participate in the total study. In addition, nine students were dropped because of color blindness. Their FD/FI scores were not significantly different from the eighty-five students who completed the study.

Instruments

The major instruments for this study consisted of the GEFT (Witkin e al., 1971), color blindness test (Dvorine, 1953), and a pretest and postt (Dwyer, 1967) programmed on the Apple II microcomputer. Since the pretes and the posttest were given on the same day, the pretest was created to b more general in nature and would not contaminate the posttest results. T pretest was used solely to establish the uniformity of the entry level of the Ss, and the posttest was used to determine the effects of stimuli variability and time on task. The computer was programmed to display the questions, record the answers and time from initial display until the subject responded to the questions.

Treatment Groups

The treatment groups were established as follows: Group one Ss were treated with programmed instruction supplemented by detailed, shaded drawings of the human heart in color. The subjects also used color draw of the heart to answer the posttest questions. Group two Ss had the sam treatment given to the color group with the only difference that B/W vis were used instead of color visuals. Group three (control group) Ss were treated with only the instructional script without visuals.

All the subjects answered the pretest (using the computer) before th experimental treatment. Finally, all the Ss were asked to answer the posttest questions using color or B/W visuals and the computer as soon a they finished reading the instructional script.

Data Analysis

The Statistical Package for the Social Sciences (Nie, Hull, Jenkins

Steinbrenner and Bent, 1975) and the SPSSX (Nie et al., 1983) were used in the analysis of the data. WYLBUR was used to provide on-line interactive text editing capabilities that allow the user to create, change, store and display text. The system also provided services for submitting jobs for batch processing and retrieving the resulting output. The analysis of variance (ANOVA) and Pearson product-moment correlation was used for data analysis.

Results

FD/FI scores were established for each S, and all the Ss were then assigned to FD and FI groups. Ss scoring between 1-11 were classified as FD, and those in the 12-18 range were classified as FI as recommended by Witkin et al. (1971). Because scores were skewed toward FI, that group had a much larger size - 23 FD, and 62 FI Ss.

Pretest scores listed in Table 1, indicated that the cell means were pretty much the same. Analysis of variance (Table 2) enabled the researcher to conclude that no significant differences existed in either rows or columns. It was assumed, therefore, that groups were relatively equal at the start of the experiment.

Posttest scores are listed in Table 3. Analysis of variance (Table 2) indicated that no significant differences appeared between FD/FI groups and that no significant interactions were present. However, significant differences were noted among treatment groups. Further analysis confirmed that the two experimental groups had significantly higher mean posttest scores than the control group. This had been anticipated and is not considered important, since the posttest items dwelled heavily on the visual aspect of the instructional materials. What is important, however, is that the means of the two experimental groups were not significantly different from each other.

Pearson product-moment correlations are reported in Table 4. The correlations reported reveal that FD/FI and color treatment group had a l positive correlation (r=0.35, p=0.03).

ANOVA of posttest time by FD/FI with treatment groups (Table 5) also yielded a significant F-ratio (F=3.60, Significance of F = .03). This indicated that the treatments accounted for the difference in posttest ti

Conclusion

The data on Table 4 indicate that the presence of color in the illustration had minimal effect on posttest scores. These findings are consistent with those of Katzman and Nyenhuis (1972) and Travers (cited i Kemp, 1975). Moreover, there appears to be no evidence to indicate that Ss are adversely affected by the presence of color. This is in consonanc with the findings reported by Hazib (1979) that no significant differenc exists between FD and FI Ss in an experiment using realistic and non-realistic illustrations. The findings also agree with those of Dwye (1976) that the stimuli variability is not a reliable predictor of learn efficiency. With regards to time on task, it was concluded that student exposed to instructional materials without visuals need more time to pro and learn new information.

Important implications concerning the use of color and B/W with Ss possessing different learning styles could be established based partly o the results of this study. Thus, there is need for more experiments to determine whether the other variables in Dwyer's (1967) realism continuu have an effect on cognitive styles. The use of the Apple II microcomput as used in the present study, also needs further investigation.

TABLE 1

TABLE 1

Cell Means of Pretest scores by Field Dependence/ Field Independence and Treatment Groups

	Color treatment	B/W Treatment	Control
Field Dependence	13.43 (7)	12.20 (10)	13.17 (6)
Field Independence	12.59 (22)	13.16 (19)	13.52 (21)
Group Mean	12.79 (29)	12.83 (29)	13.44 (27)

Field Dependence	=	12.83 (23)
Field Independence	=	13.08 (62)
TOTAL POPULATION	=	13.01 (85)

Table 2

Analysis of Variance of Field Dependence/Field Independence and Posttest Scores in the Three Treatment Groups

Source of Variation	Sums of Squares	DF	Mean Square	F	Significance of F
Main Effects	202.98	3	67.66	3.52	0.02**
FD/FI	13.10	1	13.10	0.68	0.41
Group	195.16	2	97.95	5.08	0.01*
2-Way Interactions	3.17	2	1.58	0.08	0.92
FD/FI Group	3.17	2	1.58	0.08	0.92
Explained	206.15	5	41.23	2.15	0.07
Residual	1517.81	79	19.21		
Total	1723.95	84	20.52		

* Significant at the 0.01 level of Significance

** Significant at the 0.05 level of Significance

TABLE 3

Cell Means of Posttest Scores by Field Dependence/Field Independence and Treatment Groups

	Color Treatment	B/W Treatment	Control
Field Dependence	12.14 (7)	12.20 (10)	9.50 (6)
Field Independence	13.64 (22)	12.95 (19)	9.90 (21)
Group Mean	13.28 (29)	12.69 (29)	9.81 (27)

Field Dependence = 11.48 (23)

Field Independence = 12.16 (62)

TOTAL POPULATION = 11.98 (85)

TABLE 4

Pearson Correlation Coefficients of Field Dependence/Field Independence and Achievement (Posttest Scores)

GROUP	SCORE
Color Treatment FD/FI	0.35 p=0.03
Black and White Treatment FD/FI	0.21 p=0.13
Control FD/FI	0.07 p=0.37

TABLE 5

Analysis of Variance of 2-way interactions of Posttest Time with Field Dependence/Field Independence and treatment groups

Source of Variation	Sums of Squares	DF	Mean Square	F	Significance of F
MAIN EFFECTS	20358.01	3	6786.00	2.63	0.06
FDFI	2080.08	1	2080.08	0.81	0.37
GROUP	18591.94	2	9295.97	3.60	0.03*
2-WAY INTERACTIONS	8943.48	2	4471.74	1.73	0.18
FD/FI GROUP	8943.48	2	4471.74	1.73	0.18
EXPLAINED	29301.50	5	5860.30	2.27	0.06
RESIDUAL	203784.69	79	2579.55		
TOTAL	233086.19	84	2774.84		

*Significant at the .05 level

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TITLE: A Research Methodology for Studying the Learner as a Total System: A Conceptual Paper

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A Research Methodology for Studying the Learner as a Total System: A Conceptual Paper

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Introduction

background

It has been noted by many educational researchers in recent years that our traditional research methodologies, especially conventional experimental desig seem to be unable to provide meaningful application to the practice of educati Experimental designs seem to be lacking in their ability to identify the "proc variables that could improve teaching" (Scriven, 1977, p.189); their applicati appears not to facilitate solutions to educational problems (Clark, 1978; Clark & Snow, 1975; Salomon & Clark, 1977; Snow, 1976). In seeking reasons for the apparent shortcomings of experimental design research, focus seems to center upon the methodology's unrealistic restrictiveness (Enzer, 1977), a restrictiveness that seems to be the result of tightly-controlled experiment variables. Such tight control appears to markedly restrict retest reliability of findings (Barr, 1929; Calkins, et.al., 1978; Shavelson & Dempsey, 1975) and to significantly limit generalizability of results Cronbach, 1975; Ebel, 1967; Gage, 1982; Pereboom, 1971).

problem

In reaction, there have been calls for alternatives to the structure of research design (Shulman, 1970) and the "modes of inquiry within our research endeavors" (Koetting, 1983, p.430). More specifically, researchers have aske for research models that reflect and are appropriate to the practice of educat (Becker, 1977; Clark, 1979; Shulman, 1970); and for research paradigms and methodologies that address the whole learner as a total system (Beckwith, 198 Clark, 1980; Winn, 1975), nonreductionist approaches to research which attend to the elaborate nature of learners as dynamic, changing individuals (Merrill 1975; Torkelson, 1980), research that focuses on the aims and values of education (Rosenow, 1976).

theoretical/conceptual base

Such requests demand a complex, sophisticated research paradigm founded firmly upon a theoretical/conceptual base, a base that incorporates alternative modes of valid rationality (Koetting, 1983). Beckwith (1983) has provided such a base. Following four years of constructionist research, he has developed a theoretical/conceptual paradigm of the learner as a total system. Within the paradigm four types of total learner systems have been identified and explicated according to the following categories of critical attributes:

(a) motivation;
(b) response to external variables;
(c) response to intervention;
(d) predominant strategies;
(e) transition possibilities, facilitators, inhibitors, and control;
(f) reason for goal;

(g) relation to goal;
(h) type of interaction and interrelation of system components; and
(i) type of dynamism.

In short, Beckwith's paradigm focuses upon the aims and values of education while attending to the learner as an elaborate dynamic, everchanging total system. A summary of the paradigm's four learner systems follows (exerpted from Beckwith, 1983).

The learner may be seen as four distinct systems, reactive, preactive, proactive, and spiralling, each of the four systems meeting the definitional system requirements of being dynamic, having a goal, and having interdependent and interrelated components. The differences lie in the nature of each system's goal and the relation of the goal to the dynamism of the system components. For the reactive learner the goal is internally oriented, survival focused; thus the dynamism is incidental, reacting intuitively to external variables. For the preactive learner the goal is output oriented, focused towards undefined betterment; the dynamism, being externally programmed, is related to the goal attainment process rather than a specified goal product. For the proactive learner the goal is outcome oriented, focused on solving self-predefined problems; the dynamism is thus purposeful, related to goal attainment. For the spiralling learner the goal is value structure oriented, focused on self-regeneration; the dynamism is intrinsically automatic, related to a continued process of spiralling, regenerative goal setting and attainment. (See Figures 1 and 2).

PLACE FIGURES 1 AND 2 ABOUT HERE

Just as the goals and dynamism of each learner system are different, so too is the predictability of exhibited behaviors. The reactive learner's behavior is unpredictable; reacting to external variables, the behavior will either be acceptance, denial, or denial and then acceptance (conscious or unconscious). The preactive learner, out to satisfy the social order, may exhibit highly predictable behaviors. The proactive learner's behavior is predictable within the framework of self-established goals, i.e. problems to be solved. The behavior of the spiralling learner, like that of the reactive learner, is unpredictable, for the learning process is very akin to intuition, only the spiralling learner's intuition is purposeful, being effective in spite of the learning environment.

the reactive learner system

Reactive learners are survivors, reacting - unconsciously and intuitively - to external variables and intervention of contradictory information by absorbing or rejecting them as quickly as possible. The only goal is maintenance of an unthreatened ecological system. The reactive learner system absorbs and stores information to be retrieved as stored.

the preactive learner system

While many of the equilibrium maintenance behaviours of the reactive learner (operating as a natural system) are present in the preactive learner (operating as a synergystic system), the preactive learner's behaviors are far more conscious and socially acceptable; the "rules" for equilibrium maintenance have become institutionalized, i.e., the individual has adopted the society's mores for learning survival.

The preactive learner system receives appropriate information in appropriate formats, as so deemed by the educational system. As skills increase, the preactive moves closer and closer (like externally-bound concentric circles) in harmony with the undefined goals of the educational system.

the proactive learner system

The proactive learner operates well from a traditional base, providing self-motivation, extracting essential bits from information presented, welding bits from storage and alternative sources, building himself a personalized system to facilitate personalized goals. External intervention is avoided, self-control and reinforcement being preferred. The proactive learner system uses information gleaned from the educational system to attain goals that are not those of the educational system.

the spiraling learner system

It may be said that so sophisticated is the spiralling learner system that learning tends to occur in spite of the learning environment, for this learner is able to extract out of context and rapidly assimilate into the spiral at a very high level of discrimination and purpose. The spiralling learner system productively applies information for continued self-regeneration.

transition

Transition is possible from some learner systems to others. Transition from reactive to preactive is generally possible through prolonged subjection to a social structure, spurred on by peer, institutional, and social pressures. Transition from reactive to proactive is generally possible through counter reaction to current/predominant social order, spurred by a need for independence and social conscience. Transition from reactive to spiralling is generally possible thorugh intuition, spurred by altruistic feelings and concerns. Transition from preactive to proactive is generally possible through gut-wrenching upheaval, spurred by dissatisfaction with the established order. Transition from proactive to spiralling is generally possible through practice, spurred by internal motivation. (See Figures 3 and 4).

PLACE FIGURES 3 AND 4 ABOUT HERE

It is hoped that the paradigm, after significant further testing, may serve as a theoretical base for innovative, learner-centred instructional development and research methodologies.

implications for research

As mentioned earlier, with our reductionist approach to research (experimental design) we have ignored the elaborate nature of learners as dynamic, changing individuals (Torkelson, 1980). Is it possible that our research paradigms/ methodologies reflect and explore only the preactive learner? Are the mean performances all exhibited by the preactive learner? For the most part, research in education seems to view the learner as being part of an educational system, whether such system be a classroom, subject, course of study/curriculum, or school. We look at the learner's progress in terms of the goals of this educational system, attempting to identify variables which may enhance or inhibit learner progress in reaching such goals. This could indeed be labelled as a preactive learner research tradition. Whether we look at research in aptitude-treatment interaction, cognitive styles, or learner attitudes, to name a few of the most recent research thrusts, the emphasis is the same, that of examining the learner as part of a system, i.e., a given educational system, a system dedicated to the preactive learner, who in turn is dedicated to the system. Such research, it seems, even assumes that all subjects are preactive learners, differing only in their preactive learning ability. All learners, however, are not preactive; the nonpreactive learner's reactions to external variables are, from a preactive standpoint, unpredicatable and ungeneralizable. The reactive learner will absorb or deny external variables in a quest for survival. The proactive learner will use or ignore external variables depending upon their potential usefulness in self-goal attainment. The spiralling learner will use all external variables productively for continued self-regeneration. The non-preactive learner is not operating within the goal structure of the societal system, but rather is operating in spite of this goal structure, yet through our preactive research designs and questions we are expecting, without realising it, the nonpreactive learner to behave preactively.

Perhaps it is time to view the educational environment as part of the learner's system. Our research then could look at the educational environment's progress in terms of enhancing or inhibiting the learners' attainment of their own goals. What are the variables within the educational environment which inhibit or enhance such goal attainment? How do learners' incorporate external variables into their own learner systems? This will not be an easy shift to make, for our whole socio-scientific research tradition is based upon the preactive learner model; we strive to learn, to discover, with no predefined goal in mind, but rather merely the goal of more complete understanding of what is (with the underlying belief that such more complete understanding will somehow improve us). By exploring, discovering and applying (if possible), our preactive research mode keeps alive the synergystic dream that the total of our discoveries will be greater than the sum of its parts. As long as our research efforts are confined to the framework of our own system goals, the answers to such questions as how the learner, especially the nonpreactive learner, represents an experience or perceives during the learning process will remain mystery.

In any case, more research, of course, is needed - research that explores, in nontraditional ways, the nonpreactive as well as the preactive learner system; research that looks at the transitions within and between learner systems; research, in short, that attempts to validate the assumptions inherent within the conceptual/theoretical paradigm presented here.

alternative research methodology

This paper will present an alternative research methodology based upon Beckwith's theoretical/conceptual paradigm, elucidating on the methodology's

(a) underlying assumptions,
(b) focus,
(c) nature, and
(d) management.

This will be followed by a discussion of the roles of investigator, subject, manager and design structure during operation of the research methdology.

assumptions

Since the methodology is based upon a total system learner paradigm, it is "assumed that each and every learner may be viewed as a (system) in and of itself, not only as a (system) that is but also as a (system) that could be. Even though the ... learner ... will hold together as an entity in spite of what educators may or may not do, its finer potential lies in its capability for becoming what is wishes to become. In any ... learner the ingredients are all there, even if some of those ingredients are knowing that some of the essential ingredients are not yet there; the potential of all ingredients is there." (Beckwith, 1980, p.332). Each learner, therfore, may be studied not only as an existing, dynamic system but also as a potential, dynamic system. By studying the nature of the learner's critical attributes (the categories of which are mentioned earlier) determinations can be made concerning the learner's exisitng system, former system(s), potential system(s), and paths of transition. With such data on each learner system, it is assumed, researchers/educators may tailor the educational environment to facilitate desired learner outcomes, i.e. learner goals. To accomplish this, the learner must be accepted as full partner in the research development effort. If formally stated, the learner as total system paradigm rests on the assumptions that:

(a) there are two realities (the existing reality upon which inquiry can converge, and the potential reality which inquiry can effect) and that all parts of reality (existing and potential) are interrelated and interdependent so that the study of or inquiry into any one part necessarily influences all other parts;

(b) the inquirer and object, for best results, are one, with the investigator - playing the role of facilitative co-researcher. Thus the relationship between the inquirer and the object of inquiry is neither one of independence nor dependence, but rather one of mutual introspection and creation;

(c) each learner is currently operating as a total system, and can create a potential total system; and

(d) generalizations, to other populations, concerning the nature of goals, dynamism and transitions of learner systems, is possible.

focus

Whereas traditional experimental design methodologies look at data in a frozen controlled fashion - isolating and then correlating variables in an attempt to find out "what is" - this alternative methodology looks at data as part of a growth phenomenon, dynamic, constantly changing; looks at the processes of transition, system creation, regression in an attempt to find out "what is becoming" and "how". The focus, rather than being on tightly-controlled variables, is on the dynamism of the total system, on the everchanging interrelationships and interdependencies of the system components. The focus, rather than being within the framework of the goals of the educational system, is within the framework of the goals of the learner system.

nature

The methodology in action might be described as a dynamic collection-analysis-decision system of interrelational events, a sifting-sorting-cataloging of observed, felt, and thought behaviours in order to more purposefully analyze the next behaviour(s), using, at times, the interjection of appropriate feedback, comment, reinforcement, questions, disruptions to elicit whatever behaviors will emerge. As on-going/changing research in an on-going/changing context, this methodology

(a) maintains the dynamism of system by embracing all variables;

(b) collapses the element of time between the typically separate activities of research and application;

(c) protects the inherent uniqueness, individuality and personality of the studied systems (focusing upon the extremes as well as the central tendencies);

(d) protects the integrity of the system interactions; and

(e) performs during real time, within dynamic systems, while attending to validity and reliability.

Variables are not isolated, but rather interrelationships and interdependencies of variables are explored and welcomed as they are; there are no variables that are capable of confounding, for it is accepted that all variables naturally affect all other variables and may only be controlled by being allowed their full natural freedom of expression.

In the sense that the methodology is so precisely defined, applicable to each and every dynamic learner system, generalizability is complete. Each learner system is a special case, with the focus being in-depth truth-seeking, finding that which is generalizable from him to him (or her to her) within a given point in time and/or from him or her "now" to him or her "future". Thus the methodology provides generalizability within each learner system studied and also to any and all populations, i.e., it is capable of achieving the same level of significance with each learner system.

management

While the complexity and number of interrelating and interdependent variables may appear forbidding, management of this research methodology, while certainly unusual, is not that difficult. Given

(a) the framework of expectations provided by Beckwith's paradigm,

(b) acceptance of the learner system's own goal as the context of the research study,

(c) acceptance of the learner system itself as a co-researcher in the process, and

(d) the view that the researcher and the educational environment are components of the learner's system, the seemingly formidable task becomes one of relative ease.

For the researcher as part of a defined, dynamic, goal-directed system with his or her purposes known and welcomed by the system itself, becomes comfortable with and adept at studying the dynamic interrelations and interdependencies of which he is part. As the comfort and aptitude increase, the researcher is quite quickly able to study more and more learner systems simultaneously, applying ever more increasingly and successfully what he has learned as part of each studied system to each newly-encountered system.

operation of the research methodology

It is the purpose/intent of this section to give a more specific account of how the methodology would be operationalized while at the same time suggesting how such as validity, reliability, reproducibility, bias and effects are attended to during the process. The actual techniques of the methodology are not delineated, but rather are alluded to.

For this methodology, the trained educational researcher is called the investigator-researcher, the learner system under study is called the subject-researcher, and the data interface coordinator (whether this function is provided by either or both of the co-researchers, a computer, or a specialist) is called the information manager. These three roles-investigator-researcher, subject-researcher and information manager-create the interactive dynamism of the design structure. (See Figure 5).

Through the interaction of the three components, the design structure facilitates fulfillment of the purpose of the research design - to (a) determine the nature of the current learner system (b) determine the nature of the current learner ability level, (c) determine the nature of the desired (by the learner) learner system, and/or ability level and (d) determine the most appropriate transition means. In order to do this the situation within which the design structure operates must be one in which the subject-researcher may be observed, by self and the investigator-researcher, during the learning process. There must be access to a large variety of instructional information in a large variety of formats. As Merrill (1975) has suggested:

> ... what is needed is a dynamic general strategy enabling learners to select at any moment the particular tactic that is optimal for their unique configurations of aptitudes at that moment in time. Furthermore, they must be able to select a new tactic at a moment's notice. They must **not** be required to anticipate their aptitude configuration or the tactic needed more than one step ahead. They must be able to make the change with a minimum of effort. (If all their time or even a significant part is used up in the mechanics of tactic selection, their learning continuity will be grossly impaired.) They must know how to select a variety of tactics. They must have a wide variety of tactics available to them but not so many that they are overwhelmed by the number of choices. They must be provided a procedure for adapting slowly to this dynamic instructional environment since all their previous experience has been fixed treatments which have been administered to them and over which they have had little or no control.

The learner, going through such instructional information (if the formats are varied sufficiently enough to represent the continuum from passive reception through interaction to creation) will, it is hoped, demonstrate his current learner system and ability level. To facilitate the process, the investigator-researcher, reacting to subject-researcher requests and information manager suggestions (based upon an analysis of the effectiveness of instructional information [content and format] for eliciting attributes), supplies each next piece of instructional information. The information manager supplies the subject-researcher with learner system profiles, based upon an analysis of (a) the learner's process of inquiry while going through the instructional information, and (b) the classification of demonstrated and communicated attributes (fed in by the investigator-researcher). The subject-researcher and investigator-researcher work together to analyze the incoming learner system profiles, which analyses are fed back to the information manager. Once the learning process has begun, the above procedures are simultaneous and interdependent (See Figure 5).

role of the design structure

There are three purposes of the design structure: (a) to facilitate solutions to educational problems, (b) to attend to the elaborate nature of learners as dynamic, changing individuals, and (c) to effect research reliability and validity. These are accomplished by initiating a dynamic set of interactions and interdependancies between the three major elements of the research - the subject-researcher, the investigator-researcher and the information manager. How the structure enhances the satisfaction of these purposes is discussed below:

facilitating solutions to educational problems

In order to facilitate solutions to educational problems, it is felt that a research design structure should (a) focus on the aims and values of education. (The questions that can be attended to through this design structure are those derived from a theoretical base, thus increasing leverage and reducing uncertainty); (b) reflect and be appropriate to the practice of education. (Since the users of the research results provided via this design structure are learners, and problems researched focus upon the inefficiency and ineffectiveness of learning, it may be assumed that the problems are operationally important to the user); and (c) identify the process variables that could improve teaching (Since the co-researchers are able to apply results as received, action decisions can be based on inferences drawn from the research data.)

attending to dynamic learners

By attending to the elaborate nature of learners as dynamic, changing individuals, this design structure tends to minimize (a) bounding problems by allowing the co-researchers to continuously narrow their scope of investigation-through the process of causal inferencing - as they get closer and closer to learner system and ability determination; and (b) focusing problems by organizing and ascribing meaning to collected data within the parameters of the learner as a total system paradigm. In addition, continued dynamism is effected by ensuring that data collection and data analysis occur in syncopated harmony, forming a symbionic relationship - each guiding, feeding, nurturing, leading, following the other - acting as a team, in consort toward the same end. Thus the research process is structured and restructured within real time by collapsing the time between research findings and applications. This nonreductionist type of control through acceptance of all variables is the key to researching a dynamic system.

effecting validity and reliability

By not using tightly-controlled experimental variables which tend to markedly restrict retest reliability of findings and to significantly limit generalizability of results, unrealistic restrictiveness is not a limitation of this design structure.

Generalizability is maximized not by controlling individual variables through isolation and treatment, but rather by controlling the complete set of variables within the structure of the total system framework. What is generalizable is the systemic nature that is true for each learner. It matters not and affects generalizability little if the components differ somewhat from system to system; since all subjects are systems, it is fairly easy to predict correctly the range of possible outcomes elsewhere, with other subjects, at other times. The generalizability of results is enhanced, in part, by maximizing freedom from artificially structured environments; as the subject-researcher inquires into the nature of his current learner system, he is allowed to begin virtually anywhere and to move anywhere in each succeeding step.

Generalizability also benefits from the enhancement of reproducibility; for example, sample size is minimized (one subject-researcher) as is bias, through the sharing of perceptions, input and output by the co-researchers and the information manager; and also random error, by continually feeding all steps of all processes to the information manager which analyzes all potential discrepancies within the system framework.

By structuring a real learning environment and by allowing the subject to be a conscious and integral part of the research, generalizability is further enhanced by minimizing reactivity.

Retest reliability is enhanced by teaming the subject-and investigator-researcher with the information manager in order to maximize objectivity and minimize bias. The built-in two way communication between all three research components of the design structure tends to give a reliability control to the dynamic process of data collection, analysis and application. Since all subjects are assumed to be total learner systems and a sample of one recommended for each experiment, random sampling is relatively easy. The design structure does not inhibit random sampling within the context of a disproportionate stratified design, e.g., one could randomly select subjects from a population of only one type of learner system.

Within the context of a total system all variables are dynamically related to all other variables. To study the system is to study the dynamic relationships of all variables, to embrace all variables. The notion of confounding variables is not, therefore, relevant to the study of learners as total systems.

roles of the components of the dynamic design structure

As mentioned earlier, the subject-researcher, the investigator-researcher and the information manager perform as interactive and interdependent entities of this dynamic research system. Each has a vital role to play, and each depends upon the other two in order to fulfill its role. In traditional research of dynamic systems, i.e., learners, an attempt is made to freeze reality, to make a dynamic system static, in order to study it. In so doing, the relationships studied are no longer true representations of reality; the detached observer of a dynamic system relinquishes control.

In this alternative research, in order to gain and maintain research control of a dynamic system, the researcher attempts to enter the system, interact with the system, and become a dynamic component of the system. The subject-researcher, of course, is able to achieve this complete incorporation of researcher and subject. The inclusion of subject as researcher is essential if the research is to extract and study the internal cognitive processes (e.g. selection, organization) that only the learner may be aware of. Thus the subject-researcher, by applying meta-cognition, is able to share with the investigator-researcher and the information manager the selective learning processes and cognitive organization processes that are operating.

If the subject-researcher (probably not as yet skilled in the processes of controlled inquiry) is to perform the causal inferences required by the research paradigm, tutoring, modeling, and support will be required by the investigator-researcher. As a competent inquirer, the investigator-researcher will coordinate and oversee data collection and analysis procedure, whether such data and analyses are initiated by self, and or the subject-researcher, and/or the information manager. This is necessary because the investigator-researcher is the one who is able to look beyond the experimental data and suggest decisions based also on learning theories (Allen, 1975). Unlike traditional research endeavours, this type of research may indeed benefit from the presence of certain effects. For example, the investigator-researcher may decide to encourage the Hawthorne effect in the subject-researcher in order to stimulate increased interest in and ownership of the research task at hand; similarly the John Henry effect could be encouraged to get the subject to try harder. The investigator-researcher might even allow himself to be biased by the Halo effect, i.e., seeing the subject-researcher as capable of performing the research, each positive step leading to each succeeding positive step, thus reinforcing the halo image.

Primarily, the investigator-researcher's role is that of facilitator, providing the requested and/or recommended instructional information (reflecting appropriate content and format); ensuring reliability and validity (as mentioned earlier); and working closely with the subject-researcher through the processes of data collection, causal inferencing, predictions, and applications based upon data and theory. Realizing that "social/behavioural phenomena exist chiefly in the minds of people, and (that) there are as many realities as persons" (Guba, 1981, p.77) the investigator-researcher must remove himself sufficiently to allow the subject-researcher to determine and understand the current learner system and, at the same time, involve himself sufficiently to ensure that such learner system determination and understanding is based upon appropriate, necessary and sufficient data.

As the subject-researcher takes more responsibility for the research, the investigator-reseacher becomes a less significant component of the learner system, thus allowing the investigator-researcher to introduce himself as a significant component within other learner systems. If at the same time, during this growth of learner systems as independent researchers, the investigator-researcher structures the environment so that studied learner systems can share and compare data, inferences and findings, the research process becomes even more independent of the investigator-researcher. At very least the investigator-researcher is assuming a role quite different from the usual - a role of facilitator, component of many learner systems, manager of other-defined research agendas rather than of self- or pre-defined research agendas.

For the investigator-researcher to facilitate the inquiry process for the subject researcher, information concerning the on-going learning process must be made available in usable form. The information manager will provide data on the learning processes employed by the learner, the effectiveness of instructional information, as well as a series of increasing sophisticated learner system profiles (to include the attribute categories of motivation; response to intervention; response to external variables; predominant strategies; successful learning environments; transition possibilities, facilitators, inhibitors, and control; and ability level indicators). To produce the profiles, the information manager will analyse incoming data along the following interaction dimensions: (a) contextual (What meaning does the learner appear to attach to phenomena?); (b) sequential (What is the order of the steps being followed by the learner?); (c) categorical (What categories - in requests for instructional information, in causal inferencing, in interaction with the instructional information and the investigator-researcher - is the learning using?); (d) integral (How is the total learner system operating, i.e., what are the apparent interactive and interdependent relationships between system components?); and (e) analytical (What methods of analysis is the learner using?).

If a micro-computer is being used to provide an interactive learning environment as one of the learner options, it may be possible to program the computer to function as the information manager. An added advantage is that during all interactive learning via the computer, the computer could keep a record of the processes followed by the learner.

conclusion

Recently there have been calls for (a) more global and less laboratory type research; research which allows subject investigation rather than excluding the subject through placement in an artificially-created system (Bruner, 1983); (b) more formative types of research (Parkhurst, 1982); (c) "a more positive and accurate concept of human potential" (Bloom, 1982, p.12); (d) research means for coping with the proliferation of relevant kinds of individual differences to be studied (Gagne & Dick, 1983); (e) encompassing "value systems and idiosyncracies of individuals in the large purpose of schooling and society" (Torkelson, 1977, p.); (f) solving, the problem of "how to serve the needs of theory and action simultaneously" (Bynner, 1980, p.14); (g) selecting a "paradigm (of disciplined inquiry) whose assumptions are best met by the phenomenon being investigated" (Guba, 1981, p.77); and (h) providing the individual with the opportunity of "self-growth and self-direction so that (he) can make his own bargain with life in accordance with his beliefs and values" (Grayson, 1976, p.131).

It is hoped that the learner as a total system research paradigm will offer a pathway toward answering these calls. Rather than throwing away traditional (older as well as newer) paradigms and methodologies, this paradigm incorporates all. For example, such ATI attribute variables as anxiety, achievement via independence and achievement via conformity (Snow, 1976) are incorporated within the reactive, spiralling and preactive learner systems respectively; quantitative as well as qualitative data are systematically collected, analyzed and acted upon. By incorporating aspects of rationalistic and naturalistic inquiry within the framework of the learner as a total system, the limitations of each tend to be minimized.

Figure 1

The Systemic Nature of Learner Systems

	Goal Relation	Goal Orientation (Focus)	(Purpose) Type of Interaction and Interrelation of Components	Type of Dynamism
reactive	status quo	maintenance	filling gaps, protecting, mending	reflex
preactive	output	evolution to higher level of quality	seeking, comparing, contrasting, systematic	guided (externally)
proactive	outcome	problem-solving	goal-directed systemic	focused
spiralling	epitomization of value structure	self-regeneration	lateral transfer	intrinsic

In order to classify learner systems (all of which have goals, interacting/interrelating components, and dynamism) it is necessary to analyze the systemic workings within each learner system, i.e., (a) what is the relation of goal to system? (b) what is the orientation (focus) of the system goal? (c) what is the purpose of the interactions/interrelations of system components? and (d) what type of dynamism does the system maintain? While such analysis is necessary in order to establish each learner system's basic structure and orientation, it is not sufficient for complete classification. In addition, the subsystems of motivation, response to external variables, response to intervention, predominant strategies, and successful learning environments should be analyzed. (See the text for each learner system for a fuller explication.)

Figure 2

Summary of Four Learner Systems

	Motivation	Response to External Variables	Response to Intervention	Predominant Strategies	Successful Learning Environment
Reactive	survival	absorbtion	rejection and/or absorbtion	reception	mentor
Preactive	social acceptance	acceptance	acceptance	accommodation	teacher-directed
Proactive	internal reinforcement	sifting and sorting	challenging resisting denying	introspection	traditional*
Spiralling	altruism	applied absorbtion	systemic information	dissonance	any†

*The proactive learner system, learning in spite of the learning environment, uses the traditional environment, i.e., that environment that is fashioned/structural for reactive and preactive learning, to react against, to reject, during the process of creating his own systems.

†Any environment, whether structured for learning or not, if it provides information, has potential grist for the spiralling learner's mill.

Figure 3

Learners As Systems: Transitions

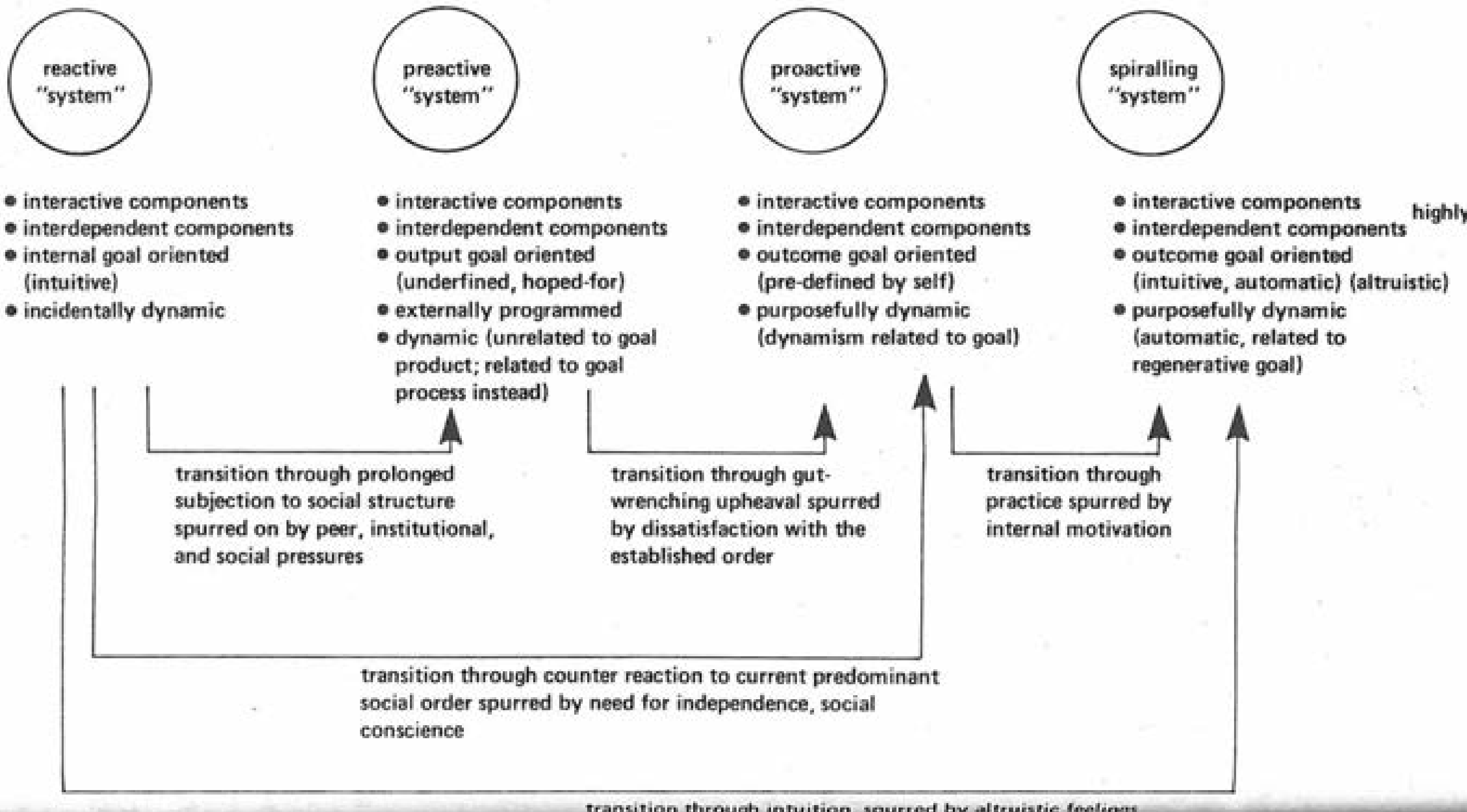


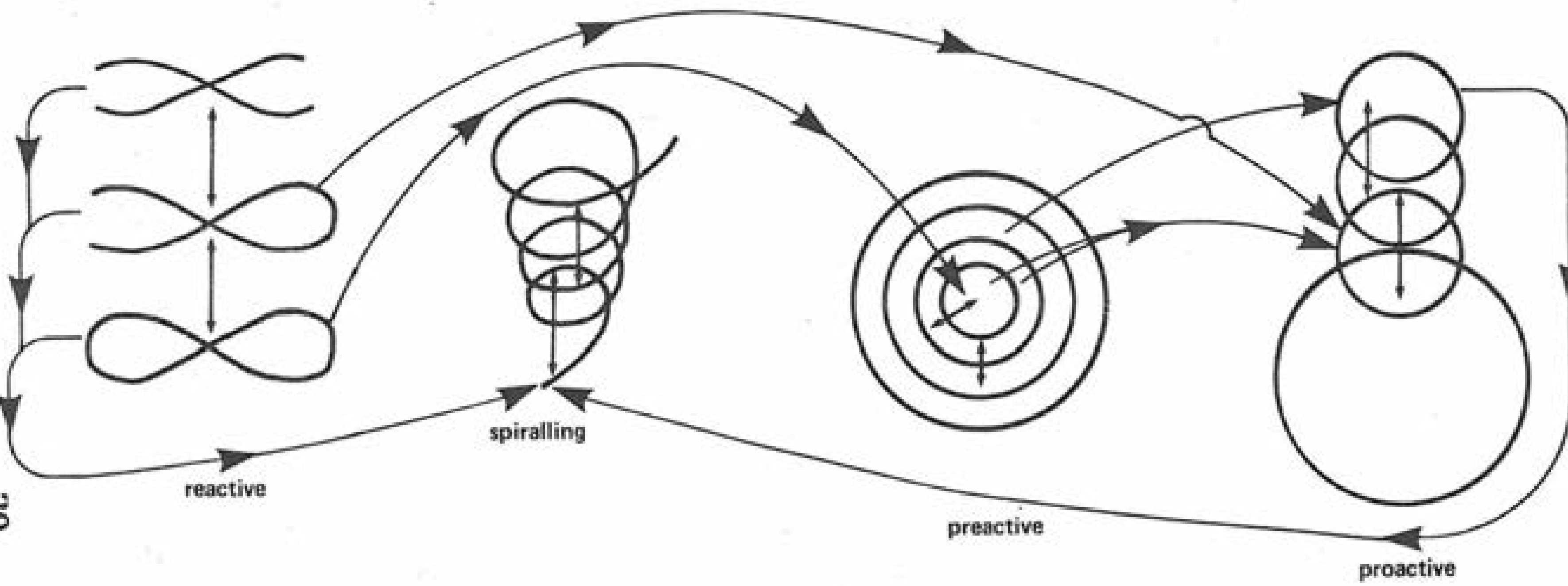
Figure 4

conscience

transition through intuition, spurred by altruistic feelings

Figure 4

Paradigm of Learner as Total System



This paradigm shows the three ability levels of each learner system (low, middle, and high); in each learner system there may be transition back and/or forth between these ability levels. In addition, transition may occur between certain learner systems.

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Abstract

In response to a loud and long call, from professionals in our field, for a research model that

(a) is not restrictive,

(b) does not limit generalizability,

(c) identifies the process variables that could improve the practice of education,

(d) addresses the whole learner as a total system,

(e) addresses the elaborate nature of learners as dynamic, changing individuals, and

(f) focuses on the aims and values of education,

this paper presents an alternative research methodology based upon a theoretical/ conceptual paradigm of the learner as a total system (Beckwith, 1983).

The methodology assumes that each learner may be viewed as both and existing system and a potential system, and that the learner must be accepted as full partner in the research effort. While traditional methodologies focus upon frozen, tightly-controlled variables, this methodology focuses upon dynamism of interacting learner system components during the process of system maintenance and transition; the focus, rather than being within the framework of the goals of the educational system, is within the framework of the goals of the learner system.

As on-going/changing research in an on-going/changing context, the methodology embraces all variables, collapses the time between research and application, and facilitates generalizability within and across learner systems.

Research management is facilitated by the researcher's becoming a dynamic component of each defined, dynamic goal-directed learner system being studied.

TITLE: The Role of Cognitive Style in Processing Color Information: A Signal Detection Analysis

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THE ROLE OF COGNITIVE STYLE IN PROCESSING COLOR INFORMATION:
A SIGNAL DETECTION ANALYSIS

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Introduction:

During the past several years, substantial research has addressed the interaction between the cognitive style of field dependence/independence and how individuals process pictorial information. Research conducted by Wieckowski (1980) and Lertchalolarn (1981) focused on the relationship between cognitive style and the role of color in pictorial recognition memory. The method of signal detection theory has not however, been applied to such research.

The purpose of this investigation was two-fold: (1) to study the interaction between cognitive style, specifically field dependence/independence and pictorial recognition memory for pictures presented in three different color modes; realistic color, non-realistic color and monochrome (black and white); and (2) to further confirm the efficacy of applying signal detection analysis to color recognition memory data as a means of obtaining a more accurate assessment of the role of color in visual information processing.

Related Literature:

The area of cognitive styles has become an area of extensive research interest in recent years. Kogan (1971) defined cognitive style as an individual variation in mode of "apprehending, storing, transforming and utilizing information." This concept was further defined by Ragan (1978) who suggested that cognitive styles represent "psychological dimensions" which describe individual differences in the means whereby information is received, processed and utilized. Cognitive styles can be considered stable psychological attributes. Witkin, Moore, Goodenough and Cox (1977) described the three characteristics of cognitive styles as being: (a) oriented toward "form" rather than "content" related cognitive activities; (b) stable over time, and (c) bi-polar rather than hierarchical as is mental ability.

Field dependence is one such cognitive style which has been researched more extensively than many others. This factor, identified by Witkin, Oltman, Raskin and Karp (1971) is generally defined as the differential ability of individuals to separate figure from ground or overcome "figural embeddedness." Although described and determined on a highly perceptual basis, this attribute is related to many other cognitive, attitudinal and personality behaviors. The perceptual ability for figured disembedding is generally considered to be representative of the more global ability to impose structure upon perceived information. Karp (1963) and Goodenough (1976) have thoroughly reviewed the various correlates of field-dependence.

Field dependence has, however, remained substantially a perceptual ability measure, assessed by the Rod-and-Frame Test or the various embedded figures tests, i.e. Group Embedded Figures Test (Witkin et al, 1971).

Substantial research has focused on the role of color in visualized instruction (Dwyer, 1972, 1978; Berry, 1974; Winn, 1976; Chute, 1979; Lamberski, 1980). This research represents one aspect of the larger theoretical debate which continues regarding visual complexity. It has long been contended that the mere addition of visual cues will increase the ability of the viewer to store and retrieve visual information. This orientation, termed "realism" by Dwyer (1967), has drawn strong theoretical support (Dale, 1946; Morris, 1946; Carpenter, 1953 and Gibson, 1954) and is indeed the major premise of cue summation theory (Severin, 1967). Other researchers (Broadbent, 1958, 1965; Travers, 1964) have, however, taken strong opposition to this "realism" orientation on the grounds that the human information processing system is of limited capacity and that, in times of rapid information reception, irrelevant cues may block the processing of other, relevant information. Studies (Kanner, 1968; Katzman and Nyenhuis, 1972; Dwyer, 1972 and 1979) have investigated this apparent contradiction with conflicting results.

The inclusion or absence of color information can be regarded as one dimension of visual complexity. Color can function in a dual role when used in visual displays. First, it can serve primarily a coding function, providing additional information but not providing any realistic description of the elements of the display. In this case, the effectiveness of color can be predicted by cue summation theory, but not by the realism hypothesis. Second, color can be cues to present a more realistic version of the visual display. In this instance, in addition to providing a greater number of overall cues, it provides the viewer with more realistic attributes or "handles" with which to store and retrieve information. When color is used in this cueing role, its value could be predicted by the realism theories as well as by cue summation theory.

Much past research investigating the differences between color and black and white visuals failed to take into account the fact that realistic color visuals contain intrinsically more information and consequently require more time for processing. In an attempt to resolve this methodological inconsistency as well as to more accurately assess the role of color in the storage and retrieval of visual information, Berry (1974) compared realistic and non-realistic color versions of the instructional materials on the human heart developed by Dwyer (1976). Data suggested that, in those learning tasks where visual materials contributed significantly to the improvement of instruction, realistic color materials were most effective. Later research (Berry, 1977, 1982, 1983) which investigated the color realism/coding question relative to pictorial recognition memory found both realistic and non-realistic color materials superior to black and white visuals. These findings suggested that cue summation theory may provide an accurate description of how color functions in basic information processing tasks such as picture recognition.

A number of researchers have investigated how the aptitude of field dependence/independence relates to an individual's ability to percieve and process both simple/complex and color/monochrome pictorial information.

French (1983) found that field independent subjects experienced less diffic processing unusually complex material than did field dependent viewers. Co however, was not considered a primary dimension of visual complexity. Rese conducted by Wieckowski (1980) and Lertchalolarn (1981) suggests that individu who differ in terms of field dependence/independence utilize color informat differentially in recognizing visuals. Color was shown to facilitate recog tion of visuals by subjects who tended toward the field independent end of continuum, while color appeared to interfere with recognition by field depe individuals. It is not clear why such findings occurred, however, one poss conclusion may be that color information functioned as a further embedding making it more difficult for field dependents to separate distinct forms wi a visual which could be used as recognition cues. It is also not clear why color tended to facilitate recognition by field independent individuals, although one possible explanation may be in the ability of such individuals to effectively disembed specific forms from the visual ground and subsequently use them as cueing devices. Neither of these hypotheses have, however, bee adequately addressed by past research on the color variable.

Simple comparison of recognition rates did not, however, take into account the subjects' rate of incorrect responses. It has been suggested by Swets, Tanner, and Birdsall (1964) that in recognition experiments, each observer applies a particular criterion value to each observation. Consequently it could be possible for a subject to identify all stimuli as hav been seen previously, the result of which would be not only a high recognit rate, but also a high error rate. Similarly, if the observer were to apply low criterion and reject all items as not previously seen, the resulting ra would be low with a correspondingly low error rate. It is apparent that analysis of pictorial recognition data should take into account the observe criterion and the resulting rate of error which accompany the reocgnition r The method of signal detection theory has been applied to the analysis of recognition data in the past as a means whereby both recognition rate and error rate are taken into account.

Signal detection theory has been accepted as a reliable technique for assessing a subject's ability to describe the occurrence of discrete binary events. The basic model of SDT was described in Swets (1961) and has been used extensively to study the ability of individuals to distinguish the presence of a signal when that signal was mixed with noise. More recently, Grasha (1970) has suggested the use of SDT parameters in the study of memory processes. Signal detection theory has been applied specificially to recognition memory experiments involving pictures in research conducted by Snodgrass, Volvovitz and Walfish (1972), Loftus and Kallman (1979), Loftus, Greene and Smith (1980), Morrison, Haith and Kagan (1980) and Kagan (1980) and Berry (1982, 1983).

The purpose of this investigation was two-fold: (1) to study the inte action between cognitive style differences and pictorial recognition memory for pictures presented in three different color modes; realistic color, no realistic color and monochrome (black and white); and, (2) to further conf the efficacy of applying signal detection analysis to color recognition memory data as a means of obtaining a more accurate assessment of the role of color in visual information processing.

Procedure:

The stimulus materials used in the study were the same as those used by Berry (1977), Wieckowski (1980) and Lertchalolarn (1981). These consisted of 150 stimulus slides and 90 distractor slides. All slides were obtained from a pool of travel and geographic scenery slides taken by several amateur photographers in various parts of the United States and Canada. In selection of the materials, care was exercised to exclude all recognizable human figures, verbal materials and unique objects. The entire collection of materials was randomly divided into approximate thirds. One third was retained as a realistic color group, a second third was recopied into black and white slides and the remaining third was altered by photographic reversal to produce a non-realistic color group. Through photographic reversal, the overall number of color cues could be held constant, while the degree of color realism could be manipulated.

The population for the study consisted of 60 students at the University of Pittsburgh. Subjects were drawn from the Schools of Education, Library and Information Science and Business and represented both graduate and undergraduate students.

Subject's relative degree of field dependence/independence was determined using the Group Embedded Figures Test (GEFT) (Witkin, Oltman, Raskin and Karp, 1971). Based upon similar data from related populations, Cutoff points of 11 and 15 were used to define field dependent (11 and below) and field independent (15 and above) groups. To avoid the loss of power associated with three-level blocking, described by Cronbach and Snow (1977), the middle, indeterminate group was deleted from the study.

The list learning procedure was employed, in which all subjects were first shown the group of 150 stimulus slides, sequentially for approximately 500 ms each. Subjects were subsequently presented with a random distribution of all slides (stimulus and distractor) for five seconds each. During that time, subjects responded in writing either "old" (stimulus slide-seen before) or "new" (distractor slide-never seen).

The design of the study followed an ATI configuration with two levels of the aptitude factor and three repeated measures of the color factor.

Findings:

The mean number of hits for each treatment and cognitive style group as well as the measure of sensitivity d' which was determined from tables developed by Elliot (1964) are presented in Table 1. In addition, total mean error rates for each treatment were calculated (total error rate = false alarm rate + miss rate) as suggested by Loftus, Green and Smith (1980) (see Table 1).

Analysis of variance procedures for repeated measures were conducted on the number of hits (recognition scores), d' and the total error scores. Significant F-values were obtained for the main effect of color on the hit rates (F=7.10, p=.001) and for the main effect of cognitive style on the d' data (F=7.59, p=.008).

Table 1

Means and Standard Deviations for Number of Hits, d' and Total Error Rate by Treatments Across Cognitive Style Groups

		Realistic Color		Non-Realistic Color		Black and
		Mean	s.d.	Mean	s.d.	Mean
Field Dependent (N=27)	Hits	26.74	9.41	24.33	9.94	20.56
	d'	.133	.172	.107	.336	.200
	Total Error	37.89	4.29	39.63	6.58	39.78
Field Independent (N=33)	Hits	25.82	7.90	23.33	9.98	22.48
	d'	.195	.327	.369	.389	.278
	Total Error	37.48	5.01	36.85	5.91	38.24

The Scheffé procedure for pair-wise comparisons was performed on the m to determine where significant differences existed. The results of these analyses are summarized in Table 2.

Table 2

Summary of statistical analyses for hit scores, d' and total error scores

Hit Scores	d'	Total Error Scor
RC > BW	FI > FD	-

Discussion and Conclusions:

Findings relative to the cognitive style variable of field dependence showed no differences in analysis of the hit rates (recognition score), how a significant main effect for the cognitive style attribute was produced on the d' parameter. This finding would suggest the general superiority of fi independent subjects in any type of pictorial recognition task regardless of color mode. Such results are consistent with current theory which suggests that field dependent individuals are better able to impose structure on a relatively undifferentiated field and consequently can more effectively process, store and retain such information. Color was not identified as a significant, contributing factor to this figural restructuring. It should be noted, however, that in the non-realistic treatment, subjects showed the greatest degree of differentiation across the cognitive style factor. This may suggest that when individuals are presented with unique or unfamiliar visual displays, field independent persons use such information more effectively than do field dependent subjects. Such comparisons would seem to merit further investigation.

Since subjects showed no apparent difference in terms of overall error rate or hit rate, it would seem reasonable to conclude that the difference produced in the d' variable is due to differences in the "false alarm" rate (positive response to distractor). This implies a greater processing and storage problem, possibly attributable to less efficient organization of the material in memory. Again, this aspect calls for more extensive exploration.

In terms of the color variable, the analyses of hit scores (correct recognition) showed no interaction with the cognitive style variable, but did show a main effect superiority for the realistic color treatment over the black and white treatment. No differences were produced however, in analyses of the d' values. Such variations are again the result of differences in the false alarm rate. It would seem that even though realistic color materials produce greater recognition values, they also produce higher false alarm rates. This would suggest that the use of realistic color materials may not be as efficient in terms of the accuracy of the response. Such a finding also suggests that the d' parameter is a better overall indicator of response accuracy.

Based on these findings, a number of conclusions can be drawn.

1. Field independent subjects exhibit greater ability to recognize previously seen visuals in terms of the d' parameter.

2. Realistic color materials tend to produce higher absolute recognition rates but not higher d' values.

3. The variables of false alarm rates in relation to overall recognition should be studied further.

4. The method of signal detection theory can and should be applied to color recognition data analysis. In so doing, a more accurate assessment of the recognition and error rate interaction can be made.

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TITLE: The Role of Naturalistic Inquiry on Research in the Instructional Uses of Pictures

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The Role of Naturalistic Inquiry on Research in the Instructional Uses of Pictures

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The Role of Naturalistic Inquiry in Research on the Instructional Uses of Pictures

Since its inception as a field of study, instructional technologists have used the scientific or rationalistic paradigm to study the instructional potential of pictures. In spite of numerous studies concerned with different aspects of pictures, concern has been raised about the products of such research to influence practice (Clark, 1983; Brody, in press). Some have pointed out that it is difficult to apply the results of this research to the classroom because the conditions under which the research has been conducted are too far removed from the realities of the typical instructional setting to be very meaningful. That is, many have concluded that emulating the practices of physical scientists may be inappropriate for social scientists who are primarily concerned with human beings and their problems.

This attention to the apparent lack of utility in research spreads far beyond those whose interests lie in the study of pictures or instructional technology; rather it has become a recurring theme sounded by a broad spectrum of educational practitioners and researchers. While some have ignored this concern over the lack of utility, others have looked to newer methods of educational inquiry. Of the newer paradigms, naturalistic inquiry has received the most attention and may have the greatest potential to influence the practices of instructional technology research in general and, more specifically, research on the instructional uses of pictures.

Although an analysis and description of the techniques and procedures of naturalistic inquiry is not the major focus of this paper, an understanding of the basic elements of naturalistic inquiry is necessary before one can understand how it may be used to study the instructional potential of pictures. Thus, the next section of the paper will briefly describe the major components of naturalistic inquiry and to better understand these characteristics, briefly compare them to the major assumptions of rationalistic inquiry with which we are more familiar (Guba & Lincoln, 1982; Smith, 1983). Following this will be a more specific discussion of how these characteristics can be used in picture-related research.

Basic Assumptions of Naturalistic Inquiry

Probably the major difference between the two types of research lies in their different views of reality and truth. The naturalist believes that reality is multifaceted and that identifying what is real depends on individual experience and interpretation. Furthermore, advocates of naturalistic inquiry believe that one can only study phenomena as coherent entities, that should not be separated into its constituent components. On the other hand, the rationalist believes that there exists a single, viable, concrete truth and that one can study phenomena by examining small components of that phenomenon. The truth could then be identified by combining the results of the various research on the constituent parts.

A second difference between the naturalistic and rationalistic paradigms concerns the relationship between the investigator and the subject. The naturalist believes that investigators and their instruments will always influence and interact with the subject. This is in marked contrast to the rationalist belief that investigators can maintain a safe distance from that which is being examined and that methodological safeguards can be implemented to help ensure that the act of investigation does not influence the outcomes of that investigation.

The development and formulation of generalizations is a linchpin of research based on the rationalistic paradigm. Such statements are usually considered true under all environmental and contextual situations. The naturalist, however, believes that it is impossible for phenomena to be free from contextual influences. Thus, naturalistic inquiry does not generally support the attempt to develop all-encompassing generalizations.

The manner in which rationalistic and naturalistic inquiry view the goals of inquiry is yet another characteristic which distinguishes the two paradigms. The naturalist maintains that the complexities of being human are so enormous that determining causality is a futile goal. Instead, naturalistic inquiry emphasizes the need to develop a broad, interpretive understanding of what is taking place. Whereas understanding is the major goal of naturalistic inquiry, determining causality is the ultimate goal of rationalist inquiry. That is, the primary purpose of inquiry based on the rationalistic paradigm is to explain the relationship between different elements in the educational setting and use these relationships to develop universal laws of behavior.

Finally, naturalistic and rationalistic inquiry differ in the way each approaches the role of values in inquiry. The naturalist supports the notion that values are always part of inquiry and that the investigator can identify and acknowledge the relevant values so that they can be utilized in interpreting the phenomena being examined. In comparison, researchers using the rationalist paradigm believe that through the use of objective methodology, inquiry can be conducted which is free from the values of the investigator. If value free, then the results of inquiry can be considered to be representative of what actually exists.

Naturalistic Inquiry and Picture Research

Although other areas of education have attempted to employ the methods of naturalistic inquiry, educational technology in general, and the study of pictures in particular, have not yet determined how the naturalistic paradigm can be of assistance. This section of the paper will try to provide some initial, if halting, reflections on how our understanding of the instructional potential of pictures can be expanded by conducting research based on naturalistic methodologies. Rather than pointing out how each research decision relates to one of the elements of naturalistic inquiry described above, only the most subtle or significant connections will be indicated; otherwise it will be left to the reader to make these associations.

While numerous studies using the rationalist paradigm have been conducted, we know little about how pictures, when included in instructional texts, are actually used by students and teachers. It is also doubtful whether rationalist research with its emphasis on highly structured and artificial treatments will ever be able to accurately describe this set of behaviors. On the other hand, naturalistic inquiry with its emphasis on conducting studies in their natural settings and qualitative research techniques would seem well-suited to examine how pictures are used by students and teachers. Let us now examine the form such research may take.

First of all, this research would take place in schools, under normal instructional settings. Unlike rationalist-based research, there will not be any manipulation of independent variables. Instead, members of the research team will spend considerable time observing how different teachers use pictures when teaching reading, as well as how students use them when reading a variety of instructional texts. The team may also observe teachers when they are planning their lessons and students when they are doing homework. Additionally, both teachers and students will be interviewed extensively, and asked questions about how they used pictures, which pictures they liked or disliked, which ones helped them the most, and any other questions which the interviewer thinks relevant. The ability of interviewers to formulate questions as they go along and to alter the questions from subject to subject is in marked contrast to rationalistic inquiry which almost demands that identical questions be asked to all respondents.

To increase the trustworthiness of the study, it is also likely that there would be a team of investigators who will observe the same classes and interview some of the same people. All of the observers and interviewers would expend considerable effort in describing the instructional environment and context. The types of pictures used, outcomes expected, teacher behavior patterns, learner behavior, subject matter, and instructional strategies are just some of the many factors that would be noted by the researchers. Finally, the research team would spend considerable time at the study site to reduce the possibility of distortion due to the presence of the investigation team at the school and to ensure that the important environmental and contextual characteristics have been identified.

The result of all the observations and interviews will be a fairly substantial set of descriptive notes which the investigator must reduce to a more meaningful and manageable size. As the data is sifted, organized, and refined, recurring patterns are identified. In the hypothetical study concerned with how pictures are used when they are incorporated into instructional texts, patterns related to some of the following may emerge:

--the way students used pictures to increase their understanding of textual material

--the way pictures are used by students with different characteristics

--which combinations of pictorial attributes are present when students believed a picture was particularly helpful

--the extent to which pictures influenced teacher behavior

--the relationship between pictures, student behavior and different types of subject matter and learning outcomes

--the procedures used by students to gain meaning from pictures

Unlike more conventional and traditional research practices, no attempts would be made to infer causal relationships for the patterns identified , nor would there be an attempt to use the results to explain what had occurred or to predict outcomes in other settings. Instead, the investigator would most likely try to use the patterns identified as a means of increasing the understanding of the phenomena being examined--the manner in which students and teachers use pictures included in instructional texts. Rather than using the data to prove or disprove generalizations or theories, the investigator would use the data to sharpen the focus for the next series of studies.

The number and variety of possible subsequent studies emerging from the initial, hypothetical study is impressive.

Studies in settings similar to those described previously could be conducted to determine the consistency of the observations across similar, yet different, settings. Taking a different approach, a future investigation could focus on one of the patterns or combinations of patterns which seem incongruent with previous research or which the investigator wishes to explore in greater detail. There is no reason, for example, why future studies utilizing the techniques of naturalistic inquiry could not examine the procedures used to gain meaning from pictures, regardless of whether or not they are included in an instructional text. Similarly, one could conduct a study concerned with the influence of pictures on the instructional behaviors and strategies of teachers.

Conclusions

The hypothetical study briefly described above is but one of many areas related to the instructional uses of pictures that could be conducted within the framework of naturalistic inquiry. Determining the types of instructional functions that can be served by pictures or examining the role of pictures within a given content area, for a specific type of learning outcome, or for a particular type of learner are all potential candidates for research utilizing the naturalistic paradigm.

What is most important to the instructional technologist concerned with examining the instructional potential of pictures is not the identification of specific questions which can benefit from naturalistic inquiry, but to understand and take advantage of the unique characteristics of this mode of research. It would appear most appropriate to develop a study around naturalistic methods when it is necessary to provide an exceptionally large data base for a previously ignored area of picture research; to determine what occurs in actual instructional settings; to generate working hypotheses for future studies when none are available; or to simply to increase one's understanding of the complexity of a problem area.

It is probably equally important to recognize that it is unlikely that inquiry based on either the naturalistic or rationalistic paradigm will answer all our questions about the instructional uses of pictures. Instead, it is likely that each paradigm will have an important role to serve in increasing our understanding of the relationship between pictures and effective instruction. On the other hand, instructional technologists have almost totally ignored naturalistic approaches to this area in favor of the more conventional rationalistic approaches. One can only wonder if we have failed to take advantage of a potentially powerful ally.

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TITLE: Testing and Measurement Potentials of Microcomputers for Cognitive Style Research and Individualized Instruction

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Testing and Measurement Potentials of Microcomputers for Cognitive Style Research and Individualized Instruction

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Testing and Measurement Potentials of Microcomputers for Cognitive Style Research and Individualized Instruction

At present, many of the instruments used to measure an individual's cognitive style are susceptible to a variety of potential errors, must be individually administered, or are otherwise logistically uneconomical. For example, *The Leveling-Sharpening House Test* (Santostefano, 1964) is individually administered and requires that the hand-held pictures be displayed for five seconds each. Lowenfeld's *Successive Impressions Test I* (1945) employs a film presentation that requires the subject to respond within a relatively short period of time in order to keep up with the film's pace of presentation. The *Group Embedded Figures Test* (Witkin, Oltman, Ruskin, and Karp, 1971) uses a 32-page booklet for each subject tested.

Over the past seven and one half years, microprocessors have become increasingly available within our schools, and will become even more widespread in years to come. With this growth in microcomputer use and the increasing emphasis on individualization of instruction, the need for student diagnostic tools that are dependable, reliable, precise, and efficient will also grow.

Microcomputers are dependable machines. In the five year history of the microcomputer teaching lab at the University of Oklahoma, time lost due to equipment failure has been negligible despite heavy use by inexperienc and accident prone students, staff and faculty.

Microcomputers are precise. When instructed to display a sequence of screens for five seconds each, it will display each screen in the prescribed sequence, at the same viewing angle, and without tremor, for exactly five seconds.

Microcomputers are economical. Once the microcomputer been purchased and a relatively small amount has been spent software, the cost of administration of diagnostic tools on individual basis to an unlimited number of students is limit the cost of electricity for a low consumption instrument, an occasional two dollar reusable floppy disk for data storage. Many tests can be scored by that same microcomputer. Yet an consideration is that microcomputer programs can be develope a way that requires virtually no prior experience with eithe computer or with typewriter keyboards. The user responses c gathered with the press of a single key (sometimes any key). Peripherals such as game paddles or joy sticks allow cursor control and response to onscreen prompts with the spin of a or the push of a button. Light pens, graphic tablets, touch screens and the 'mouse' all simplify user input.

The graphic capabilities of many microcomputers are per the asset that most enhances their value in the delivery of cognitive style diagnostic and research tools. Being able to display pictures in high or low resolution in either color or black and white, these microcomputers can replicate the test stimuli that are used in many of the commonly used tests. These same graphic capabilities may also be used to display text font sets for diffent languages and in various sized to accommodate the young and those with visual handicaps.

The remainder of this presentation will describe and demonstrate microcomputer versions of three commonly used tests: *The Group Embedded Figures Test* for Field Dependence-Independence (Witkin et al, 1971), *The Leveling-Sharpening House Test* for the Leveling-Sharpening cognitive control principle (Santostefano, 1978), and *The Successive Perceptions Test I* for the Visual-Haptic perceptual styles (United States Army Air Corps, 1944).

The Group Embedded Figures Test

The Group Embedded Test (GEFT) was derived from *The Embedded Figures Test* (EFT) (Witken, 1950) to facilitate group testing. In each of the 18 test figures taken from the EFT, one of eight simple figures is incorporated into increasingly complex figures so the extensions of the lines composing the simple figure make up elements of the complex figure. (See Figure 1). Therefore, the simple figure tends to blend with, or is embedded within, the surrounding visual field. Disembedding the simple figure from the complex field is a task that the field independent subject should be able to accomplish. Results of GEFT testing have been consistent with those from the*EFT*, *The Rod and Frame Test* and *The Body Adjustment Test* (Witkin, Moore, Goodenough & Cox, 1977).

The EFT used colors to emphasize the large organized field

and obscure the simple figure. The GEFT has accomplished th
through light shading of similar areas on each figure.

During administration of the GEFT, the simple figures ar
printed on the back cover of the booklet while the complex
figures are on the right side of each inside page. This is t
prevent the individual from seeing the two simultaneously,
although they may look from one to the other. This is
accomplished with the microcomputer by using graphics pages o
and two and allowing the subject to toggle back and forth.

Streibel (1980) reports finding decreased differentiatio
between the cognitive styles with increasing stimulus size.
imposes a limitation on the size of the monitor screen used f
testing. The figures used in the microcomputerized version w
developed to the same scale as the paper and pencil version,
an 11" monitor, a very commonly used monitor size.

The GEFT is administered in three sections. Following
sample figure and solution, the subject is given two minutes
complete First section, five minutes for the Second Section,
five minutes for the Third Section. This is duplicated in th
microcomputer version.

In the paper and pencil GEFT, the subject traces over t
outline of the simple figure. This has been accomplished wi
the microcomputer version by using a LPS II graphics light p
from Gibson Laboratories, with which the subject can draw a
colored outline over the simple figure. This new composite
stored on a floppy disk for later scoring.

The Leveling-Sharpening House Test

The Leveling-Sharpening House Test (LSHT) was developed by Santostefano (1978) to relieve the tedium and boredom that subjects encountered with the earlier *Schematizing Squares Test*, and to add the conceptual familiarity for younger children not found in the *Leveling-Sharpening Circles Test* yet still have adequate complexity for the older child that was not present in the *Leveling-Sharpening Wagon Test* (Santostefano, 1964). The LSHT is described as being effective with subjects from three years of age through adulthood (Santostefano, 1978).

The LSHT consists of a series of 60 handheld test cards, the first of which shows a black and white line drawing of a house and adjacent landscape (See Figure 2). The cards are shown for five seconds each. On every third card a picture will have some detail omitted until by the 58th card, 19 elements are missing from the original scene. Less conspicuous elements are eliminated in the earlier frames and more conspicuous ones later.

The subject is instructed to study each card and then, when the next card is shown, to stop the examiner if any changes are noted. When directed by the subject to "Stop", the examiner records the subject's response, whether correct, incorrect or imagined.

The examiner begins by raising the deck of cards so that the subject sees the first card. Observing a stopwatch, after five seconds, the first card is laid face down so that the second card is seen. This sequence is followed, pausing to record the subject's responses, until all 60 cards have been shown.

The Leveling-Sharpening cognitive control principle de with how an individual organizes information images in memo subsequently relates those images to current information. A person who is a leveler has a global image with which new information is fused, whereas the sharpener differentiates between memories and present information. Therefore, on th LSHT, the sharpener should more quickly and accurately dete changes in the scene.

The Leveling-Sharpening ratio is determined by changes detected, changes not detected, and how quickly, in number o frames from item deletion, the changes were detected. The greater the number of changes noted and the faster the chang are noted, the lower the L-S ratio will be and therefore th greater the tendency toward sharpening.

The need for manipulating handheld cards, watching a stopwatch and concurrent recording of the subject's response introduce the possibility of variable precision in administe the LSHT. This potential, as well as having noted a need fo administration technique that eliminates the necessity of ha a trained examiner present, led Ragan and Dillingham (1979) develop a microcomputerized version of the LSHT that in info trial has shown no apparent difference in adult subject responses.

The microcomputer version of the LSHT is accurate and precise in stimulus detail and in presentation timing. As t standard scenes are presented on 8 x 11 inch cards, accuracy duplication for the computer requires using full screen grap on a 13 inch monitor.

To obtain the desired advantage of eliminating the need for a trained examiner to monitor, clarify and record responses, the subject may type their responses on the keyboard. The computer will then tag the entry with the frame number and store it on disc for later interpretation. This raises the question of whether or not a typed response will retain the spontaneity and form that is obtained from an oral report. Also, when present during the testing, the examiner may clarify any unclear responses before interpretation.

An associated and probably greater drawback is that even if keyboard entry is shown to be no significant detriment, this will probably hold most true for the relatively skilled typist with at least moderate written communications skills. The hunt-and-peck typist, and those with poor writing skills, will likely become distracted and frustrated, reducing the validity of data gathered. It is also difficult to imagine many three to five year olds being able to effectively enter information this way.

The microcomputer version of thւ LSHT was developed to be used by adult subjects. For those who have difficulty with keyboard response entry, the test would retain the value of its stimulus presentation attributes by having a trained observer present for data gathering.

The Successive Impressions Test

As described by Lowenfeld (1945), *The Test For Integration of Successive Impressions* requires the subject to integrate a series of partial impressions into a whole. This ability belongs to a person of the visual perceptual style, rather than the haptic who's perception is primarily through the kinesthetic tactile modalities.

The_Successive_Impressions_Test_I (SPT-I) is a version of Lowenfeld's test presented on film for group administration. SPT-I is composed of three practice and thirty five test items. The subject is presented a blank screen with a narrow window moves from the top to the bottom of the screen in one second, successively revealing parts of a line drawing. The subject is instructed to attempt to visualize the parts as a whole figure. Then the subject is shown a screen with the intact figure and four similar drawings, and is instructed to choose the correct figure. (See Figure 3). The subject then records his/her selection on a paper score sheet.

The score is the number of correct responses. Ragan, et (1979) summarize the research in this typology and report a distribution of 50% visualizers, 25% haptics, and 35% indeterminates. This converts to scores on the SPT-I of 18-3 correct visual, 0-9 correct haptic, and 10-17 correct indeterminate.

A modification of the SPT-I for microcomputer delivery h been done by Edu-Ware Services, Inc. (copyright 1979), under title Perception_II. This version allows the user to determ the number of verticies of the target drawing and the degree variation between the target and the incorrect figures on the matching screen. Perception_II reports the number of correct responses and a score based on the difficulty of the items u This program is not described by the author as a cognitive s test.

The author is presently developing a version that will replicate the SPT-I. Lowenfeld (1945) gives no indication of object size or duration of exposure of the successive images. Given the variation in projected image size based on distance, apparently size is not important. The version under development will retain the one second exposure time used in the film version. Scoring will be done by the program.

Conclusion

Microcomputers seem to be capable of administering many of the commonly used cognitive style measurement instruments. They are dependable and can increase reliability through increased precision and accuracy. It is economical to use microcomputers for test administration. While some tests, such as The Leveling-Sharpening House Test may still need a trained observer, many others such as The Group Embedded Figures Test and The Successive Impressions Test I relieve the need for close supervision. All three maintain or increase test reliability. These factors and the ease of gathering data should help encourage further research in the use of cognitive styles for the individualization of instruction. They will surely assist in the delivery of that instruction.

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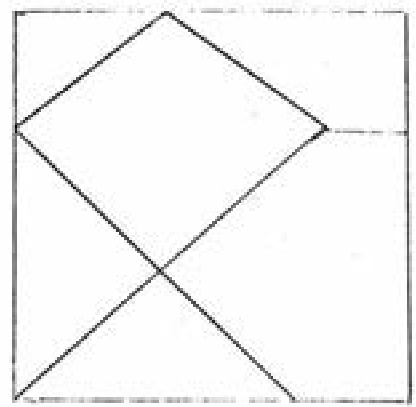
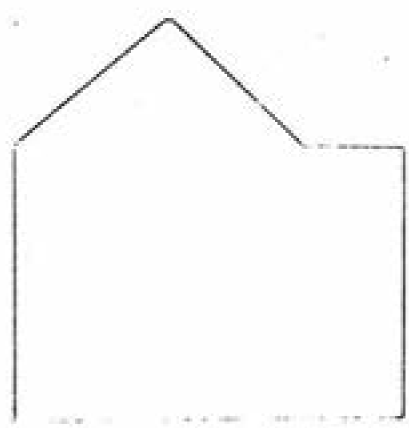
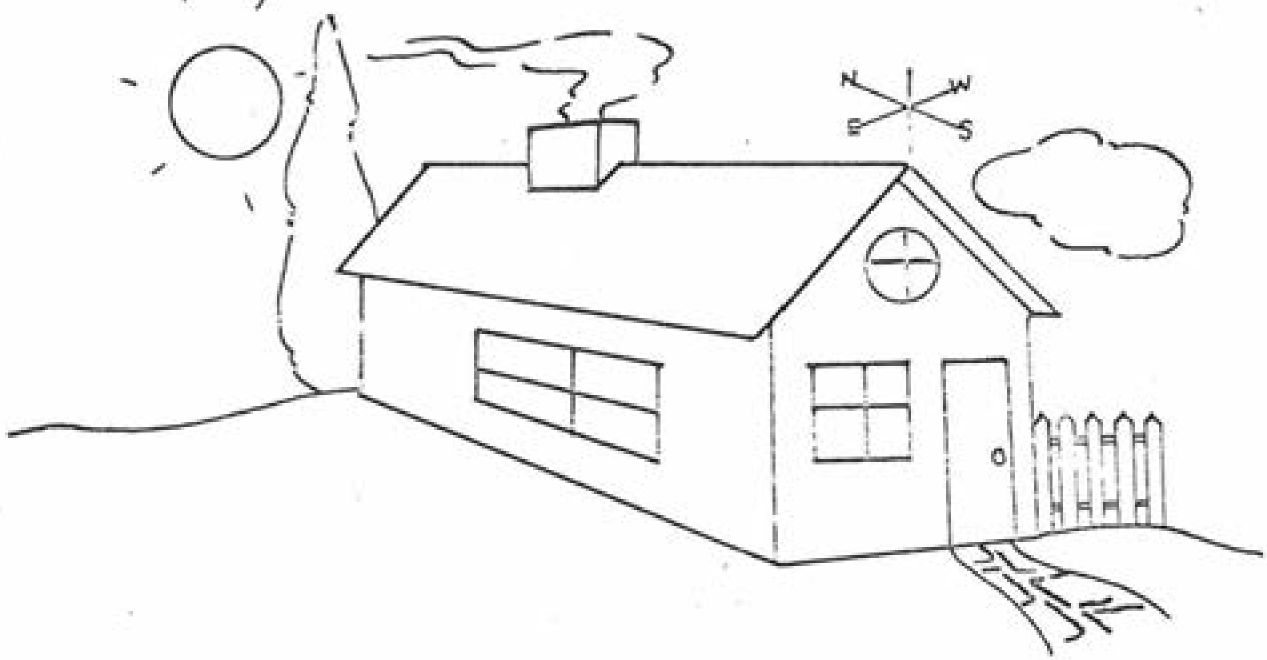


Complex Figure

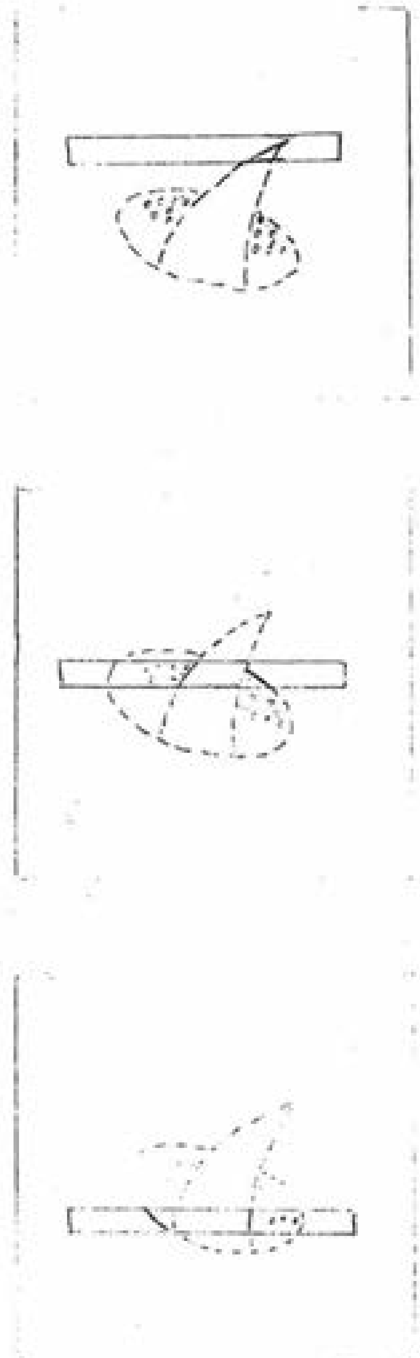


Simple Figure

Group Embedded Figures Test
Figure 1



Leveling-Sharpening House Test
Figure 2



Successive Perceptions Test-I
Figure 3

TITLE: The Effects of Recall Cue and Cognitive Trace Compatibility When Learning from Mediated Instruction

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The Effects of Recall Cue and Cognitive Trace Compatibility When Learning from Mediated Instruction:

An Applied View of Encoding Specificity

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ABSTRACT

The present study investigated the research construct of encoding specificity using an applied research orientation. Encoding specificity considers the effects on memory of the interactive relationship among encoding, the stored memory trace, and external retrieval cues. The present experiment used typical classroom presentation methods and testing methods to investigate the encoding specificity hypothesis. Two types of instructional presentations were given, one visualized and one verbalized. Three types of testing measures were used to test factual learning, each providing different types of external retrieval cues; free recall; verbally cued-recall, and visually cued-recall. A complex relationship existed between type of instruction and type of external cue provided during testing, essentially supporting the encoding specificity hypothesis.

Problem and Rationale

The psychological research construct of encoding specif addresses an important orientation for educational technolog involved with research on learning and instructional develop activities. In the encoding specificity orientation, the ab to recall learned information is a direct function of the relationship which exists among encoding [information input/learning], the stored memory trace [cognitive informat and the external retrieval cue. In this respect, encoding specificity research concludes that it is possible for information to be available in the cognitive structure, and therefore to have been learned; however, for retrieval purpo this information may be inaccessible because the appropriate external retrieval cues may not be available in the testing environment.

The importance of the encoding specificity construct fo educational technologists is revealed by the fact that a numb of research studies have found that significant interactions exist among encoding, memory trace, and external retrieval c The practical significance inherent in the encoding specific construct implies that if a mismatch exists between how instructional content was originally presented to students an how it was subsequently evaluated - in terms of having the appropriate retrieval cues available in the evaluation mode - students will not be able to utilize fully information previo acquired.

Although a number of empirical studies have been conducted on the encoding specificity construct, little applied research is currently available. Most of this research has focused on types of learning and experimental conditions far removed from what might be expected to be found in a typical classroom environment. While these research findings are valuable, they make generalization to specific classroom instructional environments difficult. The present study purports to address this problem by using typical classroom instructional materials, academic content, and environment, within the context of an encoding specificity study. The majority of past research in the encoding specificity area has used various forms of paired-associate learning tasks presented to individual subjects, representing essentially a laboratory situation, (Tulving, 1979).

The learning conditions in the present study use a slide-tape instructional presentation, typical of an audiovisual segment during a class session. The experimental conditions were conducted in a classroom setting with groups of 40 subjects. Of course the subjects were aware that they were involved in an educational study, but they were told that the content they were to learn was a typical college type of academic content in physiology. Additionally, they were told that the presentation method was a slide-tape audiovisual presentation, similar to what would be seen as part of a class session. They were also told that they would be required to remember information presented in

the audiovisual program, similar to what would be done durin
audiovisual classroom segment. While the subjects knew they
involved in an experiment in learning, the present studies'
conditions emulated a classroom situation far beyond most of
past research with the encoding specificity construct.

Furthermore, the slide-tape content presents the learne
with an instructional program which describes the names of th
parts and functions of the human heart. Again this content i
typical of what would be found at the college level in a biol
class audiovisual segment to complement a lecture. The
slide-tape instructional materials employed in the study wer
adaptation of the Dwyer (1967, 1978) instructional treatment
materials. These materials were used because they closely
resemble audiovisual instructional presentations used in the
classroom and have been validated in a large number of studi
investigating a variety of instructional and learning hypoth
(Dwyer, 1982).

Related Encoding Specificity Research

The crux of the encoding specificity research orientatio
involved with the interactive relationship which exists among
encoding phases, the memory trace, retrieval cues, and subseq
effects upon the learner's skill performance. Basic research
encoding specificity, from a psychological research paradigm,
suggests that encoding specificity is not a superficial
phenomenon, but is rather a psychological principle. Tulving
(1979, p. 417) in reviewing the related literature in this ar

has concluded that "... over a considerable range of experimental conditions, empirical facts show that remembering of events is determined by the interaction between encoding and retrieval." Similarly, in an early study, Tulving and Osler (1968) found a direct relationship between encoding and retrieval. Using a paired-associate learning paradigm, they had two encoding conditions and two retrieval conditions. The two encoding conditions were; (1) a target word plus cue A, and (2) a target word plus cue B. The two retrieval conditions were; (1) present retrieval cue A, and (2) present retrieval cue B. The experiment resulted in the following strong interaction as revealed by percent of correct recalled target words.

	(Retrieval Cue)	
(Encoding Cue)	A	B
A	62%	29%
B	33%	62%

From these results Tulving and Osler concluded that successful retrieval of information stored in the cognitive structure is contingent upon the appropriate external cue to match the stored memory traces. It should also be noted that this early study represents the typical encoding specificity experimental setting, using paired-associates, administered to individual subjects. This type of highly experimental setting is quite removed from typical classroom instructional environments. Additionally, that the retrieval cues are similar, stemming from the encod contexts, but represent different cues to access different m traces. This difference in cues should not be interpreted a incompatibility, but simply as different cueing types.

In a later experiment by Thomson and Tulving (1970), si results occurred, indicating a strong significant relationshi between encoding and retrieval cue. This experiment used a paired-associate learning task and several types of cue conditions. From their results, Thomson and Tulving (1970, p 261) concluded that "retrieval of event information can only effected by retrieval cues corresponding to a part of the tot encoding pattern representing the perceptual registration of occurrence of the event." In this respect the original enco specificity hypothesis can be interpreted to indicate that retrieval is facilitated if external retrieval cues match a p of what was stored during learning.

The majority of the encoding specificity research has us experimental designs that directly relate to the memory eleme of encoding, the memory trace, retrieval cues, and the interaction of these memory elements, (Anderson, Pichart, Go Schallert, Stevens, and Trollip, 1976; Tulving and Watkins, 1 Moscovitch and Craik, 1976). Results of these experiments generally confirm the encoding specificity hypothesis. Howev there is the counter argument that is offered by the levels o processing research orientation. Craik and Lockhart (1972, p

645) contend that "trace persistence is a function of depth of analysis, with deeper levels of analysis associated with more elaborate, longer lasting, and stronger traces." In line with the levels of processing conclusions, memory research further indicates that orienting tasks which tend to cause deeper more elaborate memory traces do improve recall of learned information, (Hyde and Jenkins, 1969; 1973). Such orienting tasks could be directions to form images, advance organizers, or specific acquired mnemonic strategies. Craik and Tulving (1975) found that free recall and recognition varied considerably, contingent upon the type of orienting tasks, or memory instructions, given prior to learning.

However, while the levels of processing orientation appears viable, in explaining psychological factors related to recall and the recognition of stored information, the levels of processing orientation provides only part of the explanation. Recall and recognition memory are probably effected by orienting tasks altering processing level, but the relationship between the stored memory trace and external retrieval cues is a strong variable determining the success of memory operations. In a series of experiments investigating the levels of processing hypothesis, Fisher and Craik (1977, p. 709) concluded that "... the retention levels associated with a particular type of encoding were not fixed, but depended heavily on the type of retrieval cue used." This conclusion may be interpreted to indicate that external retrieval cues will have a significant relationship to learned information, in terms of improving or debilitating recall and recognition.

One generalization which may be derived from past research on encoding specificity is that a significant relationship exists among encoding, the stored memory trace, and the external retrieval cue. Additionally, the compatibility of these three memory elements will have significant effects upon the learner's ability to apply stored information during the testing situation. The problem with much of the past research in this area, however, is that learning tasks, learning materials, and presentation methods, employed in the experimental context, are too removed from typical instructional methods and classroom settings. This situation makes it difficult to apply these significant research results to the task of designing appropriate evaluation and testing methods, that match instruction in terms of the basic memory elements of encoding, memory trace, and retrieval cues. The present study attempts to evaluate the encoding specificity orientation within the context of an applied learning situation.

Experimental Design and Procedures

This study employed a 2x3 analysis of variance design utilizing two between-subjects variables. The first between-subjects variable was the type of instruction presented. The two levels of the instructional variable were the visually mediated instruction (VISU) and the verbally mediated instruction (VERB). The type of content included in each instructional unit was representative of the kind of academic content typically presented in teaching-learning situations. The instructional unit was designed to instruct learners on the names of the parts and processes of the human heart. The instructional units were presented in the form of slide-tape presentations lasting 22 minutes. Both slide-tape programs used the same pulse synchronized audio tape, so the to-be-learned instructional content in both units was identical. The difference between the VISU and VERB instructional presentation was in the slide portion of the presentations. Both groups saw the same number of slides in the same sequence. The VISU group saw a color illustration slide set with a verbal label identifying the relevant heart part on each slide, and an arrow pointing to the part. Each slide was an artist drawn illustration of a dissected heart, similar to what would be found in a textbook. The VERB group saw a set of verbal label slides, which consisted of a verbal label that named the heart part described on the audio tape. the VERB slide set presented the same verbal labels that appeared on the VISU slide set, but did not contain an artist illustration. The VERB slide set contained verbally mediated instructional content, supported by the audio tape program.

The second between-subjects variable was the type of cueing measure used during testing. This variable serves as the key to the encoding specificity hypothesis in the context of this experiment. Three measures of the cueing variable were employed (free recall, visually cued-recall, verbally cued-recall). These three measures were designed to test the learners' ability t acquire from the slide-tape instructional programs the names the parts of the heart and the heart phase names. There were part names and 2 phase names to be learned from the instructi programs, producing a total of 21 possible points on each mea All three measures tested the same intellectual skill, in thi case the factual learning of 21 part and phase names. Both instructional units provided the learner with the same target information to accomplish the specified learning task. Howev the difference in each of the measures was in the type of external retrieval cue provided to the learner during testing The measures represent different cues designed to assess the encoded target information, the 21 part and phase names assum to be stored as a function of interacting with the heart slide-tape instructional programs. Both the visually cued-re measure and verbally cued-recall measure were derived from th original instructional program content, so they were compatib but represent different cues to assess the stored memory traces.

The free recall measure required the subject to list the parts of the heart and the 2 heart phase names from memory, i any order. The visually cued-recall measure required the sub to write down the correct part name when he saw that part identified by an arrow on an illustration slide. To accompli this, subjects saw the illustration slides of the heart, describing the parts and phases, with the <u>verbal labels remov</u>

Each slide had an arrow, however, pointing to the part in question, and subjects were instructed to write down the part name. The slides used were from the VISU instructional program and were the slides naming the parts and phases, however, the slides were altered by removing the verbal labels.

The verbally cued-recall measure provided the subject with a verbal cue of the part name or phase name in question. To accomplish this subjects saw a set of verbal cue slides. This set of slides consisted of 21 slides, each containing a verbal cue relevant to a particular part or name. The verbal cue on each slide consisted of the first three letters of the part name the subject was to recall. For example, the cue for myocardium, was MYO. For heart part names that distinguished between arteries, veins or valves, (i.e., Pulmonary Artery vs. Pulmonary Valve), the cue AR, VE, or VA was given next to the three letter cue. Additionally, for a part that was distinguished as Right or Left, the cue R or L was added to the three letter cue. Subjects were instructed to write down the complete name of the part or phase when they saw the cue slide.

A total of 273 undergraduate level students enrolled in the College of Engineering at The Pennsylvania State University constituted the population for this study. All subjects took a pretest on physiology to determine their level of prior knowledge in general physiology. Of the 273 subjects, 31 were identified as having significant knowledge in physiology by scoring above 59% on the physiology pretest. They participated in the study but all their data was eliminated from the final data pool. Additionally, two other subjects' data were randomly eliminat from the study to provide an equal number of subjects in eac cell of the analysis of variance. Data was calculated using a total of 240 subjects, with exactly 40 subjects in each of th six cells of the analysis of variance.

Subjects were randomly distributed to the instructional treatments of visualized mediated instruction, and verbalized mediated instruction. There were 120 subjects in each of the instructional treatment groups from which data was collected. From within each instructional treatment group, subjects were randomly distributed to each of the cueing measures, making the testing conditions of free recall, visually cued-recall, verbally cued-recall.

Instructional treatments and testing conditions were administered to each cell in the experimental design separat There were six groups of subjects, making up the six cells of experimental design. The six cells were:

1) VISU instruction + Free recall,
2) VISU instruction + Visually cued-recall,
3) VISU instruction + Verbally cued-recall,
4) VERB instruction + Free recall,
5) VERB instruction + Visually cued-recall,
6) VERB instruction + Verbally cued-recall.

The six sessions of instructional treatments and testing conditions, were administered during a six hour block of time on one day. Each session started on the hour, subjects were given 45 minutes to view the instructional treatment and take their particular test. Subjects were told prior to the instructional treatment that they would see a slide-tape instructional program on the human heart. They were told that the slide-tape program represented a typical audiovisual program used to complement a class session. They were also told to try and remember basic facts from the slide-tape instructional setting. Finally, subjects were advised to interact with the instructional program in the same way they would with an audiovisual program presented during a class session.

Immediately after the slide-tape program about the heart, subjects were given their respective testing condition. They were given instructions on how to respond to their particular test, contingent upon their type of testing condition. After the subjects completed their test, they were given instructions not to tell their friends what the slide-tape program was about and what their test was like. They were then told that the experiment investigated memory skills, and that prior knowledge about the instruction and the testing, would give their friends an advantage and contaminate the data. The same procedures and instructions were carried out in all six sessions.

Results and Discussions

The raw data was analyzed using a 2x3 analysis of varia yielding the following resulting analysis of variance summar table (Table 1).

BETWEEN SUBJECTS

Source	Mean Squares	Df	F-ratio	Probabil
Instruction (A)	484.504	1	41.030	.0001
Cue Measure (B)	734.629	2	62.211	.0001
(A) X (B)	240.754	2	20.388	.0001
Error	11.809	234		

Table 1: Resulting Analysis of Variance Summary Table

Statistically significant results occurred in the instructio variable and in the cueing measure variable. Additionally, a statistically significant interaction occurred between the instructional variable and the cueing measure variable.

The significant results on the instructional variable, [F(1,234,df) = 41.030, p = .0001] indicated that the visuali mediated instruction mean ($\bar{X}$ = 13.175) was superior to the verbalized mediated instruction mean ($\bar{X}$ = 10.333). This finding is generally consistent with prior research (Dw 1978) which contends that when visualization is properly desi and integrated into an instructional sequence, increases in student performance are likely to occur.

Significant results on the cueing measure variable [F(2,234,df) = 62.211, p = .0001] yielded statistical difference between the types of cueing measures. A Tukey test set at (.01) alpha indicated that the verbally cued-recall measure ($\bar{X}$ = 15.24) differed significantly from the free recall measure ($\bar{X}$ = 9.73), and the visually cued-recall measure ($\bar{X}$ = 10.30). In this analysis the free recall measure ($\bar{X}$ = 9.73) did not differ from the visually cued-recall measure ($\bar{X}$ = 10.30). At first glance the lack of significant differences between the free recall and the visually cued-recall measures may appear surprising, since a cued-recall measure should aid memory. However, note that a significant interaction occurred. This interaction affected the visually cued-recall overall mean score. So when the visually cued-recall mean score was averaged across the VISU and VERB instructional variable, any mathematical differences between free recall and visually cued-recall were cancelled. However, looking at Table 2, it can be seen that statistically significant differences occurred between the free recall mean ($\bar{X}$ = 10.55) and the visually cued-recall mean ($\bar{X}$ = 13.68), at the VISU instructional variable level, (Tukey test at .01 significance level). Additionally, no statistically significant differences occurred between the visually cued-recall cell and the verbally cued-recall cell at the .01 level of significance using a Tukey test. This result can be interpreted to indicate that cued-recall aids learning over free recall.

However, the encoding specificity theory would have predicted that given the VISU instructional condition, the verbally cued-recall test should have been significantly low than visually cued-recall testing, not statistically equal. can be explained by the fact that during VISU instruction th subject perceived a visual illustration <u>and a verbal label</u>. this learning condition it can be assumed that a dual code, visual and verbal, must have then been stored since both vis cues and verbal cues allowed effective recall. In a hypothe sense this supports the encoding specificity theory, since bo visual and verbal cues related to the assumed to be stored vi and verbal encoding contexts. It is likely that a complete cross-over interaction could occur by eliminating the verbal labels from the slides in the VISU instructional condition. this were done, subjects could acquire the target informatio the part and phase names, from the audio portion of the slide-tape instructional program.

The analysis indicated a significant interaction existe between the instructional variable and the cueing measure variable [F,(2,234,df) = 20.388, p = .0001]. A Tukey test s .01 alpha was used to indicate the source of the interaction The individual cell means appear in Table 2 and the resultin disordinal interaction is illustrated in Figure 1.

	Free Recall	Visually Cued-Recall	Verbally Cued-Recall
Visualized Mediated Instruction	10.55	13.68	15.3
Verbalized Mediated Instruction	8.9	6.93	15.18

Table 2: Individual Cell Means.

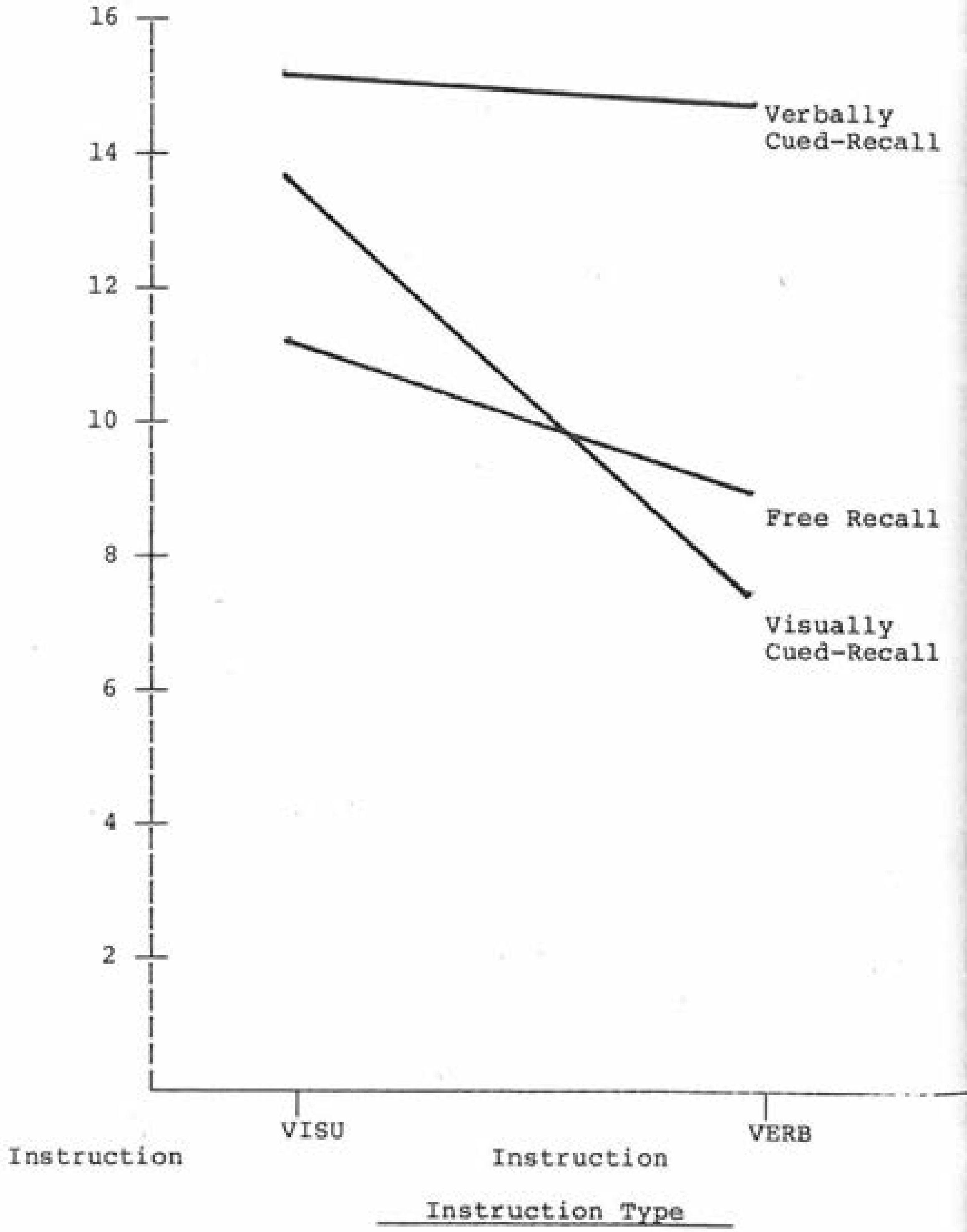

Figure 1: Disordinal interaction.

Looking at the cell means the Tukey test (alpha .01)indicated that the free recall means did not differ significantly at each of the two levels of the instructional variable, VISU and VERB. Similarly, the verbally cued-recall means did not differ significantly at each of the levels of the instructional variable. The source of the interaction was found to be with the visually cued-recall measure. As can be seen in Table 2, the visually cued-recall means differed significantly across the VISU and VERB instructional variable levels. The visually cued-recall measure was not effective for subjects receiving verbalized instruction. However, for subjects receiving visualized instruction the visually cued-recall measure was effective.

The resulting interaction finds support for the encoding specificity hypothesis, indicating a significant relationship between encoding, the memory trace, and the external retrieval cue. Both the VISU and VERB instructional conditions provided subjects with the names of the parts of the heart and the heart phase names. However, the two instructional conditions provided this essential to-be-learned information in a completely different encoding pattern. The VISU instructional condition provided subjects with the heart part and phase names in a visual context allowing storage of a visual and verbal memory trace. The VERB condition provided the part and phase information in a verbal context allowing storage of a verbal trace only. The external retrieval cue of visually cued-recall was compatible with the visual memory plus verbal memory trace assumed to be stored as a result of the VISU instructional condition, but incompatible with the verbal only memory trace given in the VERB instructional condition. Even though both instructional presentations allowed the subjects to store the relevant to-be-learned information, they could not recall the correct information if incompatability existed between external retrieval cues in the test and information stored in the cognitive structure.

In the case of the visually cued-recall test for learners receiving verbal instruction, the resulting student performance was found not to be a function of what intellectual skills were learned from the instruction, but rather a function of the compatibility between the external retrieval cue and the stored memory trace. Even though the learner had acquired the intellectual skill of factual learning, the form of the testing condition caused the difference in performance, not the actual learned intellectual ability. The practical implications of this result relate directly to the development of instruction and testing conditions existing in the typical learning environment. If visual information is presented in the instruction, or is a critical component of instruction, visual cues should be provided for in the testing condition. For example if the learner receives a demonstration of an engineering laboratory experiment using an apparatus to be set up and correctly employed, the testing situation should not be completely verbal. In this example the learner may have acquired the psychomotor and intellectual skill but the correct cues to allow performance may not be on the test. In training situations equipment operations and specific procedures are often taught via visualized instruction, but tests tend to be mostly verbal. It is likely that the learner may have acquired the skill but cannot perform satisfactorily because of the incompatibility between the learned information and retrieval cues provided on the test. Traditional verbal tests may be appropriate for verbal only instructional methods but if visuals are a significant part of the instruction and the learned skill, there should be visual cues on the test. These visual cues should relate directly to what is assumed to be stored in the learner's cognitive structure and be congruent in format. Presently, in most classroom testing situations, there exists a mismatch between the encoding context of instructional information and cues provided externally during testing. It is likely that in such a situation the intellectual skills may have been acquired, but performance failure may occur as a function of the extenal cue and memory trace mismatch.

The results of this study indicate that there is a significant relationship existing among encoding, the stored memory trace, and retrieval cues. Furthermore this significant relationship applies to the classroom teaching-learning-testing environment, since within the context of a classroom learning situation the encoding specificity hypothesis was able to be supported. This relationship has significant implications not only for the development of instruction and testing, but for subsequent research endeavors in the areas of visual learning the improvement of instruction and evaluation procedures. Fu applied research in the area of encoding specificity might fi it fruitful to consider the relationship that exists among encoding, memory trace, and external retrieval cues when cont presentation and evaluation strategies are systematically var and where student intellectual performance at different learn levels is considered as the dependent variable.

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TITLE: Administrators' Perceptions of Computer Usage in Education

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ADMINISTRATORS' PERCEPTIONS OF COMPUTER USAGE IN EDUCATION

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Paper presented to the Research and Theory Division of the Associatio
for Educational Communications and Technology, Dallas, Texas, January 20,

ADMINISTRATORS' PERCEPTIONS OF COMPUTER USAGE IN EDUCATION

PURPOSE

With the advent of the microcomputer, educators are developing an increased interest in the possibility of using this technology in the formal educational setting. There is a special interest in its application for kindergarten through twelth grade schooling. While there is a great deal of discussion relating to this possibility, relatively little data are available regarding the attitudes that school principals have toward the use of this educational medium in the classroom. Since principals are the chief administrative officers at the school level, their attitudes toward any learning approach are instrumental in guiding the adoption or rejection of the use of computers within their spere of control. For this reason, it is important that the views of these decision makers be studied and taken into consideration when looking at the potential of computers in education.

Research Questions

This study concentrates upon those attitudes which the educational leaders hold. In particular, the subtopics studied were:

A. In the opinion of principals, what would be the probable student response to computers in the classroom?

B. In the opinion of principals, what would be the probable teacher response to computers in the classroom?

C. In the opinion of principals, what is the curre level of computer literacy among their school teachers.

D. In the opinion of principals, will the effect of computers in education be positive or negative.

E. In the opinion of principals, which factors are most important in the future purchase of computer equipment?

F. In the opinion of principals, how are computers presently used in the classroom?

G. Are schools in large school districts more or le likely to have computers than schools in medium or small sch districts?

PROCEDURE

In October of 1982, a survey questionnaire was mailed t principals of 10% of the K-12 schools in Arkansas. The scho were selected randomly from three size school districts: sm medium, and large. The response rate to the questionnaire w equivalent among these groups. Sixty-four percent of the institutions surveyed returned the questionnaire (76 respon

RESULTS

During the following discussion of the results, the rea may refer to the survey questionnaire included at the end of report.

Principals in kindergarten through twelfth grade schools asked to rate the probable student interest in using compute the classroom. (Question #19 on the survey). The data indic most of the students would welcome the computer as a part of education. Sixteen of the responding principals felt that 91-100% of the students would have a very favorable attitude toward the use of computers in the classroom. As chart 1 shows, the principals believed that there would be little student opposition to the introduction of the computer.

	Responses				
Percent of Students	Very Favorable	Favorable	Neutral	Unfavorable	Very Unfavorable
1-10%	2	11	23	16	9
11-20%	2	9	6	2	0
21-30%	6	11	5	1	0
31-40%	3	3	3	0	0
41-50%	6	5	1	0	0
51-60%	2	2	0	0	0
61-70%	4	1	0	0	0
71-80%	12	0	0	0	0
81-90%	7	0	0	0	0
91-100%	16	8	0	0	0

Table 1. Principals perceptions of student response to the use of computers in the classroom

The results of probable student interest were not particularly surprising. However, the question which dealt with the probable teacher response to using computers in the classroom yielded an unexpected response. (Question 20 on the survey). The principals' responses suggested that, the great majority of

educators in their schools would also support the use of co
technology. In table 2, note that the attitude trends towa
use of computers in the classroom is quite similar between
and teachers.

	Responses				
Percent of students	Very Favorable	Favorable	Neutral	Unfavorable	Very Unfavorab
1-10%	4	11	23	16	9
11-20%	4	9	6	2	0
21-30%	6	11	5	1	0
31-40%	1	3	3	0	0
41-50%	7	5	1	0	0
51-60%	3	2	0	0	0
61-70%	3	1	0	0	0
71-80%	6	0	0	0	0
81-90%	4	0	0	0	0
91-100%	8	8	0	0	0

Table 2. Principals' perceptions of teacher response to the use use of computers in the classroom

Even though the school administrators did think that the majority of their teachers would support the use of computer technology in their classrooms, when asked to indicate the percentage of teachers who prese know how to use the computer for educational purposes, the principals f that very few of their educators were presently competent in the use of computer. (Question #17). Seventy-three percent of the school adminis stated that less then 10% of their faculty could use the computer effe in the classroom. See table 3.

Percent of computer literate teachers per school	Number of schools	Percent of total number of schools
0-10%	53	72.6
11-20%	8	11
21-30%	8	11
31-40%	1	1.4
41-50%	0	-
51-60%	1	1.4
61-70%	0	-
71-80%	0	-
81-90%	1	1.4
91-100%	1	1.4

Table 3. Percentage of teachers in each school who know how to use a computer for educational purposes.

When questioned regarding the probable teacher interest in receiving instruction on the use of computers, the probable teacher interest level fell. (Question #18). Approximately a third of the principals believed that less than 30% of their faculty would wish to receive instruction in computers. Twenty-two and four tenths percent of the principals felt that 78-100% of the faculty at their schools would want to participate in additional instruction. The mode value on this question was 40-50%., suggesting that about half of the teachers at most schools would be interested in further instruction.

Percent of teachers interested in further instruction	Number of schools	Percent of total number of school
0-10%	7	10.4
11-20%	10	14.9
21-30%	5	7.5
31-40%	8	11.9
41-50%	12	17.9
51-60%	6	9.0
61-70%	4	6.0
71-80%	4	6.0
81-90%	8	11.9
91-100%	3	4.5

Table 4. Percentage of teachers in each school who would like to receiv instruction in the use of computers.

On question #21 of the survey, each administrator was asked to pred the usefulness of computer technology. They clearly thought that the po effect of computers in the classroom would be a positive force in educat Two thirds of the administrators rated the future effect of computers as favorable, one third felt the technology would be favorable, and none of respondents rated the computer as a negative factor.

Response	Number of schools	Percent of total number of schools
Very favorable	44	66%
Favorable	22	33%
Neutral	1	1%
Unfavorable	0	–
Very unfavorable	0	–

Table 5. Administrators' perceptions of potential effect of computers in the classroom.

The principals were asked to indicate the ways in which computers were being used in their schools. The rank order of responses is given in table 6.

Use	Number of schools
Instruction	28
Computer literacy	18
Word processing	11
Record keeping	8
Data manipulation	5
Testing	2
Other	9

Table 6. Rank order of computer usage in schools.

Question #16 presented the principals with a list of eight items that could possibly affect their decision to purchase computer equipment in the future. Respondents were asked to place the items in rank order as to the relative importance each would have in affecting the decision making process.

The most important factors affecting the decision to purchase were:

A. Availability of funds

B. Administrators belief that computers would improve education

C. Student interest

Thirty-eight of the principals rated availability of funds as the n one factor in deciding to purchase or not purchase computers. Forty-nin administrators rated their belief that computers could help students lea first or second in importance. No respondent rated teacher belief in th computer's potential to help students learn as number one in importance, however, twenty-three principals rated this factor as second in importan

	Responses				
Importance rating	Student interest	Teacher interest	Teacher belief	Administration interest	Administration belief
1	10	5	-	2	24
2	16	2	23	2	25
3	13	3	-	7	-
4	10	7	9	7	8
5	3	14	-	14	5
6	6	15	15	11	-
7	-	1	-	1	-
8	-	-	6	1	-
9	1	2	7	1	1

Table 7. Factors affecting the decision to purchase computers.

The principals were asked to look into the future and predict the bility of their schools purchasing one or more computers in the next fi

The findings were remarkable. Ninety five percent of the administrators expected to purchase more machines in the next five years. All of the school administrators whose school presently owned a computer expected to purchase additional equipment in the next five years.

Finally, data was collected to determine whether the size of a school district in which a school was located was a good predictor of the probability of the individual schools owning one or more computers. As may be seen in table 9, there was no difference of computer ownership among schools located in small, medium, or large school districts. Furthermore, table 9 shows that a school's membership in a small, medium, or large school district does not affect the intention of principals to purchase computers in the future.

	Size District			
	Small	Medium	Large	Total
Own Computers	14	9	14	37
Do not Own Computers	12	13	14	39
Total	26	22	28	76

Table 8. Size of school district vs computer ownership.

Size of School District

	Small	Medium	Large	Tot
Will Purchase	15	13	17	45
Will not Purchase	1	2	1	4
Uncertain	10	7	10	27
Total	26	22	28	76

Table 9. Size of school district vs probable future purchase of compute

CONCLUSIONS AND IMPLICATIONS

One of the better known principles of diffusion and adoption of inn tions is that, whenever possible, it is desirable to have upper level su within an organization or system. The results of this study suggest tha group of important decision makers in our educational system (the princi strongly support the use of computers in formal education. These admini indicated that they believe that their subordinates, teachers and student would be avid supporters of bringing computer technology into the classr Perhaps more important is the fact that the principals themselves seem t developed a strong committment to the belief that computers will have a p effect on the education of students in the elementary and higher grade le The data show that roughly 95% of these leaders plan to purchase their fi computer or additional computers in the next five years. One hundred pe of the principals at schools which presently have computers plan to make purchases. This information suggests that educators have already develop a readiness to use this educational technology. There doesn't seem to be difference between the views of educators in schools located in small, medium, and large size school systems. Most respondents indicated agreement as to the usefulness of the computer in education in the future.

APPENDIX
SURVEY TOOL

School Service Personnel
LEARNING RESOURCES
339 Graduate Education Building
Fayetteville, Arkansas 72701
(501) 575-5100

UNIVERSITY OF ARKANSAS · College of Education

October 18, 1982

Dear Administrator:

This survey is being conducted to learn more about the use of computers in education in Arkansas schools. A random sample of schools has been selected and your institution is among them. Please take time to answer the questions. You will note that we are interested in the responses from schools which do not have computers as well as from those which do use this educational technology. Your input into this survey is invaluable and your responses will be held in confidence.

The survey may be returned in the enclosed self-addressed, stamped envelope. Your effort is appreciated; a prompt reply would aid us greatly.

Thanks again.

Sincerely,

David Carl, Ed. D.
Assistant Professor
Instructional Resources

DC/sb
Encl.

SURVEY

COMPUTERS IN ARKANSAS EDUCATION

1) Name of school:____

2) Address:____

____

____

3) Name of county____

4) How many teachers (FTE) are at your school?____________________

5) How many students attend your school?________________________

6) What grade levels are included in the school?______ ______________ ______

7) Name of person responding to this questionnaire:____________________

8) Title (eg. math teacher, principal, library media specialist)__________

9) Does your school have a computer?

____ YES (please continue answering the questionnaire)

____ NO (please skip to question 15)

10) What type of computer(s) does your school have?

Number of computers	Brand of computer	Model
_____	TRS - 80	____________________
_____	APPLE II	____________________
_____	PET	____________________
_____	ATARI	____________________
_____	I.B.M.	____________________
_____	OTHER (specify)	____________________

11) What date(s) (month/year) did your school purchase the machine(s)?

12) What types of peripheral devices does your school have (eg. printer, plotter, modem, etc)?

13) How is the computer used in your school?

_____ Instruction

_____ Record keeping

_____ Teaching computer literacy

_____ Testing

_____ Data manipulation (calculating machine)

_____ Word processing

_____ Other, please specify_______________________________________

14) What equipment problems have you experienced with your computer and peripherals? Do you believe that these problems affected the education of your students?

15) Are there plans to purchase one or more machines in the next five years?

_____ YES _____ NO _____ UNCERTAIN

16) Which of the following factors affect the decision to purchase or not computers for use in your school?
(List the factors in order of importance from 1 to 9. Consider 1 to be the most important factor and 9 to be the least important).

_____ Student interest

_____ Teacher interest in using the computer for keeping track of stud progress and records

_____ Teacher's belief that computers will significantly help their st learn

_____ Administration interest in using the computer for management purp

_____ Administrators' belief that computers will significantly help the students learn

_____ Availability of funds

_____ Other reasons: ______________________________

____

____

____

____

17) Approximately how many teachers presently know how to use a computer for educational purposes?
____0% to 10% _____11% to 20% _____ 21% to 30% _____31% to 40% ___
____51% to 60% _____61% to 70% _____ 71% to 80% _____81% to 90% ___

18) How many teachers (including those who presently know how to use comput would like to receive instruction on the use of the computer in the cla
____0% to 10% _____11% to 20% _____21% to 30% _____31% to 40% ___
____51% to 60% _____61% to 70% _____71% to 80% _____81% to 90% ___

19) In your opinion how would students respond to the use of a computer in t classroom?

percent of students (approx.)	Response
_____	Very favorable
_____	Favorable
_____	Neutral
_____	Unfavorable
_____	Very unfavorable

20) How

21) In the

22) Wo

20) How would the teachers respond to the use of computer in the classroom?

Percent of teachers (Approx.)	Response
_____	. . . . .Very favorable
_____	. . . . .Favorable
_____	. . . . .Neutral
_____	. . . . .Unfavorable
_____	. . . . .Very unfavorable

21) In your opinion, what is the potential effect of the use of computers in the classroom?

_____ very favorable

_____ favorable

_____ neutral (no effect)

_____ unfavorable

_____ very unfavorable

22) Would you like a copy of the results of this study?

_____YES _____ NO

TITLE: Publications of the Profession:
AVCR/ECTJ, AVI/II, JID

AUTHORS: Patricia Dimond
Michael Simonson

PUBLICATIONS OF THE PROFESSION:

AVCR/ECTJ, AVI/II, JID

by

Patricia Dimond
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and

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Ames, Iowa

Most members consider the Association for Educational Communications and Technology to be a professional organization. The designation "professional" is taken for granted. Little thought is given by most to what is meant by the key term "professional".

A profession has at least six characateristics:

a. an intellectual technique,

b. an application of that technique to practical affairs,

c. a period of long training necessary before entering into the profession,

d. an association of members of the profession into a closely knit group with a HIGH QUALITY OF COMMUNICATION BETWEEN MEMBERS,

e. a series of standards and a statement of ethics that is enforced, and

f. an organized body of intellectual theory constantly expanding by research.
(Finn, J. "Professionalizing the Audiovisual Field," AUDIO-VISUAL COMMUNICATION REVIEW, Vol. 1, No. 1, Winter 1953, pp 6-17.)

It was obvious to Finn in 1953, and it is obvious today, that AECT is not truly "professional". Rather, it is a quasi-professional organization of dedicated practitioners moving slowly towards real professionalism.

One dynamic force influencing that advance is the communication program used by the Association to disseminate information of impact to the discipline. At the foundation of that communication system are the Associaton's periodical publications. The journals published by AECT are: INSTRUCTIONAL INNOVATOR, THE JOURNAL OF INSTRUCTIONAL

DEVELOPMENT, and THE EDUCATIONAL COMMUNICATIONS AND TECHNOLOGY JOURNAL. It is through these three publications that the Association establishes a permanent record of what it considers to be currently significant issues, ideas and insights. These periodicals, more than any other Association activity, provide to all a visible and influential identification of purpose of the Association. The professionalism of the Association will be demonstrated through the information printed on their pages.

Recently, each of these journals experienced a change in editors. In order to help these individuals plan the future of their publications, and to provide Association members with a better understanding of these periodicals, a historical review was undertaken to describe some characteristics of each journal. Each issue of each publication was examined, and the information reported in Tables 1-3 was obtained. Additionally, information about each journal is provided below.

INSTRUCTIONAL INNOVATOR (AUDIOVISUAL INSTRUCTION prior to 1980)

Editors: Floyde E. Brooker - 1956-57

Anna Hyer - Iss. 10, 1957-1970

Howard Hitchens, Jr. - 1971-1982

Current Editor: Lyn Gubser

II/AVI is the most widely distributed of the Association's three journals. While its purpose varies, it is the primary information dissemination tool of the organization. Feature articles are generally of the "position paper" type. They are usually short (2-5 pages), and on topics of current general interest to members of the Association and to users of technology.

Three characteristics of II/AVI distinguish it from the other two AECT publications. First, each issue carries a large number of advertisements, from a high of approximately 50/issue in 1969, to lows of 9/issue in 1956 and 13/issue in 1977. Also, each issue carries announcements of significant events that might be of immediate interest to readers. Last, II/AVI carries a variety of special columns, sections and departments that deal with specific issues of interest to sub-groupings of readers. The "Learning Resources" supplements, "Division" columns and "Techniques" departments are notable examples.

The most significant trend obvious from an examination of Table 1 is the steady climb in the size of the journal through the 1960s, and the decline during the 1970s. 1969 seems to have been the peak year for AVI. In that year the average issue was 115 pages, had approximately 50 advertisements, included 18 feature articles of four pages each, and published 63 photographs. In 1982, by comparison, the average issue of II was 54 pages, had 11 advertisements, included 5 feature articles of two pages each, and published 13 photographs. While a weakened economy was partially responsible for this disturbing downward spiral in the size of II, other considerations, less easily identified, also contributed to the weakened stature of this once proud journal.

EDUCATIONAL COMMUNICATION AND TECHNOLOGY JOURNAL(ECTJ)
(formerly AV COMMUNICATION REVIEW-AVCR)

Editors: William Allen - 1953-1969

Robert Heinich - 1970-1983

Current Editor: William Winn

Managing Editors: Anna Hyer - 1956-57

Mary Hedquist - 1958

Mickey Bloodworth - 1959

Alice Finstad - 1960-61

Katherine Rogers - 1962-63

Janet Leban - 1964-65

Olger Zabludoff - 1966-68

Vita Pariente - 1969-81

The oldest of the Association's three periodicals, ECTJ publishes papers on theory, development and research related to technological processes in education. Generally, ECTJ is considered a research and theory journal. Feature articles typically contain descriptions of scientific experimentation complete with hypotheses, statistical tables and levels of significance.

ECTJ has experienced a rise and fall somewhat similar to that experienced by II. During the 1950s, an issue of AVCR was approximately 75 pages long and contained five feature articles, each of about 12 pages. During the 1960s and early 1970s, an average issue of AVCR was approximately 125 pages. During this period of plenty, each issue typically contained 6 or 7 research or theory papers of approximately fifteen pages in length. During the last decade, AVCR (ECTJ since 1978) declined in size to approximately 100 pages per issue(and more recently 70 pages). In the most recent three years of ECTJ an average journal contained four or five feature articles of approximately 14 pages in length.

JOURNAL OF INSTRUCTIONAL DEVELOPMENT (JID)

Editors: Kenneth Silber, Chair of Editorial Board
and Robert Heinich, Consulting Editor

- 1977

Kenneth Silber - 1978-82

Kent Gustafson, Guest Editor - 1982

Current Editor: Norman Higgins - 1983-

The JOURNAL FOR INSTRUCTIONAL DEVELOPMENT was originally begun by the Division for Instructional Development(DID) of AECT. This journal was proposed because many AECT members believed that the instructional development process was a viable and growing technique influencing the improvement of education and training at all levels and in all settings. The purpose of JID was, and is, to contribute to the analysis and improvement of instructional development in the form of quality, professionally-oriented articles, and to stimulate communication between theoretically and practically oriented instructional developers.

The Journal carries articles related to instructional development within the following parameters:

1. theories, models and conceptual framework of instructional development;

2. techniques for designing and evaluating instructional systems;

3. reports on evaluations of instructional development projects;

4. case studies of instructional development projects.

The focus of JID is on:

1. the performance of the instructional development process;

2. the management or implementation of the instructional development process;

3. the teaching of the instructional development process.

Since JID is a relatively new publication there are few trends obvious from an analysis of Table 3. Generally, a typical issue of JID has had forty pages, with four or five feature articles. Advertising has appeared periodically, but not routinely, and photographs have been rarely included.

SUMMARY:

Communication for professional development might be a phrase used to describe the purpose of AECT's three periodical publications. In the last three decades these three journals have published over 3450 feature articles written by 4208 authors (3424 men and 784 women). Certainly, these statistics indicate a dramatic influence on the professional growth of AECT.

Any analysis of these three periodicals, even a brief one such as this paper, would be incomplete if it did not call attention to the drastic decline in the apparent impact of two of these journals during the last ten years. Certainly, this problem is one of the most critical for the Association to address. Possibly, the three new editors of these publications will reverse this unfortunate trend. The professionalization of Educational Communications and Technology is directly related to the success of these journals, and while size indicators are definitely not the most significant available, they do provide considerable cause for concern.

TABLE 1: Audiovisual Instruction/Instructional Innovator (AVI/II)

AVI/II	[illegible]	57	58	59	60	61	62	63	64	65	66	67	68	69
# of feature articles/yr.	[illegible]	48	57	54	62	72	102	91	93	116	110	133	131	175
# of men authors	36	59	45	38	45	63	78	82	84	130	120	171	112	172
# of women authors	13	15	18	12	15	[illegible]	12	18	14	25	16	19	29	38
Avg feature article length	3	3	2	3	3	4	4	3	[illegible]	3	4	3	4	4
# of photos	220	270	236	204	173	231	278	319	318	177	293	455	401	631
# of TV articles	2	9	3	4	3	6	8	10	10	4	11	25	16	16
# of film articles	2	3	3	3	0	4	3	6	11	3	11	1	7	6
# of computer articles	4	0	0	0	[illegible]	[illegible]	0	0	[illegible]	2	3	6	1	7
# of advertisers	85	112	117	177	240	267	310	266	306	333	347	338	365	486
Avg. # of pages per issue	33	[illegible]	30	31	32	47	65	68	64	71	76	104	103	115
Editorial Bd. size	10	15	15	14	17	17	18	18	18	18	18	18	18	16
# of issues per year		9	9	9	9	9	9	9	10	10	10	10	10	10
price, membership cost*	$4	$4	$4	$4	$4	$4	$4	$4/$5*	5/2*	5/2*	6/3*	6/3*	6/3*	6/3*

AVI/II	70	71	72	73	74	75	76	77	78	79	80	81	82	83
# of feature articles/yr.	156	183	121	131	100	97	103	100	80	72	89	47	43	60
# of men authors	155	182	124	110	99	86	104	97	83	58	63	49	39	52
# of women authors	28	48	29	20	24	27	31	34	17	31	[illegible]	17	14	24
Avg feature article length	4	4	5	4	4	4	4	4	3	4	4	3	2	2
# of photos	470	344	237	169	188	240	287	195	110	116	150	120	86	109
# of TV articles	9	17	11	8	9	11	9	7	13	6	5	8	7	2
# of film articles	3	9	4	3	9	4	1	6	4	8	7	2	0	0
# of computer articles	4	4	2	3	3	1	6	3	7	3	7	6	7	20
# of advertisers	372	348	273	257	176	142	136	126	166	148	149	134	148	88
Avg. # of pages per issue	108	110	99	81	83	72	75	47	62	59	52	49	35	54
Editorial Bd. size	18	18	18	18	18	18	18	16	16	16	12	12	13	13
# of issues per year	10	10	10	10	10	10	10	10	9	9	9	9	8	8
price, membership cost*	8/3*	12/3*	12/3*	12/3*	12/3*	18/9*	18/9*	18/9*	18/9*	18/9*	18/[illegible]*	18/9*	24/12*	24*

M. Simonson
Iowa State University
Ames, Iowa
Jan. 1984

TABLE 3: Journal of Instructional Development (JID)

	77	78	79	80	81	82	83
ial Bd.	6	9	12	11	10	12	12
ssues ar	4	4	4	4	4	4	4
	$15	$15/ 10	$15/ 10	$15/ 10	17.50 10	24/ 15	$24/ 15
eature es	15	14	19	20	23	13	12
en s	15	15	29	25	24	16	12
women rs	3	1	3	7	11	8	2
length re art.	3.5	3.5	6.5	5.7	5	8	5.5
# of pgs. ssue/year	40	38	42	40	40	41	40
photos	0	0	0	0	0	0	6
advertisers	0	2	8	3	3	0	0
computer cles	0	0	0	2	0	0	1
video cles	0	0	1	1	0	0	0
Instr. gn art.	2	0	2	0	0	0	0
task ysis art.	4	9	10	10	13	5	0

TITLE: A Signal Detection Analysis of Digitized and Photographic Image Modes and Color Realism in a Pictorial Recognition Memory Task

AUTHOR: Abdel-Latif I. El-Gazzar

A SIGNAL DETECTION ANALYSIS OF DIGITIZED AND PHOTOGRAPHIC IMAGE MO[illegible]

AND COLOR REALISM IN A PICTORIAL RECOGNITION MEMORY TASK

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A SIGNAL DETECTION ANALYSIS OF DIGITIZED AND PHOTOGRAPHIC IMAGE MO
AND COLOR REALISM IN A PICTORIAL RECOGNITION MEMORY TASK

ABSTRACT

In this study, signal detection theory analysis is used to investigate the re effectiveness of digital versus photographic images in a pictorial recognition me task.

Digital images are the result of advances in computer graphics and digital processing and may facilitate the recognition of images by human subjects. ability to manipulate the pseudocolor in the digital image can result in form arrays which can be more easily distinguished from one another, thereby incre the probability of a particular image being recognized.

Subjects consisted of 96 college students. A 2x2 balanced factorial design employed to test eight hypotheses. The four groups are: (1) Digitized black and (DBW), (2) Digitized Pseudocolor (DPC), (3) Photographic black and white (PBW) (4) Photographic Realistic Color (PRC). The original pictorial materials in the s were selected from the pictorial materials developed by Berry (1977). Those pic materials (140 35mm in B&W and in Color) were manipulated photographically by the image processing system (PRL) to produce the four treatments.

A two-way anova and one-way anova followed by Tukey-B multiple compa test were conducted on three of the signal detection theory parameters, d', A' an to test the study hypotheses and the differences among the experimental group significance level α= .05.

Introduction

Computer graphics and digital image processing are providing a relatively new and rapidly growing type of pictures known as the digital images and will be termed here as digital imagery mode as opposed to the photographic imagery mode. Digital images are numerical representations of different types of pictorial methods, including B&W photographic pictures, by using different types of sampling and quantization techniques of gray levels. Computers can manipulate the psycho-physical characteristics of pictures by processing their digital forms. As a result, pictures gain better contrast and better quality. Pseudo-color can be added to pictures according to the gray level of their elements which are called pixels. The use of color in digital pictures with suitable choices of shade, degree of brightness and level of saturation will increase the amount of information that can be conveyed . This is based on the psychological fact that the human visual and perceptual system can easily discern thousands of shades and intensities of color but only 20 to 30 shades of gray (Gonzalez, 1977). Psycologically, in view of the cue-summation theory (Severin, 1967) in learning, color adds more cues that aid the learner in processing and recognition of pictorial information. There are some speculations and theoretical views that claim that digital images with enhancement taking place become more suitable for human processing and recognition (Moik, 1980). Digital images are characterized by being discrete in their gray level. The display of digital images at some magnification power makes the picture elements(pixels) start to be visible. The quality of digital images depends on the display subsystem of the digital image processing system and the method used in making hard copies such as slides or prints. Slide-making and print-making equipments are started to be parts in the image processing systems, but they are not available in most research laboratories of image proce[...] Photographing the screen of the display subsystem of the image processing sy[...] is considered a true way of obtaining the picture resolution and grey level [...] 1982). This method is largely used to make hard-copies of the digital images [...] the other hand, the conventional photographic mode provides a more rea[...] representation of the real situations such as realistic color. This color realism [...] view of realism theories (Dwyer, 1967), is claimed to be more effective in pict[...] processing and recognition. The relative effectiveness of both the imagery mo[...] digital and photographic, in designing effective visual communication, iconic de[...] and representation of information, and visual learning can not be predicted wit[...] systematic research. Realism theories as well as the cue-summation theory can[...] easily be applied to predict the effectiveness of the two imagery modes sin[...] because studies have revealed some inconsistencies (Berry, 1982). Extensive stu[...] are needed to investigate the effectiveness of the two imagery modes, digital [...] photographic modes and the type of color in pictorial recognition memory task.

Rational of The Study

Digital images are considered a potential source of visuals for visual learning [...] computer assisted instruction (CAI). Research is needed to examine the effective[...] of the digital image attributes in the design of effective visual learning [...] instruction. Pseudo-color and enhancement are two attributes of the digital ima[...] that need to be studied to discover their effect and function in visual learning [...] recognition.

The function of pseudo-color in picture processing is to increase the effec[...]

viewing of the gray scale of the original image (Andrews, 1974). The study of the effectiveness of image enhancement needs to be carried on in an objective way. Andrews (1979) has pointed out the difficulty found in the evaluation of optimum color mapping in the pseudocolor because of the subjectivity of both enhancement and color viewing. Hall (1979) has pointed out that the quality improvement in image enhancement is not objectively defined. One way to find solutions to such problems is to conduct controlled experiments to study the effectiveness of different digital image enhancements in visual learning tasks such as pictorial recognition memory. Lipkin and Rosenfeld (1970) in their book, Image Processing and Psychopictorics, have stated that:

> ... The art of picture processing by computer has reached the point where on-line, real-time manipulation of images is now possible, this making it feasible to conduct controlled experiments of the perception of natural pictures ... (p. vii)

This experimental approach to study the effectiveness of image processing and enhancement on the human viewer's perception, understanding, and recognition defines the human link in the image processing system (Hall, 1979). Such a link between the individual and the digitized image in comparison with the photographic image and color realism should be subjected to extensive studies.

The presence of color in visual learning and memory is one of the major issues in the design of media for learning and instruction. Studies which have been carried out on color and pictorial memory have resulted in a set of contradictory findings. Myatt (1974) carried out a study on pictorial attributes and pictorial recognition memory . In that study, Myatt (1974) found that color didn't appear to be a significant factor in pictorial recognition memory in any of the three experimental groups. Myatt found also that color didn't appear to be a significant fa recognition memory at any level of the three levels of pictorial informatio medium, and high. Studies (Berry, 1974; Dwyer, 1971) concluded that colo significant dimension in the design of instruction. The same conclusio supported by later studies. Color was found to increase or to improve p recognition memory more than black and white presentations (Berry, Wieckowski, 1979; Chute, 1980; Lertchalolarn, 1981). In a review of color a learner, research shows that learners do prefer color in media presentations (1981). Studies that investigated the color realism showed that there wa significant difference between the realistic and the non-realistic color in p recognition memory (Berry, 1977; Lertchalolarn, 1981).

The Signal Detection Theory (SDT) and Pictorial Recognition Memory

Research methods in recognition memory are more standardized than meth data analysis used by researchers. The recent applications of the SDT mo human perception, detection, attention, vigilance, inspection, and recognition s have made researchers like Murdock (1982), Berry (1982), and Swets and (1982) argue against the use of other approaches applied by researchers in mea the recognition memory as being inadequate. In typical <u>old-new</u> recognition m experiments and elsewhere, researchers have used different measures of accur the discrimination between old and new items such as: the conditional probab old items, the conditional probability of the old items paired with the cond probability of correct rejection, the overall probability of correct responses, <u>posteriori</u> of old items, and the ratio of the <u>a posteriori</u> probability of old items a posteriori . Swets and Pickett (1982) have warned against the use of those because they do not take into account the decision criterion. Murdock (1982) says that decision factors certainly affect performance on many tests of recognition memory and this may lead to erroneous conclusions on the part of the experimenter. Murdock (1982) and Berry (1982) agree that using signal-detection analysis in recognition memory provides the statistic d' (d-prime) that characterizes the overall accuracy that combines both old items and new items. The d' index used in Signal Detection Theory (SDT) has been described in various publications and research articles (Green, 1966; Swets, 1964; Bourbon, 1978; Swets, 1982; Berry, 1982). The accuracy and the application of d' in pictorial recognition memory have been demonstrated by Berry (1982). The SDT index d' has been supported, preferred, and justified as an adequate measure of recognition memory for its depth and accuracy (Murdock, 1982; Berry, 1982; Banks, 1970; Lockhart & Murdock, 1970; Murdock, 1964).

The SDT index d' assumes that the observer establishes normal equi-variance distributions of the memory trace strength of the old items (O) (Signal + Noise) and the new items (N) (Noise) (Murdock, 1974). Moreover, d' is indetermined when either the hit rate is one or the false alarm rate is zero (Berch, 1975). The violations of that distributional assumption result in erroneous conclusions concerning d', meaninglessness of d', and a significant correlation between d' and the criterion β (Beta). Long and Wagg (1981) have found from empirical data in situations like vigilance, visual search, and auditory recognition that the violation of the distributional assumption has resulted in an inadequacy of d'. Researchers like Norman (1964), Pollack and Norman (1964), Hodos (1970), Richardson (1972), Berch (1975), Craig (1979), and Long and Wagg (1981) have started to consider non-

parametric measures for detection and recognition. The area under the R
Operating Characteristic graph (ROC-Curve) provides two other parameters
A_G. A' and A_G are distribution-free measures of response sensitivity and have
used in detection and recognition. The index A' has been described and dev
by Norman (1964) and Pollack and Norman (1964). The computational formula
was developed by Grier (1971) and was used in research by Craig (1979) in vi
and by Berch (1975) in recognition memory. The measure A_G is another mea
the area under the SDT ROC curve. It has been described by Green and Swets
and used by Craig (1979). Since, in old-new recognition memory experimen
distributional assumption of d' can not be verified, the author will use
distribution-free measures of recognition memory (A' and A_G) besides the
parameter of detectability (d').

The Problem of The Study

The present study was designed to investigate the interactive effects of
image and photographic image modes and color realism on a pictorial reco
memory task. The Signal Detection Theory (SDT) was used to model the reco
memory task. Three indexes from the SDT were used to analyze the p
recognition data: the d-prime (d'), A-prime (A'), and A_G. The problem was def
the following research questions:

1. Is there a significant interaction between color modes (B/W and color presentation) and the imagery modes (digital and photographic images) in a pictorial recognition memory task?
2. Is there a significant main effect of color presentation (B/W and color modes) in a pictorial recognition memory task?

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3. Is there a significant main effect of imagery modes (digital and photographic image modes) in a pictorial recognition memory task?

4. Is there a significant difference between the means of the four treatments, digitized B&W, photographic B&W, digitized pseudocolor , and photographic realistic color, in a pictorial recognition memory task?

5. Is there a significant difference between the realistic color in photographic images and the pseudocolor in digitized images in a pictorial recognition memory task?

6. Is there a significant difference between digitized B&W images and photographic B&W images in a pictorial recognition memory task?

7. Is there a significant difference between digitized pseudocolor images and digitized B&W images in a pictorial recognition memory task?

8. Is there a significant difference between photographic realistic color and photographic B&W images in a pictorial recognition memory task?

The significance of The Study

There are three major contributions of this study in three aspects: practical, theoretical and methodological.

1. In the practical aspect, this study will provide contributions to:

   A. The discovery of the effective use of digital images in designing Computer Assisted Instruction (CAI) and visual learning.

   B. The discovery of the effectiveness of both image enhancement and pseudo-color addition in pictorial recognition memory.

   C. The discovery of the relative effectiveness of the realistic color and the pseudo-color in pictorial recognition memory.

   D. The discovery of the effects of the manipulation of some physical characteristic memory.

2. In the theoretical aspect, this study is an investigation of the contention of realism theories versus cue-summation theory in the prediction and interpretation of visual learning as applied to different imagery modes.

3. In the methodological aspect, this study is using the Signal Detection Theory in the analysis of the recognition data. Two new parameters from the ROC curve in SDT (A' and A_G) were used in the analysis besides the use of the d' (the index of SDT detectability).

Methodologies and Procedures

The Subjects

The subject of this study were university students: graduates and undergradu Students signed-on for participation. Sign-on scheets were made availab students in most of the University of Pittsburgh libararies, classes, reserve rooms and bulletin boards. From a total of 120 subjects participating in the stud completed the experiment according to the instructions.

Subjects were randomly assigned to the four experimental groups of the factorial design. Data were collected on the subject's age, major of study, study and sex. The Subjects' ages were in the range 17 to 57, the average was 27.7 the median was 24 years and one subject did not report his/her age. Subjects majoring in 48 different areas of study. Fourty five of the subjects were ma were females and six students didn't report their sex. Fifty four of the subjects undergraduates, 32 were graduates and 10 did not report their study level. descriptive data show that subjects were varied in their age, major of study, le study and sex. Subjects were evenly distributed between the four experim groups: Group 1.1, Group 1.2, Group 2.2 and Group 2.2.

The Study Variables and Design

In this study, there were two independent discrete variables (factors) and one Pictorial recognition memory was the dependent variable which has been measured by the use of the signal detection analysis. The following are the variable classification and their codes as used in data processing and analyses:

1. The color modes of the images: B&W mode and the color presentation mode. Color modes (Color) was used as one of the two factors in this study.

2. The imagery modes of the pictures: digital imagery mode and photographic Imagery modes (Immode) was the second factor of the study design.

3. The recognition memory, the dependent variable, as measured by the signal detection parameters in two types of analyses: Yes-No signal detection parameters. The Yes-No signal detection parameters used to measure recognition memory were: d', A' and A_G(area under ROC measure described by Green and Swets (1966)).

To investigate the research questions of this study, a 2X2 balanced factorial experimental design was used. This design is illustrated in Figure 1.

Figure 1 shows that Group 1.1 performed the pictorial recognition task using the digitized B&W pictures(DBW), Group 1.2 performed the pictorial recognition task using the digitized pseudocolor pictures(DPC), Group 2.1 performed the pictorial recognition task using the photographic B&W pictures(PBW) and Group 2.2 performed the pictorial recognition task using the photographic realistic color pictures(PRC).

COLOR MODES

		B&W	Colored
I M A G E	Digital Image Mode	24 Group 1.1 Digitized B&W DBW	24 Group 1.2 Digitized Pseudocolor DPC
M O D E S	Photo-graphic Image Mode	24 Group 2.1 Photographic B&W PBW	24 Group 2.2 Realistic Photo Color PRC

<u>Figure 1:</u> The 2x2 Experimental Design of The Study

Study Materials

A sample of 140 2x2 slides drawn from a large pool of 700 slides develo Berry (1977) and used in research by Berry (1977) and other researchers (Wieck 1980; Lertchalolarn, 1981; Berry, 1982), was the original 35mm pictorial stimul 140 were in both B&W and realistic color versions. These 140 slides randomized and randomly divided by a computer program using the random-nu generator function between the old set (O) and the new set (N) (distractors order of this randomization and the assignment were used to constru recognition test of the pictorial recognition memory task. The random resulted in 66 slides to the old and 74 slides to the new set.

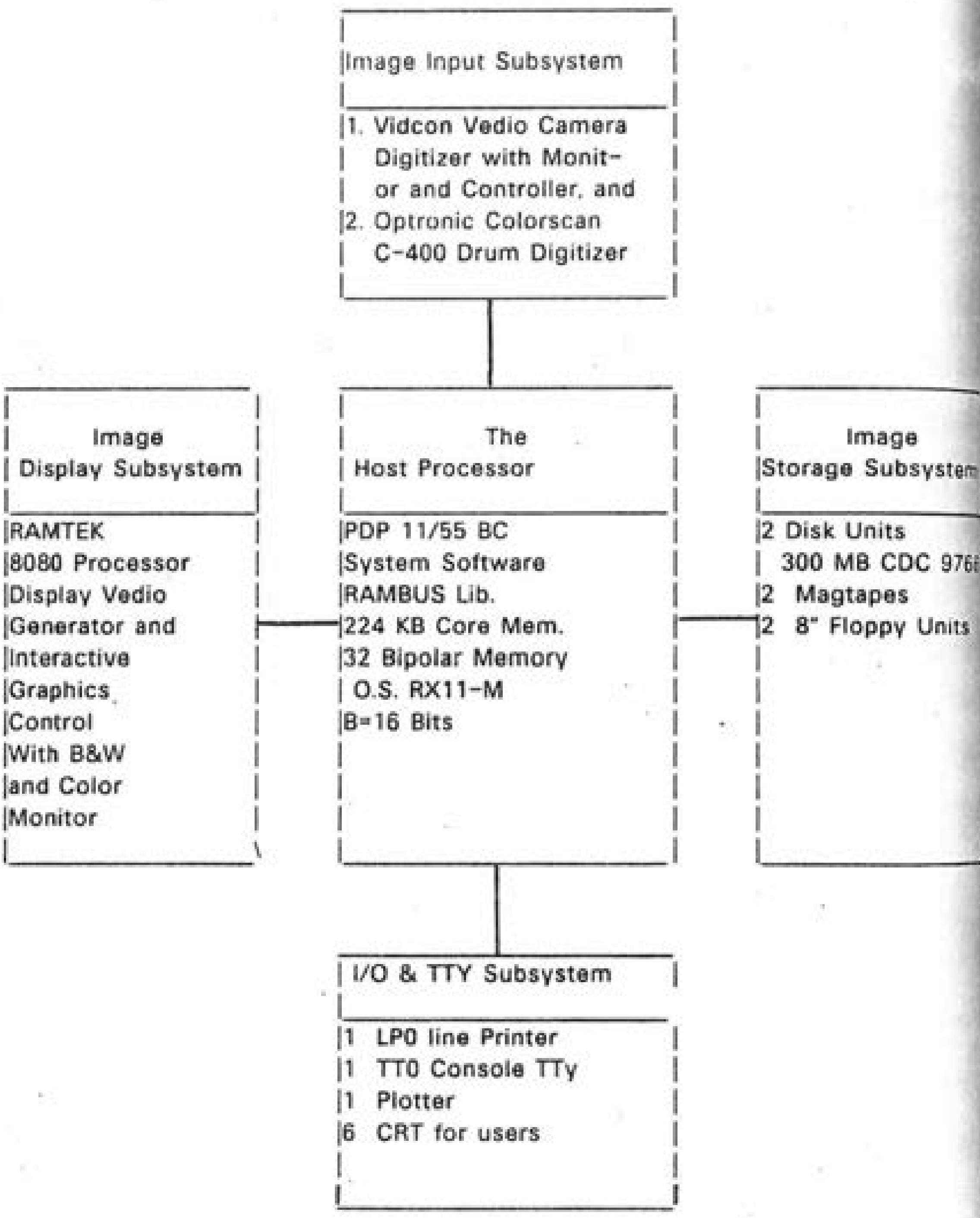
The square image format is the most common format in digital image processing (512x512 pixels). This format is the one that is also supported by the Pattern Recognition Laboratory System (PRL) in the Department of Electrical Engineering at the University of Pittsburgh. A simplefied functional diagram based on Sze (1982) is shown in Figure 2.

The image input subsystem, particularly the Optronic C-400, was interfaced to digitize the central square portion of the 35mm B&W negatives which was about 24x24mm. So, the original had to be trimmed to produce the photographic treatments to match the digital image contents. An Optical Slide Duplicator was used in producing the photographic B&W (PBW) and the photographic realistic color (PRC) from the original 35mm. The above copying system was copying only the central portion of each 35mm slide (24x24mm) by masking the rest of the slide scene.

The production of the digitized treatments was done by first digitizing the 140 35mm negatives of the original B&W version using the high precision Optronic C-400 image input subsystem. The 140 pictures were digitized, satisfactorily matching their counterparts in the photographic treatments.

Three different digital images were selected randomly and enhanced utilizing the PRL image processing routines by two different pixel-by-pixel image contrast corrections (Todhunter, 1978). The same digital images were pseudo-colored by four different pseudo-color tables. Twenty one slides were photographed from the RAMTEK display subsystem of the PRL where photographing the RAMTEK display is considered the best way to get a hard-copy of the digital image (Sze, 1982) . These 21 slides were as follows:

Figure 2: The PRL Facility: A Functional Block Diagram



1. Three original digitized B&W images (no enhancement done),

2. Three digitized B&W images enhanced by method one of the two methods,

3. Three digitized B&W images enhanced by the other method.

4. Three digitized pseudo-colored images by pseudo-color table-1,

5. Three digitized pseudo-color images by pseudo-color table-2,

6. Three digitized pseudo-color images by pseudo-color table-3, and

7. Three digitized pseudo-colored images by pseudo-color table-4.

Those 21 slides were randomized and displayed to a total of 30 judges from the same population (university students) using a seven point judgment scale. The seven points were: Extremely Poor, Very Poor, Poor, Fair, Good, Very Good, and Extremely Good to each picture of the 21 pictures.

The judgment data were analyzed by using One-Way Analysis of Variance with Repeated Measures (treatments) followed up by Tukey-B multiple comparison test. The judgments for the digitized B&W versions were significant ($F=3.28$; $df=2,58$; $P=0.044$). The digitized B&W (no enhancement) was found to be judged significantly higher than one of the two other methods and just higher than the other. So, the digitized B&W (DBW) treatment was produced by photographing the original digitized B&W images.

The judgments for the pseudo-color versions (four methods) were not significantly different ($F=2.60$; $df=3,87$; $P=0.06$). The pseudo-color method that was judged to be the highest was used in the production of the digitized pseudo-color (DPC) treatment.

The Procedures of The Experimentation

1. Instructions about the task sequence and the subject role and performance were read and explained by the investigator. All means were used to make those instructions fully understood by subjects individually or in groups.

2. Subjects were assigned randomly to the four experimental treatments prior to coming to the experimentation session. Subjects assigned to the color treatments were not to be color blind. If color blindness was detected, the subject would have to be excluded from the analysis None was excluded from the analysis because of color blindness.

3. The old set (66 slides) was projected at the rate of 500ms (half a second) using the computer based projection system described in the study instrumentation.

4. Subjets were given a five minute break before proceeding to take the pictorial recognition memory test (T).

5. The pictorial recognition memory test (T) was projected at the rate of 10 seconds to each slide using the computer based projection system described in the instrumentation section. Subjects were required to respond to each picture in the test using an answer form that was combining both the Yes-No method and the Confidence Rating method. The number of each slide in the pictorial recognition memory test (T) was projected in a window at the lower right corner of the picture to guide subjects to mark the answer to the correct number.

The Study Instrumentation and Environment

The administration of the pictorial recognition memory task was done indiv[idually] and in small groups in a classroom-like situation. The projection was from th[e] screen. It was an interactive computer based projection system. The s[ystem] components were:

1. Two Kodak Ektagraphic III AF slide projectors (labeled PR#1 and PR#2), one super-wide angle projection lens for PR#2, extension cables, one projector stand and different high projection tables.

2. One Commodore SuperPET SP9000 Microcomputer with 96 Kb RAM and dual processors : the 6502 processor (same as the Commodore CBM 8032 microcomputer) and the 6809 processor with Waterloo Micro Software (MicroBASIC, MicroFortram, MicroPASCAL, MicroAPL, MicroCOBOL, 6809 Assembler, Linker-Loader, Monitor and MicroEDITOR). One CBM 8050 dual drive floppy disk of approximately 1 MB of storage.

3. One Projector Interface was developed and assembled by the investigator to be used in Pictorial Recognition Memory Research. The Projector Interface is connected to the IEEE-488 Parallel User Port of the SuperPET on the 6502 processor mode via an assembled cable. The Projector Interface was connected to the two slide projectors: PR#1 and PR#2. The Projector Interface was driven by the "CONTROL PROGRAM" written in Commodore BASIC 4.0. The execution of the CONTROL PROGRAM was controlled by the Real-Time Clock in the computer system.

The projector PR#2 was equipped with the super-wide projection lens and was used to project the pictures of the old set (O) and the pictorial recognition memory test (T) on the screen while the projector PR#1 was projecting the picture number on the window in the pictorial recognition memory test (T). The program "CONTROL PROGRAM" was driving the two projectors according to the pictorial recognition memory task specifications in the program. This program was also printing on the SuperPET CRT the slide number currently on the screen. The user had to load and change the carousels on the projectors as the task progressed.

The total projection time for the old set (O), 66 slides, was one minute, 29 seconds and 149 milliseconds. The projection time for the pictorial recognition memory test Part#1 (slides: 1-70) was 12 minutes, 48 seconds and 883 milliseconds .The projection time for the pictorial recognition memory test Part#2 (slides: 71-140) was 12 minutes, 48 seconds and 883 milliseconds which was the same as Part#1. The subjects were given a five minute break after the presentation of the old set (O) before the beginning of the pictorial recognition memory test (T) . The total time of the experiment was 32 minutes, 48 seconds and 915 milliseconds.

The Computational Procedures of The SDT Parameters of Recognition

The computational procedures of Yes-No signal detection parameters fo pictorial recognition memory , d', A', A_G, were done from the 2x2 signal dete matrix (sometimes called the 2x2 stimulus-recognition matrix). The constructio based on the analogy between the detection and recognition processes. The o (O) is viewed as (Signals + Noise) and the new set (N) ,the distractors , is view (Noise Only) as in the signal detection terminology. Figure 3 shows the SDT/Stimulus-Recognition matrix that summarizes the SDT approach to the pic recognition memory processes.

		SUBJECT'S RESPONSE		
		YES (o)	NO (n)	Row total
S T I M U	OLD (O) P(O)	F(o,O) P(o|O) Hit Rate P(o,O)	F(n,O) P(n|O) Miss Rate P(n,O)	Signals + Noise O
L U S	NEW (N) P(N)	F(o,N) P(o|N) F.A.Rate P(o,N)	F(n,N) P(n|N) C.R.Rate P(n,N)	Noise N
				(O+N)

Figure 3: The 2x2 SDT/Stimulus-Recognition Matrix

The above mentioned SDT measures of pictorial recognition memory were com by the following formulae:

$$d' = z[P(o|O)] - z[P(o|N)]$$

and

$$A' = .5 + \{[(P(o|O) - P(o|N))(1 + P(o|O) - P(o|N))]/[4P(o|O)(1 - P(o|N))]\}$$

and

$$A_G = \{P(o|O) + [1 - P(o|N)]\}/2$$

This estimator of the area under ROC was described by Green and Swets (1966) and its formula was found in Craig (I979).

$$P(o,O) = F(o,O)/(O+N)$$

and

$$P(o|O) = P(o,O)/P(O) = F(o,O)/O$$

where

F(*,*)	is the frequency in the designated cell of the matrix.
P(*,*)	is the joint probability of that cell.
O	is the number of the old set (O).
N	is the number of the new set (N).
(O+N)	is the total number of valid responses.
z[P(o|N)]	is the z-score of the probability of the occurrence of the response old (o) when the stimulus is (N), False Alarm,
z[P(o|O)]	is the z-score of the probability of

the occurrence of the response old (o)

when the stimulus is (O). Hit

P(O) is the a priori probability of old set in the test (T)

P(N) is the a priori probability of new set in the test (T)

A computer program "SIGNAL.FOR" was written by the investigator in [illegible] language for the DEC 10/20 computers to calculate the above signal de[illegible] measures for pictorial recognition memory based on the Yes-No analysis. [illegible] program calculates the signal detection parameters from reading the subject[illegible] recognition data based upon the data descriptions in the file "SIGNAL.DDF" [illegible] program outputs a hardcopy of the signal detection analysis report for every s[illegible] and a disk file "SIGNAL.OUT" to be used in the further statistical analyses [illegible] major statistical packages (SPSS, BMDP, etc.).

The Statistical Hypotheses

To investigate the research questions of the study, the SDT parameters [illegible] computed to each subject in the study. The three signal detection measures [illegible] and A_G, of the pictorial recognition memory were computed. The followin[illegible] statistical hypotheses were tested. μ (Mue) is the population mean in the desig[illegible] experimental condition.

1. The interaction effect of color modes and imagery modes is not statistically significant.

2. μ(Color) = μ(B&W), i.e., the main effect of color is not statistically significant.

3. μ(Photographic Imagery Mode) = μ(Digitized Imagery Mode), i.e., the main effect of imagery modes is not statistically significant.

4. $\mu_1 = \mu_2 = \mu_3 = \mu_4$, i.e., there is no significant difference between the means among the four treatments.

5. μ(Photographic Color) = μ(Pseudocolor), i.e., the difference between the means of photographic color (realistic) and pseudocolor is not statistically significant.

6. μ(Digitized B&W) = μ(photographic B&W), i.e., the difference between the means of B/W photographic and digitized B&W is not statistically significant.

7. μ(digitized B&W) = μ(Pseudocolor Digitized), i.e., the difference between the means of digitized B&W and pseudocolor digitized is not statistically significant.

8. μ(photographic B&W) = μ(Color Photographic), i.e., the difference between the means of B/W photographic and color photographic is not statistically significant.

TWO-WAY ANOVA, TWO-WAY ANOVA (Repeated Measures) and ONE-WAY ANOVA followed-up by the Tukey-B will be used to test the above statistical hypotheses. The level of significance that will be used to reject or retain any null hypothesis will be at (0.05). The Statistical Package of The Social Sciences (SPSS) and/or the Biomedical Computer Programs P-Series (BMDP) will be used in the statistical analysis.

The four experimental groups/treatments were denoted as: Digitized B&W (Group 1 .1), Digitized Pseudo-color (Group 1.2), Photographic B&W (Group 2 Photographic Realistic color (Group 2.2). Table 1 shows the descriptive sta the recognition memory measures for the four experimental groups.

Table 1: Means and Standard Deviations of the SDT Measures By the Four Experimental Groups

The Measure		Group 1.1	Group 1.2	Group 2.1	Group
SDT Detectability, d'					
	Mean	0.3314	0.2479	0.4120	0.50
	SD	0.1079	0.1634	0.1839	0.26
Area Under ROC, A'					
	Mean	0.6153	0.5868	0.6371	0.65
	SD	0.0330	0.0528	0.0520	0.07
Area Under ROC, A_G					
	Mean	0.5644	0.5481	0.5788	0.59
	SD	0.0207	0.0315	0.0351	0.05

Testing The Statistical Hypotheses

The testing of the statistical hypotheses was carried over the three pictorial recognition memory measures. The statistical analysis was consisted of two statistical procedures: two-way analysis of variance and one-way analysis of variance. The first three hypotheses were tested at once by the two-way analysis of variance and the last five hypotheses were tested at once by the one-way analysis of variance followed-up by the multiple comparisons test of Tukey-B. The four experimental groups were of the same size (24). The F-Test is robust against the violation of the homogeneity of variance when the experimental groups are equal in size (Huck, 1974, Maisel, 1972).

Testing Hypothesis 1, 2 and 3

Table 2 shows the summary of the Two-Way ANOVA for d', A' and A_G as measures of pictorial recognition memory.

The results of testing hypotheses were as the following:

1. Hypothesis No.1 was rejected (d' F=5.283, df=1,92, P=0.024; A' F=5.244, df=1,92, P=0.024; A_G F= 5.329, df=1,92, P=0.023). This means that the interaction of color mode and the imagery mode is significant at α=.05.

2. Hypothesis No.2 was retained (d' F=0.022, df=1,92, P=0.882; A' F=0.071, df=1,92, P=0.791; A_G F=0.013, df=1,92, P=0.91). This means that the main effect of color is not significant at α=.05.

3. Hypothesis No.3 was rejected (d' F=19.125, df=1,92, P=0.000; A' F=17.995, df=1,92, P=0.000; A_G F=18.003, df=1,92, P=0.000). This means that the main effect of imagery mode is significant at α=.05.

Table 2: TWO-WAY Analysis of Variance Summary For The SDT Detectab[illegible]
Measure: d', the area under ROC: A' and A_G

Source	SS	DF	MS	F	Prob
The Measure d':					
Main Effects:					
IMMODE(I)	0.693	1	0.693	19.125	0.000
COLOR(C)	0.001	1	0.001	0.022	0.882
Interaction(IxC)	0.191	1	0.191	5.283	0.024
Residual	3.332	92	0.036		
Total	4.217	95	0.044		
The Measure A':					
Main Effects:					
IMMODE(I)	0.054	1	0.054	17.995	0.000
COLOR(C)	0.000	1	0.000	0.071	0.791
Interaction(IxC)	0.016	1	0.016	5.244	0.024
Residual	0.274	92	0.003		
Total	0.344	95	0.004		
The Measure A_G:					
Main Effects:					
IMMODE(I)	0.024	1	0.024	18.003	0.000
COLOR(C)	0.000	1	0.000	0.013	0.910
Interaction(IxC)	0.007	1	0.007	5.329	0.023
Residual	0.122	92	0.001		
Total	0.152	95	0.002		

Testing Hypothesis 4, 5, 6, 7 and 8

Tables 3 and 4 show the One-Way ANOVA summary and the Tukey-B multiple comparison test for d', A' and A_G. The results of the tests of the statistical hypothesis 4, 5, 6, 7 and 8 are as the following:

1. Hypothesis No.4 was rejected (d' F=8.143, df=3,92, P=0.0001; A' F=7.770, df=3,92, P=0.0001; A_G F=7.781, df=3,92, P=0.0001). This means that the differences among the means of the four treatment groups are statistically significant at α=.05.

2. Hypothesis No.5 was rejected. The two treatment groups do not fall in one homogeneous subset at α=.05, see Table 4. This means that there is a significant difference between the photo realistic color and the digital pseudo-color.

3. Hypothesis No.6 was retained. The two treatment groups fall in one homogeneous subset at α=.05, see Table 4. This means that there is no significant difference between digitized B&W and the photographic B&W treatments.

4. Hypothesis No.7 was retained. The two treatment groups fall in one homogeneous subset at α=.05, see Table 4. This means that there is no significant difference between the digitized B&W and the digitized pseudo-color treatments.

5. Hypothesis No.8 was retained. The two treatments fall in one homogeneous subset at α=.05, see Table 4. This means that there is no significant difference between the photographic B&W and the photo realistic color treatments.

Table 3: ONE-WAY Analysis of Variance Summary For The SDT detectability d', the area under the ROC A' and A_G

Source	SS	DF	MS	F	Prob
<u>The Measure d'</u>:					
Between Groups	0.8848	3	0.2949	8.143	0.0001
Within Groups	3.3323	92	0.0362		
Total	4.2171	95			
<u>The Measure A'</u>:					
Between Groups	0.0695	3	0.0232	7.770	0.0001
Within Groups	0.2744	92	0.0030		
Total	0.3439	95			
<u>The Measure A_G</u>:					
Between Groups	0.0308	3	0.0103	7.781	0.0001
Within Groups	0.1216	92	0.0013		
Total	0.1524	95			

Table 4: Multiple Comparison Test of Tukey-B at α= .05 For The SDT detectability Measure: d', the area under ROC A' and A_G

The Measure d':

Experimental Group	Group 1.2	Group 1.1	Group 2.1	Group 2.2
Sorted Means	0.2479	0.3314	0.4120	0.5071
Homogeneous Subset 1	———	———		
Homogeneous Subset 2		———	———	
Homogeneous Subset 3			———	———

The Measure A':

Experimental Group	Group 1.2	Group 1.1	Group 2.1	Group 2.2
Sorted Means	0.5868	0.6153	0.6371	0.6596
Homogeneous Subset 1	———	———		
Homogeneous Subset 2		———	———	
Homogeneous Subset 3			———	———

The Measure A_G:

Experimental Group	Group 1.2	Group 1.1	Group 2.1	Group 2.2
Sorted Means	0.5481	0.5644	0.5788	0.5968
Homogeneous Subset 1	———	———		
Homogeneous Subset 2		———	———	
Homogeneous Subset 3			———	———

Findings of the study suggest that the use of the digitized B&W ima computerized instruction and information transmission of pictorial info provides the same pictorial information as of the photographic B&W pictures. based on the lack of significance of the difference between the photograph and the digitized B&W. This could be interpreted as that the change of the pictures from photographic to digitized form does not change the features th human viewers need to recognize these pictures. This conclusion is important design of visual learning in future developments in computer based visual le systems by constructing pictorial banks or pictorial data bases of naturalistic that could be retrieved for learning and instruction.

It was expected, in view of the cue-summation theory of learning, that pseudo-color to the digitized B&W images would increase the distinctivene recognition of these pictures in the task. The lack of the significance betwe digitized B&W and the digitized pseudo-color could be because of the use pseudocolor method. So, this result should be limited to the case of usi pseudocolor method. Using one pseudo-color method could have made the have much the same of their color look. This may suggest that the use of mo one pseudocolor method (color tables) and adjusting these color methods coul the picture more distinctive and recognizable than its digitized B&W counterp should be noticed that the pseudocolor (single method) is different than th realistic color in other studies (Berry, 1977, 1982; Lertchalolarn,1981). The realistic color (NRC) used in those studies was based on the original picture color complements which are more distinctive from one picture to another. In view of this study's findings and the other research on color realism, the digitized pseudocolor could be more effective in learning and instruction if it is used purposefully in multiple methods and adjusting them to each picture to make them more suitable to the objectives of the learning task.

The result that there is no significance in the difference between the photographic B&W and the photographic realistic color supports similar findings (Myatt, 1974). However, this doesn't support other studies (Berry, 1977; Wieckowski, 1979; Lertchalolarn, 1981). This could be interpreted by the view that the realistic scenes need more processing time than the black and white which is not given in recognition experiments since the acquisition time of the old pictures is always around 500ms.

With regard to the finding that the photographic realistic color is significantly different than the digitized pseudocolor, this finding could be interpreted by the contention of the realism theories. So, this concludes that the realistic color is preferred more than digitized pseudocolor in learning from realistic scenes.

The findings of this study partially support the contention of realism theories. The cue-summation theory was not supported by any of the findings. However, both realism theories and the cue-summation theory can not predict or interpret the lack of the significance of the difference between the digitized B&W and the digitized pseudocolor and also the photographic B&W and the photographic realistic color.

The approach of modeling the pictorial recognition by the signal detection theory and the use of the parameters d' A' and A_G to measure the recognition should be considered for accuracy analysis of recognition data. The measures were consistent in all the decisions involved in testing the hypotheses of this study. The new parameters A' and A_G are accurate and distribution-free measures of recognition memory. It is suggested,in view findings of this study, that the parameters A' and A_G should be used when experimenter is in doubt of the parametric assumptions of the parametric measure detectability (d').

Based on the findings and the above discussions, some conclusions recommendations could be drawn:

1. The signal detection theory (SDT) parameters of Yes-No experiments, and A_G are consistent and should be used for accuracy analysis of recognition data.

2. The two distribution-free SDT parameters of the area under the ROC curve, A' and A_G offer the same accuracy of the d' (SDT index of detectability) in analysing recognition data. A' and A_G should be used the experimenter is in doubt of the distributional assumptions of the parametric measure d'.

3. Pseudocolor methods should be used in digital images with adjustment each image to meet the purpose of making the picture suitable to the learning task. In recognition and detection, various pseudocolor methods should be used, not just one color table.

4. The digitized B&W images could be used in learning at the same effect the photographic B&W pictures. This conclusion could be applied to support any computerized visual learning system to use pictorial data bases and also support the computerized slide-making for learning and presentation of information.

5. The main effect of color is not significant, but the main effect of the imagery mode is significant. Given the result that their interaction significant, the effect of these two factors is not additive. On the contrary, these two factors systematically interact and affect the

recognition. This suggests that the interaction of the two factors should be considered in the interpretation and design of pictorial learning in such tasks.

6. The contention of realism theories is partially supported while the cue-summation theory is not supported. However, both of these theories are not suitable to interpret the zero effect of color in both the two imagery modes.

7. The failure of the applicability of both the two contentions of of realism theories and the cue-summation theory should be attributed to the learner variables more than to the pictorial design and attributes.

8. The above conclusion supports the view that learner variables should be also considered in the interpretation and design of learning tasks. Learner variables such as learning and thinking styles, cognitive styles, and other personality traits should be considered in the design and interpretations of recognition and learning. This suggests follow-up studies or new studies that take into consideration the learner variables in the learning process.

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TITLE: Visual Attention to Picture and Word Materials as Influenced by Characteristics of the Learners and Design of the Materials

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IV. [illegible]

From: Mac Fleming

Visual Attention to Picture and Word Materials as Influe[illegible] Characteristics of the Learners and Design of the Materia[illegible]

Purpose. The long range goal of this program of research [illegible] improve the match between the design of instructional mate[illegible] and the characteristics of learners. Particular attentio[illegible] the cognitive strategies which skilled learners employ in [illegible] study of materials combining words and pictures.

Theoretical interest centers on the fact that recent research on verbal and imaginal processing suggests that w[illegible] and pictures are cognitively disparate, requiring differe[illegible] and amounts of processing. This implies potential cogniti[illegible] problems where words and pictures are mixed indiscriminate[illegible] instructional materials.

What follows was an exploratory study of how skilled learners cope with materials combining words and pictures [illegible] textbooks.

Background. This study was done in a framework of cogniti[illegible] theory. It specifically examined the eye movements of lea[illegible] studying print materials combining text and illustrations. [illegible] eye-movement patterns were seen as useful indicators of th[illegible] cognitive strategies employed. (There is ample precedent [illegible] this interpretation of eye-movement data, e.g., Snow, 196[illegible] and Carpenter, 1980; Farnham-Diggery and Gregg, 1975) Str[illegible] were inferred from the differential duration of attention [illegible] and picture areas and from the numbers and patterns of transitions between areas.

The writer ascribes to a constructivist model of reading, where reading comprehension involves the reader's search for meaning from the author's words as well as his diagrams, graphs, pictures, etc. Meaning is constructed by the reader both from what the material provides and what the reader provides from his/her own world knowledge. The skilled (university-level) reader's prior knowledge includes strategies for studying and schema for interpreting and remembering various kinds of materials, e.g., stories, expository text, research articles, science diagrams, pictorial scenes, etc.

Research to date on reading comprehension has examined primarily the words (prose learning), to a lesser extent the illustrations (picture learning), and rarely both in interaction (textbook learning). This both explains the preponerance of prose learning concepts in what follows and justifies the curren study of strategies involving both text and illustration.

Much has been made of the differences between word processing (linear, digital, symbolic, left brain, visual and auditory modalities, learned skill) and picture processing (simultaneous, analogic, concrete, right brain, visual modality, less learning). Clearly there are processes specific to each, but on a typical page combining both they must somehow be integrated. A macrostructure (theme, gist) must be constructed that includes both. Apparently, these diverse elements are integrated primarily at a higher semantic level.

Reading theories differ in degree of emphasis on wha information is given in the text as compared to what is br to it by the reader. Those emphasizing meaning-in-the-te remindful of the position of many audiovisual professiona i.e., the meaning is in the medium, especially the pictur Both emphasize the given stimulus, whether word or pictur contrast, the reading constructivist theories which empha interaction of reader characteristics, context, and print remindful of the aptitude (or trait) treatment interactio theorists in instructional development. Both emphasize th differential outcomes from what's given depending on the learner's prior knowledge, interests, skills, etc.

The above suggests the two sets of pertinent variabl this study investigated, i.e., what's given (design varia and what the learner brings to it (learner variables). O the design variables (what's given) often cited in readin comprehension research is context, i.e., the verbal conte the page. In the present analysis of realworld instructio materials it is apparent that words in textbooks often pro context for pictures, e.g., interpretive captions, and pic often provide context for words, e.g., pictured examples o concepts. Often the intended relation between text and illustration appears ambiguous. Where one appears above t other on a page, do readers assume that the one provides a context for what follows? The question of page-layout or i.e., which comes first, words or pictures, was examined in this study. Different cognitive strategies were expected for the two page-layouts, WP and PW, but the direction of those differences was not predicted.

Another of the design variables common in reading research is complexity, which is often operationalized according to a readability formula involving word length or frequency, sentence length, etc. Complexity has also been variously operationalized in picture studies by number of figures, degree of realism, etc. In this study complexity was operationalized in two ways: grade level of the materials and length of sentences. It was predicted that cognitive strategies for complex materials would include longer study durations and more transitions between areas than for simple materials.

Common measures of learner characteristics in reading studies are proficiency tests, e.g., vocabulary or comprehension. The present study using graduate students assumed high reading and study skills. However, the sample was divided by sex because it was hypothesized that word/picture study strategies of males and females might differ. The evidence that women tend to have higher verbal skills (Lips and Colwill, 1978) as well as higher grades in general (Maccoby and Jacklin, 1974) was the basis for predictions of greater attention to words and longer overall study duration for women than men.

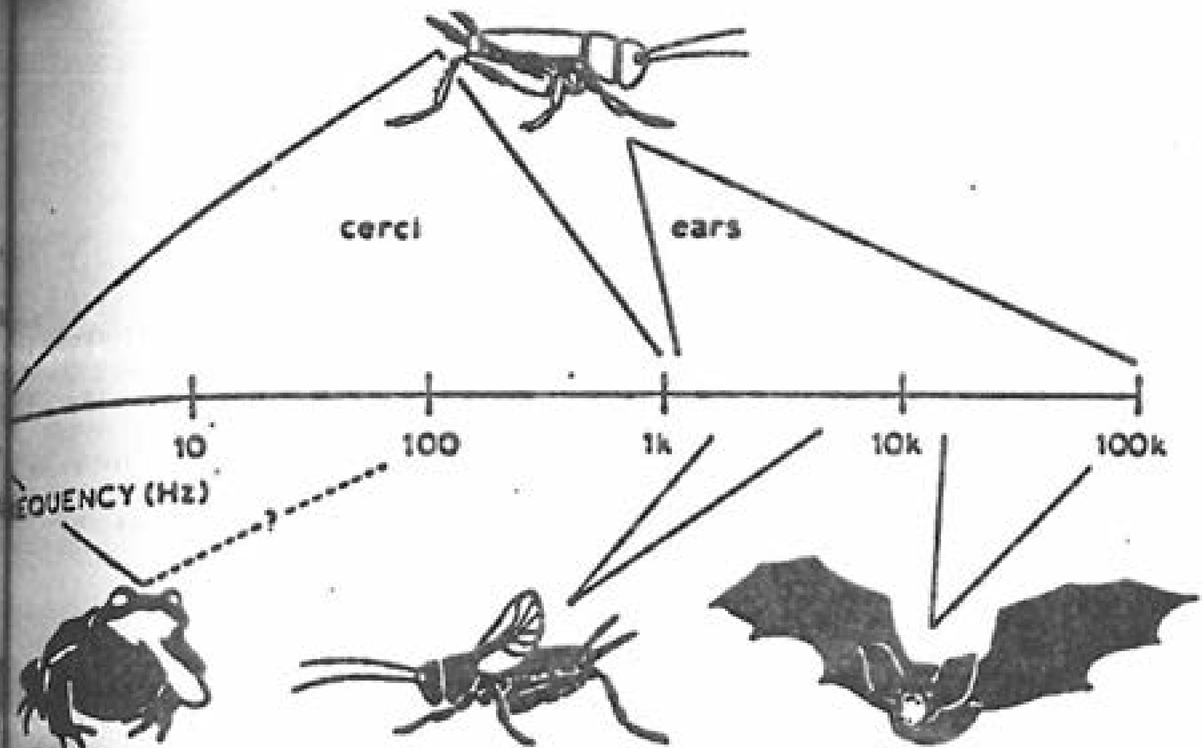
Another learner characteristic studied here was cognitive style, specifically field dependence-field independence. The

evidence that field dependents tend to be more global anc
independents more analytical (Witkin, et al, 1974) led to
prediction that global field dependents would follow (be
dependent on) the given pattern of information on the pag
whereas the more analytical field independents would tend
deviate from (be independent of) the given pattern.

World knowledge is considered to be an important fact
reading comprehension. In the present study an attempt w
to estimate the prior knowledge of the learners about the
matter, biological science. It was predicted that the mo
knowledgeable learners would have study strategies which
shorter in duration and which involved fewer transitions
areas than would less knowledgeable learners.

Procedure. A convenience sample of 24 students was select
a graduate class in Education such that half were males a
females. Half of each sex grouping were randomly assigned
of two page-layout treatments.

The design variables were complexity at two levels,
v.s. complex, and page layout at two levels, picture first
then words (PW) v.s. words first then picture (WP). See
for an example of a PW layout. The simple material was f
8th grade text, while the complex was from a scientific r
journal. They contained comparable numbers of words, but
sentences in the complex material averaged about twice as
The learner variables were sex, cognitive style (field



2 The range of hearing in field crickets. The frequency line is drawn logarithmically, from zero Hertz through the infrasound and terminating in the ultrasound at 100,000 Hz (100 kHz). Low frequency ...s are detected by the cricket's cerci, and higher frequencies are detected by its tympanal organ or "ear." ... the frequency line are drawn typical sources of sound that fall within the cricket's range of audition: ...strial predators such as frogs produce low frequency vibrations, crickets produce middle frequency ...s, and flying bats produce ultrasound.

Recognizing Predators by Ear: The Pitch Is the Switch

In its world a cricket hears not only oth... crickets, it hears potential predators. ...ckets are sensitive to a surprisingly wide ...nge of frequencies; in fact, the frequen... band devoted to social communication ...only a narrow one considered in light of ...e insect's auditory capabilities. Figure 2 ...ows a frequency range from zero Hz to ...0,000 Hz—from infrasound to ultra...und. Crickets are sensitive over a good ...rt of this range; compare this with the ...ditory sensitivity of humans, which spans ...range of 50 Hz to 15,000 Hz.

Figure 3A–C shows diagrams taken from ...otographs of flying crickets responding ...acoustic stimuli. In the absence of sound ...cricket flies with a symmetrical flight pos...re, with its longitudinal body axis per...ctly straight. When a series of sound ...lses consisting of pure 5 kHz tones i... ...ayed from a speaker on the cricket's lef ; ...e insect bends its abdomen and legs to ...e left, a rudder-like action that would ...opel the insect toward the speaker, were ...e insect not tethered. However, when the sound pulses are composed of 40 kHz tones, the cricket's abdomen and legs abruptly veer to the right; in free-flight this would propel the cricket away from the sound source. Thus, 5 kHz tones elicit positive phonotactic movements and 40 kHz cause negative phonotactic movements. The sign of the movements makes behavioral sense: 5 kHz is the carrier of frequency of the calling song of *Teleogryllus oceanicus*; female crickets are attracted to this frequency. Forty kHz is in the ultrasonic range and occurs in the vocalizations produced by insectivorous bats (Griffin, 1974); crickets attempting to escape from echolocating bats would be expected to react to 40 kHz aversively.

The frequency sensitivity of steering behavior can be ascertained by examining a behavioral tuning curve (Fig. 3D) made by measuring the threshold sound intensities required to elicit a phonotactic response as a function of the tone frequency. *T. oceanicus* is most responsive to tones in the range 4–6 kHz, with peak sensitivity at 5 kHz; a second area of sensitivity occurs in the ultrasound, from 25–100 kHz.

FIG. 1.

dependent/field independent), and prior knowledge.

The dependent variable was visual attention as indica eye-movement data, specifically the amount of time spent attending to each area of the materials (duration), the n shifts between areas (transitions), and the pattern of transitions (sequences).

Subjects were instructed to study the material as th had been assigned for them to understand and remember. Th then fitted with head-mounted eye-movement-detecting equip (NAC Eyemark IV). They were allowed as much time as neede study the materials.

Subjects then completed a brief questionnaire concern relative familiarity and difficulty of the materials and t number of related courses (biology) which they had taken. then took a cognitive style test, the GEFT (Group Embedde Figures Test).

Raw data records consisted of videotape recordings s the stimulus a subject was studying plus a superimposed m which indicated just where on the stimulus the subject was looking at any moment. The four pages of stimuli were di into 30 significant areas, i.e., either figures in the pi or captions and paragraphs in the text. Read out from the videotape records were the duration of attention to each a the number and sequence of transitions between areas. Tw the 24 records were usable.

Results:Overall. A 3-way ANOVA of the effects of Sex and Layout (independent measures) and Complexity (repeated measure) on total transitions revealed the predicted signficant main effect for complexity, $p<.001$, but no effect for sex or layout. Subjects made more transitions in studying the complex material than the simple.

Analysis of the effects on total duration revealed significant differences, as expected, for both sex, $p<.004$, and complexity, $p<.001$. Females attended longer overall to the study materials than did males. All subjects studied the complex materials more than the simple.

There was no main effect for layout (PW v.s. WP) nor for prior knowledge. Analyses of the data relative to familiarity of the content as well as number of biology courses taken revealed no significant relationships to cognitive strategy.

There was a significant positive correlation between cognitive style (GEFT) and number of transitions for complex materials only (Spearman $p<.034$. Kendall $p<.037$). So, a median split was made of the subjects by GEFT score and two groups formed, higher scorers (Field Independents) and lower scorers (Field Dependents). An ANOVA revealed a significant two-way interaction between cognitive style and complexity, $p<.003$, for transitions. While subjects of both cognitive styles made more transitions on complex materials than on simple, the field independents made a larger adjustment to complexity, i.e. they made relatively fewer transitions for the simple and relatively

more transitions for the complex materials than did the
dependents. See Fig. 2.

Results:Complex Material. Because subjects' strategies
most influenced by the complexity factor, it was decided
analyze the most complex page further. A 3-way ANOVA, Pa
Layout by Sex by Sequence, revealed a significant main ef
sequence, p<.05. There were, of course, more transitions
given sequence (top down) than in the reversed. However,
was a significant 2-way interaction between sex and seque
p<.05, the females favoring the given order and the males
reversed. This was further modified by a 3-way interacti
involving page layout, which revealed that the tendency
to make more reverse order transitions was limited to the
layout condition (words first, then pictures). See Fig.

The above interactions suggest a very interesting
possibility. Assume that a compatible match of cognitive
strategy and page layout would show up as a largely strai
through (top down) attention sequence, i.e., a minimum nu
transitions and most of these in the given order. It fol
according to this assumption, that the most compatible la
males was PW and for females WP. See Fig. 3 for the curv
a low overall number of transitions and with more in the
than reversed order.

A further analysis was made of attention patterns to
five pictorial areas, two related verbal areas, and one c

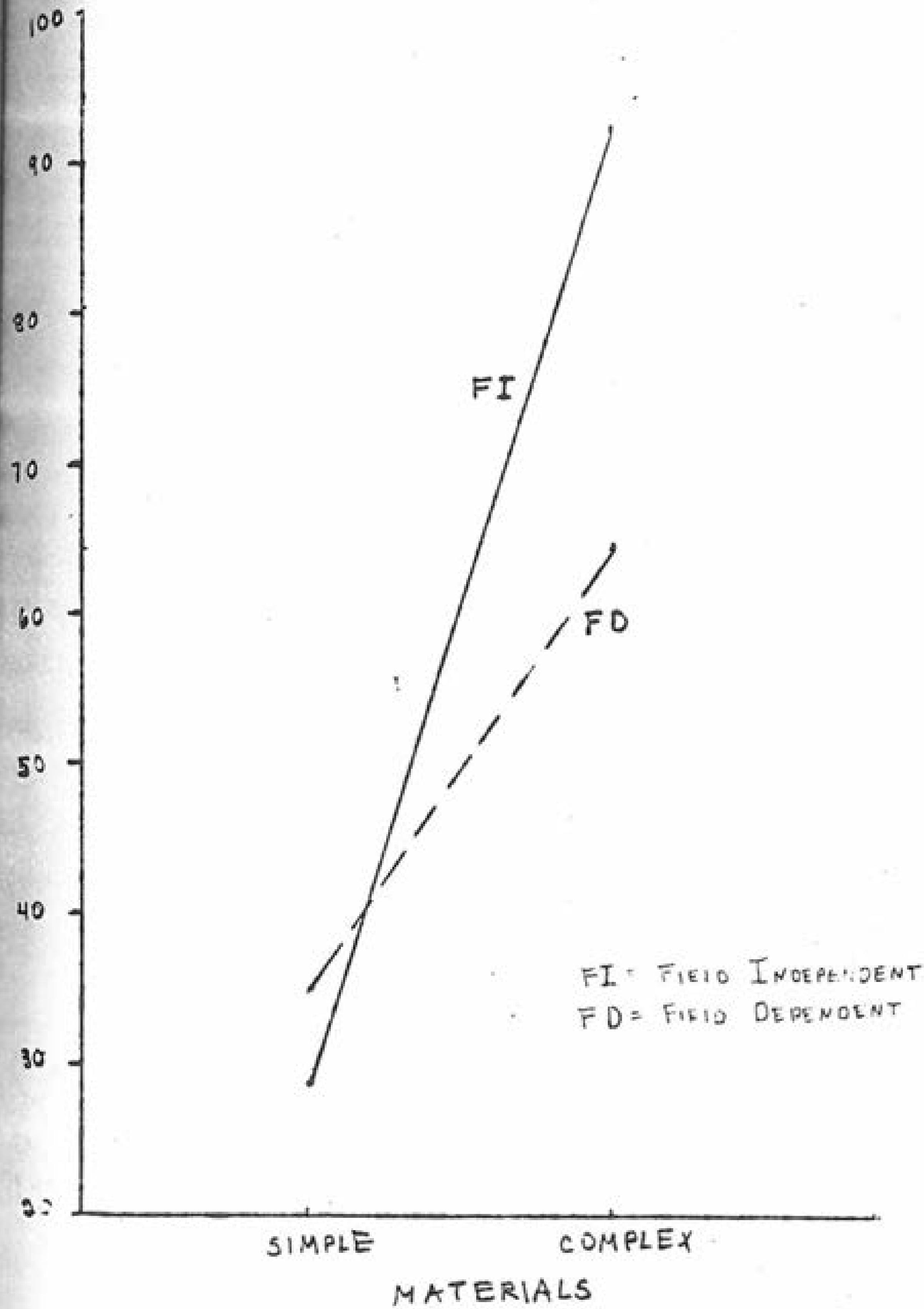
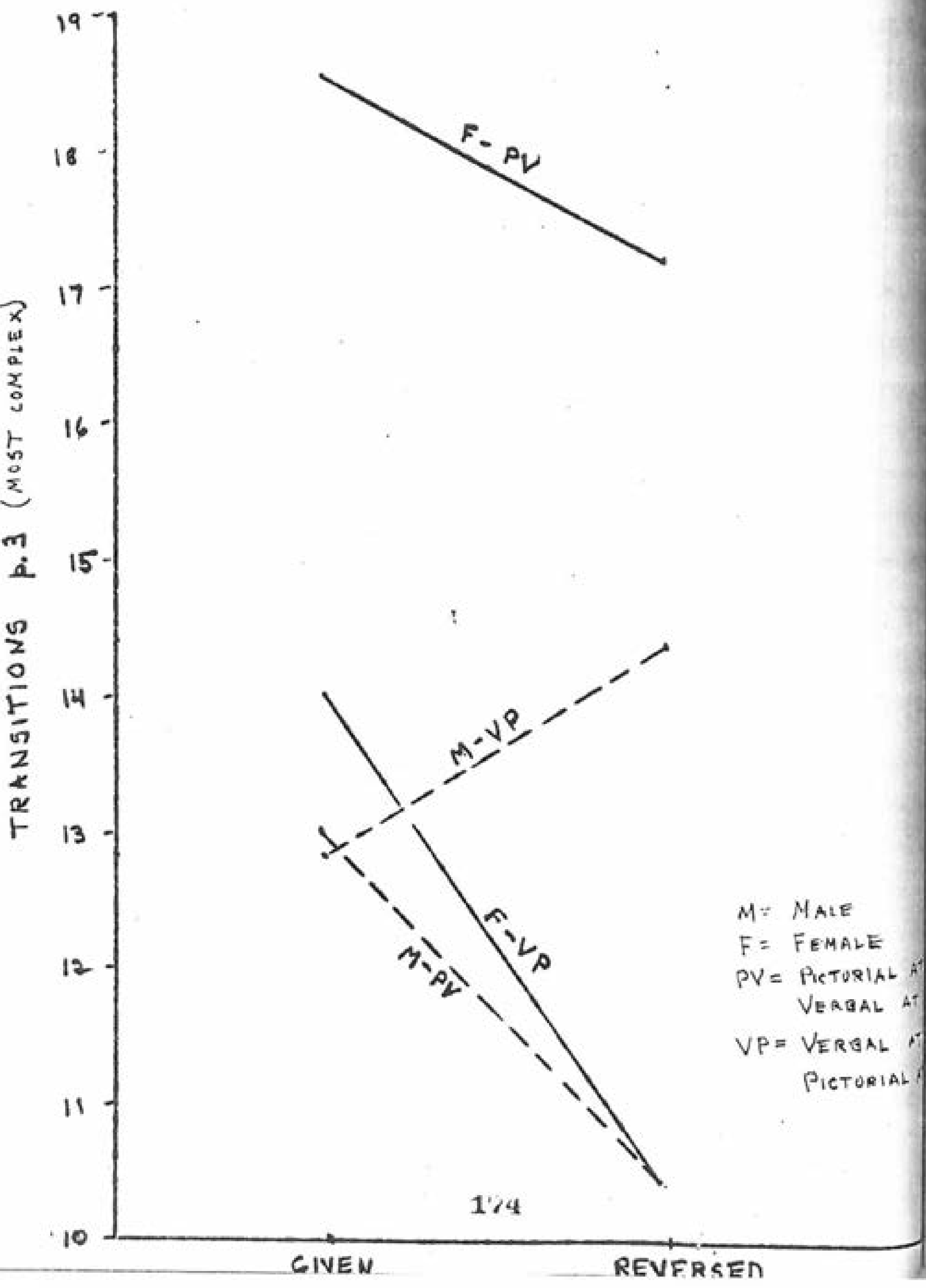

100
90
80
70
60
50
40
30
FI
FD
FI = FIELD INDEPENDENT
FD = FIELD DEPENDENT
SIMPLE
COMPLEX
MATERIALS

FIG. 2.

FIG. 3


TRANSITIONS p. 3 (MOST COMPLEX)
19
18
17
16
15
14
13
12
11
10
F - PV
M - VP
F - VP
M - PV
GIVEN
REVERSED
M = MALE
F = FEMALE
PV = PICTORIAL
VERBAL
VP = VERBAL
PICTORIAL

area on the complex page. A 2-way ANOVA, Sex by Layout, revealed no differences in attention to picture areas but a significant difference in attention to verbal areas, $p<.05$. As predicted, women made more transitions to verbal areas and maintained attention there longer than males. For the caption area there was a significant effect for layout, there being more transitions to the caption, $p<.01$, and longer durations on the caption, $p<.05$, for the PW layout than for the WP layout. This is understandable because the PW layout put the caption in the middle of the page where it was more noticeable, whereas the WP layout put it at the bottom.

Another analysis of the complex page, Cognitive Style by Layout, revealed no differences for the verbal areas but significant differences for pictorial areas, $p<.05$ for durations and $p<.01$ for transitions. Field independents looked longer and more often at picture areas on the complex page than did field dependents. This was not predicted.

Conclusions. Of the design variables, the complexity factor was clearly the most determinative of learner strategy. Of the learner variables, prior knowledge had no effect on strategy. Perhaps the measures of prior knowledge were inadequate. The other learner variables, cognitive style and sex, were reliably associated with learner strategies.

These main effects and interactions with cognitive style and sex were largely as predicted from prior research and theory.

However, there were some surprises, e.g., the effect of c style on strategy adaptation to instructional material complexity, and the effect of sex on strategies for sequ attention to words and pictures.

Clearly, more such studies are needed to confirm or disconfirm these conclusions. However, the results do su that the design of science materials for graduate studen need to take account of two learner variables, sex and co style, and two design variables, complexity and picture- layout.

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TITLE: Aptitude Sensitive Instruction: The Role of Media Attributes in Optimizing Transfer of Training

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Aptitude Sensitive Instruction: The Role of Media Attributes in Optimizing Transfer of Training

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ABSTRACT

The supplantation approach of this study hypothesized that media attributes may serve to bridge the processing link between learner aptitude capacity and the demands of a concept attainment task. The study utilized a treatment-by-blocks design. The aptitude block was composed of two levels: extreme field-independent individuals and extreme field-dependent individuals. Three treatment variables combined to form eight treatments. Each treatment contained either color - or non-color - cueing, plus simple or complex line-drawings accompanied by either an inductive or a deductive verbal presentation. These treatments were selected according to their proposed supplantation value to increase the salience of relevant concept attributes. Analyses of variance revealed interactions which suggested that treatments were differentially effective in meeting the differing task requirements of a transfer and a non-transfer posttest measure. Findings may be of interest to those in instructional/training settings in which learners are required to transfer learning from a technical line-drawing presentation to a real object.

APTITUDE SENSITIVE INSTRUCTION:

THE ROLE OF MEDIA ATTRIBUTES IN OPTIMIZING

TRANSFER OF TRAINING

The power of media to influence our values, opinions and actions confronts us whenever we turn on the television or open a magazine. Many training/educational materials aim to utilize this power for instructional advantage. The study to be described in this paper argues that sound instructional use of media must be based upon consideration of the impact that specific combinations of media attributes have on the internal psychological/cognitive processing operations of learners.

RATIONALE AND PURPOSE

The Role of Media Attributes

The aim of the present study was to investigate treatment variables which may interact to facilitate perception and learning of a concept. In many areas of training and technical education, students are frequently required to utilize line-drawings in learning situations. Because much instruction is primarily conceptual in nature, instructional designers often express interest in how best to design technical line-drawings for effective use with other media in instructional modules which teach concepts.

A frequent decision facing the instructional designer is the selection of a way to present the instructional message most effectively for all learners. This problem of media choice has raised continuing concern among media researchers, instructional designers and classroom teachers. Educational philosophy today places emphasis upon both the need to consider alternative means of providing instruction, and the need to choose from media alternatives on the basis of criteria which will maximize effective learning (cf. Cronbach & Snow, 1977; Salomon, 1979). This raises the need for sound criteria upon which to base selection of media. Jackson and Kieslar (1977) have observed that most practitioners prefer to rely upon experiences and intuition, rather than to turn to researchers for advice. This observation is not surprising in the light of growing criticism of educational/instructional media research findings. Many authors have commented upon a disappointing lack of practical, definitive research findings to guide media selection (Allen, 1971; Heidt, 1975; Olson, 1974; Salomon and Clark, 1977). Several writers have noted that hundreds of studies to date have compared the effect of one medium with the effect of another medium without carefully defining what is being compared (Chute, 1979; Clark, 1975; Levie and Dickie, 1973; Salomon and Clark, 1977; Schramm, 1977). The use of these macro-media comparisons has been termed "research with media" (Salomon and Clark, 1977, p. 102). The realization that gross media comparisons have contributed little to educational practice has been accompanied by appeals for more theoretical conceptualization to focus researchers' attention upon more valid questions dealing with more specific qualities of media (Levie and Dickie, 1973; Salomon and Snow, 1968; Salomon and Clark, 1974, 1977). These authors have suggested that a more productive conceptualization of research would be one that specifies relevant media variables in terms of the attributes of media rather than media as modes of stimulus presentation. Salomon and Clark referred to this different research focus as "research on media" (1977, p. 102). It has been suggested that attributes of media may be defined in terms of their psychological effects and instructional effectiveness, rather than in terms of their physical appearance (Heidt, 1977; Levie and Dickie, 1973; Salomon and Clark, 1977; Salomon, 1979). This view places emphasis upon a learner's mode of internal processing of information. Salomon (1979) has noted that learning will be most effective when media and the teaching process are precisely adjusted to the processes the learner has to carry out. He noted that different learners often respond to the same information in quite different ways, and advocated that the presentation of information must be precisely adjusted to a learner's own internal symbolic representations. Salomon and Clark (1977) suggested that future media research should seek to find which physically different attributes of media or technology have a high probability of eliciting common responses in learners of similar aptitudes. They suggested that these attributes could then be treated conceptually as equivalents. This approach is linked closely to the theory of Aptitude Treatment Interaction (ATI) research, which has also called for more specification of experimental variables (Cronbach and Snow, 1977). The ATI approach seeks to study the nature of a medium's most relevant attributes as they relate to the psychological functions they can accomplish for different learners under specified task conditions. Both Cronbach (1975) and Salomon (1979) have called for research that is theoretically based to develop explanatory principles that may function as "skeleton hypotheses" (Salomon, 1979, p. 12) to which numerous practical instances could apply.

Thus, a new set of research assumptions may be applied to the role of media in instruction. The most important difference to those of past research with media is that research on media should specify relevant variables in terms of attributes of media which relate to learners' psychological responses. Media attributes may be defined first as properties of stimulus materials that are inherent in the physical dimensions of media.

> The attributes of a medium then, are the capabilities of that medium -- to show objects in motion, objects in color, objects in three dimensions; to provide printed words, simultaneous visual and auditory stimuli; to allow for overt learner responses or random access to information. (Levie and Dickie, 1973, p. 860)

THEORY INTO PRACTICE

The present study sought to combine media attributes according to Aptitude Sensitive Instruction research model. This model is bas upon the supplantation approach (cf. Ausburn and Ausburn, 1977; French, 1982; and Salomon, 1979). The supplantation approach of study hypothesized that specific combinations of media attributes serve to bridge the processing link between learner aptitude cap and the processing demands of the concept-attainment task. Treatments were selected according to their hypothesized supplantation value on the basis of: 1) Analysis of processes reflected by field-dependent/independent cognitive style, and 2) extensive task analysis.

The Effect of Cognitive Style on Concept Attainment

In a typical visual concept-attainment task, learners are require distinguish examples from non-examples of each concept class. To complete this task successfully, a learner needs the aptitude capacity: 1) to discriminate small visual details which charact each concept example, and 2) to structure this information as generalizable rules which may be utilized to classify examples as members of a concept class (Gagne, 1977). In concept attainment tasks, learners appear to differ in their ability to discriminate visual into its component details. Furthermore, learners also di in the strategies they use to structure and generalize informatio concepts. The cognitive style "field-dependence-independence" ha been related empirically to these differences (Witkin, Moore, Goodenough, and Cox, 1977). Research findings have indicated that typical concept-attainment tasks are often more demanding for field-dependent individuals (Dickstein, 1968; Kirschenbaum, 1968; Witkin, Moore, Goodenough and Cox, 1977).

The current view of field-dependence-independence is still evolvi During recent years, research has resulted in a complex descripti of the dimension which includes an ever-broadening pattern of an individual's psychological, intellectual and neurophysiological functioning. This pattern has been explained by what has been te psychological differentiation theory (Witkin, Goodenough and Olt 1977). Differentiation theory attempts to account for the networ functions and behaviors that are responsible for an individual's self-consistency in approaching a variety of tasks and situations. Individuals who are more differentiated are implied to be more capable of carrying out specific functions in a specialized fashi Goodenough and Witkin (1977) have hypothesized that a person's tendency to function in a more differentiated or less differenti way is likely to characterize that individual's activities across psychological, intellectual and neurophysiological domains, thus contributing to self-consistency in individual functioning.

Individuals who are perceptually field-dependent have been found to experience their world in a less differentiated fashion when dealing with perceptual/cognitive tasks (Witkin, Goodenough & Oltman, 1977; Witkin & Goodenough, 1977). The field-dependent learner tends to rely on external referents which influence the strategies used in concept attainment tasks. That is, field-dependent persons tend to accept the visual field passively, as presented, and to ignore important details which presumably are not salient to them. Furthermore, they appear to be dominated by the most salient or noticeable parts of a visual (Dickstein, 1968; Kirschenbaum, 1968). Hence, field-dependent individuals may be handicapped by unstructured materials in which relevant details are not made salient (Goodenough, 1976; Witkin, Moore, Goodenough & Cox, 1977). Their tendency to display less differentiated functioning is also evident in the processing strategies they use when directed to form concept hypotheses. Their hypothesis-testing strategy has been associated with a partist approach (Goodenough, 1976; Kirschenbaum, 1968). Field-dependent learners tend to form one concept hypothesis at a time, based on the most noticeable or salient features of the concept example. If subsequent examples reveal that the hypothesis is not valid, then new features are chosen, and a new hypothesis is formed. If subsequent examples substantiate these features, then the hypothesis is retained (Goodenough, 1976). In other words, the field-dependent learner acts as a passive spectator who tends to note the dominant, salient cues, until it becomes obvious that certain features are associated with positive examples of the concept (Witkin, Moore, Goodenough & Cox, 1977).

This strategy may be contrasted with the active, participant role of the field-independent learner. These learners are capable of more differentiated functioning. That is, they are capable of using their restructuring skills as internal mediational processes (Witkin, Moore, Goodenough & Cox, 1977). Their hypothesis-testing strategies have been associated with a wholist approach (Goodenough, 1976; Kirschenbaum, 1968). The field-independent learner tends to scan the first positive concept example, and to retain all its attributes for later comparison with those in subsequent examples. If the hypothesis is proven to be inappropriate, then a revised hypothesis is formed. The wholist strategy of hypothesis testing is more active than the partist approach, and has resulted in better learning performance particularly when subjects were under time pressure (Bruner, Goodnow & Austin, 1956; Bourne, 1966).

In his discussion of hypothesis-testing strategies, Mayer (1977) pointed out that the superiority of the wholist strategy could be due to its reduced demands on memory. The wholist has only to remember the attributes of the first example. Subsequent checks against examples reduce the memory requirement because the wholist is able to eliminate those attributes which fail to reappear. Conversely, the memory demands for the partist strategy will increase with each incorrect hypothesis. Subsequent new hypotheses will need to incorporate a record of all prior hypotheses that were disproven, to avoid using them twice.

In summary, it is important to note that both approaches can lead successful concept attainment (Nebelkopf and Dreyer, 1973). However, field-dependent learners do have more difficulty than field-independent learners with discrimination tasks. That is, they have less ability to break down a visual into its component details. In concept learning tasks in which relevant details are not made obvious, the field-dependent learner may be at a disadvantage (Witkin, Moore, Goodenough and Cox, 1977). Furthermore, field-dependent and field-independent learners do differ in the methods they use to generalize information into concepts. Thus, when material to be learned is not clearly structured and organized, the field-dependent learners may experience learning difficulties (Witkin, Moore, Goodenough and Cox, 1977). Their difficulty may be particularly apparent when instructional time is limited by a fixed-pace presentation (cf. Bruner et. al., 1956, Bourne, 1966).

> The relationship between field-dependence-independence and concept attainment is of particular concern to educators because of their interest in having students learn concepts, rather than facts alone. It is therefore natural to ask how field-dependent students may be aided ... . (Witkin, Moore, Goodenough and Cox, 1977, p. 26).

The Effect of Media Attributes

French (1982) has developed an Aptitude Sensitive Instruction Research model to help the educator in deciding the best method to meet the different processing needs of learners (See Figure 1). The Aptitude Sensitive Approach asserts that learning will be most effective when the requirements of the learning task together with media attributes, either precisely complement the internal processing skills of the learner, or adapt to the aptitude of the student (French, 1982).

This approach places an emphasis upon learners' modes of internal processing of information. To those interested in the development of instructional materials, this means that it is as important to consider what students ought to do while they are learning, as it is to consider the validity of the content. This consideration was also apparent in the early work of Salomon (1970, 1972) when he added a new component to the conventional stimulus-response model and changed it to a three-stage S-r-R model. The new component, "r," signifies the internal operations of information processing, which are released by the stimulus, "S," and lead to the overt behavior, "R." Salomon's initial hypothesis about the relations between media and the learner can be stated as follows: a) Different attributes of media affect or stimulate different internal operations of the learner; b) Different learners often respond to the same information in quite different ways: apparently they perceive the same stimulus in various ways and encode and process it in different manners; c) Learning will be more effective when the teaching process is precisely adjusted to the processes the learner has to carry out.

Ausburn & Ausburn (1977) and French (1982) advocate the use of media attributes as a "connecting link" which would otherwise be incomplete due to a learner's inability to meet certain task demands. Both Ausburn & Ausburn (1977) and French (1982) view this media link as a connection between learner and task that is facilitated through the use of <u>supplantation</u> techniques which form a bridging mechanism (See Figure 1).

The present study sought to utilize media attributes according to an aptitude sensitive approach which was aimed to increase the effectiveness of instructional materials for all subjects. Specifically, the study aimed to use a <u>compensatory</u> supplantation approach to facilitate concept attainment for field-dependent learners by "short circuiting" processing demands (cf. Salomon, 1979). See Figure 1. The "short circuiting" method provides ready-made transformations which may save the field-dependent trainer from having to perform the required processing operations. The study also aimed to use media attributes to <u>activate</u> appropriate processing strategies for field-independent learners.

The present study incorporated the use of several media attributes which varied both in the nature and the amount of supplantation provided. These attributes represent the three independent treatment variables which were selected according to the hypothesized functions they may perform for learners differing in aptitude. The three treatment variables were varied systematically to determine their influence upon both field-dependent and field-independent learners' performance on a concept attainment task. The three treatments were:

a) color versus non-color type of cueing;

b) simple versus complex degree of informative detail;

c) inductive versus deductive type of verbal presentation.

The first treatment variable of interest was that of the use of color-cueing of relevant visual details. In color-cued treatments, the relevant features (attributes) of each concept class were colored in red. Both Hull (1920) and Trabasso (1963) have used red to emphasize relevant attributes as an effective aid to concept-attainment. On the basis of discussions (e.g. Allen, 1975; Chute, 1979; Garrick, 1978) relating to the potential functions of color in instructional variable, several considerations led to the inclusion of color-cueing. These included the hypothesized ability of color:

a) to direct attention to relevant details by making cues more salient and by delineating figure-ground relationships;

b) to isolate details while maintaining context relationships as an aid in making discriminations;

c) to provide organizational aids by showing interrelatedness.

It was hypothesized that these functions may facilitate concept attainment by increasing the salience of relevant concept attributes. However, color appears to be a "fragile cue ... apt t be superceded by more potent cues" (Otto & Askov, 1968, p. 163). Both Otto & Askov and Chute (1979) have suggested that instructio materials should not have color as the only cue available to facilitate processing, especially in complex tasks that are high i stimulus similarity. This should not be interpreted to suggest th color is an ineffective cue. When used to perform an integral function (cf. Chute, 1979), color can be more effective, especiall when the relevant concept attribute is embedded (Trabasso, 1963). Both Chute (1979) and Lamberski & Roberts (1979) have suggested th the value of color may lie in its possible interrelated role.

Trabasso (1963) revealed that the effect of color emphasizers may reduced by counter-emphasizers; that is, irrelevant information wh was not held constant appeared to compete for the subject's atten by directing the learner away from relevant details. Many relevant-cue theorists (e.g., Canelos, 1979; Dwyer, 1972) propose that in some learning tasks, complexity should be edited or simplified in order to avoid processing interference caused by too many relevant cues. To test these views, the present study inclu both simple line-drawing and complex line-drawing treatments as a second independent, treatment variable. This variable was termed degree of informative detail, in order to reinforce that degree of abstraction/realism was not used to differentiate simple from com line-drawings.

In complex treatments, the line-drawings were high in informative detail; that is, they showed a high degree of interior (figure) an ground detail that was not related to the concept. Simple line-drawings were lower in degree of informative detail; that is, they showed mainly relevant interior (figure) detail and as little irrelevant detail as possible. Several functional considerations to the inclusion of simple degree of informative detail in the study. These included the hypothesized ability of simple line-drawings:

a) to isolate details while maintaining context relationshi (cf. Heidt, 1977);

b) to reduce the counter-emphasizer effect of irrelevant stimuli (cf. Trabasso, 1963);

c) to decrease abstraction time and learner effort (cf. Canelos, 1979; Fleming & Sheikhian, 1972; and Joseph, 19

d) to facilitate objectives requiring the comprehension and explanation of concepts (cf. Arnold & Dwyer, 1975).

a cue-summation theory, Severin (1967) raised the question of the possible summation of cues between auditory and visual channels. The present study was also concerned with the possible summation of an emphasizer effect by presenting information through more than one sense modality. Hence, the third treatment variable related to the auditory mode. This variable was termed inductive versus deductive mode of verbal presentation.

Both inductive and deductive treatments were presented via an audiotape which accompanied the line-drawings. Deductive presentations utilized a specific verbal description of the features of each concept type. The deductive presentation was made immediately before the visual presentation of examples and nonexamples. The deductive mode of presentation may be contrasted with the inductive mode which did not provide a verbal description of each concept type. Instead, the inductive presentation urged the subjects to search for the defining attributes of each concept type. The provision of a concept definition in addition to a set of teaching examples has been found to be significantly more facilitative than a set of teaching examples alone (Feldman, 1972). Pishkin (1965) has suggested that specification of concept attributes may reduce learning difficulty by reducing the number of hypotheses to be considered. Ausubel & Robinson (1969) have suggested that for learners to learn effectively, they should be presented with background information as a basis for understanding new facts. This "advance organizer" approach may closely parallel the deductive presentation used in the present study. Several studies have supported the use of descriptions which provide verbal cues to concept definition (e.g., Frayer, 1970; Frederick, 1972; Pishkin, 1965). Based on the preceding research findings, several functional considerations led to the inclusion of deductive mode of presentation in the present study. These included the hypothesized ability of deductive presentations:

a) to direct attention to relevant details through the use of verbal cues and by increasing redundancy of critical information;

b) to provide organizational aids through advance verbal description of relevant details.

METHODOLOGY

The study utilized a treatments-by-blocks design (cf. Keppel, 198 The aptitude block was composed of two levels: extreme field-independent individuals and extreme field-dependent individuals. Aptitude blocks were designated on the basis of performance on the Group Embedded Figures Test (Witkin, Oltman, Raskin and Karp, 1971). Field-independent subjects were determi to represent the upper 27-1/2% of highest scoring subjects. Field-dependent subjects were determined to represent the lower 27-1/2% of lowest scoring subjects (cf. Feldt, 1961).

The subject sample of 492 males aged 16-21 years, was drawn from College of Technical and Further Education in Melbourne, Australi All subjects were trade apprentices predominantly from the automo department. As subjects were trade apprentices, the classificati of five types of diesel fuel injectors was determined to be an appropriate concept attainment task. Five types of injectors wer selected to represent five different concept classes. Most of th injectors had global similarities, yet, each concept class had specific differences which allowed for the classification of each example into one of the five concept groups.

The instructional materials consisted of a series of line-drawing which were copied onto filmstrips with an accompanying audiotape. Subjects were pretested for existing knowledge, and then randomly assigned to an individual soundfilmstrip machine which was loaded with one of the treatment combinations. Each treatment was externally-paced. The three treatment variables combined to form eight treatments, each of which contained either color or non-col cueing, plus either simple or complex line-drawings accompanied b inductive or deductive verbal presentation. By administering the eight treatment combinations to each of the aptitude blocks a tot of sixteen treatment groups were formed. Thus, a 2 x 2 x 2 x 2 factorial, extreme-groups design was used to implement this study. Six dependent variables were measured for all subjects. For this discussion, the results of two immediate posttest measures will b outlined and compared.

a) An identification test. (This test is referred to as t line-drawing test.) Following the completion of all instructional sequences, the subjects were presented wi series of 21 line-drawings. Subjects were also given a answer sheet numbered from 1 to 21, with the names of e of the five injector types repeated for each item. The test required that each subject view each line-drawing, then identify the injector type by circling the appropri name for the corresponding item on the numbered answer sheet. The choice of 21 line-drawings was based on a concept analysis conducted by the researcher, prior to t experiment.

The ability to identify different examples as belonging to the same concept class appears to relate most specifically to the classificatory level of Klausmeier, Ghatala & Frayer's model of conceptual learning (1974). At the classificatory level, the learner not only can discriminate and recognize concept attributes, but also can generalize to other examples on the basis of specific, common attributes. It is important to note that learners who performed well on the line-drawing test may have reached the formal level of Klausmeier's model. At the formal level the learner can identify examples and nonexamples of the concept, and most importantly can name the concept and accurately identify it in terms of all its relevant attributes.

b) An identification - transfer test (called the realia test). Following completion of all instructional sequences, the subjects were presented with a series of "real fuel injectors" for identification. The test required that each subject view and handle each injector, and then identify it by circling the appropriate name on a numbered answer sheet. This test is similar to the preceding identification, line-drawing test in that it also related to Klausmeier, Ghatala and Frayer's classificatory and perhaps formal levels of concept learning (1974). However, in the realia (identification-transfer) test, the learner was required to transfer learning from the two-dimensional, line-drawn representations of fuel injectors to actual three-dimensional realia. The realia posttest was included as a practical "real world" measure of student achievement. Selection of the seven items for the identification-transfer (realia) test was based on detailed concept analysis.

DATA ANALYSIS

A four-way analysis of variance was used to investigate main effects and interactions among the four factors; that is, the three treatment variables and the subject aptitude variable. Where a significant three-way interaction occurred, the interpretation of the nature of the interaction was facilitated through a series of analyses of simple effects. These analyses sought to identify the source or locus of the interaction using procedures and formulae given by Keppel (1973, 1982) and Kirk (1968).

It should be noted that there was some subject mortality after subject allocation to treatments resulting in unequal n's in the treatment of groups. These subject losses were caused by equipment breakdown and administrative procedures. Mortality was not related to the experimental treatments. Analyses of designs with unequal sample sizes may warrant consideration of the possible violation of the homogeneity of variance assumption (Keppel, 1982; Kirk, 1968). Hence, in the present study, this assumption was tested using the Hartley Test using procedures given by Kirk, 1968. Results indicated that the homogeneity assumption was not violated (see Table 1). This permitted the use of standard F tables in the analysis of data from this study.

RESULTS

The Pretest

Analyses of scores for the pretest of prior knowledge revealed that there was no significant difference between the pretest scores of the field-independent and field-dependent groups, $\underline{t}$ (247) = 1.08, $\underline{p} > .1$.

The Posttests

This paper will focus upon a comparison of three-way interactions revealed by the posttest measures.

The Line-Drawings Posttest

Analysis of variance revealed statistically significant findings for the line-drawings test. As interactions were found, the main effects of the factors involved in the interaction must be interpreted with caution (cf. Keppel, 1982). The analysis of variance and inspection of treatment means suggested the following main effects: (a) Degree of informative detail -- students in simple line-drawing treatments scored significantly higher than students in complex line-drawing treatments, $\underline{F}$ (1,299) = 10.45, $\underline{p} < .01$; (b) Mode of verbal presentation -- the deductive-treatments resulted in significantly higher scores than the inductive treatments, $\underline{F}$ (1,229) = 11.95, $\underline{p} < .001$; (c) Subject Aptitude -- field-independent subjects scored significantly higher than field-dependent subjects on the line-drawing (identification) test, $\underline{F}$ (1,229) = 60.36, $\underline{p} < .0001$.

The analysis of line-drawing scores also revealed two statistically significant interactions. Simple/complex treatment (degree of informative detail) interacted with field-dependence-independence (subject aptitude), $\underline{F}$ (1,229) = 6.31, $\underline{p} < .05$. The color/non-color cueing by simple/complex drawings by inductive/deductive treatments interaction; (that is, type of color cueing x degree of informative detail x mode of verbal presentation) also was significant, $\underline{F}$ (1,229) = 5.30 $\underline{p} < .05$. Table 2 provides a summary of the analysis of variance.

The presence of significant interactions in the analysis of variance renders the main effects uninterpretable without further analyses of the nature of the interactions. These tests were conducted and led to the following results. Figure 2 graphically presents the means of the significant three-way interaction. It is important to note that the influence of color/non-color cueing appears to be significant in this higher-order interaction. This led to a test of the simple interaction effect of the simple/complex variable with the inductive/deductive variable for each of the color and non-color treatment groups. The results of these $\underline{F}$ tests indicate that the interaction effects were not significant in color-cued treatment, but were significant in non-color-cued treatments, $\underline{F}$ (1,229) = 4.87, $\underline{p} < .05$. A summary of the results of the tests of simple interaction effects may be found in Table 3.

Subsequent analyses of simple, simple main effects of the three-way interaction revealed that there was no significant difference between deductively presented, simple, non-color-cued treatments and inductively presented, simple, non-color-cued treatments. However, deductively presented, complex, non-color-cued treatments scored significantly higher than inductively presented, complex, non-color treatments; $\underline{F}$ (1,229) = 10.84, $\underline{p}$ < .001. See Figure 2 (right panel) and Table 4. This pattern of results was not evidenced in color-cued treatments. Analyses of simple, simple main effects revealed that in treatments that were color-cued, there was no significant difference between deductively presented, complex treatments and inductively presented, complex treatments. However, deductively presented, simple, color-cued treatments were superior to inductively presented, simple, color-cued treatments; $\underline{F}$ (1,229) = 6.95, $\underline{p}$ < .01. See Figure 2 (left panel) and Table 4.

A second set of simple, simple main effects focused on simple/complex degree of informative detail. These analyses revealed that simple, inductive, non-color treatments scored higher than complex, inductive, non-color treatments; $\underline{F}$ (1,229) = 9.76 $\underline{p}$ < .01. There was no significant difference between simple, deductive, non-color treatments and complex, deductive, non-color treatments. See Figure 2 (right panel) and Table 4. This pattern of results was not evidenced in color-cued treatments. Analyses revealed that in treatments that were color-cued, there was a significant difference between simple, deductive treatments and complex, deductive treatments; $\underline{F}$ (1,229) = 4.09, $\underline{p}$ < .05. However, there was no significant difference between simple, inductive, color-cued treatments and complex, inductive, color-cued treatments. See Figure 2 (left panel) and Table 4.

All treatment group means and standard deviations for the line-drawings posttest have been presented in Tables 5 and 6. The line-drawings posttest reliability coefficient was r_{tt} = .72.

<u>The Realia Posttest</u>

Analysis of variance of the realia posttest revealed one statistically significant main effect, and one statistically significant three-way interaction. It is important to note that the main effects of the factors involved in the interaction were not significant in the overall analysis. Hence, the $\underline{F}$ test involving the significant main effect may be interpreted <u>without qualification</u>. The analysis of variance and inspection of <u>treatment means</u> revealed the following main effect: (a) Subject Aptitude--field-independent subjects produced significantly higher realia posttest scores than field-dependent subjects, $\underline{F}$ (1,231) = 7.35, $\underline{p}$ < .01.

The analysis of realia posttest scores also revealed a significant three-way interaction. All treatment variables contributed to this interaction; that is, type of color cueing X degree of informative detail x mode of verbal presentation, $\underline{F}$ (1,231) = 6.44, $\underline{p}$ < .025. Table 7 provides a summary of the analysis of scores on the realia posttest items.

Further analyses were conducted to determine the nature of the three-way interaction. Figure 3 graphically presents the means of this higher order interaction of the three treatment variables.

Tests of the simple interaction effects of the three-way interaction were conducted to determine the nature of the variation due to the interaction of two of the independent variables, B and C, at each of the two levels of the third variable, factor A. This interaction, shown in Figure 3, represented a meaningful way for this researcher to view the three-way interaction. That is, the interaction of factor B, the simple/complex (degree of informative detail variable with factor C, the inductive/deductive (mode of verbal presentation) variable was analyzed within each of the levels of factor A (color-cued/non-color-cued treatments). The results of the F tests of simple interaction effects revealed that the interaction effect was not significant in color-cued treatments (B x C at a_1), but was significant in non-color-cued treatments (B x C at a_2), $F(1,231) = .62$, $p < .01$. In other words, the tests of simple interaction effects indicated that the interaction of simple/complex treatments with inductive/deductive treatments was not significant for color-cued materials, but was significant in non-color-cued treatments. A summary of the results of the tests of simple interaction effects may be found in Table 9.

The significance of the B x C interaction for non-color-cued materials (a_2) suggested further analysis. Subsequent analyses consisted of testing the variation among the cells of a given row or column of the non-color matrix; that is, testing simple, simple main effects of factors within the non-color matrix. The first set of tests of simple, simple main effects focused on factor B (simple/complex--degree of informative detail). These tests sought to determine the influence of factor B at levels a_2c_1 (non-color, inductive), and a_2c_2 (non-color-deductive). The results of these tests of simple, simple main effects may be interpreted with reference to the right panel of Figure 3. The test of B at a_2c_1 revealed that simple, non-color, inductive treatments scored significantly higher than complex, non-color, inductive treatments, $F(1,231) = 8.04$, $p < .01$ (see Figure 3 and Table 9). However, the results of the test of simple, simple main effects indicated that there was no significant difference between simple, non-color, deductive treatments and complex, non-color, deductive treatments.

A second set of tests of simple, simple main effects focused on factor C (inductive/deductive -- mode of verbal presentation). These tests sought to determine the influence of factor C at levels a_2b_1 (non-color, simple), and a_2b_2 (non-color, complex). Results of these tests of simple, simple main effects may be interpreted with reference to the right panel of Figure 3. The test of C at a_2b_1 revealed a significant difference, $F(1,231) = 12.30$, $p < .001$ (see Table 9). Inspection of the appropriate means in Figure 3 shows that inductive, non-color, simple treatments were superior to deductive, non-color, simple treatments in this test of C at a_2b_1. There was no significant difference between inductive, non-color, complex treatments and deductive, non-color, complex treatments in the test of C at a_2b_2 (see Table 9, and Figure 3).

Tests of simple, simple main effects were extended to determine the influence of both factor B and factor C among the cells of a given row or column of the color-cued matrix. The results of these tests of simple, simple main effects may be interpreted with reference to the left panel of Figure 3. The tests of B at a_1c_1 and B at a_1c_2 were not significant (see Table 9). The tests of C at a_1b_1 and C at a_1b_2 were also not significant (see Table 9, and Figure 3).

All treatment group means and standard deviations for the realia posttest have been presented on Tables 10 and 11. The realia posttest reliability coefficient was $r_{tt} = .42$.

DISCUSSION

The success of attempts to improve the general effectiveness of instructional materials for all subjects was evident in the significant findings reported for both interactions and treatment main effects for both posttests. Some treatment combinations were more effective than others for all subjects. Theoretically, this may suggest that it is possible to utilize instructional materials which not only allow high-aptitude (field-independent) learners to activate successful processing strategies, but also provide compensatory supplantation for the reduced capacity of low-aptitude (field-dependent) learners. The need to provide such supplantation may be most apparent when learners are constrained by the time demands of an externally-paced presentation in a concept attainment task in which concept attributes are not salient. The general effectiveness of some treatment combinations for all subjects should not be interpreted as suggesting that prescription of instructional media should be made without consideration of aptitude factors. The same treatment may serve different processing functions for high and low aptitude groups. These results suggest that instructional prescription needs to be sensitive to the specific processing needs of the specific learners for whom materials need to be produced. Results from both measures confirmed that learners with field-dependent aptitude have difficulty with externally paced, concept attainment tasks which require the ability to discriminate and to generalize.

In general, there was no significant difference between color-cued and non-color-cued materials in both posttests. However, analyses of the three-way interactions of all treatment variables revealed that the pattern of results in the color-cued treatments differed to the pattern of results in the non-color-cued treatments for both posttests. These results may support the conclusions of Chute (1979) and Lamberski & Roberts (1979) who have suggested that the significance of the color variable may be in its possible interrelated role.

Analyses of simple, simple main effects (realia posttest) revealed that the effectiveness of treatments that were not color-cued was greatly facilitated when simple, inductive presentations were used. That is, non-color-cued, simple, inductive treatments scored higher than non-color-cued, simple, deductive treatments, and non-color-cued, complex, inductive treatments. There was no significant difference between any of the treatments that were color-cued (realia posttest). It is important to note that these patterns of results for the three-way interaction (realia posttest) are quite different to those reflected by the three-way interaction of the same factors on the line-drawings posttest. (See Figures 2 and 3.)

Performance in non-color-cued treatments was not facilitated by simple, deductive presentation or complex, deductive presentations as it was on the line-drawings posttest. The superiority of simple, deductive presentations in color-cued treatments, evident in the line-drawings posttest, was not revealed in the realia posttest. Furthermore, simple, inductive, non-color treatments were superior to all other non-color-cued treatments on the realia posttest.

The apparent superiority of simple, inductive presentations in non-color-cued treatments may be related to the unique processing demands of the realia posttest. This posttest required that learners demonstrate concept attainment by correctly identifying realia which belonged to the same concept class. The realia (identification) posttest differed from the line-drawings (identification) posttest in that the realia measure required that learners transfer their knowledge to identify actual examples of the concept. The processes required to transfer learning in order to classify actual concept examples appear to have been aided by non-color-cued, simple, inductive presentations. In other words, non-color, inductive presentations may have freed learners to utilize their cognitive restructuring skills and hypothesis testing strategies when simplified visuals were used. The inductive treatments may have facilitated transfer by actively involving each learner in processing concept information when used in conjunction with the other two variables. The simple line-drawings may have contributed the interactive effect by: (a) directing attention through removing irrelevant details and thus reducing their counteremphasizer effect; (b) directing attention to relevant cues and thus delineating figure-ground relationships; (c) isolating relevant concept attributes; and (d) decreasing abstraction time and effort. The functional attributes of simplified visuals may have been of critical importance for low-aptitude learners. These field-dependent learners may have had difficulty in successfully completing the task when non-color, inductive presentations (low in salient cues) were used. This difficulty may have been accentuated without the addition of simplified visuals to isolate relevant details and to direct attention.

Previous research findings provide partial support for the findings on the realia posttest. For transfer tasks, inductive/discovery approaches have been found to result in superior performance (Wittrock, 1966; Travers, 1977). As Travers (1977) pointed out the advantage of discovery-learning would seem intuitively to be based on the importance of encouraging learners to be more actively involved in their own learning.

Although the three-way interaction of all treatment variables accounted for only 1.3% and 2.2% of the total variance for the line-drawing test and the realia test respectively, the theoretical implications of these findings may be of significant interest to those involved in the research and design of instructional materials

IMPLICATIONS

From the findings of this study the following skeleton hypotheses have been proposed as guides for future research and practice relating to aptitude sensitive instruction and the role of attributes in optimizing transfer of training. The findings of this study are based upon the view that attributes of a mediated stimulus may interact with task demands and learner aptitude to enable the presented information to be processed more efficiently and effectively by learners of differing cognitive styles.

1. In general, field-dependent performance on an externally-paced, concept-attainment task may fail to reach an acceptable criterion (for both identification/line-drawing and transfer/realia posttests) unless materials provide <u>supplantation</u> by increasing the salience of relevant cues and by providing organizational aids. For example, simple, deductive, color line-drawings may have provided supplantation for field-dependent learners (on the line-drawings posttest). These treatments may have functioned to compensate for processing weaknesses by directing attention and by increasing the salience of critical concept cues. This may have produced an organizational aid to reduce abstraction time and effort for field-dependent learners.

2. In general, field-independent performance on an externally paced, concept-attainment task may reach an acceptable criterion (for both identification/line-drawing and transfer/realia posttests) even when materials lack organization and salient, relevant cues. Nevertheless, performance may be facilitated through the use of media attributes which increase the salience of relevant cues and provide organizational aids. For example, although field-independent learners reached an acceptable criterion for all treatments -- simple, deductive, color presentation may have provided most appropriate supplantation for field-independent learners (on the line-drawing posttest). Simple, deductive, color treatments may have functioned to actuate appropriate processing strengths, thus reducing abstraction time and effort.

3. Materials designed to teach a concept may be most effective when media attributes are selected with sensitivity for specific processing demands of the task as they relate to the cognitive styles of the learners. For example, in this study the processing strategies of both subject groups were constrained by an externally-paced presentation. Simple, deductive, color treatments were facilitated for both subject groups (on the line-drawing posttest). While this treatment facilitated ease of processing for field-independent individuals, it may have been of critical importance for field-dependent learners. Difficulty for these learners may have been accentuated by presentations which demanded ability to isolate relevant details and to organize information into concept classes. Improved

field-dependent performance in simple, deductive, color treatments may be attributed to their supplantation value in compensating for these processing differences. Hence, simple, deductive, color treatments may have facilitated the perform[ance] of both field-independent and field-dependent groups in different ways.

4. The attributes of color-cueing may have a possible interrelat[ed] role in concept-attainment tasks in which performance is measured through the use of both line-drawings and realia. A comparison of the significant three-way interaction (color/non-color x inductive/deductive x simple/complex) for the line-drawings posttest in Figure 2 with the three-way interaction of the same variables for the realia posttest in Figure 3, will illustrate the potential of the interrelated ro[le] of color.

5. In concept-attainment tasks, media attributes can facilitate information transfer from two dimensional instructional materials to realia. For example, simple, inductive, non-colo[r] treatments facilitated performance for all subjects in treatments that were not color-cued in the realia posttest. This effect was not apparent in the line-drawings posttest scores. The difference in findings may be related to the uni[que] processing demands of the realia posttest which required learners to transfer knowledge and to identify actual examples of the concept (realia) that were taught the line-drawings. Simple, inductive, non-color presentations may have freed learners to actually utilize cognitive restructuring skills an[d] hypothesis testing strategies. These treatments may have facilitated transfer by <u>actively</u> involving each learner in processing concept information.

   Ease of transfer to real objects may be facilitated by media attributes which function to:

   (a) free the learner to utilize restructuring skills and hypothesis testing strategies

   and/or

   (b) <u>permit active processing involvement</u> by the learner.

   (c) increase the salience of relevant cues by isolating relevant details and directing attention to relevant details. Attention may be directed by delineating figure-ground relationships and reducing the counteremphasizer effect of irrelevant details.

   (d) decrease abstraction time and effort

cluding Comments

pplantation approaches seek to match the components or variables at contribute to instructional effectiveness. These variables are presented by the learning task (or <u>what</u> is to be learned), the arner (or the person to <u>whom</u> instruction is directed) and the media tributes (or <u>how</u> the message will be communicated). Ineffective struction fails to integrate these three components. In order to responsive to learners' processing needs, instructional design eds to be sensitive to the complex interrelationships between riables which contribute to instructional effectiveness. By rging theory into practice, instructional designers may master the t of developing instructional materials that are truely <u>aptitude nsitive</u>.

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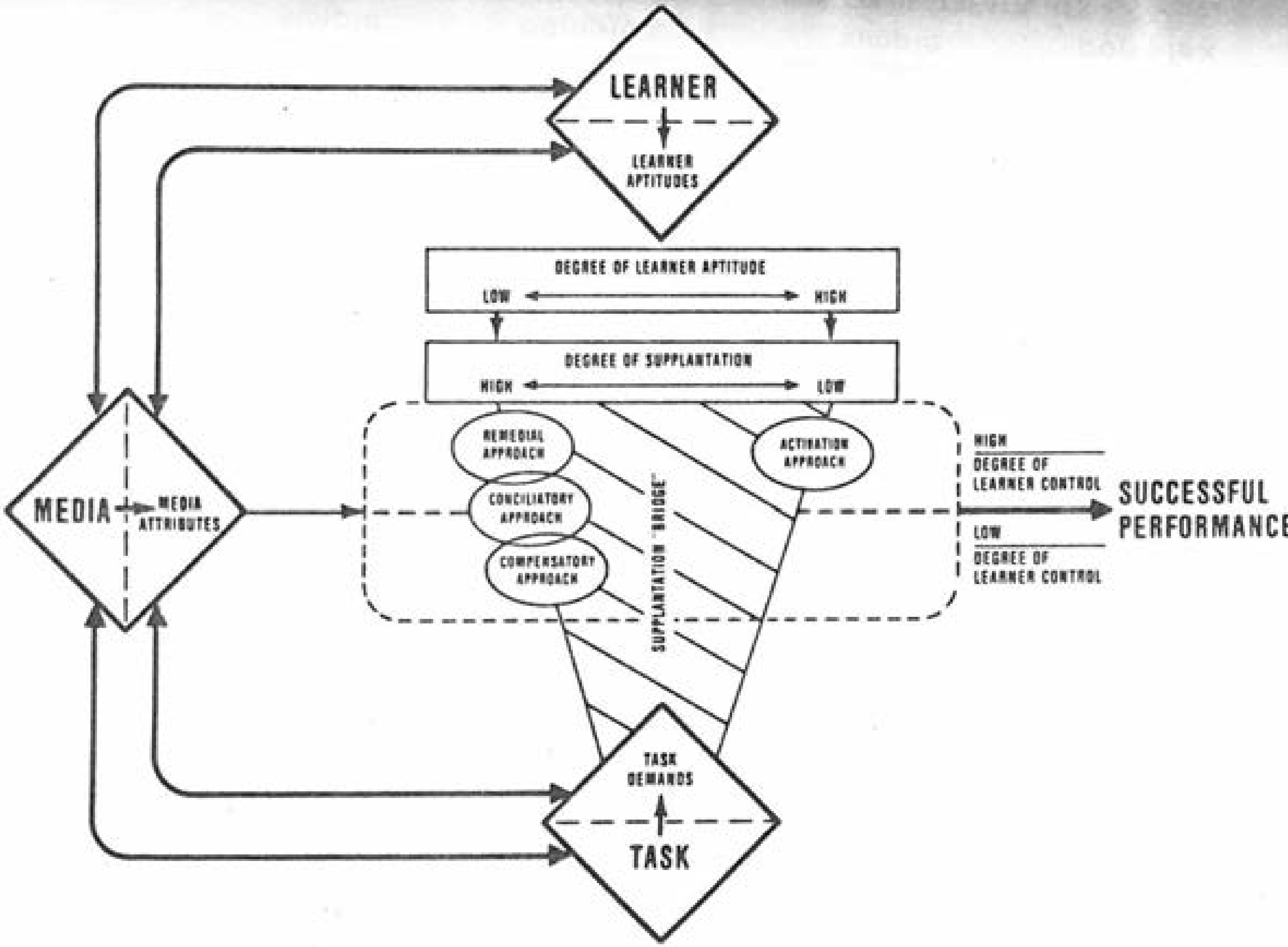
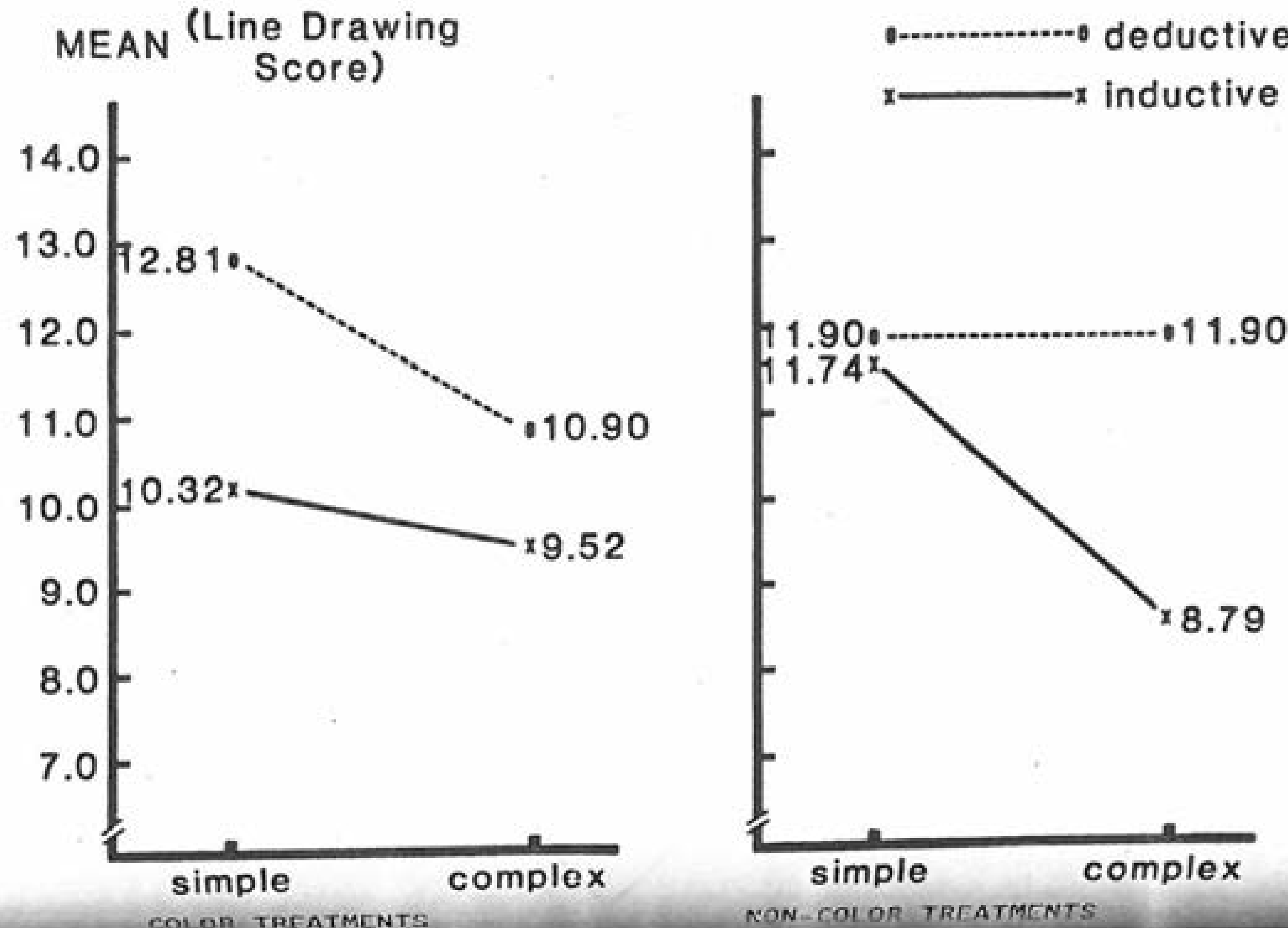
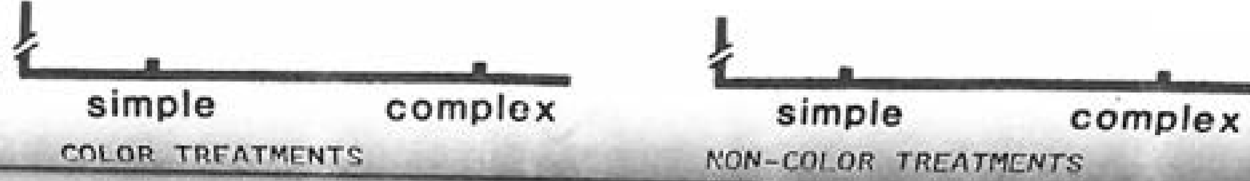


Figure 1: A Model for Aptitude Sensitive Instruction


MEAN (Line Drawing Score)
deductive
inductive
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
12.81
10.90
10.32
9.52
11.90
11.74
11.90
8.79
simple
complex
COLOR TREATMENTS
simple
complex
NON-COLOR TREATMENTS



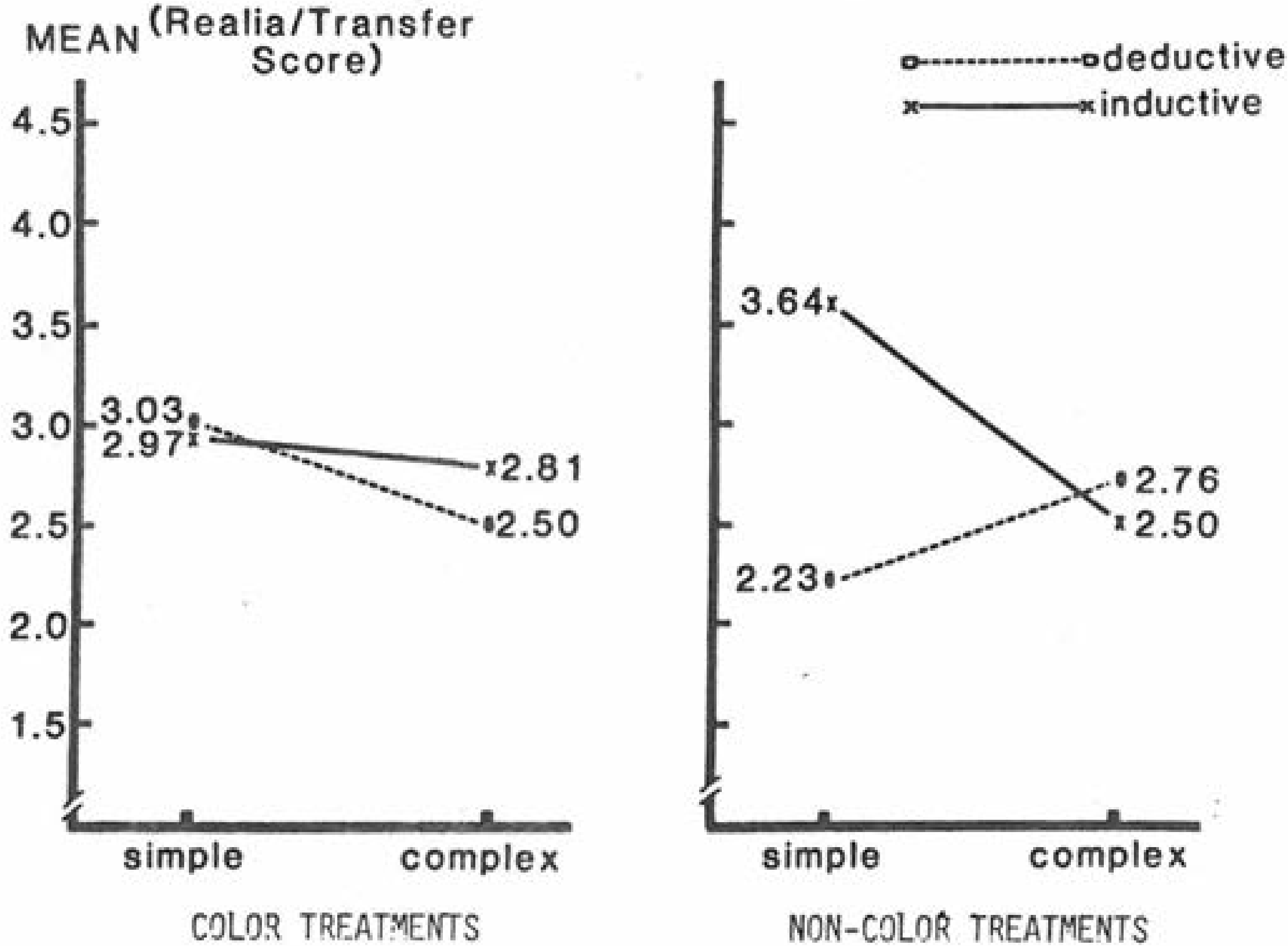


Figure 3: Graph of treatment means of the significant three-way interaction (color/ non-color X simple/complex X inductive/deductive treatments)--Realia posttest

Table 1

Results of Hartley's Test of Homogeneity of Variance for all Posttest Scores (Kirk, 1968, p. 62)

Posttest	Largest Variance	Smallest Variance	df	$\underline{F}$ max.
Line Drawings	23.98	7.27	16,13	3.30*
Realia	3.74	1.60	16,16	2.34*

* $\underline{p} > .05$

Table 2

Analysis of Variance for Scores on Line Drawing Posttest Items

Source of Variance	SS	df	MS	F
A Color/Non-Color Treatments	1.106	1	1.106	0.08
B Simple/Complex Treatments	141.401	1	141.401	10.45**
C Inductive/Deductive Treatments	161.716	1	161.716	11.95***
D Field-Dependent-Independent Aptitude	816.918	1	816.918	60.36****
AxB	0.017	1	0.017	0.00
AxC	6.591	1	6.591	0.49
AxD	0.884	1	0.884	0.07
BxC	27.057	1	27.057	2.00
BxD	85.416	1	85.416	6.31*
CxD	2.330	1	2.330	0.17
AxBxC	71.710	1	71.710	5.30*
AxBxD	3.945	1	3.945	0.29
AxCxD	42.299	1	42.299	3.13
BxCxD	10.584	1	10.584	0.78
AxBxCxD	10.117	1	10.117	0.75
Explained	1407.626	15	93.842	6.93
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

* $p < .025$

** $p < .01$

*** $p < .001$

**** $p < .0001$

Table 3

Summary of Variance for Scores on the Line-Drawings Posttest Items, Including Tests for Simple Interaction Effects.
(Adapted from Keppel, 1973, pp.286-290, pp.325-327, pp.360-362; 1982, pp.304-309, pp.341-344; and Kirk, 1968, pp.222-224)

Source of Variance	SS	df	MS	*F*
A Color/Non-Color Treatments	1.106	1	1.106	0.0[illegible]
B Simple/Complex Treatments	141.401	1	141.401	10.4[illegible]
C Inductive/Deductive Treatments	161.716	1	161.716	11.9[illegible]
BxC	27.057	1	27.057	1.9[illegible]
BxC at a_1	9.347	1	9.347	0.6[illegible]
BxC at a_2	66.023	1	66.023	4.8[illegible]
AxBxC	71.710	1	71.710	5.3[illegible]
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

* $p < .05$
** $p < .025$
*** $p < .001$

1. a_1 = color-cued

   a_2 = non-color cued

Table 4

Summary of the Analysis of Variance on Line-Drawing Test Items, Including Tests for Simple, Simple Main Effects
(Adapted from Keppel, 1973, pp.290-292, pp.326-327, pp.360-362; 1982, pp.309-311; and Kirk, 1968, pp. 222-223)

Source of Variance[1]	SS	df	MS	F
A Color/Non-Color Treatments	1.106	1	1.106	0.08
B Simple/Complex Treatments	141.401	1	141.401	10.45****
C Inductive/Deductive Treatments	161.716	1	161.716	11.95****
AxB	0.017	1	0.017	0.00
AxC	6.591	1	6.591	0.49
BxC	27.057	1	27.051	2.09
B at a_1 c_1	9.710	1	9.710	0.72
B at a_1 c_2	55.354	1	55.354	4.09*
B at a_2 c_1	132.046	1	132.046	9.76***
B at a_2 c_2	-	1	-	-[a]
C at a_1 b_1	94.090	1	94.090	6.95***
C at a_1 b_2	28.896	1	28.896	2.14
C at a_2 b_1	0.388	1	0.388	0.03
C at a_2 b_2	146.758	1	146.758	10.84****
AxBxC	71.710	1	71.710	5.30**
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

* p <.05   *** p <.01
** p <.025   **** p <.001

a the mean scores for these cells were equal

1. a_1 = color-cued
a_2 = non-color cued
b_1 = simple line-drawing
b_2 = complex line-drawing
c_1 = inductive presentation
c_2 = deductive presentation

Table 5

Treatment Group Means and Standard Deviations for Field-Dependent and Field-Independent Aptitude (Line-Drawing Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent					
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n
1. Simple, Inductive, Non-Color	10.00	(2.89)	19	13.93	(3.43)	15	11.74	(3.67)	34
2. Simple, Inductive, Color	7.27	(3.47)	15	13.85	(2.91)	13	10.32	(4.60)	28
3. Complex, Inductive, Non-Color	7.88	(3.04)	17	9.75	(3.45)	16	8.79	(3.33)	33
4. Complex, Inductive, Color	8.53	(3.78)	15	10.44	(4.35)	16	9.52	(4.13)	31
5. Simple, Deductive, Non-Color	8.54	(2.70)	13	14.47	(3.69)	17	11.90	(4.41)	30
6. Simple, Deductive, Color	11.06	(4.07)	16	14.67	(3.75)	15	12.81	(4.27)	31
7. Complex, Deductive, Non-Color	9.86	(4.90)	14	13.80	(3.63)	15	11.90	(4.66)	29
8. Complex, Deductive, Color	9.80	(4.34)	15	12.07	(3.83)	14	10.90	(4.19)	29
COLUMN	9.15	(3.78)	124	12.84	(3.99)	121	10.97	(4.30)	245

COLUMN 9.15 (3.78) 124 12.84 (3.99) 121 10.97 (4.30) 245

Table 6

Treatment Group Means and Standard Deviations for Aptitude x Degree of Informative Detail x Type of Color-Cueing x Mode of Presentation (Line-Drawing Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent					
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n
A. Degree of Informative Detail:									
(low) Simple	9.32	(3.56)	63	14.25	(3.42)	60	11.72	(4.27)	123
(high) Complex	8.97	(4.02)	61	11.45	(4.06)	61	10.21	(4.21)	122
B. Type of Color Cueing:									
Color-Cued	9.20	(4.13)	61	12.69	(4.02)	58	10.90	(4.42)	119
Non-Color-	9.10	(3.45)	63	12.96	(3.78)	63	11.04	(4.20)	126
C. Mode of Presentation:									
Inductive	8.50	(3.30)	66	11.87	(3.54)	60	10.10	(4.04)	126
Deductive	9.90	(4.00)	58	13.80	(3.73)	61	11.89	(4.38)	119
COLUMN	9.15	(3.78)	124	12.84	(3.99)	121	10.97	(4.30)	245

Table 7

Analysis of Variance of Scores on Realia Test Items

Source of Variance	SS	df	MS	F
A Color/Non-Color Treatments	0.180	1	0.180	0.07
B Simple/Complex Treatments	8.036	1	8.036	3.24
C Inductive/Deductive Treatments	8.322	1	8.322	3.36
D Field-Dependent-Independent Aptitude	18.210	1	18.210	7.35**
AxB	0.017	1	0.017	0.01
AxC	3.759	1	3.759	1.52
AxD	0.011	1	0.011	0.01
BxC	7.383	1	7.383	2.98
BxD	0.008	1	0.008	0.00
CxD	1.242	1	1.242	0.50
AxBxC	16.470	1	16.470	6.44*
AxBxD	0.046	1	0.046	0.02
AxCxD	5.608	1	5.608	2.26
BxCxD	0.928	1	0.928	0.38
AxBxCxD	4.298	1	4.298	1.73
Explained	73.435	15	4.896	1.98
Residual	572.622	231	2.479	--
TOTAL	646.057	246	2.626	--

* $p < .025$

** $p < .01$

Table 8

Summary of the Analysis of Variance for Scores on Realia Posttest Items, Including Tests for Simple Interaction Effects.
(Adapted from Keppel, 1973, pp.286-290, pp.325-326, pp.360-362; 1982, pp.304-309, pp.341-344; and Kirk, 1968, pp.222-224)

Source of Variance	SS	df	MS	F
A Color/Non-Color Treatments	0.081	1	0.081	0.07
B Simple/Complex Treatments	8.036	1	8.036	3.24
C Inductive/Deductive Treatments	8.322	1	8.322	3.36
BxC	7.383	1	7.383	2.98
BxC at a_1	1.046	1	1.046	0.42
BxC at a_2	21.378	1	21.378	8.62**
AxBxC	16.470	1	16.470	6.64*
Residual	572.622	231	2.479	-
TOTAL	646.057	246	2.626	-

* $p < .025$

** $p < .01$

Table 9

Summary of the Analysis of Variance for Scores on Realia Posttest Items, Including Tests for Simple, Simple Main Effects.
(Adapted from Keppel, 1973, pp.290-292, pp.326-327, pp.360-362; 1982, pp.309-311; and Kirk, 1968, pp.222-223)

Source of Variance	SS	df	MS	*F*
A Color/Non-Color Treatments	0.180	1	0.180	0.07
B Simple/Complex Treatments	8.036	1	8.036	3.24
C Inductive/Deductive Treatments	8.322	1	8.322	3.36
AxB	0.017	1	0.017	0.01
AxC	3.759	1	3.759	1.52
BxC	7.383	1	7.383	2.98
B at a_1 c_1	0.393	1	0.393	0.16
B at a_1 c_2	4.307	1	4.307	1.74
B at a_2 c_1	19.927	1	19.927	8.04**
B at a_2 c_2	8.491	1	8.491	3.43
C at a_1 b_1	0.055	1	0.055	0.02
C at a_1 b_2	1.475	1	1.475	0.59
C at a_2 b_1	30.484	1	30.484	12.30***
C at a_2 b_2	1.037	1	1.037	0.42
AxBxC	16.470	1	16.470	6.64*
Residual	572.622	231	2.479	-
TOTAL	646.057	246	2.626	-

* p <.025
** p <.01
*** p <.001

Table 10

Treatment Group Means and Standard Deviations for Field-Dependent and Field-Independent Aptitude (Realia Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent					
	$\overline{X}$	(SD)	n	$\overline{X}$	(SD)	n	$\overline{X}$	(SD)	n
1. Simple, Inductive, Non-Color	3.61	(1.75)	18	3.66	(1.40)	15	3.64	(1.58)	33
2. Simple, Inductive, Color	2.40	(1.40)	15	3.57	(1.60)	14	2.97	(1.59)	29
3. Complex, Inductive, Non-Color	2.35	(1.93)	17	2.65	(1.50)	17	2.50	(1.71)	34
4. Complex, Inductive, Color	2.67	(1.35)	15	2.94	(1.44)	16	2.81	(1.38)	31
5. Simple, Deductive, Non-Color	1.54	(1.27)	13	2.76	(1.86)	17	2.23	(1.72)	30
6. Simple, Deductive, Color	3.00	(1.26)	16	3.07	(1.07)	15	3.03	(1.45)	31
7. Complex, Deductive, Non-Color	2.29	(1.54)	14	3.20	(1.61)	15	2.76	(1.62)	29
8. Complex, Deductive, Color	2.13	(1.36)	15	2.87	(1.88)	15	2.50	(1.66)	30
COLUMN	2.54	(1.59)	123	3.07	(1.62)	124	2.81	(1.62)	247

Table 11

Treatment Group Means and Standard Deviations for Aptitude x Degree of Informative Detail x Type of Color Cueing x Mode of Presentation (Realia Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent					
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n
A. Degree of Informative Detail:									
(low) Simple	2.73	(1.61)	62	3.24	(1.65)	61	2.98	(1.64)	123
(high) Complex	2.36	(1.54)	61	2.90	(1.58)	63	2.64	(1.58)	124
B. Type of Color Cueing:									
Color-Cued	2.56	(1.35)	61	3.10	(1.63)	60	2.83	(1.51)	121
Non-Color	2.53	(1.80)	62	3.05	(1.62)	64	2.79	(1.72)	126
C. Mode of Presentation:									
Inductive	2.78	(1.61)	65	3.18	(1.48)	62	2.98	(1.61)	127
Deductive	2.28	(1.37)	58	2.97	(1.75)	62	2.63	(1.62)	120
COLUMN	2.54	(1.59)	123	3.07	(1.62)	124	2.81	(1.62)	247

TITLE: The Relative Effectiveness of Pictures Versus Words in Conveying Abstract and Concrete Prose

AUTHOR: Michael J. Hannafin

THE RELATIVE EFFECTIVENESS OF PICTURES VERSUS WORDS IN CONVEYING ABSTRACT AND CONCRETE PROSE

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ABSTRACT

A total of 121 third and fourth graders were randomly assigned to instructional treatments which each featured a short children's story. The treatments were oral-only, picture-only, and a combination of oral and pictures. Students saw and/or heard the presentation and were tested immediately and after a two-week retnetion interval for recall of abstract and concrete presentation content. As expected, the combined presentation yielded the greates recall of both abstract and concrete content. Oral-only and picture-only presentations were equally effective for abstract content, but the picture presentation was more effective for concrete content. In effect, picture presentation were relatively more effective overall than oral-only presentations.

THE RELATIVE EFFECTIVENESS OF PICTURES VERSUS WORDS IN CONVEYING ABSTRACT AND CONCRETE PROSE

The ability to derive meaning from prose is of major importance in classroom learning settings. A large percentage of classroom instruction is presented to prospective learners through oral or written prose. Prose learning typically involves different information processing skills from simple paired associate or serial learning tasks. For example, contextual and inferential learning are more often associated with prose learning than other types of isolated learning tasks. Consequently, much of the non-prose research regarding presentation stimuli effects may not be readily generalizable to prose learning tasks. For these reasons, the continued investigation of prose learning effects warrants attention.

The mythical best audiovisual presentation medium has been pursued extensively during the past several years. The supplementary effect of pictures when applied to oral presentations has also been investigated. Levin and Lesgold (1978) listed several conditions under which pictures facilitate the learning of oral prose: learners should be children rather than adults, pictures must overlap with story content, and learning should be demonstrated by factual recall. Researchers have generally found that pictures are effective supplements to prose when such pictures are well designed and congruent with prose content and sequence (Carrier & Clark, 1978; Haring & Fry, 1979; Lesgold, Curtis, DeGood, 1975; Lesgold, Levin, Shimron, & Guttmann, 1975; Levin, Bender, & Lesgold, 1976; Levin & Berry, 1980; Peng & Levin, 1979; Pressley, 1977; Rusted & Coltheart, 1979).

Although the use of well-designed and congruent pictures has resulted in positive effects on learning when paired with different types of prose, the relative information carrying value of verbal and picture presentations is unclear. Many researchers who have compared the effectiveness of verbal and pictorial presentations of the same information have concluded that verbal presentations are generally more effective than pictorial presentation. However, these findings are by no means conclusive (Fleming, 1979). Conflicting results have been reported recently (e.g., Rohwer & Harris, 1975 vs. Hannafin, 1981). Consequently definitive conclusions regarding the relative effectiveness of different presentation stimulu are not readily derived from existing research.

Some studies designed to investigate the relative effectiveness of pictures and verbal presentations may have been confounded by loading effects, i.e., effects due to differentially loading either verbal or visual presentations with criterion information (Hannafin, 1983). While loading bias often reflects accurately a natural weighting of information found in many materials, it is unlikely that the potential of a given medium to transmit information is accurately assessed using such materials. Recently, researchers have found that both verbal and pictorial presentations enhance student learning when each presentation is systematically and equally loaded with criterion information (Carey & Hannafin, 1981).

The type of information to be remembered in prose learning also warrants further study (Salomon & Clark, 1977). Paivio (1971) suggested that the most powerful factor that determines how well information will be remembered is its location on a continuum of concreteness-abstractness: The more concrete, the more easily remembered; the more abstract, the harder to remember. Paivio and Foth (1970) further suggested that the concreteness or abstractness of information interacts with the stimulus attributes of the presentation medium. Verbal presentations may be more effective than visual presentations for teaching abstract information and visual presentations may be more effective than verbal presentations for teaching concrete information. Research findings, however, have not consistently supported this hypothesis. Other resarchers have found that although visual presentations are more effective than verbal presentations for communicating concrete information, no significant differences exist between visual and verbal presentations in communicating abstract information (Hannafin, 1981, 1983). The nature or existence of Paivio and Foth's (1970) postulated interaction between presentation medium and relative concreteness of information to be learned, therefore, remains unclear.

The purposes of the present student were to investigate the relative effectiveness of different verbal versus pictorial audiovisual presentations on student recall of concrete and abstract prose.

METHODS

Subjects

A total of 60 third-grade and 60 fourth-grade students served as subjects. Students were selected from either of two schools located in a predominantly middle-class suburban school district.

Materials

Three presentations, each depicting an adapted children's text, The Wump World (Peet, 1970), were used. Each of the story versions was systematically loaded with both concrete and abstract criterion information. The Wump World is a high interest, animated story with a Spache graded readability estimate of 4.8. The story was slightly adapted to include both concrete and abstract information. The three presentations included: ORAL, an audiotape verbal presentation of the story; PICS, a 35-mm slide presentation of the text pictures used to depict the story; and ORAL + PICS, a combination of the audiotape and 35-mm lides.

Each of the presentation versions was 18 minutes in duration and paced identically to control student time on task.

Criterion Measure

The criterion measure was a 24-item short-answer test, consisting of 12 items measuring recall of abstract information presented in the story and 12 items measuring recall of concrete information. The concreteness-abstractness of the test information, where possible, was based on the ratings provided by Paivio et al. (1968). Reliabil coefficients for the 24-item test used in the present study were .7 the 12-item abstract scale, .85 for the 12-item concrete scale, and for the full-length criterion test.

All test directions and questions were presented and paced audiotape.

Procedures

Students were randomly assigned to presentation treatment gr assignments. Students then heard and/or viewed The Wump World accordance with presentation group assignments. Following presentation, there was a brief interpolated activity during which students stood and stretched at their assigned seats while test answ sheets were distributed to them.

The criterion test was administered both as a measure of immedi recall and also one week after the initial story presentation as measure of delayed recall and retention. The delayed test w administered to all students in their home classrooms.

Design and Data Analysis

The research design was a completely crossed 3 x 2 x 2 factor design with repeated measures on both the test scale and the te interval. The three levels of presentation (ORAL, PICS, and ORAL PICS) were crossed with two levels of ability (HI and LO), and bo factors were crossed with grade level (THIRD and FOURTH). The lear ability classifications were based upon a median split of student sc on a group-administered standardized intelligence test. The test scale yielded immediate and delayed scores for concrete and abstract information.

In addition to the immediate and delayed scores for concrete and abstract information, a relative effectiveness score was derived by subtracting the concrete score from the corresponding abstract score for the immediate test, the delayed test, and the overall repeated measure.

Due to chance cell imbalance, resulting primarily from attrition, students were randomly eliminated from the analysis in order to balance the cell sizes.

Separate repeated measure MANOVAs were conducted for recall and for the relative effectiveness scores. In addition, planned orthogonal contrasts were conducted for each anticipated effect source.

RESULTS

Recall Effects

The mean recall scores for both abstract and concrete scales w contained in Table 1. As expected, recall of concrete information w significantly greater than abstract recall, $F(1,108) = 15.83$, $p < .000$ The results further indicated significant presentation gro differences, $F(2,108)=13.81, p<.0001$, and a presentation by sca interaction $F(2,108)=6.21, p<.005$. The ORAL + PICS presentation w consistently the most effective for both abstract and concrete recall The mean scores obtained by the ORAL and PICS presentation groups fo abstract recall were comparable but the PICS presentation w significantly more effective than the ORAL presentation for recall concrete content.

Expected differences were also found for learner ability $F(1,108)=13.57, p<.001$. HI ability learners consistently out perform LO learners across scale, test interval, presentation, and grade level

Grade level effects were also found for test recall $F(1,180)=4.73, p<.05$, and the grade level-by-test scale interaction $F(1,108)=9.02, p<.005$. Fourth graders consistently, but marginally out-performed third graders. The differences were most pronounced in concrete recall, where fourth graders recalled proportionately greater information than third graders.

Insert Table 1 About Here

Relative Effectiveness Scores

The relative effectiveness scores, measures of the difference in student recall of abstract and concrete information, are shown for both the immediate and the delayed test in Table 2. The scores indicate the direction and magnitude in which differences in learning occurred: positive scores indicate greater learning of abstract than concrete content; negative scores indicate greater learning of concrete than abstract content.

Differences in relative effectiveness were found for presntation group, $F(2,108)=6.21, p<.005$, and for grade level, $F(1,108)=9.02, p<.005$. The ORAL + PICS presentation yielded greater relative effectiveness differences than either the PICS or the ORAL presentation ($p<.01$).

Similar differences were found between the PICS and the ORAL presentations ($p<.01$) with relatively greater learning of concrete information than abstract information in the PICS and ORAL + PICS presentations, and slightly greater learning of abstract information under the ORAL presentation. These differences were most pronounced for the fourth graders, with relatively greater concrete than abstract learning.

No other significant differences were found.

Insert Table 2 About Here

DISCUSSION

The present study was conducted to determine the relative effectiveness of different prose presentation forms on the learning of concrete and abstract prose. The results indicated that students' learning of both abstract and concrete prose was differentially affected by the form of prose presentation.

The combined oral-plus-pictures presentation yielded the highest recall of both concrete and abstract content. Although this result was expected, the magnitude of the performance difference between the oral-plus-picture presentation and both the oral and picture presentation is noteworthy. As noted by several researchers (Lesgold, Levin, Shimron, & Guttman, 1975; Levin et al., 1976; Pressley, 1977) well-designed and congruent pictures are effective supplements to oral or written prose. However, the relative supplementary contribution of pictures to oral prose or oral prose to pictures has been unclear. In the present study, pictures were found to be highly effective supplements to the oral prose presentation. The oral-plus-picture presentations resulted in signficantly greater recall of both abstract content and concrete content than the oral-only presentation. The difference was greatest for concrete content, where the mean score for the oral-plus-pictures presentation was more than double the mean score for the oral presentation. This result suggests that the supplementary value of pictures, although evident for both concrete and abstract content, may be most pronounced for concrete content.

Performance was also improved through the addition of the oral component to pictures depicting prose. However, the supplementary effect of the oral presentation to pictures, demonstrated by the performance differences between the picture-only presentation and the oral-plus-picture presentations, was less pronounced and more consistent than the oral-only versus oral-plus-presentation. The contrast between the effects of picture versus oral story supplements suggests that well-designed pictures may be more effective supplements to oral prose than oral story supplements are to pictured prose. In addition, the relative effectiveness of picture supplements may be affected by the type of information, concrete or abstract, to be learned from the presentation.

The finding that the systematically loaded picture presentation was equal in effectiveness to the oral presentation in conveying abstract content is of particular interest. These findings provide additional support for the conclusions made by previous researchers (Hannafin, 1983). The results could be related to the clarity of each medium in communicating abstract or concrete content to learners, since learner acquisition undoubtedly is affected by the clarity of the presentation medium in conveying the information. Concrete information, as defined in the present study, can be presented unambiguously in both pictures and words. Abstract information, on the other hand, may be more difficult to present unambiguously in pictures than in words because it tends to be subject to greater interpretation when portrayed in picture form. Consequently, student learning from pictures is likely to be greatest when the picturability of the content is unambiguous. Thus, picture presentations would be more effective for concrete content than for abstract content.

The manner in which information is represented internally by learners could provide a further explanation of the differences in performanc by presentation. Presentations that include combined oral and picture forms typically require less interpretation by learners and result in greater learning. In order to produce a verbal response to demonstrate the recall of information presented initially in picture form only, however, at least two steps are required. The learner first must encode the picture and then must label the picture verbally. Oral presentations do not require a transformation of the information from one form to the other since both presentation and response modes are verbal in nature (Kosslyn, 1978, 1980). Consequently, an ordering of learning outcomes might be predicted based upon the modality required to encode presented information and the modality required to produce a response to demonstrate acquisition of information. In the present study, the presentations that include both oral and picture forms resulted in the greatest learning; presentations that included only picture forms yielded the next most effective learning, and presentations that included only the oral form produced the least effective learning. This pattern was more pronounced for concrete content than abstract content, since the difference between the oral and picture presentations was significant only for concrete content. The pattern of performance by presentation group was identical for abstract content, although the difference was not statistically reliable. As suggested earlier, this could be related to the greater claity of pictures in conveying concrete content than abstract content.

The results of the analysis of relative learning of abstract and concrete content within each presentation indicate that the type of information to be learned interacts with the presentation medium. Educators frequently evaluate the effectiveness of instructional products based upon the degree to which intended learning results from the use of the products. In the present study, intended learning included both abstract and concrete prose content. Students in oral presentations recalled relatively more abstract content than concrete content, while students in picture and oral-plus-picture presentations recalled more concrete content than abstract content. The effectiveness of presentation media, therefore, appears to be affected partially by the type of information, concrete or abstract, to be conveyed to learners.

In the present study, a number of issues pertaining to the relative effectiveness of different presentation stimuli have been raised and tested. Certainly, it is unlikely that even the most enthusiastic of "picture researchers" will advocate the wholesale scrapping of oral-aural instruction in favor of visual-only instruction. It is important to note, however, that much of the cognitive psychology and human learning literature has also emphasized the functions and effectiveness of visual images in encoding, retaining, and decoding information for skills ranging from simple list learning to recall of prose facts and features. Perhaps the instructional technology profession, and the picture research component in-particular, will expand the notions of the external stimuli to include the internal processing component of learning from pictures.

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TITLE: The Use of Mental Imagery in the Problem Solving Process

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The Use of Mental Imagery in

the Problem Solving Process

by

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Abstract

Flashes of insight or mental leaps are commonly associated with problem solving. This phenomenon requires careful naturalitic methodology with a comprehensive approach that investigates the dynamics of a situation to illuminate such factors as prior knowledge, motivation, internal and external imagery, perseverance, executive processes and problem-solving approaches. It is the belief of this author that ex post facto research or experimental research does not allow for the complexity and richness of the interactions inherent in mental imagery and the problem solving processes.

When I attempted to investigate how students solved problems, I found that they had verbalized, visualized, added and subtracted information, and recalled past experiences. Students made internal representations of the puzzles presented to them and then used these internal representations for sorting through information, acting out situations, rehearsing solutions and keeping track of decisions made in the problem solving process. Students also made external representations of their internal representations. The external representations were symbols of the internal processing and provided a record of decisions made, of knowledge discovered and of solutions presented. These kinds of external representations have the potential to become records of thought to share with others in the class; therefore, I felt it important to stress to the students the need for externally representing their thoughts on the instruments provided. They could then use these external representations to share with others the thinking process involved in solving various problems.

After explanation of visual rehearsal, students had the opportunity to experience the process. Visual rehearsal, an aspect of mental imagery, is the controlled and conscious act of visualizing situations, people and behavior for planning for the future. A student might visualize the important procedures in a difficult task before actually performing that task. Results showed that visual rehearsal helps the individual to gain insight and develop problem solving schemas. With the results in mind, I developed several instruments containing visual and verbal problems to give training in the use of visual rehearsal and mental imagery.

Problem Solving

Technology and change in our society create the need to develop better methods to prepare students for the future. Gregory wrote, "These situations demand different skills: different ways of ordering, handling and seeing objects" (p. 166). No longer are remembering information or even knowing where to find it enough to keep up with our changing world. An innovative approach to help students understand and prepare for the future is the use of mental imagery in problem solving. Problem solving prepares students for changing situations. If we can get students to visualize new situations and help them become better problem solvers, then we are preparing them to take responsibility to meet the challenges of change. Conventional experimental research in visualization and mental imagery presents us with conflicting findings (Guba & Lincoln, 1982, p. 234). Paivio (1971) describes imagery as a photographic reproduction of what the subject sees. This picture taking of the mind's eye, he said, is a one-to-one correspondence to the external event. Penfield (1975) supports this theory with his experiments involving electrical probing of the brains of conscious patients during brain surgery. Patients relived earlier periods or experiences through moving-picture flashbacks. These were not dreams but sequential records of the patients' earlier experiences recorded in the brain. However, Piaget and Inhelden (1971) argue that visual images recorded in the mind depend on the active coding and perceptions of the subject. Yuille and Catchpole (1977) also believe that the active construction of images in the mind plays a role in mental imagery, that more takes place in a person's mind than just a recording of external stimuli. Naturalistic inquiry offers an alternative approach for the study of mental imagery and problem solving that may provide a more complete explanation.

Rationale for Naturalistic Inquiry

In recent years there has been a growing interest in qualitative or naturalistic methods of research that involve watching, talking to, listening to and participating with subjects in natural settings to gain knowledge of an insight into human learning and behavior. Qualitative research allows for innovative styles and methods in collecting broader explanations of phenomena.

Some critics have said that qualitative (or naturalistic or ethnographic) research methodologies are less scientific and easier to do than quantitative ones. In fact, qualitative researchers have the same concerns about reliability and validity that quantitative researchers have and, far from being easier to do than quantitative research, qualitative research can be more difficult to do if the researchers uphold quality standards. Furthermore, as those in the qualitative camp have charged, the quantitative research methods of control of specific variables and manipulation of other specific variables lead to possible questions about external validity; that is, the findings and conclusions of one experiment with a selected group may not apply to another group. Thus, both methods of research have their limitations. With the limitations of qualitative research in mind, let us look at one method in which students attempted to solve problems through mental imagery.

In his book, <u>Pedagogy of the Oppressed</u>, Paulo Freire (1970) provides an example of this naturalistic approach. Freire used photographs with subjects to encourage dialogue which resulted in action to bring about conscientization in the minds of oppressed people. Inherent in Freire's approach is the rejection of authoritarian teaching, a feeling of trust acquired through learners' participation, the seeking of truth and a call for cultural expression and action. Perhaps the "human-as-instrument" characteristic that Guba and Lincoln (1982, p. 235) described could be met by adopting the Freire approach.

Freire (1970) developed a philosophy of teaching and learning based on the conviction that every human being is capable of looking critically at his or her world in a dialogical encounter with others. Given an active, participatory role in his or her education a student could perceive his or her reality and be able to deal with that reality with confidence and dignity. The key to the Freire (1970) approach is active, rather than passive, involvement in learning.

Participatory learning through mental imagery and problem solving allows the naturalistic researcher to gain insights into learning behavior by examining students' sketches and discussing them with the students. Students often act out or keep track of their internal thoughts in order to solve the visual puzzles and verbal problems given to them. Students can then use these internal thoughts as data to share with other students. Asking students to become participants in problem solving allows them to learn how each thinks and learn the steps of mental processing that lead to finding solutions to the problems.

Mental Imagery in the Classroom

There is a growing amount of research on visualization, mental imagery and relaxation techniques that is applicable for naturalistic inquiry. Some researchers have used the stress-free and fast learning technique of Georgi Lozanov called suggestology (Ostrander & Schroeder, 1979). Suggestology is a holistic approach to learning that uses relaxation and concentration techniques, visualization, Baroque music and breathing exercises to learn foreign languages, memorize information, improve self-image, prepare for sports events and solve intellectual and emotional problems. Simonton (1978) in his book, <u>Getting Well Again</u>, describes how positive attitude, relaxation, imagery and exercise are used for treating cancer patients. Simonton (1978) describes how patients form mental pictures of white blood cells killing cancer cells and then carrying them out of the body through the liver and kidneys. In the mind's eye the patients visualized the cancer decreasing in size and the body tissue returning to normal.

Imagery can play an important role in learning. Teaching with visualization can help students design materials, prepare for presentations, understand and retain information and gain control over their learning. Visual thinking involves seeing the external world, making visual representations of that world and using the inner eye or exercising mental imagery. Mental imagery is the ability to create images in the mind to understand, remember and enjoy experiences. We create images in our minds to organize, simplify and explain our experiences. Our interpretations of those experiences are based on our ability to "see" external stimuli and use the "inner eye" to interpret our world.

The value of imagery is that it can be applied directly in the classroom (Fleming & Hutton, 1983). Problems and the act of solving problems are common experiences in the study of all disciplines. In my work, I plan to have high school students apply mental imagery in a college reading course and middle school students to a science course. In both cases, I plan to introduce mental imagery and problem solving into the existing curriculum and teaching practice with minimum interference with the natural setting of the classroom.

Research Possibilities

The research on mental imagery and problem solving will involve three basic activities: 1. learning to visualize; 2. using images (internal and external) to solve problems; and 3. using mental rehearsal to conduct science experiments or take tests in a college reading course.

I. Learning To Visualize

The subjects will see a slide program as an introduction to visualization and will learn to see and read visual illusions and visual symbols through the slide program. The students will also learn to communicate visually through overhead transparencies, slides, and videotapes they make. This activity is called the "participatory instructional design approach" (Hortin, 1983).

Participatory instructional design means that students become involved in the instructional design process at a more intensive level than is usually the case. Participatory design is a sharing of the thinking processes with the rest of the class -- a "participation" from all who are involved in the experience. The students become their own instructional designers and learn to make their ideas visible with materials provided by the school.

Here are six steps that I will ask my students to use in order to develop materials for the classroom:

1. Affirm you visualization abilities.

2. Assume a relaxed state.

3. Read the problem and data you will treat.

4. Visualize the idea, problem or data (internal representations).

5. Immediately write down, act out, record, sketch, or design the images you see (external representations).

6. Evaluate the instructional materials as a group.

Also, I will discuss with the students the practices and research on mental imagery of the following authors:

Arnheim, R. Visual thinking. Berkeley and Los Angeles: University of California Press, 1969.

Bry, A. Visualization: Directing the movies of your mind. New York: Barnes & Noble Books, 1978.

Edwards, B. Drawing on the right side of the brain. Los Angeles: J. P. Tarcher, 1979.

Gregory, R. L. The intelligent eye. New York: McGraw-Hill Book Company, 1970.

Hortin, J. A. Visual literacy--The theoretical foundations: An investigation of the research, practices and theories (Doctoral dissertation, Northern Illinois University, 1980). Dissertation Abstracts International, 1980. (University Microfilms No. 81-11564)

Ihde, D. Experimental phenomenology: An introduction. New York: G. P. Putnam's Sons, 1977.

McKim, R. H. Experiences in visual thinking. Monterey, California: Brooks/Cole, 1972.

Patten, B. M. Visually mediated thinking: A report of the case of Albert Einstein. Journal of Learning Disabilities, 1973, 6 (7), 15-19; 420.

Samples, R. The metaphoric mind: A celebration of creative consciousness. Reading, Massachusetts: Addison-Wesley Publishing Company, 1976.

Wendt, P. R. The language of pictures. In S. I. Hayakawa (Ed.), The Use and Misuse of Language. Greenwich, Connecticut: Fawcett Publications, 1962.

Whimbey, A. & Whimbey, L.S. Intelligence can be taught. New York: Bantam Books, 1975.

Wileman, R. E. Exercises in visual thinking. New York: Hastings House, 1980.

Williams, L.V. Teaching for the two-sided mind. Englewood Cliffs: Prentice-Hall, 1983.

Finally, a shortened version of the Betts' Questionnaire by Sheehan (1967) will be given to the students. This instrument measures a general ability to image in a number of sensory experiences.

II. Using Images for Problem Solving

In the second activity I will show students how to use images of the mind for problem solving. I want the students to "see" situati internalize visually the data given, devise a plan for finding the solution and solve the problem.

In the past when I have attempted to investigate how students solved problems, I found they verbalized, visualized, added and subtrac information, and recalled past experiences. Students made internal representations of the puzzles presented to them and then used these internal representations for sorting through information, acting out situations, rehearsing solutions and keeping track of decisions made in the problem solving process. Students also made external represen-tations of their internal representations. The external representati were symbols of the internal processing and provided a record of deci made, of knowledge discovered and of solutions presented. These kinds of external representations have the potential to become records of thought to share with others in the class; therefore, I felt it impor to stress to the students the need for externally representing their thoughts on the instruments provided. Students could then use these external representations to share with others the thinking process involved in solving various problems. Sample questions from the instruments include the following:

1. If Tom is shorter than Dick, and Harry is taller than Dick, is Tom taller or shorter than Harry? (Albrecht, 1980, p. 43)
2. My house faces the street. If a boy passes by my house walking toward the rising sun, with my house at his right, which direction does my house face? (McKim, 1972, p. 15)
3. A dwarf lives on the twentieth floor of a skyscraper. Every morning he goes into the lift [elevator], pushes the correct button, and is taken to the ground floor; he goes off to work and comes back in the evening. He enters the lift, pushes the button, and goes up to the tenth floor; he then walks up the rest of the stairs. The question is: Why doesn't he go up to the twentieth floor in the lift? (Eysenck, 1966, p. 9)

Most students solved the first question by drawing stick figures and discovering that Tom must be shorter than Harry. The second problem found students drawing a map to arrive the answer (north). The third question caused students to visualize the scene and see that the dwarf cannot reach higher than the tenth button on the elevator.

Another instrument asked students to identify a sequence of figures, perform closure exercises, identify hidden figures, judge distances of lines and move figures in patterns from one position to another.

III. Mental Rehearsal

One aspect of mental imagery that students can find useful is the act of mental rehearsal. Students, like all people, often think about the consequences of certain behavior and decide for or against that behavior. Since they are accustomed to this process, students can learn to use images or scenes in the mind to help them make decisions and plan their school work. For instance, in my future research I plan to have the science students mentally rehearse their experiments before they perform them and to have the students in the reading course practice mental rehearsal before taking a test.

I believe that experimental research is limited in describing and documenting comprehensively the imagery process and subsequent learning behavior. A well thought out research plan involving both experimental and naturalistic methodologies is the best approach. The intention of this paper was to share some activities for possible research with the mental imagery process that involves participation by students in a natural setting.

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TITLE: Structure As a Source of Meaning Within AudioVisual Messages

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Structure As A Source of Meaning
Within AudioVisual Messages

Denise Kervin
Dallas January 21, 1984

In my presentation, I will be discussing work done for my dissertation structural aspects of television messages. I will provide a brief overview the theory that underlies my study and a slightly less brief overview of my methodology and research tools, which I believe will be of interest to anyone doing observational research. I will conclude with a mention of preliminary results from my study and recommendations for future research.

The main focus of my work is the interaction between structure and content in the creation of meaning. Current theory in our field holds that, ideally, the medium chosen to teach must match with the information and task to be learned, and with the student doing the learning. It is the structural characteristics of a medium, its particular formal means of communicating, that helps to decide if it is used. Thus, for example, if film or video is chosen that decision should be based in large part on their structural elements, that is, on their ability to show motion, juxtapose images, portray action from various angles and distances, and so on.

Gavriel Salomon has done very important work in this area, found particularly in his book, <u>The Interaction of Media, Cognition, and Learning</u>. Salomon's own experiments and others that he draws upon show that the structural characteristics of a medium interact with the content of a message and ultimately affect meaning. For example, Salomon found that the structural element within film and video whereby the camera zooms into a detail within a larger whole conveyed different information than the same content presented using other formal characteristics, such as cutting from the whole image directly to the detail.

Salomon concludes that structural characteristics can act as both carriers of information and as information in their own right. Calvin Pryluck is also interested in the form of media in his book, <u>Sources of Meaning in Motion Pictures and Television</u>. He concludes that meaning derives, first, from the intrinsic properties of <u>what</u> is recorded by a camera --the thing in the world; second, meaning comes from the ways in which that thing is photographed, in other words the use of structural elements in its presentation; and, third, meaning derives from the interaction between this content and form.

An example of the interaction between structure, content, and meaning should make this clearer. Imagine a film designed to develop young children's self-esteem and self-image. Depending in part upon how the content is structurally presented, the film may or may not achieve its goal. For instance, if the children within the film were always photographed from a high angle, as they are normally seen by adults, the aim of improving the self-esteem of young viewers might be jeopardized. That is, while the film aims to make the audience of children feel like important individuals in their own right, the particular formal element of a high angle is implicitly showing the children within the film as small and insignificant compared with adults. Thus, a structural choice within the presentation of the film may relay a message to the young viewers that conflicts with what the film wants to say.

This example points up both the importance of studying the structure of messages and how structure affects meaning. Research into how form actually affects meaning, however, has neither been extensive, nor in complete agreement. Most studies on formal elements such as camera angles do indicate an interaction between structure and content in visuals. Unfortunately, such research has only looked at single, isolated elements without regard to the other structural characteristics at work in messages.

In my research I wanted to examine certain of the most important structural elements within televised messages, both as they were individually used, and as they combined together. A second concern was to determine if these elements were used consistently in the same way, or if they changed over time. The consistent use of formal elements within the presentation of the same content is, I believe, fundamental to the impact of that structure. In the example of the film to build self-esteem, the strength of the negative message being sent to a young audience would seem to depend upon whether that message was reinforced by structural characteristics other than the camera angle, by whether similar or different messages were presented within other sources, and by the length of time over which the children were exposed to the negative message.

This examination of structural elements formed the first part of my study, and was based on quantitative data recorded during an observational analysis of videotaped messages. The second part of my study was to see how that form interacted with the content of those messages. This part of my analysis could not be done using a quantitative methodology, but only through a qualitative examination of how the form and content interacted to create meaning. For both the quantitative and qualitative sections of my study I relied on the research mentioned earlier. For the most part, however, my theoretical base and methodology derived from semiotics, which I will discuss shortly.

As my sample I chose five years of television news coverage by all three commercial networks on the fighting in El Salvador. The news stories in my sample totaled 137, with a total time of 2 hours and 48 minutes. The news reports were compiled by the Vanderbilt University Television News Archive. This choice of sample material came from an interest in the formal aspects of television, particularly television news reporting, and from the ability of such a sample to provide a series of messages on the same general topic spanning a considerable length of time. This allowed an investigation of how structural elements were used at any one time and over a five year period.

Turning now to semiotics, I can provide only a very brief introduction to this complicated subject. The concern of semiotics is signs and the codes used to organize those signs. A sign, according to Charles Peirce, an early semiotician, is anything that "stands to somebody for something in some respect or capacity." (quoted in Hawkes, 1977: 126) Thus, a word is a sign, as is a picture. Television messages are composed of a multitude of different signs, organized through various codes. Codes act something like a grammar within a medium. For example, within film and video there exist codes related to editi as in the use of a dissolve to indicate that time has passed between two shots. Codes are involved both in how signs are put together to make sense and in how they are interpreted. My study focused on the initial part of this communica process, on how structural elements were used by newsworkers, those decisions being a product of different codes, and how that usage interacted with the con tent to affect meaning.

The first section of my study, then, was to observe and record formal cha acteristics in a sample of news stories, primarily in the visual track. I was mainly interested in how the structure of visuals affects meaning; the structu of the aural track would be studied only in how it interesected with the images. As to the particular formal characteristics chosen, I relied on information a general newswork routines and on film theory and practice. The elements were grouped under the code that determines their usage. For example, it is a cod editing that decides whether two images will be joined by a cut or a wipe. Ce tain elements were further clarified, such as that pans were to the left or ri and tilts were up or down. A partial list of the main formal elements studie follows:

Editing (cuts, dissolves, wipes)
Camera Work:
- Angle (high, low, eye-level)
- Movement (pan, zoom, track, tilt)
- Distance from camera to subject

Visual/Aural combination (e.g. a voice-over)

How these formal characteristics were used within my sample of news stor was one focus of inquiry. Equally important was how these elements interacte with the content of the reports to produce meaning, requiring that a certain amount of information about what went on in the stories be recorded. Using t shot as my basic unit of analysis, I collected data about the main subject, action, and location of each shot. The particular categories within subject, action, and location came from my own interests and from what was found in th sample. I viewed approximately one-third of the news stories to determine if the particular structural elements and content categories chosen were actuall being used. Minor adjustments were made on the basis of what I found.

Turning now to the actual recording of the data from the videotaped stor it is obvious that I wanted a great deal of information. I also wanted to re it in the same sequence and temporal order as it occurred in the reports. Fo example, I wanted to be able to record that the anchor spoke for ten seconds, then a reporter began a voice-over, while four civilians carried a coffin in a five second shot, and so on.

To accomplish such data collection by hand would have been prohibitivel time-consuming. Luckily, from work done on video narratives by Professor An Becker at the University of Wisconsin-Madison, I was aware of a set of tools can be used to efficiently and with amazing detail record observational data. These tools were developed by Gordon Stephenson, also at Madison, initially f field observation of animals. Information about a situation is entered onto portable keyboard that sends it via a short cable to a cassette tape recorder. When filled, these tapes are decoded by a computer where the data is checked errors and undergoes statistical analysis. Stephenson also had plans to adapt his computer programs for use on an IBM personal computer and also to substitute a portable microcomputer using micro-cassettes for the more bulky keyboard and cassette recorder.

Before taking any data, the researcher must carefully define the situation to be observed, recording that information in a computer program called Plexyn. This is a complex process; put very simply, the researcher must decide on the dynamics within the observational situation, the logic that underlies it, and relay that information to Plexyn. Plexyn then uses that information to check the recorded data for errors, giving a fairly detailed description of the mistakes it encounters.

In the process of recording data, the researcher follows a form of entry similar to the structure of a sentence in English, that is: subject-action-object-location. Thus, someone, or something, performs an action, often in relation to another person or thing, and in a particular place. Besides these basic pieces of information, the researcher can also include the positioning of the subject and object in relation to the observer and to each other, and modifiers can be added for even more data.

The data is entered in brief letter and number codes whenever an action occurs, or the situation under observation changes. For example, following are examples from my study of coded entries and their English equivalents:

1Ø-4Ø4 The anchor reports to the camera in a medium shot (includes the head and torso)

W-2Ø4J A government soldier moves right in a medium shot within the jungle

% ST-6Ø7VS Five civilians stand facing left on a village street, in a long shot (includes the entire body)

The data gathered need not be as dense as the above and definition of the categories is also very flexible. For instance, I designated the news camera as a subject and structural elements such as pans and zooms as actions. It does take some time to learn the use of the keyboard, as well as the coding procedure. The benefits lie in the amount and richness of the data one is able to record quickly and in having an error-detector for that data as well.

Once data is gathered, the tapes are decoded on a computer and the resulting output contains descriptions of any errors made, which can then be edited out. Finally, a statistical program is used, offering such information as total frequencies and durations, as well as high, low, and average duration, and the percentage of the total time taken up by each variable. The data collected can also be analyzed using other computer programs, such as SPSS.

I am currently in the process of working through the enormous amount of data from my observational study. To touch on only one structural element analyzed, camera movement, I have found both similarities and differences among the three networks. For example, ABC has the camera either pan, zoom, track, or tilt every nine and one-half seconds, while CBS, and NBC use camera movement about every ten seconds. More specifically, ABC and NBC use the same number of zooms, while CBS uses more. How these zooms are used within the news stories is, however, similar across the three networks. Generally, a zoom in focuses on a subject of a shot, or on a symbolic detail, such as a bombed building or a leftist banner. Zooming out involves the opposite process as the camera first focuses on a detail and then widens out to place it into context. The basic question of my study is what effect does a structural element such as a zoom in or out have on the particular content it conveyes.

Thus, my study moves from a quantitative analysis of the use of formal elements within the news reports to a qualitative examination of how these characteristics interact with the content they convey. It is in this interaction between form and content that, as Pryluck concludes, meaning arises. To analyze this interaction I relied upon semiotic theory, particularly on the concepts of denotation and connotation.

These twin concepts involve how form and meaning operate within messages. Very simply put, every message has two levels of meaning, the denotative and the connotative, which are inextricably intertwined for receivers of messages. The denotative level includes the overt form, content, and meaning of a message. For example, a picture of a child on the denotative level means simply that particular child, at that particular point in time. Connotative meanings derive from the denotative level, but are more diffuse and covert. Connotations result from the interaction of form and content on the denotative level. For example, if the picture of the child is taken from a high angle, the connotations will be different from those in a picture of the same child taken at eye-level. The primary theorist in semiotics to advance the idea of connotations was Roland Barthes, although the general concept of implicit meaning is widely held within media criticism.

The leap from statistical data drawn from observation to interpretation of implicit meanings may seem a fairly precarious one. Within semiotic theory, however, it is not only justifiable, but necessary to examine both levels of meaning that go to make up the total meaning of a message. Semiotic theory holds that these two levels are inseparable, are two levels of the same phenomenon and therefore must both be studied. My study assumes that examining messages both quantitatively and qualitatively is more complete and fruitful than using either methodology alone, offering a richer analysis of the interaction of form, content, and meaning.

In conclusion, I would like to point out that my study is only the first part of a truly complete analysis of how structural elements function and their effect on meaning. It is also necessary to study audience reaction to these elements and, in doing so, attempt to take into account all levels of meaning inherent in messages. In addition, a concern for the implicit meanings within media as a function of form is not the province of theorists and researchers alone. If, as I have argued, meaning is affected by the interaction of content and form, then we as educators must be as aware of the form of a message as we are of its content.

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TITLE: Practical Strategies For Encouraging Research in Computer-Based Instruction

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PRACTICAL STRATEGIES FOR ENCOURAGING RESEARCH IN COMPUTER-BASED INSTRUCTION

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INTRODUCTION

The widespread use of microcomputers in schools which began in the first part of this decade signalled a new era for educational computing research. Before this movement, most studies of computer-based instruction were limited to large-scale, centralized projects such as the Stanford math and reading (Fletcher & Atkinson, 1972; Suppes & Morningstar, 1972), Computer Curriculum Corporation, (Lysiak, Wallace & Evans, 1976; Crandall, 1977; Holland, 1980), Control Data PLATO (Alessi, Siegel, Silver & Baines, 1982-83; Poore, Qualls & Brown, 1981), and TICCIT (Jones, 1978) programs. These studies were usually performed as grant-funded projects with a research and evaluation component built into them. But with the acceptance of low-cost computing in schools and the explosion of new computer-based materials, the opportunities for research in this area have greatly expanded and changed in nature. Small school and classroom-based programs have been started throughout the country. Not only do studies of these programs have the potential for making a significant contribution to the field, they are, in fact, essential if we are to make any progress in establishing the usefulness of new computer-based methods and materials.

However, since the focus of these educational computing projects is often implementation rather than research, at least two factors are likely to inhibit systematic studies of their activities. First, there are practical difficulties in arranging research studies with the traditional randomized two-group designs in these settings. Secondly, project personnel usually lack the expertise to employ other effective designs and analyze the resulting data. If we are to take advantage of the valuable information available from classroom computer projects, alternative designs to study computer-based activities must be employed, and "cookbook" data analysis methods for each design must be made widely available. This paper will:

- Present five designs (three one-group and two two-group) which can be effectively employed to study computer-based methods when a randomized two-group experimental design is not practical,

- For each design, give examples of research studies which effectively employ such designs,

- Supply example utility programs and procedures which can be used by persons with limited training in statistics and research methods to analyze data resulting from these non-traditional designs, and finally,

- Give a decision flowchart and describe how to select the most appropriate non-traditional design for one's project.

FIVE NON-TRADITIONAL RESEARCH DESIGNS

Design #1: Sequential Analysis

Sequential analysis techniques originated almost forty years ago (Wald, 1947), but, with few exceptions, they have been used for quality control of products rather than to analyze results of research studies. However, they can also be used to construct an effective behavioral research design. In such studies, all sequential analysis techniques would employ the same strategy: (a) an observation would be made (e.g. one or more students are tested on some skills), (b) the results are recorded on a chart or graph developed for this purpose, and (c) by reading the chart, a decision is made to accept the null hypothesis, to accept an alternative hypothesis or to make another observation.

This technique has many advantages for computer-based studies besides not requiring a control group. Its principal advantage is efficiency. As a sampling technique, it can allow decisions to be made with as much as 50% fewer observations than would be required for procedures in which sample size must be specified in advance. This makes it an ideal choice when the number of people which can be tested on the materials is limited by factors such as the number of computers available or by constraints such as not being able to get the whole student group at one time or the expense of the treatment.

There are some limitations on when it can be effectively used. Since there is no control in this design for prior learning, it is better to use it when there is little likelihood that students would be able to do the skills involved <u>before</u> exposure to the materials, as with programming concepts or verbal information drill such as in social studies or history. It is also desirable that the skill units be relatively short, to cut down on effects due to maturation and history (Campbell and Stanley, 1963). If the materials under study are lengthy, they can be divided up into short units, and a sequential analysis can be done on each one. This technique is also most useful when teachers want to make an absolute judgement about materials ("Are these computer-based lessons effective?") rather than a comparative one ("Are these lessons better than non-computer lessons?")

<u>Example of sequential analysis use.</u> A typical study using the sequential analysis method is currently being undertaken by the U. S. Army to evaluate the effectiveness of microcomputer/videodisc training materials. The modules were designed to teach specialist students to perform a lengthy and

expensive procedure for testing the purity of jet fuel. No other training is currently being given, so no control condition is available. Effectiveness is to be defined in terms of the proportion of students who successfully complete the simulated task in no more than two trials. Based on the experience of the faculty of the school in training similar students on similar tasks, that proportion is determined to be at least .80. After this proportion is set, the following steps are to be completed.

<u>STEP 1: Setting acceptable/unacceptable quality levels</u> - Since absolute accuracy in judging instructional quality cannot be achieved with a sampling technique, the success proportion (.80) must be translated into a range of proportions which define acceptable and unacceptable instructional quality. In this instance, the range is set at .80 plus or minus .10. The Acceptable Quality Level (AQL) or the proportion of the population which indicates acceptable quality, is .90. If 90% or more of the students in the population can meet te success criterion, the instruction is considered to be of high quality and accepted for routine use. The Rejectable Quality Level (RQL) or the proportion of the population that indicates unacceptably low quality, is .70. This means that if only 70% or fewer of the students can meet the success criterion, the instructional is rejected as unacceptable. If the proportion alls between .70 and .90, the instruction is of questionable quality.

<u>STEP 2: Setting risk parameters and proportions</u> - The probablity of rejecting high quality instruction (alpha) and the probablity of accepting low quality instruction (beta) must be set. Because obtaining high quality instruction is very difficult, the probability of rejecting wrongly it must be very low, thus alpha is set at .01. Mistakenly accepting low quality instruction for quality instruction is not deemed to be very serious because it can always be remedied later, thus Beta is set at .10. One more calculation is necessary. Since sequential analysis was originally designed to detect <u>proportions</u> of defective units, p(1) and p(2) must be calculated, respectively, as 1-AQL and 1-RQL.

<u>STEP 3: Construct Operating Characteristics Curve (OC), Average Sample Size Curve (ASN) and truncation number</u> - Now we have all the values to construct (a) an OC Curve, which will show the probability of rejecting or accepting the null hypothesis for any true value of the success proportion under consideration (given the specifications of the test), (b) the ASN, which gives the average number of observations needed to reach a decision for any true value of the success proportion and (c) the truncation number, which is the largest sample size that could be needed to make a decision without altering the risks the experimenter is willing to accept. Figures 1 and 2 illustrate the OC and ASN curves with sample data. The truncation number is 113. The slope and intercepts for the lines in the figures, as well as the truncation number, are calculated from the values derived or set in Step 1 above. (For further directions on how to calculate values, see Wald (1947), Burr (1980) or Epstein (1979).

[Figures 1 and 2 about here.]

Figure 1 (the OC) shows that, for very high quality instruction (p <.10), the probability is almost 1.0 that it will be accepted (i.e., the null hypothesis that p > .30 will be rejected). For very low quality instruction (p < .30) the probability of rejecting the null hypothesis (i.e., accepting the instruction) drops from .10 to almost zero as p increases. For values of p between .30 and .10, the probability of rejecting the null hypothesis varies from .99 to .10. If the population proportion is .20 (1-.80), for example, the probability of rejecting the null hypothesis is about .64.

Figure 2 (the ASN curve) shows that the largest average number of observations (38) required for a decision to be made occurs when the population proportion (p) is equal to .20. As p varies on either side of .20, the ASN decreases. The truncation number represents the worst possible case in which 113 subjects would have to be observed before the null hypothesis would be accepted or rejected.

<u>STEP 4: Construct graph for recording observations.</u> The graph for recording observations contains three zones corresponding to the three possible decisions which are considered each time an observation is made (to reject, accept, or take more samples). The actual decision choice is determined by the pattern of recorded data. A graph of sample data is shown in Figure 3.

[Figure 3 about here.]

The data were placed on the graph in the following way. The first student is tested and if the student passes, a line is drawn horizontally from 0 to 1. If the student fails, a horizontal line is constructed from 0 to 1 and a vertical line drawn from 1 to 1. Both points are in the zone labeled "continue sampling," so another student is tested and the results placed on the graph in the same way. This process continues until either the bottom line is crossed and the decision is made to accept the instruction (reject the null hypothesis), or the upper diagonal line is crossed and the decision is made to reject the instruction (accept the null hypothesis). If sampling continued until the truncation number was reached, the instruction would be accepted if the last point were nearer the bottom diagonal than the top diagonal, or it would be rejected if the opposite prevailed. In Figure 3, the first eight students passed, the ninth failed, the next six passed, and the decision was made to accept the instruction.

<u>Program to do sequential analysis calculations.</u> A utility program to do the necessary calculations mentioned in Step 3 above is given in Appendix A. The experimenter must enter AQL, RQL, alpha and Beta. The program can produce:

1) The intercepts and slope for both the upper and lower lines of the acceptance/rejection regions.
2) The truncation number
3) A table of values of the coordinates to plot an OC.
4) A table of values of coordinates to plot an ASN curve.

Design #2: Value-added Analysis

The basic idea underlying this model is that the effect of a treatment can be estimated by comparing the average observed growth between pretest and posttest with the estimated growth which is expected to occur in the absence of a treatment (Bryk & Weisberg, 1976). An unbiased estimate of the estimated growth rate can be provided via ordinary least squares regression of pre-test on the subject's age, if age at the time of pretest is not related to systematic growth. When growth (estimated from cross-section of the total population) is not linear, transformations must be made before value-added analysis can be completed.

Many computer-based treatments deal with such areas as reading and writing skills, motor skills development and increasing problem-solving ability through use of tools like LOGO. Study of such treatments is difficult because treatment must extend over a long period of time in order for measurable differences to occur, giving rise to the possibility of effects due to maturation and history. The value-added analysis is ideal for research into these long-term activities since it controls for these effects.

Certain conditions must, however, be present. An independent variable which can be measured without error (i.e. chronological age) must be available, and it must be correlated with pretest scores. Also, a large enough number of students must be available to be able to do a product-moment correlation.

<u>Example of value-added analysis use.</u> This procedure was used in a study of a microcomputer-based reading and writing program in grades K-1 (Garretson, Vertuno, King and Roblyer, 1982). All students in these grades (approximately 100) were to receive the computer-based instruction, which was to take place over the school year. Several measures were used to measure skill levels, including a Nonsense Words Test devised by the school resource teacher, and several subtests of the California Test of Basic Skills. The value-added analysis was used with the Nonsense Words Test. (Analysis methods for the other test will be discussed later under another design.) The following steps were completed:

<u>STEP 1: Estimate of growth rate.</u> First, an unbiased

estimate of growth (G) was obtained. This is done by regressing pretest scores on age and using the resulting regression coefficient (b) as the estimate of growth rate, then using the following formula:

$$G = \bar{y}_1 + b(a_2 - a_1)$$

where $\bar{y}(1)$ is the pre test mean and a(2) and a(1) are the ages at pre and post test times.

<u>STEP 2: Calculate value added.</u> Use the following formula to determine the effect of the treatment, taking into account the natural growth of students over time:

$$V = \bar{y}_2 - G$$

where $\bar{y}(2)$ is the post test mean.

Unfortunately, no test of the significance of V exists. However, Bryk et al. (1980) pointed out that the jack knife technique (Mosteller and Tukey, 1977) can be used to provide a test statistic. It involves the computation of a pseudo-value (V*i) for each individual in the sample, treating these values as data points, and calculating their mean and standard errors. The mean is an unbiased estimate of V and the standard error allows the calculation of a t-test (df = N-1) for significance testing or interval estimation. In the K-1 study, this yielded the following results:

$$V = 35.3 - 21.3 = 14.00$$

$$t \text{ ratio} = 5.36 \qquad p < .05$$

To increase the precision of this model, Bryk et al (1980) also describe how it can be extended to incorporate background variables that may be related to individual growth rates. This is done by regressing the pre test on age and the first order interactions of age and each background variable.

<u>SPSS procedure to do calculations.</u> The listing of an SPSS program to do the above calculations is shown in Appendix B.

Design #3: Non-equivalent Dependent Variables

This design involves one group of subjects to which two (or more) variables are administered as pretests. Performance on one of the variables is expected to change as a result of a treatment, while the others are not expected to change (Cook and Campbell, 1979). Such an approach has two advantages. First, no non-treatment control group is needed, since performance on one variable acts as a control for the other. Second, older students can be used since, unlike the value-added analysis, no independent variable such as age is required. The basic design is diagrammed as:

$$\begin{array}{ccc} \emptyset_{1A} & X_{A} & \emptyset_{2A} \\ \hline \emptyset_{1B} & & \emptyset_{2B} \end{array}$$

where Ø(1A) and Ø(2A) are pre and post tests for the variable that is hypothesized to be affected by the treatment and Ø(1B) and Ø(2B) are pre and post tests for the variable hypothesized <u>not</u> to be affected.

In order to be sure this design will be credible for the situation, the researcher must (a) specify in advance which variables are expected to change and which are not; (b) demonstrate that differential change is not due to differential reliability of measures or to ceiling/basement effects; and (c) use variables which are conceptually so similar that both would be equally affected by the same threats to internal validity, namely maturation and testing.

For example, suppose a school wanted to evaluate a computer-based module on birds and mammals, and they also had available a test on reptiles. Students could be given pretests on both units, instruction on the birds and mammals units only, and then post tests on both units. If statistically and educationally significant changes occur on the birds and mammals unit but not on the reptiles test, the birds and mammals unit is judged to be effective. Of course, they would have to be satisfied that the reptiles test was not more unreliable that the other one, and that students were not already scoring at the ceiling of the reptiles test at the time they were pretested. In addition, the investigators would have to be satisfied that the change in the bird and mammals test was not due to some learning experience other than the modules, such as a television show about this topic during the treatment period.

Cook and Campbell (1979) point out that this basic design is weak because it is hard to be certain that all conditions necessary for its validity have been met. However, it can be made much stronger by increasing the number of measurement "waves" or the number of variables. This also presents an excellent design evaluating two or more modules <u>at the same time.</u> In this expanded design, instruction on one variable is given, followed by testing on all variables. Then instruction on the next module is given, followed by testing on all variables, and so on. This design may be shown as:

$$\begin{array}{cccccc} \varnothing_{1A} & X_{A} & \varnothing_{2A} & & & \\ \hline \varnothing_{1B} & & \varnothing_{2B} & X_{B} & \varnothing_{3B} & \end{array} \text{ etc.}$$

If the expected pattern of change occurred, the conclusion concerning the effectiveness of both units would be relatively strong. If the expected change between Ø(1A) and Ø(2A) occurred but the expected change between Ø(2B) and Ø(3B) did not occur, the conclusions about the effectiveness of either unit would be uncertain. Steps in analyzing data from such a design are as follows:

<u>STEP 1: Determine pre-post differences.</u> Means are determined for each groups' test results and a difference calculated between each:

$$D_1 = \varnothing_{2A} - \varnothing_{1A} \qquad D_2 = \varnothing_{2B} - \varnothing_{1B} \qquad D_3 = \varnothing_{3B} - \varnothing_{2B}$$

<u>STEP 2: Determine significance of differences.</u> A t-test is done between each pre and post test pair to determine if post test scores were significantly different from pre test scores.

<u>STEP 3: Compare results or groups.</u> If D(1) and D(3) are significantly significant and D2 is not, the instruction for the two modules under consideration can be said to be effective.

Berquist and Graham (1980) expanded this design to allow the evaluation of instruction of many objectives over many waves of measurement. Their design is shown in Figure 4 below. They point out that this approach is useful to evaluate instruction with single students as well as groups.

[Figure 4 about here.]

If more than one unit of instruction is to be evaluated and the group is sufficiently large (e.g. 60 students), this design can be converted to a powerful true experimental design which does not require a non-CAI control group. Where instruction can be individually administered to each student (as with CAI), the following design could be used:

$$R \quad \emptyset_{1A} \quad \emptyset_{1B} \quad X_{A} \quad \emptyset_{2A} \quad \emptyset_{2B}$$

$$R \quad \emptyset_{1A} \quad \emptyset_{1B} \quad X_{B} \quad \emptyset_{2A} \quad \emptyset_{2B}$$

Here, students must be randomly assigned (R) to treatment groups (Xa or Xb) and pre and post tested with both unit tests (Ø1A and Ø1B).

<u>Example of true experimental design involving non-equivalent dependent measures.</u> One study using this design as part of its total evaluation program was the ETS/LAUSD study of computer-assisted instruction and compensatory education (Ragosta, Holland and Jamison, 1982). Schools in the Los Angeles Area School District used math and language CAI available from the Computer Curriculum Corporation. In Grade 4 students were randomly assigned to receive two sessions of CAI daily. They received either: (a) two sessions of mathematics (MM), (b) one session of reading and one of language arts (RL, or (c) one session of mathematics with one session of reading or language arts on alternate days (MRL). All students were pretested in the fall with the Iowa Test of Basic Skills (ITBS) and a curriculum-specific test (CST) in mathematics, language and reading. They were posttested the next spring with the California Test of Basic Skills (CTBS) and the CST. Thus, the students were controls for evaluating the effectiveness of two levels of mathematics instruction (MM and MRL), while the MM students were controls for the evaluation of two levels of reading (RL and MRL). A regression analysis was used to analyze the data. These analysis procedures are the same as those used in Design #4 which follows.

This design is really better in some ways than one having a non-CAI control group because it is a better control for Hawthorne effects. The novelty of the CAI experience is the same for both groups so that the computer aspect alone cannot be expected to produce significant achievement differences between groups.

<u>Design #4: Regression-Discontinuity</u>

Although this is the one design which actually calls for a no-treatment control group, the regression-discontinuity design is especially useful when compensatory or enrichment programs are to be evaluated. This is so because of its requirement that students be pretested and all students below (or above) a certain percentile be placed in a treatment group All those above (or below) the cutting score (i.e. those who would not be eligible for the program anyway) comprise the control group. At the end of the treatment time, the postest is administered to all those who received the pretest, and a "dummy" treatment variable is constructed by assigning a score of "1" to each member of the treatment group and a "0" to each member of the "non-treatment group." Finally, a regression analysis is done using the following model:

$$\hat{Y} = a + b_1 T + b_2 Pre$$

where $\hat{Y}$ is the adjusted posttest score, T and Pre are the treatment and pretest variables, a is the regression intercept, b(1) is the difference between the adjusted means of the treatment groups, and b(2) is the regression coefficient for the pretest. If b(1) is statistically significant, the treatment is effective.

The principal advantage of the regression-discontinuity design over other quasi-experimental designs is that it is not biased by errors of measurement in the pretest. That is, in the absence of a treatment effect, the expected posttest adjusted mean difference is zero. That is not true in designs in which unknown selection variables operate in the formation of treatment and control groups.

A primary disadvantage of the design when compared to a randomized treatment-control group design is that it has low power in being able to reject the hypothesis of no differences between groups. If a randomized design used a sample of 100 subjects, the regression-discontinuity design would require 275 subjects to have equal power (Reichardt, 1979). In addition, if one of the groups is relatively small, the estimate of the regression of post test on pre test for that group may be unstable.

Two other precautions should be kept in mind when using this design. First, the process of assigning students to groups should be done without error. If the pretest is to be used as the covariate in the analysis, selection should be based on it only. If other sources of information, such as teacher or parent judgements, are used in addition to or instead of the pretest, the analysis may be seriously biased. Huitema (1980) gives procedures for dealing with multiple sources of information in the assignment process. The second precaution in using this design is that non-linear relationships between pre and post tests, which result from selection-motivation factors, may cause spurious treatment effects to occur. Reichardt (1979) suggested that the first step in analyzing the data from this design should be to plot the raw data to see what relationships are suggested. If non-linear or interactive effects are suggested, the analytic model given previously can be expanded in an attempt to account for them.

Example of regression-discontinuity use. Although no use of this design is available from the literature, an example of a data file, an SPSS procedure file and the results from this procedure are given in Appendix D, along with steps for completing the procedure.

Design #5: Cohort Design

Cohorts are groups of persons who follow each other through an institution. For example, last year's first graders are cohorts of this year's first graders. The cohort design compares the performance of students in a treatment group with their cohorts that did not receive the treatment. This design is especially useful in evaluating the effectiveness of newly-installed, year-long computer-based programs where it is not feasible to withhold the program from some students in order to have a control group. The design makes the assumption that student cohorts are comparable in most respects, and that differences between them on a dependent variable can be attributed to a treatment administered to one of the groups.

In its simplest form, the design is as follows:

```
      Ø
       1
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            X      Ø
                    2
```

Ø(1) represents, for example, a final achievement measure of students in a certain grade in a given year, and Ø(2) represents the same final achievement measure of students in the same grade the year after that after having received some instructional treatment. If a t-test of the differences between means of independent samples yields a statistically significant result, and that difference is large enough to be considered educationally significant, the treatment is said to be successful.

A disadvantage to this design is that its use depends on the yearly availability of appropriate equivalent measures. Also, Cook and Cambell (1979) indicated that the design in this form weak because differences between the two groups (other than the treatment) could cause a difference in achievement (selection). Events other than the treatment could depress achievement for the control cohort or enhance it for the treatment cohort (history). Variations in testing conditions or procedures could also be responsible for differences in performance. The design can be strengthened by adding a pretest if it is available. This augmented design is shown as follows:

```
  Ø     Ø
   1     2
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            Ø     X     Ø
             3           4
```

The pretest could be an end-of-year test or one that is routi administered in the fall. The data would be analyzed using regression analysis, the same method used in the regression-discontinuity design. Here, however, each treatment student would be given the "dummy" code "1" and each student in the cohort from the year before a code of "0."

<u>Example of cohort design use.</u> Garretson, Vertuno, Roblyer and King (1983) used this design in a study of a computer-based reading and writing program, the "Writing to Read" program from IBM, Inc. Approximately fifty students from each grade served as subjects, and it was not considered feasible to withhold the treatment from any of them. A readiness test was available for both the treatment and control kindergarten cohort, so it was used as a pretest. No pretest measure was available for the first grade students. The dependent variable was the reading score (prereading for kindergarten) from the California Test of Basic Skills (CTBS) administered at the end of both kindergarten and first grade. The analysis for the kindergarten students was performed as follows:

<u>STEP 1: Calculate means and standard deviations.</u> The means and standard deviations of both groups on both measures were determined:

	Treatment (1982-83)		Control (1981-82)	
	Mean	SD	Mean	SD
Reading	129.00	13.73	124.59	14.13
Pretest	6.29	1.47	6.11	1.57

<u>STEP 2: Perform regression analysis.</u> This analysis actually involves several steps, but they will not be detailed here since the SPSS program described in Appendix D accomplishes them. The results were as follows:

Variable	b	F	Significance
Treatment (b1)	3.79	2.12	>.05
Pretest (b2)	4.10	22.54	<.05
Intercept (a)	99.52	314.96	<.05

Data for the first grade were analyzed using a t-test for comparing two groups. The results were:

	Treatment (1982-83)		Control (1981-82)	
	Mean	SD	Mean	SD
Reading	63.79	14.36	61.56	18.80

t-ratio = .65
(p>.05)

The results for neither grade showed a significant treatment effect. These findings are not in agreement with those in the value-added analysis in which the treatment effect for the

Nonsense Words Tests were significant. The different results could be due to a number of reasons. (See discussion in Garretson et al.)

However, despite its failure to demonstrate a significant treatment effect, the cohort design is considered to be superior to a design in which the control group is not equivalent to the experimental group (e.g. the groups are obtained from different schools). The populations from which the cohorts were drawn were probably more similar than those using students from different schools. Also, the school environment (principal, teachers, facilities, etc.) for the cohorts would probably be more similar than would the environments in different schools.

DISCUSSION AND SUMMARY

Although most research studies reported in the educational technology literature use a non-treatment control group design, this approach is often not feasible in non-laboratory situations. The microcomputer movement in schools has created a wealth of new research opportunities, many of which will require designs more suited to actual classroom implementation. Five such designs are described here:

1. Sequential analysis
2. Value-added analysis
3. Non-equivalent dependent variables
4. Regression-discontinuty
5. Cohort design

Depending upon the needs of the researcher and the characteristics of the research situation, each of these can serve as a practical alternative to a design requiring a non-treatment control group. To aid school researchers in employing these designs, statistical analysis methods and tools are also provided for each one. Several caveats are, however, in order.

Choosing the Appropriate Design

Each of the designs described here can be appropriate for studying various aspects of computer-aided instruction. But like all research designs, each has assumptions which must be met and requirements which must be considered if the research is to be perceived as valid. The flowchart shown in Figure 5 summarizes a decision path which one might take to choose the most appropriate design for the situation.

[Figure 5 about here.]

However, even after selecting the most useful of these designs, the researcher must recognize that, like all designs, each has its strengths and weaknesses. Using two of these designs together can work to make the total study stronger. For example, in Garretson et al (1983), the cohort design and the value-added analysis were used. Ideally, the results of these two designs would be the same and thus support the conclusions of the research.

Specifying Power

The sequential analysis method is the only one of the five which forces the researcher to set alpha, Beta and effect size ahead of time. However, this practice is desirable for all designs (including true experiments) in order to determine that the study has sufficient power to reject the null hypothesis when it is false or to allow acceptance when it is true (Cohen, 1969).

Required Research Expertise

Several aids are provided here to assist those with limited statistical experience in selecting and implementing the most appropriate of these designs. It should be apparent, however, that using these designs require some expertise in both research and statistics. The minimum training would probably include introductory courses in research methods, descriptive statistics and inferential statistics. And, of course, some experience in implementing research studies is helpful. To those with such expertise available to them, the designs described here can and should be useful in implementing research to direct the course of their educational computing activities.

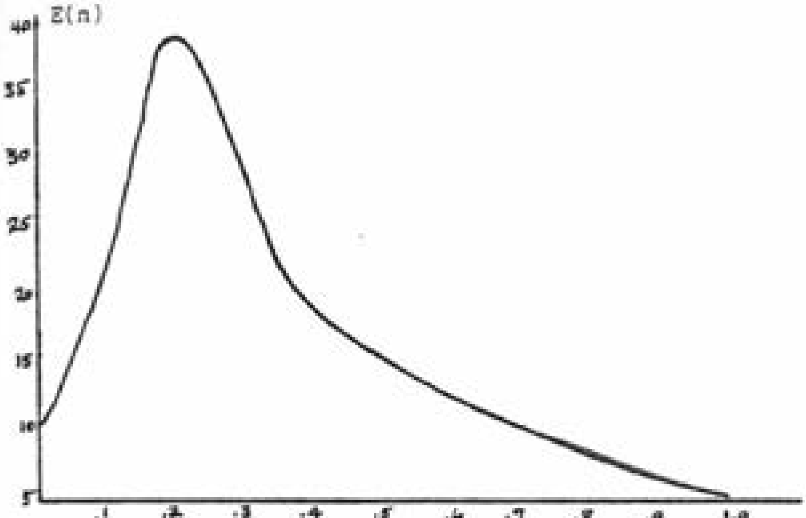

Figure 2. Average Sample Number Curve

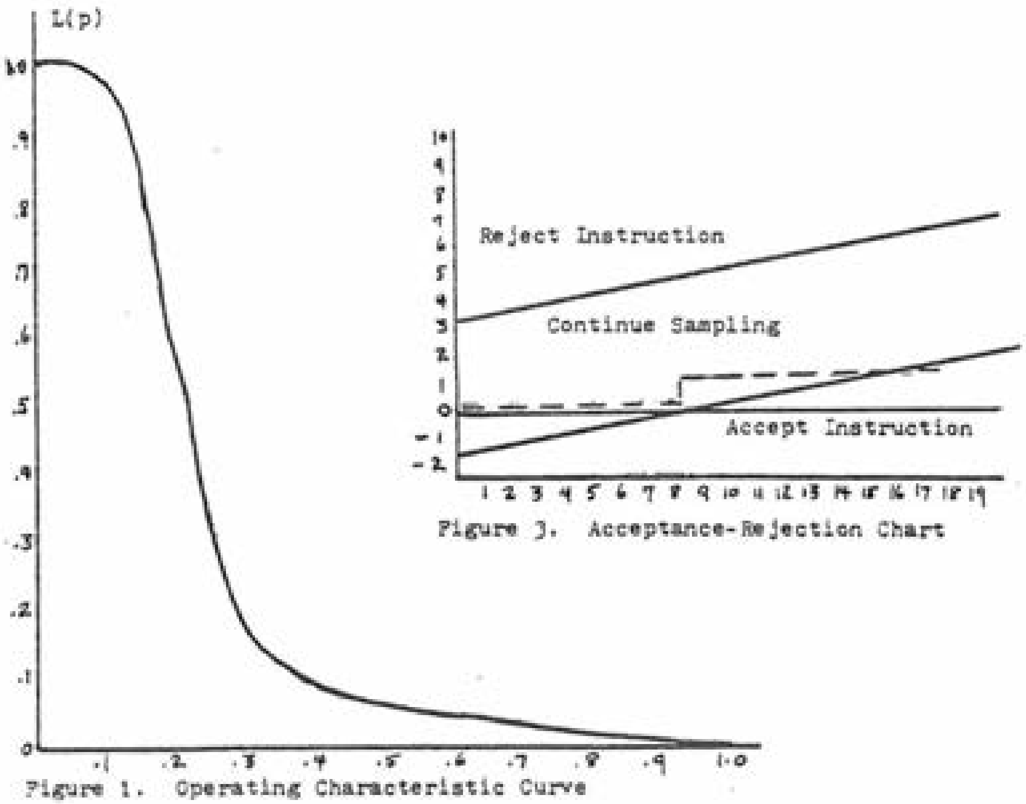

Figure 3. Acceptance-Rejection Chart

Figure 1. Operating Characteristic Curve

Obj.	Pretest		Interim Tests			Posttest
	1		2	3	4	
A	O_{a1}	X_a	O_{a2}	O_{a3}	O_{a4}	O_{am}
B	O_{b1}		O_{b2} X_b	O_{b3}	O_{b4}	O_{bm}
C	O_{c1}		O_{c2}	O_{c3} X_c	O_{c4}	O_{cm}
D	O_{d1}		O_{d2}	O_{d3}	O_{d4} X_d	O_{dm}
.	.					
.	.					
J	O_{j1}		O_{j2}	O_{j3}	O_{j4}	O_{jm}

Figure 4. Multiple Waves, Multiple Variables Design (Berquist and Graham, 1980)

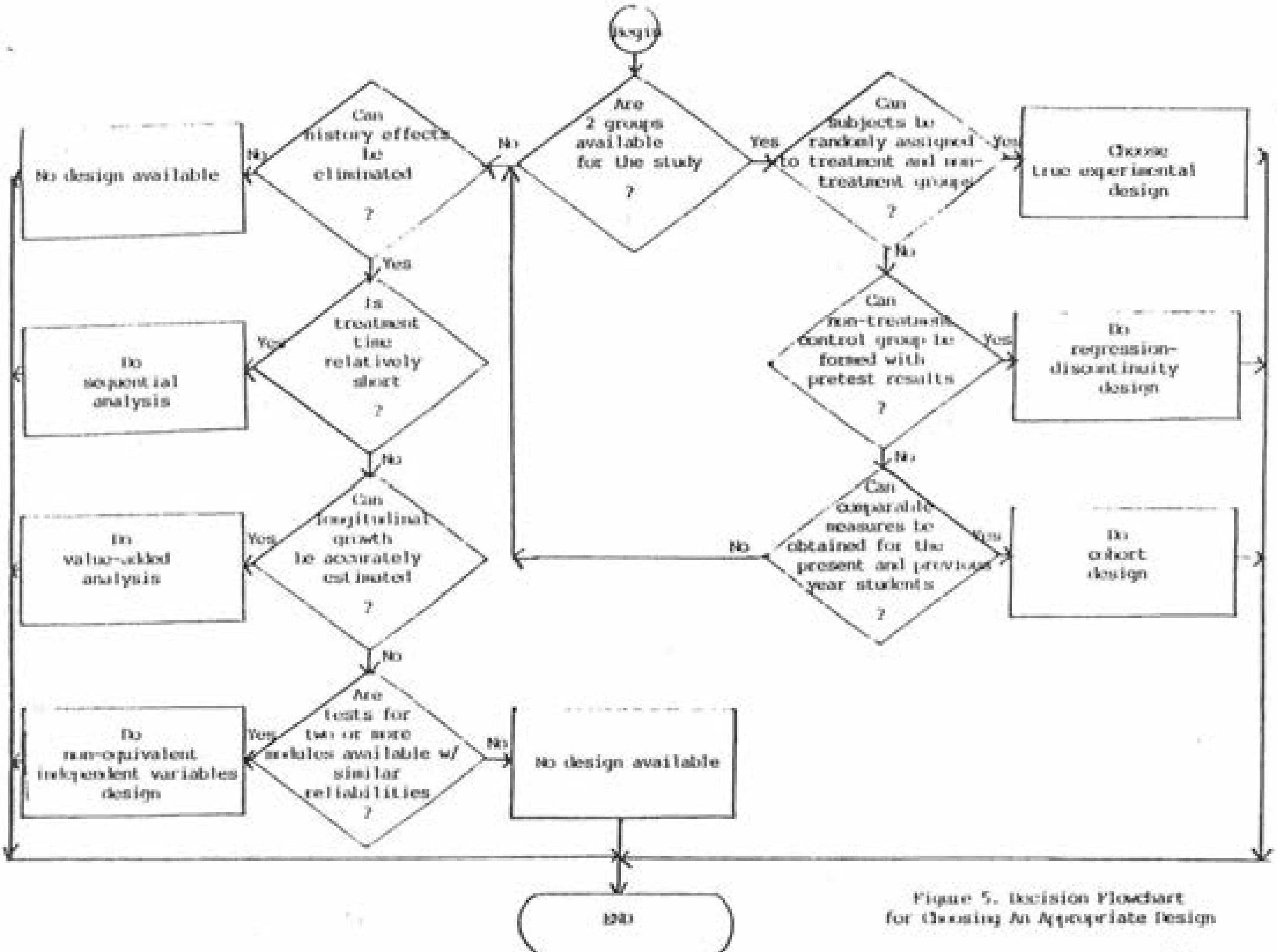

Figure 5. Decision Flowchart for Choosing An Appropriate Design

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Appendix A
Applesoft Basic Program for Sequential Analysis

The program requires the user to enter proportions for the AQL and RQL, as well as values for alpha and Beta. H1, H2, and S are used to construct the upper (UL) and lower lines (LL) of the acceptance-rejection graph:

$$LL = -H1 + Sn$$
$$UL = H2 + Sn$$

where n is the nth subject. D1 and D2 in the output are values for the lower and upper lines where n=10. They are given to facilitate plotting of the lines.

Following the listing of the truncation number and input specifications, the user is asked whether or not a table of values should be printed. If the answer is "yes," the acceptance/rejection table is printed. It is simply a tabular representation of the graph.

Coordinates for the Operating Characteristics (OC) Curve and the Average Sample Number (ASN) Curve are printed if the user desires them. In both curves, p (the true proportion of failures) is plotted on the horizontal axis. L(p), the probablity of rejecting the instruction, and E(N), the average sample numbers, are plotted on the vertical axis.

The following sets of numbers can be used to check your program entry:

Input

	AQL	RQL	alpha	Beta
(1)	.90	.70	.01	.10
(2)	.90	.70	.05	.15
(3)	.85	.75	.05	.15

Output

	H1	H2	S	Truncation
(1)	-1.698	3.333	.186	112
(2)	-1.367	2.099	.186	57
(3)	-2.902	4.455	.197	245

```
15  INPUT "ENTER PROPORTION FOR H
     IGH QUALITY ";P1
20  PRINT
25 P1 = 1 - P1
30  INPUT "ENTER PROPORTION FOR L
     OW QUALITY ";P2
35  PRINT
40 P2 = 1 - P2
45  INPUT "ENTER ALPHA ";A1
46  PRINT
50  INPUT "ENTER BETA ";B1
51  PRINT
55  INPUT "ARE ALL ENTRIES CORREC
     T? Y^N ";N$
56  PRINT
60  IF N$ = "N" GOTO 15
70 G1 = ( LOG (P2 / P1)) * .43429
     448
75 G2 = ( LOG ((1 - P2) / (1 - P1
     ))) * .43429448
80 A = ( LOG ((1 - B1) / A1)) * .
     43429448
85 B = ( LOG (B1 / (1 - A1))) * .
     43429448
90 H1 = B / (G1 - G2)
95  PRINT "H1=INTERCEPT AT ZERO F
     OR THE LOWER LINE=  ";H1
96  PRINT
100 H2 = A / (G1 - G2)
105  PRINT "H2=INTERCEPT AT ZERO
     FOR THE UPPER LINE= ";H2
106  PRINT
110 G3 = G1 - G2
115 G4 = ( LOG ((1 - P1) / (1 - P
     2))) * .43429448
120 S = G4 / (G1 - G2)
122  PRINT "S = ";S
123  PRINT
125 D1 = H1 + (S * 10)
130  PRINT "D1=LOWER LINE VALUE A
     T N EQUALS 10 =      ";D1
131  PRINT
135 D2 = H2 + (S * 10)
140  PRINT "D2=UPPER LINE VALUE A
     T N EQUALS 10 =      ";D2
141  PRINT
150 N = (3 * (A * B)) / (G1 * G2)

155  PRINT "TRUNCATE AT N= ";N
156  PRINT
160  PRINT "WALD,""P1="1 - P1",""
     P2="1 - P2",""ALPHA="A1",""B
     ETA="B1
161  PRINT
166  PRINT
170  INPUT "DO YOU WANT TO PRINT
     A TABLE OF VALUES? Y ^ N:   "
     ;N$
171  PRINT
175  IF N$ = "N" GOTO 250
180  PRINT "N","ACCEPT","REJECT"
181  PRINT
185 N = 0
190 I = 10
195 N = N + 1
200 R0 = (B / G3) + (N * (G4 / G3
     ))
210 R1 = (A / G3) + (N * (G4 / G3
     ))
220  PRINT N TAB( 16)R0 TAB( 31)R
     1
225  IF N = I GOTO 235
230  GOTO 195
231  PRINT
235  INPUT "DO YOU WANT ANOTHER 1
     0 VALUES? Y ^ N:   ";N$
236  PRINT
240  IF N$ = "N" GOTO 250
245 I = I + 10
246  GOTO 195
250  INPUT " DO YOU WANT A TABLE
     OF VALUES OF THE COORDINATES
      TO PLOT AN OC CURVE? Y^N: "
     ;N$
260  PRINT
270  IF N$ = "N" GOTO 340
275  PRINT
280  PRINT "COORDINATES FOR OC CU
     RVE"
285  PRINT
290  PRINT "VALUES OF P","L(P)"
295  PRINT
300  PRINT 0,1
305  PRINT
310  PRINT P1,1 - A1
314  PRINT
315 K =  INT ((S + .00005) * 1000
     0) / 10000
316 K1 = H2 / (( ABS (H1) + H2))
320  PRINT S,K1
321  PRINT
322  PRINT P2,B1
325  PRINT
330  PRINT 1,0
335  PRINT
340  INPUT "DO YOU WANT A TABLE O
     F VALUES FOR THE COORDINATES
      TO PLOT ASN CURVE? Y^ N: ";
     N$
350  IF N$ = "N" GOTO 440
360  PRINT
370  PRINT "COORDINATES FOR ASN C
     URVE"
375  PRINT
380  PRINT "VALUES OF P","E(N)"
385  PRINT
386 K2 =  ABS (H1) / S
390  PRINT 0,K2
395  PRINT
397 K4 = ((1 - A1) *  ABS (H1) -
     A1 * H2) / (S - P1)
400  PRINT P1,K4
405  PRINT


406 K5 = ( ABS (H1) * H2) / (S *
     (1 - S))
410  PRINT S,K5
415  PRINT
416 K6 = (((1 - B1) * H2) - (B1 *
      ABS (H1))) / (P2 - S)
420  PRINT P2,K6
425  PRINT
426 K7 = H2 / (1 - S)
430  PRINT 1,K7
435  PRINT
530  END
```

```
ENTER PROPORTION FOR HIGH QUALITY .90
ENTER PROPORTION FOR LOW QUALITY .70
ENTER ALPHA .01
ENTER BETA .10
ARE ALL ENTRIES CORRECT? Y/N Y
H1=INTERCEPT AT ZERO FOR THE LOWER LINE=  -1.69826828
H2=INTERCEPT AT ZERO FOR THE UPPER LINE= 3.3333733
S = .186168942
D1=LOWER LINE VALUE AT N EQUALS 10 =      .163423334
D2=UPPER LINE VALUE AT N EQUALS 12 =      5.12596272
TRUNCATE AT N= 112.290667
WALD,P1=.9,P2=.7,ALPHA=.01,BETA=.1

DO YOU WANT TO PRINT A TABLE OF VALUES? Y OR N? N
 DO YOU WANT A TABLE OF VALUES OF THE COORDINATES TO PLOT AN OC CURVE

COORDINATES FOR OC CURVE
VALUES OF P      L(P)
0                1
.1               .99
.186168942       .662482552
.3               .1
1                0
DO YOU WANT A TABLE OF VALUES FOR THE COORDINATES TO PLOT ASN CURVE
COORDINATES FOR ASN CURVE
VALUES OF P      E(N)
0                9.12217724
.1               19.1246365
.186168942       37.3635557
.3               24.9632439
1                4.39590128
```

Appendix B
Computations for Value-added Analysis

1. Computation of the value added by the treatment (V)

$$V = \bar{y}_2 - \bar{y}_1 - b(\bar{d})$$

where $\bar{y}_1$ and $\bar{y}_2$ are pre and post test means

b is the slope coefficient for the regression of pretest on age, and

$\bar{d}$ is the mean time span between the pre and post tests.

2. Computation of pseudo-values (V_{*i})

A. Compute the regression coefficient (b) using the whole data set.

B. Compute a regression coefficient (b_i) with observation i removed from the data. N coefficients will be computed.

C. Compute a pseudo-value (V_{*i}) for each individual:

$$V_{*i} = y_i(t_2) - y_i(t_1) - b_{*i}\ \cancel{[a_i(t_2)]}\ \ a_i(t_2) - a_i(t_1)$$

where $y_i(t_2)$ and $y_i(t_1)$ are post test and pre test scores for individual i

$a_i(t_2)$ and $a_i(t_1)$ are the ages of individual i at post test and pre test times, and

b_{*i} is computed as shown below:

$$b_{*i} = Nb - (N - 1)\ bi$$

D. Compute the mean and standard error of the V_{*i}'s.

Calculate a t-ratio by dividing the mean by the standard error.

The data file on the next page contains scores for age (in months), and pre test and post test scores for 10 subjects. The first SPSS procedure file computes the regression coefficient and the sums, sums of squares, and sum of cross products needed for the next program.

Appendix B (cond.)

The output of the procedure is as follows:

Regression coefficient (b)	1.134
Sum of age scores (SX)	690
Sum of pre test scores (SY)	224
Sum of cross products of age and pretest (SXY)	15778
Sum of squares of age (SXQ)	47894

The output of the second SPSS procedure gives the mean (2.028) and standard error (2.515) of the pseudo-values (V_{*i}).

The t-ratio is 2.028/2.515 = .806. Thus, for these 10 cases, value added by the treatment is not statistically significant.

DATA FILE

```
73 35 29
72 38 39
77 30 35
79 30 44
63  7 12
69 10 16
59 22 27
68 22 36
64 28 30
60 12 19
```

SPSS PROCEDURE #1

```
 5.     VARIABLE LIST
 5.005   AGE PRE POST
10.     INPUT FORMAT
10.005 FIXED(F2.0,2F3.0)
15.     COMPUTE
15.005 SXY=AGE*PRE
16.     COMPUTE
16.005 SXQ=AGE**2
20.     REGRESSION
20.005  VARIABLES=AGE PRE/REGRESSION=PRE WITH AGE
30.     CONDESCRIPTIVE
30.005 AGE,PRE,POST,SXY,SXQ
```

SPSS PROCEDURE #2

```
 5.     VARIABLE LIST
 5.005   AGE PRE POST
10.     INPUT FORMAT
10.005 FIXED(F2.0,2F3.0)
60.     COMPUTE
60.005 SXY=15778
65.     COMPUTE
65.005 SXQ=47994
70.     COMPUTE
70.005 SX=690
75.     COMPUTE
75.005 SY=224
80.     COMPUTE
80.005 B=1.134
85.     COMPUTE
85.005 NUM=(9*(SXY-(AGE*PRE)))-((SX-AGE)*(SY-PRE))
90.     COMPUTE
90.005 DENOM=(9*(SXQ-(AGE**2)))-((SX-AGE)**2)
92.     COMPUTE
92.005 BI=NUM/DENOM
94.     COMPUTE
94.005 BSI=(10*B)-(9*BI)
S/C/RETURN
C
96.     COMPUTE
96.005 V=POST-PRE-(BSI*4)
98.     CONDESCRIPTIVE
98.005 V
99.     STATISTICS
99.005 1,2
```

Appendix c

Analysis and Results of the Regression-Discontinuity Design

The data file is shown in the upper left-hand corner of the page. There are eight treatment students below the pretest cutting score of 40, and eight control students above it. Columns 1 and 2 contain a student ID number, Column 3 is the group membership variable (treatment=1, control=2), the next two columns contain the pre test scores, and the post test is in the last two columns.

The SPSS procedure file is given to the right of the data file. Lines 5.0 and 10.0 specify the names of the variables and the input format, respectively. Line 200 is the regression procedure. It specifies the dependent variable is the post test and the independent variable is the treatment variable and the pretest. Line 25.0 causes means, standard deviations, and correlations to be printed.

The output of the procedure consists of means, standard deviations, and correlations of the three variables as labeled. The last three lines of output show the intecept and regression coefficients:

$$\overline{Y} = 35.00 + 9.72 + .37 \text{ Pre}$$

The columns labeled F and Sig. show that all effects are statistically significant. The treatment regression coefficient (bl) is the adjusted difference between treatments. The results are graphically illustrated in the figure that follows the output. The difference in intecepts of the cutting score is the estimate of the treatment effect.

DATA FILE

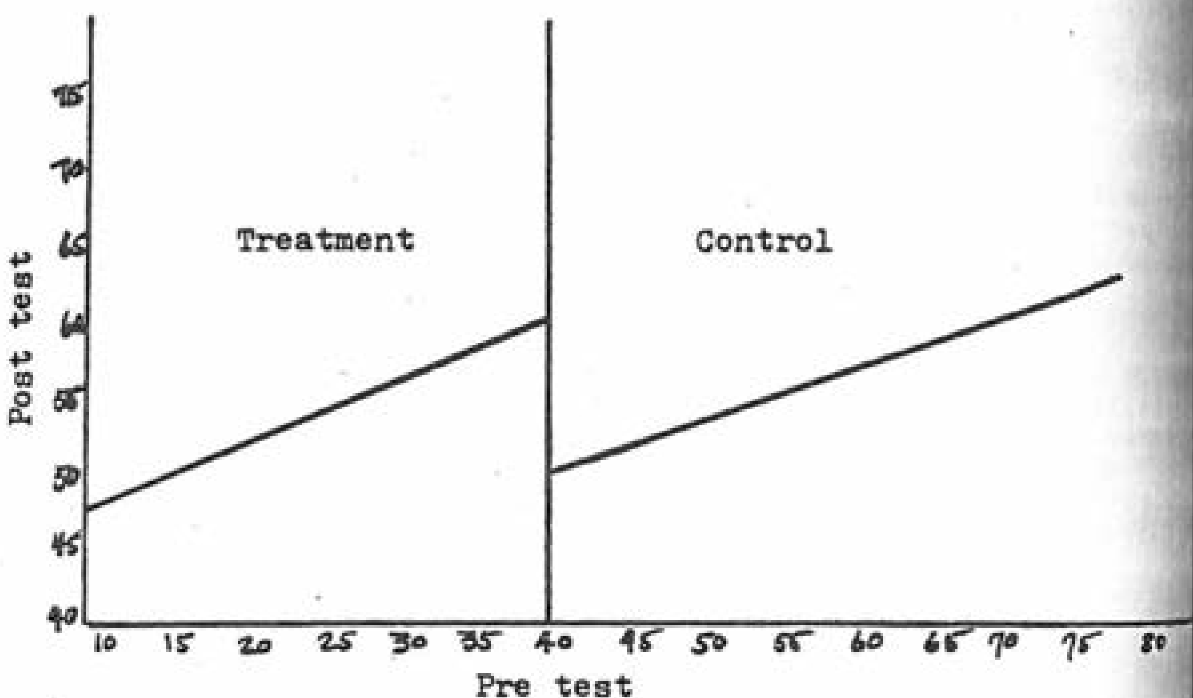
```
 1 1 11 39
 2 1 13 44
 3 1 19 42
 4 1 25 46
 5 1 24 50
 6 1 30 42
 7 1 29 54
 8 1 18 48
 9 0 43 56
10 0 42 60
11 0 50 58
12 0 51 61
13 0 55 62
14 0 54 66
15 0 62 63
16 0 63 67
```

SPSS PROCEDURE

```
 5.      VARIABLE LIST
 5.005   ID,T,PRE,POST
10.      INPUT FORMAT
10.005   FIXED(2F2.0,2F3.0)
20.      REGRESSION
20.005   VARIABLES=T,PRE,POST/
20.006   REGRESSION=POST WITH T,PRE
25.      STATISTICS
25.005   1,2
```

OUTPUT

```
VARIABLE            MEAN      STANDARD DEV      CASES

T                  .5000            .5164          16
PRE              36.8125          17.7058          16
POST             53.6250           4.3340          16


CORRELATION COEFFICIENTS.

A VALUE OF 99.00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.


PRE          -.91507
POST         -.23830      .46642

                T          PRE
                           ---------

DEP. VAR... POST

MEAN RESPONSE        53.62500       STD. DEV.        4.33397

FINAL STEP.

MULTIPLE R      .6603 ANOVA          DF   SUM SQUARES   MEAN SQ.        F
R SQUARE        .4360 REGRESSION     2.     122.847     61.423      5.025
STD DEV        3.4962 RESIDUAL      13.     158.903     12.223 SIG.  .024
ADJ R SQUARE    .3492 COEFF OF VARIABILITY      6.5PCT

VARIABLE          B        S.E. B         F      SIG.       BETA   ELASTICITY

T               9.727       4.334      5.036   .043     1.15893     .09069
PRE              .374        .126      8.741   .011     1.52692     .25657
CONSTANT       35.903       6.751     26.883   .000
```



Treatment
Control
Post test
Pre test

TITLE: Foundations of Naturalistic Inquiry: Developing a Theory Base For Understanding Individual Interpretations of Reality

75 80

AUTHOR: J. Randall Koetting

Research and Theory Division Symposium:

Naturalistic Methodologies for
Deriving Individual Meanings from Visuals

FOUNDATIONS OF NATURALISTIC INQUIRY: DEVELOPING A THEORY BASE FOR UNDERSTANDING INDIVIDUAL INTERPRETATIONS OF REALITY

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January 20-24, 1984

Foundations of Naturalistic Inquiry:
Developing A Theory Base for Understanding
Individual Interpretations of Reality

This symposium is concerned with naturalistic methodologies in research on visuals. The purpose of my paper is to focus on the foundations of naturalistic inquiry. Foundation, in this sense, is concerned with explicating the theory base of naturalistic inquiry.

I will focus on the foundations of naturalistic inquiry by looking at paradigms for research. My discussion will center on questions of epistemology (what do you mean? How do you know?). I will indicate the place of naturalistic inquiry within the above discussion and identify differences between paradigms. Finally I will suggest elements of a research methodology that exemplifies an interpretive and critical methodology.

When we do research, we try to gain a clear or clearer perception of reality. This clearer perception of reality can be of benefit to us depending on our interests, what we are searching for (truth? knowledge? Information? Understanding? Explanation? Emancipation?). This in turn has a bearing on what we define as the research "problem/situation" under investigation.

There are certain research paradigms that have emerged over the last few years. Bredo and Feinberg (1982) identify differing paradigms according to the research methodologies utilized. These methodologies have inherent interests in the kinds of research findings generated.[1] I find their identification of three research paradigms useful for determining what I consider to be the foundations of naturalistic inquiry.

Bredo and Feinberg identify the positivistic approach, the interpretive approach, and the critical approach to social and educational research. Returning to my earlier comment regarding research and gaining a clear/clearer perception of reality, our interests in doing research are varied. For example, we may try to better control reality, in order to make predictions, develop law-like theories/

explanations, establish causal relationships, etc. This would correspond to the positivistic approach to research.

We may want to better understand reality, and hence ourselves and others within a given context, meanings attached to social customs, etc. This would correspond to the interpretive approach.

We may want to better understand reality, and hence ourselves and others within a given context in order to <u>act</u> within that context, to effect change. This corresponds to the critical approach to social and educational research.

Fundamental differences separate the positivistic approach from the interpretive and critical approaches. The differences are of a philosophical nature, concerned with the nature of reality (ontology), the relationship of subject-object, the purpose of inquiry (generalization), the nature of knowledge the means of data collection/analysis (epistemology), the relationship of individuals to society, and the role of values in inquiry (axiology).

Using Guba (1982, 1983), and Bredo and Feinberg (1982), I would like to highlight some of the major differences between the positivistic approach, and the interpretive and critical approaches. The differences I want to discuss are concerned with ontology, subject-object dualism, generalization, causality, and axiology.

There is a danger here in oversimplifying the positivistic, interpretive and critical approaches. Guba (1983) points out that there is no "real or ultimate absolute statement that could be made" for each of these approaches. As he states, "All statements are constructions; the issue here is whether my construction is fair" (p. 6).

<u>The Positivistic Paradigm</u>

<u>ONTOLOGY</u> (nature of reality). For the positivist researcher, reality is a "given". It exists "out there", and can be divided into dependent and independent variables. These can be studied independently of each other. "Inquiry can converge onto that reality until, finally, it can be predicted and controlled" (Guba, 19

1983). In other words, the world is seen as given, single, tangible, fragmentable, convergent.

SUBJECT-OBJECT RELATIONSHIP. The researcher maintains a distance between self and the object under investigation, "neither disturbing it or being disturbed by it" (Guba, 1982, 1983).

PURPOSE OF INQUIRY (Generalization). The purpose of inquiry is to develop a nomothetic body of knowledge." This knowledge is best stated in law-like (nomological) generalizations which are seen as truth statements outside of time and specific context (hence they are true for all circumstances and times-cf. Guba, 1983, p. 7).

EXPLANATION-CAUSALITY. As Guba (1983) states: "Every action can be explained as the result (effect) of a cause that precedes the effect temporally (or is simultaneous with it" (p. 7).

AXIOLOGY (The role of values in inquiry). Inquiry is value neutral. This is ensured by the nature of the methodology used - "the facts speak for themselves" (Guba, 1983, p. 7).

The Interpretive Paradigm

I will use the same areas I briefly indicated in the previous section in characterizing basic viewpoints of the positivistic paradigm to identify the interpretive paradigm. The viewpoints I describe below also hold for the critical paradigm. The viewpoints discussed stand in oppostion to each other. Naturalistic inquiry falls within the interpretive and critical paradigms, so I am getting closer to identifying the theoretical underpinnings of naturalistic inquiry.

ONTOLOGY - The world is made up of tangible and "intangible", multi-faceted realities. These are best studied as a unified whole.(2) Investigation into each of the multiple realities will bring about divergence (suggesting further questioning). Understanding can be achieved, but "prediction and control" are not our intent (cf. Guba, 1983, p. 9).

SUBJECT-OBJECT RELATIONSHIP. The inquirer and the object of study inter
to influence one another (especially when the object is another human's perc
cf. Guba, 1982, 1983).

PURPOSE OF INQUIRY (Generalization). The aim of inquiry is to develop an
"ideographic" body of knowledge. We can then develop a series of working hyp
that exemplify the "individual case" (cf. Guba, 1983, p. 9).

EXPLANATION (Causality). Guba (1983) states that

> An action may be explainable in terms of multiple interacting factors, events, and processes that shape it and are part of it; this interaction manifests itself as mutual and simultaneous shaping; inquirers can, at best, establish plausible inferences about the pattern of such shaping in a given case (p. 9).

AXIOLOGY (The role of values in inquiry). Inquiry is value-laden. Inqu
influenced by the researcher's values as shown in the "choice of the problem an
in the framing, bounding, and focussing of that problem." Inquiry is influen
the research paradigm the researcher choses. The paradigm "guides the investi
into the paradigm." Inquiry is influenced by specific methodologies within th
research paradigm. The methodologies "guide the investigation into the probl
Finally, "inquiry is influenced by the values that inhere in the context: soci
and cultural norms" (cf. Guba, 1983, p. 10).

The following schematic representation (fig. 1) is offered to help clarif
the previous discussion. It is based on Guba (1982, 1983), Culbertson (1981),
and Feinberg (1982), Habermas (1971), and my own efforts at putting this info
into some systematic order.

Figure 1

It is important to acknowledge the differences between the paradigms. The
are based on differing world-views. All three paradigms are needed to better
understand/to gain a clearer perception of our world and our place within that
world. Although I do not want to overly emphasize these differences, they do

Research Paradigms

Research Paradigm	Interests	Ontology (Nature of Reality)	Subject-Object Relationship	Purpose: Generalization	Explanation: Causality	Axiology: the role of values
Positivistic	To explain To control To predict	Given, single, tangible, fragment-able, convergent	Independent, neutral, value-free	Context and time free generalizations; Law-like statement (nomothetic); deductive quantitative focus on similarities	Real causes, temporally precedent/ simultaneous	Value - free
Interpretive	To understand, to interpret, (mutual/shared understanding)	Constructed, multiple, wholistic, divergent.	Inter-related, relationship influenced by subjective factors	Context and time bound working hypotheses; ideographic statements; inductive; qualitative; focus on differences	Interactive shapers (feedback and feed forward)	Value-bound; values in-fluence selection of problem, theory, method and analysis
Critical	Emancipation to critique and to identify potential for change	Constructed, multiple, wholistic, divergent	Inter-related, relationship influenced by strong committ-ment to human emancipation	Same as for interpretive		Value-bound; Critique of ideology

exist. For this reason, it is difficult to interpret findings from a study the interpretive paradigm, using naturalistic methods, in light of findings within the positivist paradigm, using quanitative methods.

Inquiry within the three paradigms is conducted in differing manners, results aimed for are different. I point out the differences not to set up "straw man" for the purpose of justifying a "not so new" approach, but to the need to be clear on what it is we want to investigate.

The differing world-views that are the bases for the three research pa need to be examined closely by researchers. The world-views define a certa orientation toward the world. They provide ways of seeing the world, and e and people within that world.

In conducting research within the context of education, the process of schooling is also viewed differently within the framework of the three para Whether we look at schooling, learning, learners, outcomes of education, cu etc., each of these have a special meaning for researchers. For example, i were to talk about the learner (subject) within the interpretive approach, define the situation as follows:

> As individuals begin to interpret reality about them, processes of self-reflection/introspection and communication (externalization) of internal processes need to be considered by the researcher. Each individual learner is seen as a "meaning-maker", i.e., creator of their own reality. At the same time, the individual interpretations of reality are open to critique. This leads to the notion of critica thinking as it applies to an individual's interpretation of their context. To gain an understanding (interpretive approach) of an individual's perception of reality (context) through the utilization of visua the researcher must enter into a dialogic relationship with that individual.

Entering into a dialogic relationship with an individual can be most achieved through naturalistic research, within the interpretive approach. is the "encounter between men mediated by the world, in order to name the (Freire, 1970, p. 76). There are certain conditions required of subjects into dialogue:

1. a profound love of men

2. humility
3. an intense faith in man (this is an a priori faith in the person)
4. trust (established through dialogue)
5. hope (rooted in the person's incompleteness, and recognition of that incompleteness; constant search)
6. critical thinking (Freire, 1970, pp. 78-82).

These requirements demand total commitment to the process of dialogue from those who choose to enter the dialogic relationship. They are neither naive nor unworkable. They become, for subjects engaged in emancipatory praxis, a basic orientation to life.

The term critical thinking, as a necessary element in dialogue, needs to be pursued and delineated further. Critical thinking is thinking which

> discerns an indivisible solidarity between the world and men and admits of no dichotomy between them -- thinking which perceives reality as process, as transformation, rather than as static entity -- thinking which does not separate itself from action, but constantly immerses itself in temporality without fear of the risks involved. Critical thinking contrasts with naive thinking, which sees 'historical time as a weight, a stratification of the acquisitions and experiences of the past,' from which the present should emerge normalized and 'well-behaved.' For the naive thinker, the important thing is accomodation to this normalized 'today.' For the critic, the important thing is the continuing transformation of reality, in behalf of the continuing humanization of men (Freire, 1970, p. 81).

Dialogue requires critical thinking and is capable of <u>generating</u> critical thinking. Communication is based on dialogue, and education is based on communication. Communication is concerned with meaning, understanding. Relating understanding to critical thinking and interpretation roots emancipatory education within the critical approach. In the critical approach, the paradigm for knowledge is no longer the "observation" but the "dialogue" (Habermas, 1973, p. 11).

I recommend that researchers interested in research using the interpretive and/or critical paradigms become grounded in the work of Paulo Freire (1970, 1973). Freire worked with the peasant population of Brazil. His concern was centered on adult literacy education and his works are a powerful example of using visuals within an educational/learning situation. His work also exemplifies the diff world-view offered by an interpretive approach to research and its impact on t subjects within the literacy project.(3)

I offer the following ten points as elements of Freire's theory of knowle (epistemology) which, I believe, are also <u>the basic elements</u> that ground the in pretive and critical approaches to social and educational research. These ten points can provide guidelines for developing research endeavors using visuals w the interpretive and critical paradigms.

1. <u>World-view</u> - Freire adheres to a world-view that identifies the subje in relation to a particular context ("I am myself and my circumstanc
2. <u>Subjectivism</u> - Acknowledging a world of nature independent of individ does not negate individual experience of that world and the creation o a social/cultural/human world which itself is a reality (<u>cf</u>. Matthews, 1980, p. 89);
3. <u>Abstraction</u> - The individual mind plays an important part in acquirin knowledge. The world (context) "as it is conveyed and verbalized in people's knowledge, is a world composed of abstractions and is demarc by concepts . . . People never just see, just experience, just discov they always see and discover particular things, depending on what is already in their heads" (Matthews, 1980, p. 90);
4. <u>Codification</u> - Consists of re-presenting the "object of reflection" t the subjects in a form identifiable to them, and related to their experience. For example, Freire used photographs and drawings depict the existential situations of the people with whom he worked. The visuals used were familiar to his subjects because they contained situations and events based on the subjects' own descriptions of their life-situations. These "codified" visuals become the objects that mediate the subjects in their critical analysis. The codifications be "cognizable objects, challenges towards which the critical reflection

the decoders should be directed" (Freire, 1970, p. 107). The cognizable objects (visual re-presentations of the subjects in life-situations), posed as problems to the subjects, depict the situationality of the subjects. Self-reflection upon this situationality is reflection about the very "condition" of existence, namely, "critical thinking by means of which men discover each other to be 'in a situation'" (Freire, 1970, p. 100). When this situation (context) is seen as an "objective-problematic situation," subjects reach the stage wherein the ability to intervene in their self-formative, historical context becomes a possibility.

> Intervention in reality -- historical awareness itself -- thus represents a step forward from emergence, and results from the conscientizacao of the situation. Conscientizacao is the deepening of the attitude of awareness characteristic of all emergence (Freire, 1970, pp. 100-101).(4)

5. Decodification - Consists of teacher-student, students-teachers reflecting critically (dialogics) on the mediating objects (*e.g.* visuals) thus externalizing their "thematics" and consequently making "explicit" their "real consciousness" of the world (Freire, 1970, p. 108). During this time, through dialogue, interpretations are challenged and understandings questioned, constantly posing the object of discussion as problematic. Through this process, which Freire refers to as "conscientization," subjects can arrive at a greater awareness of the social context which forms their lives, and also create awareness of their capacity to intervene and transform it (*cf.* Freire, 1970, pp. 100-118).

The process of decoding the mediating objects under analysis thus consists in investigation of the subjects' thinking concerning their life-situation. Thematic investigation, which deepens historical awareness, becomes educational. At the same time "all authentic education investigates thinking" (Freire, 1970, p. 101). Investigating the subjects' thinking leads to further investigation, hence education and thematic investigation are "simply different moments of the same process" (Freire, 1970, p. 101).

When subjects begin to make explicit their views of the world, they begin to see how "they themselves acted while actually experiencing the situation they are now analyzing, and thus reach a 'perception of their previous perception'" (Freire, 1970, p. 108). Achieving this awareness, reality is perceived differently: "By broadening the horizon of their perception, they discover more easily in their 'background awareness' the dialectical relations between the two dimensions of reality." Thus the process of decodification brings about new perceptions and the development of "new knowledge" (Freire, 1970, p. 108);

6. Distancing - Knowing demands that we gain some distance from the "known object" (existential situation). Individuals "need to stand back and reflect on their situation as an object of knowledge" (Matthews, 1980, p. 91);

7. Agency - Agency/activity is a prerequisite for knowledge. Knowing demands activity, and is an active process. "Knowing is the task of subjects, not of objects. It is a subject, and only as such, that a man or woman can really know" (Freire, 1973);

8. Problem-Posing Learning - This is done at the level of decodification. It means asking questions about the codified object, and "calling into question", challenging perceptions and interpretations. It is an unmasking of "social constraints" and, going a step further, questioning the reasons why those constraints exist.(5)

9. Holistic Viewpoint - For Freire, to know things (objects) is to know things in relation. "To know a part is to know how it connects with the whole. In the process of codification, different impressions of the same object or process are utilized so that interrelations might be recognized. It is the total vision which we call knowledge" (Matthews, 1980, p. 57);

10. The Social Dimension - "Just as there is no such thing as an isolated human being, there is also no such thing as isolated human thinking.

the act of thinking about the object s/he cannot think without the co-participation of another subject" (Friere, 1973).

Conclusion

The differing world-views of the three paradigms is the point with which researchers will have to become more familiar. The dominant approach to research today, the positivistic approach, is ingrained in our ways of talking about schooling and research. We will need to learn a new language. We will have to learn to live with ambiguity. Certitude is not always possible. We will need to become comfortable with new ways of looking at reality and defining what is legitimate knowledge. We will have to concern ourselves with epistemology.

Perhaps we should concern ourselves less with creating "effective" visuals, or even trying to define elements of effective visuals, and focus our attention on developing critical thinking skills. Materials are readily available to us. Moving beyond the visual to the use of language in interpreting visuals offers great research potential regarding how individuals come to grips with their world. Arnold Wesker, in an insightful essay entitled Words As Definitions of Experience (London: Writers and Readers Publishing Cooperative, 1976) has already offered us an exciting possiblity for blending research on visuals and the use and power of language. The interpretive and critical paradigms for research should offer new directions and possiblities for future endeavors.

Footnotes

1. Also see Anthony Giddens. New Rules of Sociological Method: A Positive Critique of Interpretive Sociologies (New York: Basic Books, Inc., Publishers, 1976; Egon G. Guba and Yvonna S. Lincoln. Effective Evaluation (San Francisco: Jossey-Bass Publishers), 1982; Gail McCutcheon. "On the Interpretation of Classroom Observations", in The Educational Researcher, May, 1981; Richard J. Bernstein, The Restructurring of Social and Political Theory. (Pennsylvania: University of Pennsylvania Press), 1978; Egon G. Guba. The Context of Emergent Paradigm Research. Paper presented at A Career Development Seminar, Center for Public Affairs and the School of Education, University of Kansas and The University Council for Educational Administration, Overland Park, Kansas, November 4-5, 1983; and Egon G. Guba and Yvonna S. Lincoln. Epistemological and Methodological Bases of Naturalistic Inquiry. ECTJ, Vol. 30, No. 4, Winter, 1982.

2. C. Wright Mills, in The Sociological Imagination (New York: The Grove Press, Inc., 1961), strongly states the case for empirical investigation and the need for examining the part in relation to the whole:

> The specific methods--as distinct from the philosophy--of empiricism are clearly suitable and convenient for work on many problems, and I do not see how anyone could reasonably object to such use of them. We can of course, by suitable abstraction, be exact about anything. Nothing is inherently immune to measurement. If the problems upon which one is at work are readily amenable to statistical procedures, one should always try to use them. If, for example, in working out a theory of elites, we need to know the social origins of a group of generals, naturally we try to find out the proportions coming from various social strata. If we need to know the extent to which the real income of white-collar people has gone up or down since 1900, we run a time-series of income by occupation, controlled in terms of some price index. No one, however, need accept such procedures,

when generalized, as the only procedure available. Certainly no one need accept this model as a total canon. It is not the only empirical manner.

We should choose particular and minute features for intensive and exact study in accordance with our less exact view of the whole, and in order to solve problems having to do with structural wholes. It is a choice made according to the requirements of our problems, not a 'necessity' that follows from an epistomological dogma.

I do not suppose that anyone has a right to object to detailed studies of minor problems. The narrowed focus they require might be part of an admirable quest for precision and certainty; it might also be part of a division of intellectual labor, or a specialization to which, again, no one ought to object. But surely we are entitled to ask: If it is claimed that these studies are parts of some division of labor which as a whole constitutes the social science endeavor, where are the other divisions of which these studies are parts? And where is the 'division' wherein just such studies as these are put into some larger picture? (pp. 73-74).

3. I have outlined Freire's view of education and the implications his views have for the field of instructional technology.(Koetting, 1981).

4. Freire's Educational for Critical Consciousness (New York: The Seabury Press), 1973 gives examples of visuals used in the codification process. For a detailed discussion of the codification/decodification process, see Freire's Pedagogy of the Oppressed (New York: The Seabury Press, 1970), Chapter 3.

5. Denis Goulet, in his introduction to Freire's Education for Critical Consciousness, op. cit., draws the distinction between Freire's notion of problem-posing-education (wherein the natural, cultural and historical reality in which the subject is immersed is seen as "problematic") and the "problem-solving" view of education, wherein

> An expert takes some distance from reality, analyzes it into component parts, devises means for resolving difficulties in the most efficient way, and then dictates a strategy or policy. Such problem-solving, according to Freire, distorts the totality of human experience by reducing it to those dimensions which are amenable to treatment as mere difficulties to be solved. But to 'problematize' in his sense is to associate an entire populace to the task of codifying total reality into symbols which can generate critical consciousness and empower them to alter their relations with nature and social forces (p. IX).

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TITLE: Philosophical Foundations and Instructional Design (Curriculum Theory)

AUTHOR: J. Randall Koetting

Research and Theory Division Symposium:

Open Forum on the Foundational
Issues of the Field of
Instructional Technology

Philosophical Foundations and Instructional Design (Curriculum Theory)

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Association for Educational
Communications and Technology
National Convention
Dallas, Texas
January 20-24, 1984

Philosophical Foundations
and Instructional Design
(Curriculum Theory)

Our purpose for this symposium is in keeping with last year's original proposal, i.e. to address, from a different vantage point, some major theoretical issues of our field, and to stimulate interest in these issues among members of AECT and to provide an opportunity for dialogue and discussion.

Last year my paper addressed the notion that within the field of education, researchers are faced with competing educational philosophies that reflect divergent interpretations of reality, knowledge and value. Depending upon our individual orientation toward living and our perception of the "world" (our immediate social-context), we consciously/unconsciously espouse a particular philosophy of education and act in certain ways within the classroom.

The major focus of my paper was on epistemology. I tried to develop an epistemological framework within which diverse modes of inquiry could be used to comprehend reality. I identified the implications differing modes of inquiry would have for future research within our field, specifically research of a conceptual/theoritical/philosophical nature. I tried to situate our current practice and thinking in the field within that epistemological framework, identifying the need to generate diversity in our reserach methodology.

Introduction: Situating My Discussion

This paper is concerned with curriculum theory and development, and the place of curriculum theory within the area of instructional technology. Our field utilizes the instructional design model, or the systems approach to instruction (e.g. Kemp, 1977; Banathy, 1968; Gagne and Briggs, 1975; etc.), for organizing subject matter for instructional purposes. Hence, our field is concerned (or should be concerned) with curriculum theory and development.

Instructional design is a valid model/process to utilize for organizing curricular content. It is a very popular model. It has strong historical roots within the field of curriculum (Kliebard, 1975; Apple, 1979; Koetting, 1979). Yet it is only one model for organizing the instructional process. When we examine the notion of curriculum theory, we begin to get a broader sense of the complexity of the process of schooling.

I will develop my paper as follows: I want to identify the central question of curriculum (what should we teach?) and examine the notion of curriculum theory. I will then look at the implications for the field of instructional technology that I believe would enhance the utilization of media within the instructional process.

I chose to look at curriculum theory because, as I hope to show, it is through an analysis of curriculum theory that we begin to move toward differing philosophical viewpoints regarding schooling. This will provide a framework for viewing the instructional design model as one means of curriculum design.

Curriculum: What Should We Teach?

Kliebard (1977) has stated that the central question of curriculum is "What should we teach?" Asking this question, we are immediately faced with a series of questions/issues:

1. Why should we teach this rather than that?
2. Who should have access to what knowledge?
3. What affects would accrue from the study, particularly the prolonged study, of a given domain of knowledge?

4. How should the various parts of the curriculum be inter-related in order to create a coherent whole?

Taking the central question of curriculum (what should we teach?) and the questions we are confronted with, namely the four just mentioned, what definition/understanding of the word theory (curriculum theory), can help us come to grips with our central question?

Kliebard (1977) suggests the following meaning for the word theory:

> Any more or less systematic analysis of a set of related concepts.

The systematic analysis is an

> Attmept to clarify what may be initially vague concepts and thereby unpack the nature of the problems under consideration.

Thus, through systematic analysis, we attempt to clarify the various concepts/understandings implied in our four questions.

Examples may be helpful here. What is implied in our four questions? What are the implications, what are the hidden notions we can "unpack" from these questions?

1. Why teach this rather than that?

   We can't teach everything. We need to be selective and chose what we are to teach from a vast array of information within a given field. What will be the the basis of our choices? Utility? Relevance? Personal meaning? Survival skills'? Needs of business/industry? Is there an "accepted" curriculum/body of knowledge for each discipline?

2. Who should have access to what knowledge?

   What criteria do we use for determining who gets what information? Probable destination of students? Social efficiency? I.Q.? Standardized testing? Vocational/trade? Who determines what is legitimate regarding a body of knowledge?

3. What affects would accrue from the study of a given domain of knowledge?

   Does the study of mathematics encourage rational thought processes? Do certain studies "make us" better people? Do the humanities/cultural studies make us more complete human beings? What knowledge is of most worth?

4. How should the various parts of the curriculum be inter-related in order to create a coherent whole?

   Schools are the only "place" where reality is isolated into disciplines of study. Why emphasize the basics? Why not organize/integrate disciplines through team teaching?

The problems we are unpacking, analyzing and trying to clarify are philosophical in nature. They are concerned with the nature of reality (ontology); the nature of knowledge (epistemology); the nature of valuing (axiology); the nature of society; the purpose of schooling; the nature of society.

If we pursue this kind of questionning, we move into neglected areas in curriculum studies, for example

1. The taken-for-granted reality of schooling;
2. The conceptual emptiness of our notion of, and use of the term knowledge;
3. The position of value-neutrality regarding the process of schooling; etc.

What we end up clarifying/analyzing are our assumptions underlying our orientation to understanding "curriculum".

Implications for Instructional Technology

If I can accept the points made up to this point regarding the central question of the field of curriculum (What to teach?) and the attendant questions raised

Why teach this rather than that?
Who should have access to what knowledge?
What affects would accrue from the study of a given domain of knowledge?
How should the various parts of the curriculum be inter-related to form a coherent whole?

Then I can make the following statement:

> Teaching is essentially a philosophical endeavour and therefore educational activity can be conceived within the context of a philosophy or world-view.

Essentially we would be examining our teaching activity through a process of self-reflection based on a philosophical world-view. This is not a new idea. I think most of what we do in schools can be examined within the context of particular framewords. What I am suggesting here that is different is the choice of frameworks.

If the statement I just made on teaching can be accepted, we are led to different kinds of questions within the field of curriculum because we are using a very different kind of language, a different conceptual framework that asks different questions than we usually ask in the field of curriculum. As Giroux (1981) suggests, a different question arises:

> Whether the new language and concepts used are raising profoundly important questions and issues about the curriculum itself.

My contention is yes, the new language and formas of analysis will do just that, namely raise more profoundly important issues not only within the field of curriculum, but within our own field as well. We will be required to examine the disciplines of philosophy of education, sociology of education, the revisionist historian's work on public schooling; etc. This will certainly broaden our base/perceptions and help us to see the larger picture, not just the "What to teach?"

Apple (1982) has suggested that teachers today are being de-skilled in the art and craft of teaching because of the form curriculum has taken. At the same time, they are being re-skilled into managerial roles because of that form. The curriculum field can bring back the art and craft of teaching. Educational technology can provide diversity of thinking regarding curriculum and instruction. That would be curriculum theorizing.

This means that we might focus less on the specifics of instructional design, and attend more to the content of instruction and to the diversity of modes of expressing ideas for instructional purposes. This will require that we become familiar with the area of curriculum studies, and the debates, issues, problems and concerns of that area of study. For example, current curriculum literature is critical of systems management procedures used in organizing subject content (cf. Apple, 1979). These same critiques can be used in examing the instructional design model as a means of organizing the learning process. The I.D. model has a constitutive interest in controlling that process.

Control is consititutive of the model itself, the nature of the model. The instructional developer (teacher) makes all the decisions regarding the organization and planning of the learning process, and this is done usually prior to meeting students who will undergo the instruction. One primary legitimating factor for using this "scientific/systematic approach" to designing instruction is the objective nature of the results planned for. Yet, methods of inquiry have constitutive interests. Empirical methodology has an interest in control. This is verified in praxis by examining the instructional design model and progrmas that have been designed according to the model. Knowledge is predetermined, what students will "think, feel and learn" is predetermined, by someone other than the students. The major difficulty with applying a control model to the learning process is centered on questions that point toward the "non-neutrality" of education: "Whose knowledge is it? Who selected it? Why is it organized and taught in this way? To this particular group?" (Apple, 1979, p. 7). Linking these questions with the emphasis on standardization of methodology and outcomes that is characteristic of the instructional design model, and the model's emphasis on control of the learning process, any deviation from predetermined outcomes cannot be considered. Thus all students who through the structured learning activities of the model are expected to arrive at the same point (input-output model). I believe this is a reductionist and simplistic view of education that poses strict limitations on what is determined "legitimate knowledge," and how one arrives at legitimate knowledge.

If I focus on diverse forms/modes of rationality, I can arrive at knowledge through interpretive understanding (Verstehen) and critical science. In working with symbol systems, e.g. in analyzing the language of film, the language of video, the language of photography, visual imagery, etc., I am situated in another mode of rationality, I am looking for interpretive understanding. When these interpretations are open to critical analysis, I am situated in yet another mode of rationality, that of critical science, critical thinking and analysis. The empirical model of education does not use/recognize interpretive understanding or critical thinking as methodology. I suggest we explore alternative ways of organizing curricula that acknowledge that students are capable of having valid views of the world and at the same time recognizing that those views are open to critical analysis.

There are other models of curricula organization that we could explore. We will need to examine the literature outside of our field that is specifically concerned with curriculum development. This could be a fruitful area for future research and alternative praxis. Our research efforts will be of a theoretical/conceptual nature, and once the theory/conceptual base is clearly explicated (a legitimate research endeavor), testing the frameworks will demand varied research techniques and reporting. Definitive, generalizable conclusions regarding the "one best" curriculum organizational model will not be our research aim. However, greater understanding of the complexity of the curriculum organizational process could result and enhance our praxis.

To link the notions of curriculum and media together will suggest new ways of looking at the learning process. It will provide a differe language and conceptual framework for looking at the debates, issues, problems and concerns in our field.

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TITLE: Development and Validation of a Measure of Computer Anxiety

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DEVELOPMENT AND VALIDATION OF A
MEASURE OF COMPUTER ANXIETY

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INTRODUCTION

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DEVELOPMENT AND VALIDATION OF A MEASURE OF COMPUTER ANXIETY

by
Matthew M. Maurer
and
Michael R. Simonson PhD

INTRODUCTION

The rate at which computerization is propagating is constantly accelerating. Thus, the need to understand the effects of computer usage on the individuals involved with computers is important. Many individuals fear computer utilization, and this fear can be very detrimental to their performance in a highly computerized environment.

Before fear of computers, or computer anxiety, can be analyzed, it must first be identified. The state/trait theory of anxiety proposed by Spielberger (1972) was used as a foundation for describing the new phenomenon of computer anxiety identified in this research.

The intent of this study was to develop a measure that could be used to identify individuals who had a tendency to become unusually computer anxious when faced with a situation in which computers were involved. This tendency to become anxious is called the trait of computer anxiety. The actual development of anxiety when the individual is involved with computers is called the state of computer anxiety. The Computer Anxiety Index (CAIN) is intended to measure the trait of computer anxiety, and to be predictive of the development of the state of computer anxiety.

Three goals were identified to insure that the final product of the study would be a usable paper and pencil test of computer anxiety. These three goals were as follows:

1. Develop a general measure of computer anxiety.

2. Gather information to test the reliability and validity of the instrument.

3. Gather data to be used as norm references for the test.

Before the process of developing the actual test could begin, a clear definition of the computer anxiety had to be developed to guide the development process. Computer anxiety was defined as the fear or apprehension felt by an individual when using computers, or when considering the possibility of computer utilization. To further clarify the construct, it was made clear that, although there are rational fears related to computer utilization, (e.g. job displacement, increased exposure to radiation from terminal screens) the fears that were being addressed in this study were fears that could be called "irrational" fears (e.g. impending doom or sure calamity because of contact with computers).

This definition is quite helpful in guiding the development of the computer anxiety measure, but to further assist in the development process, the construct had to be further described in terms of the observable behaviors that suggest the underlying feelings related to computer anxiety. In other words, it was necessary to define how we would know if someone were computer anxious. This is important since the ultimate purpose of the CAIN is to predict the state of computer anxiety. Thus, the behaviors of that state must be identified so that the predictive ability of the test can be validated. The following are the behaviors that were identified as being indicative of computer anxiety:

1. Avoidance of computers and the general areas where computers are located.
2. Excessive caution with computers.
3. Negative remarks about computers.
4. Attempts to cut short the necessary use of computers.

METHODOLOGY

With computer anxiety clearly defined, and its indicative behaviors enumerated, it was possible to begin the process of developing the actual test of computer anxiety. It was decided that the test would use a six point Likert scale of agreement/disagreement and that the Hennerson, Morris and Fitz-Gibbon (1978) model of psychological test development would be used.

The first step in this development process was to generate numerous test items that would be indicative of an individuals feelings of anxiety toward computers. Rohner (1981) had previously developed a measure of computer anxiety, but it was specifically directed toward prospective teachers, and there were other minor problems identified with it. However, the items of the Rohner test were used to suggest other more appropriate items. College students were also asked to generate statements reflecting how they felt about computers. These statements were used to suggest items that reflected an individual's feelings of anxiety toward computers. Test items were generated that related to the previously defined construct of computer anxiety. The specific definition and the associated behaviors were used as the initial criterion for an appropriate item.

Once items were developed, they were pilot tested to determine if they were good discriminators. As a result of the pilot test, poor items were identified and eliminated, and questionable items were modified. A second pilot test was completed, and only the best items were kept to make up the final version of the Computer Anxiety Index. This rigorous development and pilot testing procedure accounted for the high level of reliability that was later found to exist.

The next goal of this project was to determine the reliability of the test and to gather information to demonstrate the validity of the test. College students enrolled in an undergraduate instructional media class at Iowa State University were used as subjects in gathering this information. The reliability of the test was measured using two different methods. The internal consistency of the test was checked using Cronbach's (1970) coefficient alpha formula. The students were also tested and retested with an intervening period of three weeks to test the test/retest reliability of the measure.

The establishment of the reliability of the test made it possible to examine the validity of it. The validation portion of the study was done using students in an instructional media class at Iowa State University as subjects. This group was chosen because part of their planned curriculum included a two hour laboratory session in which the students were required to work with a computer.

Four steps were followed to demonstrate the validity of the Computer Anxiety Index (CAIN). The first step was to administer the CAIN to the subjects two weeks before their lab on computers. The CAIN was administered prior to the subject's required use of computers because the CAIN was being developed as a measure of the trait of computer anxiety (rather than the state of computer anxiety) and naturally as a predictor of the development of the state of computer anxiety under the proper conditions (i.e. exposure to computers).

The second step of the validation process was to administer the State-Trait Anxiety Index (STAI) (Spielberger 1970), which was intended as a concurrent measure of computer anxiety. The STAI was chosen as the best measure to use as a concurrent measure of computer anxiety because there was no other appropriate, valid measure of computer anxiety in existence. However, since the STAI is actually a measure of general anxiety, the timing of its administration was considered crucial if it was to be construed as measuring computer anxiety. The state portion of the STAI was administered to the subjects after they were seated in front of their computers. The assumption was made that if an individual had the trait of computer anxiety they would develop a state of anxiety while seated before a computer, and this state of anxiety could be measured by the STAI.

The third step of the validation process was to actually observe subjects while they were using computers. During this observation session, a judgement was made about each individual on his/her observed level of computer anxiety. Subjects were judged on a three point scale, either computer anxious, neutral, or computer comfortable. The criterion on which the subjects were judged were those behaviors that were stated earlier as being indicative of the state of computer anxiety.

The final evaluation procedure was to compare the results of the three independent measures of computer anxiety. The STAI and the observed measure of computer anxiety were correlated to the results of the CAIN. It should be emphasized that these three measures were each very different. The CAIN was a measure of the trait of computer anxiety, and the portion of the STAI that was used was a measure of the state of anxiety. Both of these measures were administered using self-reports, while the third measure was an observational one. The observation was also measuring the state of computer anxiety, while the test was designed to measure the less transient trait of computer anxiety. Since these three measures were each somewhat different, it was not expected that their correlations would be extremely high. To be demonstrative of the validity of the CAIN however, the correlations of the measures had to be positive and significant.

The collection of normative data was the third and final goal of this study. The intent in collecting this data was to allow a person who might take this test at a later time to be compared to others who had already taken the test.

The following six groups were identified as being important and interesting to those concerned with computer anxiety:

1. Computer professionals
2. Those who use computers on a daily basis, but are not computer users
3. Educators

4. Junior high school students

5. College students

6. Adults who fit none of the above categories

Subjects for the collection of normative data were solicited from across the state of Iowa. They were from schools, businesses and government agencies.

The intent in gathering this data was not to identify scientifically comparable random samples, but to gather a large volume of data. Therefore no scientifically valid comparisons should be made between the groups of subjects.

RESULTS

The computer anxiety index was found to be highly reliable, using two methods of demonstrating reliability. A group of 25 subjects were tested with the CAIN, and retested 3 weeks later. The coefficient of reliability for the test/retest situation was .90 (r=.90).

The internal consistency of the second administration of the test of the above mentioned subjects was checked using Cronbach's coefficient alpha method. The coefficient alpha was found to be .94 (r=.94). The internal consistency was also calculated for a second group of randomly selected from the tests returned as part of the collection of norm data. The coefficient alpha for this group was .96 (r=.96).

The three independent measures of computer anxiety, (the CAIN, STAI and observation) were taken and they all correlated positively and significantly with each other. The correlation constant of the STAI with the CAIN was .32 (r=.32). With a subject population of 111, this was significant beyond the .01 level (p § .01).

The observation measure was correlated with the CAIN and the correlation coefficient was .36. This too was significant beyond the .01 level (p § .01).

The normative data was successfully collected and compiled. Table 1 shows the number of subjects, their means, standard deviations and the range of scores for each of the six groups. The scores were grouped into 2/10 intervals and compiled into a percentile table (Table 2) to allow easy comparison.

ANALYSIS OF RESULTS

The reliability and validity figures give strong evidence that the test is measuring what it was designed to measure. The normative data gives some indication of the normal range of responses that can be expected from the test. The results imply that a necessary measure is now available for future research and evaluation. The stated goal of the project, to develop a usable measure of computer anxiety, was accomplished. The test can be used as a tool in career planning, and as a test to identify individuals in need of special training.

In addition to the accomplishment of the stated goals of the study, this study is significant as an important first step in the scientific examination of the phenomenon of computer anxiety. This study provides a tool to use in that examination.

One avenue of research that is suggested by this study is to determine if the several groups that were inspected are in fact as similar as the normative data would suggest. Four of the six norm groups showed normal distributions skewed to the right (towards the positive). (The group called "other" was not sufficiently large to show a regular distribution, and the teachers had a skewed and elongated distribution.) This is as can be expected for a measure that is examining a phenomenon that is generally identified as a negative one. The distribution shows that most people cluster around the less anxious end of the scale. However, even with a skewed distribution, there were individuals in all of the six norm groups that were separated from the rest of the group by at least one full interval. This seems to indicate that in all groups, including people who use computers on a daily basis, there are those who are critically computer anxious. The examination of this peculiarity in the distribution of the scores of the norm groups could prove to be very interesting and enlightening.

A second area in which this study could be very valuable is in examining the change in computer anxiety following a specific treatment or remediation activity. The CAIN can be used to measure changes in computer anxiety. Since the reason for concern about computer anxiety is that it is generally believed that computer anxiety may interfere with people's functioning, this test can be used to determine which treatments prove to be most effective in reducing computer anxiety.

CONCLUSIONS

The Computer Anxiety Index is a valid and reliable test that can can be used to measure computer anxiety. This test has several practical applications. It can be used effectively in the further study of the phenomenon of computer anxiety. It can also be used as an evaluation tool by guidance counselors to identify students that are either well or poorly suited for careers involving computers. It can also be used by employers and educators to identify individuals who are in need of special curriculum or training programs to help reduce computer anxiety.

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Table 1. Mea
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Mean score	
Standard deviation	
Low score (1 = lowest possible)	
High score (6 = highest possible)	

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Table 2. Per

	Colleg studen
1.0	0
1.2	-
1.4	1
1.6	4
1.8	8
2.0	14
2.2	24
2.4	35
2.6	47
2.8	59
3.0	69
3.2	78
3.4	86
3.6	91
3.8	92
4.0	94
4.2	-
4.4	96
4.6	97
4.8	-
5.0	99

Table 1. Means, standard deviations, and ranges of CAIN scores by norm groups

	College student	Junior high	Teacher	Profes-sional	User	Other	All
N	111	247	42	67	122	25	614
Mean score	2.70	2.21	2.44	1.78	1.99	2.21	2.23
Standard deviation	0.71	0.67	0.92	0.58	0.54	0.72	0.72
Low score (1 = lowest possible)	1.00	1.00	1.00	1.00	1.00	1.12	1.00
High score (6 = highest possible)	5.04	5.04	4.69	3.73	4.28	4.31	5.04

Note - the higher the CAIN score, the higher the individual anxiety

Table 2. Percentile table for CAIN raw scores by norm group

	College student	Junior high	Teacher	Profes-sional	User	Other	All
1.0	0	1	2	4	2	-	1
1.2	-	4	3	14	6	3	5
1.4	1	9	16	30	12	7	11
1.6	4	18	24	45	23	19	20
1.8	8	30	32	59	38	32	31
2.0	14	43	38	72	52	44	42
2.2	24	54	43	80	65	57	53
2.4	35	63	48	86	79	69	63
2.6	47	72	55	-	89	78	72
2.8	59	81	60	91	94	84	79
3.0	69	86	65	-	96	-	85
3.2	78	90	74	95	-	88	89
3.4	86	94	83	97	97	-	93
3.6	91	97	89	-	-	-	95
3.8	92	97	93	98	98	92	96
4.0	94	-	95	-	-	-	97
4.2	-	98	-	-	99	-	98
4.4	96	-	-	-	-	96	98
4.6	97	-	97	-	-	-	99
4.8	-	-	-	-	-	-	-
5.0	99	99	-	-	-	-	99

TITLE: Cognitive Style and Microcomputers: Instructional Management Potentials

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Kathy L. Bruce

Cognitive Style and Microcomputers: Instructional Management Potentials

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Abstract

This paper focuses on how microcomputer technology can be used to manage individualization that is based on student differences in cognitive style. Generalized approaches to individualization and the management of individualization are discussed, along with specific approaches based on individual differences in cognitive style variables. Benefits from the use of computers for the management of this type of individualization and the requirements for management with microcomputers are presented. The paper concludes with a discussion of practical issues and implications to be considered in an implementation of this approach.

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Cognitive Style and Microcomputers: Instructional Management Potentials

The success of any individualization approach in large part depends on how well the process of matching individuals with alternative treatments can be managed. This paper focuses on how microcomputer technology can be used to manage individualization that is based on student differences in cognitive styles. Although this topic has general relevance to the management of individualization based on measurable student differences on a variety of dimensions, attention will be given to considerations that can be derived from the growing body of research on cognitive styles and its implications for the management of individualization. As background to this topic, a generalized approach to the management of individualization, traditional approaches to instructional management based on cognitive style differences, and benefits from the use of computers for the management of this type of individualization are described. The final sections of the paper describe the possibilities and requirements for the management of individualization with microcomputers and the practical issues and implications to be considered in an implementation of this approach.

Generalized Approach to the Management of Individualization

In defining the approach to be taken to the management of individualization, including one based on cognitive styles, two component processes must be specified: the approach to individualization and the approach to the management of this defined individualization process. The past decade has seen significant progress in the articulation of general approaches in both these areas, such that it is possible to describe well-defined and evaluated procedures.

Beginning with the first component, specification of the individualization approach, the approach defined by McCombs and McDaniel (1981) and Parkhurst

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and McCombs (1979) provides a basis for the following generalizable working model. This model consists of the following steps:

1. Analyzing the student population to identify characteristics related to success/failure in mastering course objectives;

2. Selecting or designing individual difference measures to assess student characteristics identified as important in step 1;

3. Administering selected individual difference measures to the target population in order to analyze reliability and predictive validity, using course performance variables of interest as criterion variables (e.g., test scores, failure rates, learning times, etc.);

4. Identifying best predictors of student performance with current instructional approach;

5. Defining alternative strategies/treatments for accommodating identified student differences;

6. Specifying the individualization approach, including types of decision rules and procedures to be used in individualized assignment to defined treatments;

7. Developing alternative treatments and randomly administering them to the student population;

8. Evaluating alternative treatments and deriving selected decision rules;

9. Implementing alternative treatments per derived decision rules and procedures; and

10. Evaluating decision rule performance and revising as necessary.

The end result of the foregoing process is a validated individualization approach. Ideally, it is at this point that individualization can be implemented on a full-scale basis, thus necessitating the need for an approach to the management of this individualization process. That is, a systematic procedure must be defined for moving students through the individualized program and keeping track of their performance and progress. In defining the management approach, decisions need to be made concerning the degree to which ongoing research and evaluation will be supported during full-scale implementation. This would allow the management system to be structured such that data required for research and evaluation can be routinely collected along with data used for the management of student performance and progress. Bozeman (1979) discusses several other factors to be considered when defining the management approach, including resources available (e.g., availability of staff personnel or computers to perform management functions), administrative support (e.g., commitment of upper level management to the individualization approach), staff attitudes and competence (e.g., staff perceived need for individualization and resulting need for staff development/training), and a variety of environmental factors (e.g., size of school, number of courses to be involved, etc.).

Regardless of the sophistication of the designed management system and the degree to which it supports research, the general procedures to be accommodated in the management of individualization include (1) administration and scoring of individual difference measures, (2) diagnosis of student characteristics and prescription of specific treatments or strategies, (3) monitoring and evaluation of student performance on selected treatments, and (4) formatting of data into necessary reports for both student and instructor/researcher. These procedures are particularly well-suited for implementation with computer-based technologies.

For example, Bozeman (1979) describes how the conceptual model of computer-managed instruction (CMI) can be used to assess instructional outcomes, update records, identify instructional needs through reports, and group students for instruction based on specified individual difference characteristics. McIsaac and Baker (1981) maintain that microcomputers provide an effective way to implement CMI because they are less costly, provide more direct control, and allow better user access and convenience than large mainframe, timesharing systems. More will be said about the use of microcomputers for the management of individualization in the following sections. For now, however, the discussion focuses on traditional approaches to individualization and the management of individualization based on cognitive style differences.

The Management of Individualization Based on Cognitive Styles

Up to this point, the topics of individualization and the management of individualization have been treated in a general way. Recent research indicates that individualization can be maximized by using information about cognitive sytles, sometimes more broadly referred to as learning styles (e.g., Cosky, 1980; Dunn & Dunn, 1979; Gregorc, 1979; Hunt, 1979; Keefe, 1979; Lindelow, 1983; Wardell & Royce, 1978; Whitley, 1982). Whatever term is used, it is clear that styles provide a theoretically based, multivariate method for adaptation to individual differences. Styles include student differences in cognitive, affective, and physiological characteristics or ways of perceiving, analyzing, interpreting, and responding to learning situations (Cosky, 1980; Lindelow, 1983; Wardell & Royce, 1978).

Researchers applying individualization approaches based on cognitive or learning styles have generally handled the management of this individualization with manual, teacher-based procedures. That is, they have implemented manual procedures for administering and scoring cognitive style inventories, compiling scores into student profiles that can be matched with alternative treatments, assigning students to these treatments, and administering appropriate post-tests and remediation. Examples of these individualization approaches include Hunt's (1979) implementation of a Conceptual Level Matching Model for matching students' stages of development and present styles to specific teaching approaches that differ in degree of structure; Anderson and Bruce's (1979) practical application of a plan for matching learning and teaching styles in a high school setting; and implementations of treatment matching approaches based on cognitive styles in an elementary school setting (Ellis, 1979; Epstein, 1981). In each of these examples, the primary responsibility for diagnosing, prescribing, implementing, and evaluating the individualization rested with the teachers.

A number of other applications of individualization based on cognitive styles have used a cognitive mapping approach wherein Hill's (1975) Cognitive Style Inventory provides a cognitive learning style profile that can be used to specify the conditions under which a student can best learn (e.g., Kusler, 1979; Strother, 1980; Whitley, 1982). Although some of these applications utilize computers for the analysis of inventory scores, creation of cognitive maps, and generation of learning prescriptions, the total management of the individualization process is manually controlled by teachers and staff. Similarly, Cavanaugh (1979, 1981) describes a diagnostic/prescriptive approach to individualization based on learning styles in a high school setting where the computer is only used to analyze learning style information and produce suggested prescriptions by subject for each student. The management functions of (a) monitoring and evaluating student performance on alternative treatments, and (b) formulating data into reports for students and teachers have generally not been computer supported in these individualization approaches.

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That computer-based techniques can greatly enhance the management of individualization based on cognitive or learning styles has been recognized (e.g., Cosky, 1980), but to-date costs of computer equipment have made practical applications rare. The emerging microcomputer technology is rapidly changing these possibilities, however, and provides an opportunity to overcome problems associated with manual management of individualization and the resulting limitations to individualization. For example, without the aid of computer technology for diagnosing, prescribing, and evaluating student performance and progress, teachers must spend considerable time in administrative and clerical tasks associated with student management. In addition, complex decision making is difficult and refined matches of student cognitive style differences with alternative treatments are less likely to be based on updated student performance data. These limitations are particularly critical to the emerging science of individualization based on cognitive styles--a science that requires systematic analysis and decision making to revise and present a comprehensive learning environment with sufficient alternative treatments (Lindelow, 1983; Whitley, 1982).

As a final point, Lindelow (1983) has made a strong case for the position that simply matching treatments to a student's learning or cognitive style is not an adequate procedure. Rather, it is argued that the judgment and expertise of the educator/researcher should be used in determining how closely treatments and styles are matched. Lindelow (1983) recommends a matching approach which periodically exposes students to demands that do not precisely match their styles in order to develop their flexibility and ability to select appropriate strategies for particular learning contexts. The use of this more complex type of matching strategy is particularly well suited for implementation within a computer-based management system.

The Use of Computers in the Management of Individualization

The development of computer management programs used in individualization of instruction has followed that of instructional computing in general. The first CMI systems were designed for large mainframe computers, most commonly on a timesharing basis. An example of an early research effort in CMI in the public schools is WIS-SIM (Wisconsin Student Information Management), a project undertaken by the University of Wisconsin beginning in 1972 (McIsaac & Baker, 1981). This program ran on a mainframe computer and stressed the grouping function of the management process in a variety of curricula. A concurrent study at the same institution involved a management system called MICA (Management of Instruction with Computer Assistance). This system emphasized the management functions of prescription and diagnosis, applied to the tracking of individual student progress independent of group progress.

In 1977, the University of Wisconsin began working on a microcomputer management system based on the earlier mainframe CMI efforts. This system, called MICRO-CMI, is designed to handle both the diagnosis and prescription functions of MICA, as well as the grouping capability of WIS-SIM (McIsaac & Baker, 1981). The program runs on a single microcomputer. The entire system includes the microcomputer, a printer, a sheet scanner, and disk drives (presumably two). As it has been implemented in the McFarland (Wisconsin) Public Schools, MICRO-CMI functions as a tool used by teachers primarily to recommend groupings of students for instructional purposes, and to generate a variety of reports for teachers, parents, and students. As an example of its grouping capability, students in reading, math, and science are regrouped every two weeks. Compared to the 50 hours required for the manual regrouping of 200 students in reading, MICRO-CMI accomplishes the same job at a higher level of sophistication in less than an hour. Grades are the criteria upon which grouping and diagnosis decisions are made, where grades presumably refer to measures of mastery level of content or skill.

Two examples of large scale CMI systems for the management of individualization in military technical training are the Navy's CMI system (VanMatre, 1980) and the Air Force's Advanced Instructional System (AIS; McCombs & McDaniel, 1981). Both of these systems are implemented on large mainframe computers and both systems accommodate a wide range of management options including student diagnosis and prescription, progress monitoring and management, test scoring and evaluation, report generation, and resource management. The AIS also has the capability for complex individualization decisions based on adaptive decision rules which utilize both pre-course and within-course student information. In both the Navy and Air Force systems, printers and scanners are interfaced with the mainframe computer to provide a management terminal used for inputting student data and outputting student prescriptions and other management reports.

Several commercial computer firms have designed CMI systems to be used in the management of instruction. Control Data Corporation's (CDC) PLATO system and Hazeltine Corporation's TICCIT system are two well-known and widely used examples of commercially available CMI systems. Both of these systems were originally implemented on mainframe computers, but are currently being converted to microcomputer-based systems. The currently available micro-PLATO capability involves a tie in to CDC's mainframe to handle management functions. A new version of TICCIT, MicroTICCIT, is now being marketed, however, which combines the authoring, delivery, and management of instruction through a micro network system. A third commercially available system is manufactured by WICAT Systems, Inc. WICAT's capabilities include the handling of CMI from several hardware configurations ranging from stand-alone to networked microcomputers.

Since the early 1980's, there has been a surge of interest in microcomputers and their application to instruction (Charp, 1982). There currently exists a large number of microcomputer firms (e.g., APPLE, Commodore, IBM) offering stand-alone systems at relatively low costs. Dramatic cost reductions from mainframe to mini to microcomputers have increased the use of computers in education. This phenomena, combined with the increased memory and storage capabilities of microcomputers, have increased interest in using microcomputers for more than the delivery of instruction, i.e., computer-assisted instruction (CAI). Microcomputers are now being explored for CMI application and can be effectively used in the management of individualization based on cognitive styles. The next section explores the range of management options to be considered in designing a microcomputer-based system that can manage cognitive style-based individualization.

Range of Management Options

In designing a management system to be implemented via microcomputer, two sets of options or requirements must be considered. This section considers the first set of options, what functions are required by the management system itself; the following section describes the second set of options, what equipment is required.

Bozeman (1979, p. 51) has defined CMI as: ". . . management information systems designed to support certain management functions (e.g., planning, organizing, controlling) associated with individualization of instruction. The support of decision making, in particular decision making associated with the identification of the instructional needs of students and in the selection of the most appropriate instructional activities to meet these needs, is emphasized in systems of CMI."

The following list contains most of those functions which have been cited as desirable in a computer-based management system (Bozeman, 1979; McCombs, 1979; McIsaac and Baker, 1981):

1. Test administration
2. Scoring
3. Diagnosis
4. Prescription, or treatment recommendation and/or assignment
5. Automatic branching to on-line treatments
6. Performance evaluation
7. Report generation
8. Resource management and scheduling
9. Data base maintenance
10. System evaluation

Testing functions allow the system to administer a test or battery of tests to measure a student's entry level characteristics, including cognitive or learning style, as well as within-course performance.

Scoring includes the scoring itself and the storing of scores for later use in diagnosis and performance evaluation.

Diagnosis is defined as the assessment of a student's entry level characteristics based on information obtained from precourse test scores. Depending on the level of sophistication desired, diagnosis can also be extended to the assessment of students' within-course performance or alternative treatments.

Prescription involves either recommending or assigning the student to a particular treatment based on the previous diagnosis and predefined decision rules for matching student characteristics to treatment options, or to remediation based on individual performance evaluations and associated decision rules.

Automatic branching is a capability that can be used if treatments are provided on the computer in the form of CAI, wherein the management system could automatically branch to the prescribed on-line treatment.

Performance evaluation refers to the assessment of a student's level of mastery on particular treatments.

Report generation includes providing the instructor and/or researcher with individual student data such as test scores, cognitive style diagnoses, prescribed treatments, and progress reports. Summarized group data could also be available.

Resource management and scheduling is desirable in those applications where there are limited resources (i.e., less than the total number required to support all students needing a particular resource such as CAI, sound-slide devices, etc.), and/or when there is a linear sequence of course units (i.e., no flexibility in the order in which the units can be taken). If these conditions do not exist, the assignment to a particular resource can be analogous to the assignment to a particular treatment.

Data base maintenance is necessary in order for any computer-based management system to operate successfully, i.e., data bases must be initialized, updated, and maintained. Data bases most likely to be needed for cognitive style management are (1) a data base of student information, including entry level and course performance data, (2) a data base defining the course hierarchy of alternative treatments, (3) a data base containing the decision rule parameters for each individualization decision, and (4) if resource management is included in the system, a data base containing the number and types of resources required for each course unit--to be used in determining resource availability.

System evaluation is a management option that consists of a built-in evaluation system to aid the implementor or researcher in determining the success of the prescribed treatments, and therefore, the appropriateness of the system's decision rules.

Some of these functions may be considered optional, depending on such issues as (1) whether the system will be used by instructors only, or by students as well, (2) the balance between research and practical implementation requirements, (3) level of financial and other support allocated for the system, and (4) the level of individualization to be addressed.

It should be noted that the management options discussed thus far have been in the context of CMI as defined by Bozeman (1979). In individualizing on the basis of cognitive style, the levels of individualization may range from gross cognitive style differences to very fine-grained ones. CMI is most capable of handling individualization at the gross level. As one approaches the finer distinctions of cognitive style, many of the management options listed above must be considered within the context of a particular lesson. This moves one away from the realm of strict CMI, and toward CAI. In other words, within a particular treatment, a student may be tested, diagnosed, and branched to a subtreatment, all within the context of a single on-line lesson.

For example, if the overall management system determines that a student is a visual as opposed to an aural learner, it may make assignments to a treatment consisting of graphic-intensive CAI. That lesson may begin with a test to determine a finer level of style, say whether the student is a reflective or impulsive learner. If the student is reflective, the pacing of the lesson may be put under the student's control. If the student is impulsive, the pacing may be left under the control of the system in order to encourage the student to take more time to reflect on answers. Therefore, another consideration in determining management options is how finely one wishes to distinguish cognitive style differences, so that one will know whether management options should be considered only on a broad scale, only on a fine scale within lessons, or both.

In summary, the designer must determine which management functions and what level of individualization are necessary or desired in order to evaluate the second set of options or requirements, those relating to computing hardware.

Range of Equipment Options

The simplest, least expensive type of hardware system that could handle CMI at some level would be a single microcomputer used in a manner similar to that of the MICRO-CMI project described earlier (McIsaac & Baker, 1981). It should be noted that this type of system would be a tool used only by teachers or research staff. Although the microcomputer would certainly be capable of administering tests and presenting CAI, it would be impractical to attempt to use a single machine to test and present instruction to an entire class of students.

Tests would be administered manually, and scores entered into the computer program's data base either manually at the keyboard or automatically by means of a scanner. Once the data bases are initialized in this manner, the system would be able to manipulate the data in just about any prescribed way. The MICRO-CMI system was reported to have the capability to store data on 1,000 students on a single diskette, and through swapping diskettes, do calculations on a population as large as 1,000. The major functions involved in management of individualization, diagnosis of individual need and prescription of instruction to meet that need, could be handled by a single microcomputer. Implementation of prescribed instruction would have to be handled off-line.

The major disadvantages of using a single microcomputer for CMI are matters of inconvenience. It would involve quite a bit of diskette swapping, it would require a relatively long compute time compared to larger systems, and it would be limited to one user at a time. The major advantage is that a single microcomputer will do the job of managing instruction, or actually recommending management strategies to be implemented, at a much more sophisticated level than would be possible manually, for the price of a single system. MICRO-CMI reported a cost of $15,000 for initial aquisition and $2,000 per year for operating costs, for a total of $25,000 for a 5-year period.

Combining several microcomputers together in a network can offset some of the disadvantages of using a single machine. The obvious advantage is that a network is a multi-user system. This means that the management system could take on the function of test administration. Having tests administered on-line would mean faster and more efficient scoring and data base updating. It is possible that a network of this kind could be used to present CAI as well.

However, if one wants an overall management system in operation that would control the presentation of CAI, and update the data bases with information from the lessons automatically, one would need to consider an addition to the network that would provide greater storage capability.

A network of microcomputers that shared a hard disk drive would be such a system (Charp, 1982). The increased storage capability of hard disks would mean that the management system itself, including its data bases, could be available at all times, even during the presentation of CAI lessons that might be loaded separately from floppy disk drives at the individual work stations. Other advantages of increased storage capability is the possibilities of more sophisticated decision rules, the handling of resource management, and the implementation of system evaluation functions. Of course, one would still be limited by the storage capability of an individual computer. It can manipulate only as much data as it can hold at any given time. This means that some functions, such as the system evaluation for research purposes, would need to be handled during a time when the system was not managing students directly. A final advantage of having a hard disk drive is a matter of convenience again. Diskette swapping could be eliminated or at least greatly reduced.

Several computer companies are now coming out with microcomputer network systems specifically designed for the training environment. For example, Hazeltine's MicroTICCIT is a system of microcomputers which shares a hard disk for storage of student records, courseware, and system software, including a management system, and a host processor with 256K bytes of usable memory for processing. This type of system addresses the problem of using microcomputers to handle complex management tasks without dependence on an expensive minicomputer.

Issues in the Implementation of Microcomputers for the Management of Individualization

Issues in two general areas are of relevance to the implementation of microcomputers for the management of individualization based on cognitive styles. First, it is important to clearly distinguish between what is meant by the management of individualization and the actual presentation of individualized treatment alternatives within the framework of microcomputer-based systems. For the purposes of this presentation, this distinction reduces to using the computer as a management tool vs. only for the presentation of instruction, i.e., CMI vs. CAI. Because microcomputers can be used in either capacity and management functions can be performed in both CMI and CAI applications, it is necessary to determine which application is most suitable to the management of individualization. This is particularly true if the individualization desired involves more than computer-based, on-line treatments and makes use of off-line treatments as is likely to be the case when individualizing to accommodate cognitive style differences. As has been suggested earlier, a basis for deciding whether a CAI or CMI approach to the management of individualization is most appropriate in the adaptation to cognitive style differences, is to determine whether gross or fine-grained treatment alternatives are required to meet the needs of a particular student population and content area.

Second, it is important to keep in mind that the management of individualization can be addressed in both the context of classroom implementations and the context of research and development. Ideally, however, both contexts should be considered such that even in a pure classroom implementation, research and evaluation components are present, and likewise, in a pure research and development context, classroom implementation issues are addressed. Consideration of this issue is particularly important given the current status of research in cognitive styles and the need for further experimentation and exploration of research questions (Ragan, Back, Stansell, Ausburn, Ausburn, Butler & Huckabay, 1979) . In addition, incorporating research and practical implementation concerns in a microcomputer system for the management of individualization increases the likelihood that management and individualization decisions will have both practical relevance and empirical validity.

The preceding issues have implications for the sophistication needed in a microcomputer-based system for the management of individualization based on cognitive styles, as well as concomitant implications for the selection of particular microcomputer systems and configurations. In turn, these implications have to be considered in light of practical realities in the implementation setting. That is, both the degree of sophistication and type of microcomputer system required for the desired management approach must be considered in light of such practicalities as available resources, staff commitment, etc. As Lindelow (1983) has pointed out, individualization efforts based on cognitive style or learning style are likely to fail if the approach is too demanding, costly or difficult, if teachers are not capable or committed enough, if the individualization philosophy is misunderstood or not implemented properly, or if insufficient funds are available.

For the foregoing reasons, therefore, it is critical to involve personnel who will be part of the implementation and evaluation of the management system in the design and development of this system. McIsaac and Baker (1981) have recommended a pilot project approach wherein users can be involved in the design and development of the individualization as well as its management. Such an approach can lead to greater system acceptance and commitment to its successful implementation, as has been noted in efforts to individualize on the basis of cognitive styles (e.g., Cavanaugh, 1979, 1981; Ellis, 1979; & Epstein, 1981).

In conclusion, the management of individualization based on cognitive styles is a complex but realizable solution to the problem of accommodating individual differences, when implemented with current computer-based technologies. The use of microcomputers for this management promises to provide both a practical and cost effective approach to maximizing student learning and motivation.

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TITLE: The Effect of Programmed Tutoring Upon the Reading Comprehension of Fourth-Grade Students Enrolled in a Chapter 1 Reading Program

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THE EFFECT OF PROGRAMED TUTORING UPON THE
READING COMPREHENSION OF FOURTH-GRADE STUDENTS
ENROLLED IN A CHAPTER 1 READING PROGRAM

A Presentation to the
Association for Educational
Communications and Technology

Graduate Student Research Session

Dallas, Texas

January 21, 1984

by

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ABSTRACT

The major purpose of this study was to investigate the effects of programed tutoring upon the reading comprehension of fourth-grade students enrolled in a Chapter 1 program. Reading comprehension was measured by the Reading Comprehension Test, Iowa Tests of Basic Skills, Form 7, Level 10.

The subjects of this study were 69 fourth-grade students who scored below the 37th percentile on the Reading Comprehension Test, Iowa Tests of Basic Skills, Form 8, Level 9 in the Spring of 1982. One group (N = 35) received fifteen minutes of programed reading tutoring each day throughout the 1982-83 school year as a supplement to classroom instruction. The Houghton Mifflin Reading Series was used for classroom instruction and the Houghton Mifflin Tutorials were used for the programed tutoring.

A *t*-test was conducted on the two groups' pretest mean normal curve equivalents (NCE's) scores. This test was followed by an analysis of covariance using the pretest scores as the covariate. Finally, mean gain NCE's scores were analyzed using a *t*-test.

The results of this study indicated that programed tutoring did not significantly improve the reading comprehension of fourth-grade students enrolled in a Chapter 1 program when mean NCE's and mean gain NCE's scores were analyzed. A review of the descriptive statistics

presented evidence that the experimental group did narrow the initial gap between themselves and the control group. Thirty-two percent of students in the control group showed a loss from the pretest to the test while only nine percent of the experimental group did so. The trol group's posttest scores displayed a greater varibility than the group's pretest scores while the experimental group's scores varibility remained relatively unchanged.

THE EFFECT OF PROGRAMED TUTORING UPON THE READING COMPREHENSION OF FOURTH-GRADE STUDENTS ENROLLED IN A CHAPTER 1 READING PROGRAM

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Background

Over 34 million dollars were allocated to school corporations (districts) in Indiana to conduct Chapter 1 programs in 1981-82. Nationwide, over 2.6 billion dollars were distributed to the 50 states based on a formula that takes into account the number of children living in poverty in each county of the state and the statewide per pupil expenditures. The distribution formula is specified in Chapter 1 of the Educational Improvement and Consolidation Act (1981) which replaced Title 1 of the Elementary and Secondary Education Act of 1965 and its later amendments.

Indiana school corporations that qualify for Chapter 1 funds, as determined by Chapter 1 criteria, may expend these monies for remedial reading, mathematics, or language arts programs. Over 95,000 students received a Chapter 1 reading service compared to 26,000 in math, and 2800 in language arts during 1981-82.

Programed tutoring was used by only 25 of the 189 school corporations of which the Tippecanoe School Corporation (Lafayette, Indiana) was one. Since 1976 when programed tutoring was implemented in the Tippecanoe School Corporation, TSC Chapter 1 student gains have been higher than the state wide gains as measured by normal curve equivalents (NCE's).

The superior gains made by the TSC Chapter 1 students who have been taught using programed tutoring would indicate that programed tutoring is a viable method for providing remedial reading instruction for educationally deprived students.

In these days of ever-~~in~~decreasing Federal dollar support for special programs, it would seem appropriate to achieve the greatest gains possible with the dollars that are available. Indications from the TSC results are that programed tutoring has the potential to be an instructionally effective and cost efficient method for use in Chapter 1 programs.

Problem Statement

The purpose of this study was an attempt to answer the following question:

Do fourth-grade students in a Chapter 1 reading program taught by programed tutoring have a significantly higher increase in reading comprehension scores than those not receiving programed tutoring as measured by the Reading Comprehension Test (R), Iowa Tests of Basic Skills Form 7, Level 10?

Basic Assumptions

The following assumptions were basic to the investigation:

1. Reading is the most important skill a child learns in school because it is vital for success in all school subjects and for the child to become a literate, productive member of society.
2. Educationally deprived children should receive instruction in deficient basic skills in addition to the instruction received in the classroom--a basic premise of ECIA Chapter 1.

3. Educationally deprived students should receive remedial reading instruction that provides the potential for maximum gains in reading comprehension.

Limitations

First, second, and third graders are served first by the Tippecanoe School Corporation's (TSC) Chapter 1 program because these students are deemed to be the ones who benefit the most from the program, based on the gains reported by past achievement test scores. Since all eligible students in the first three grades were served by the program, there were no students available from these grades to serve as a control group. Inclusion of students from the first three grades in this study would have strengthened this investigation.

Sample

This study involved 69 fourth-grade students from six elementary schools in a rural or suburban setting of the Tippecanoe School Corporation, Lafayette, Indiana. All students included in this study scored below the 37th percentile on the Iowa Tests of Basic Skills (ITBS) Reading Comprehension Test (R), Form 8, Level 9 in May, 1982. Students in the experimental group were assigned on the basis of tutoring time being available when the student was not in a special class such as art, music, or physical education. Students' scores on the Iowa Tests of Basic Skills (Spring, 1982) were not a basis for assignment to the experimental group.

The experimental group (N = 35) received fifteen minutes of programed reading tutoring each school day throughout the 1982-83 school year as a supplement to classroom instruction. The control group (N = 34) re[illegible] no supplemental instruction. Both groups received classroom instr[illegible] based on the Houghton Mifflin Reading Series.

Stimulus Materials

The Houghton Mifflin Tutorials designed to be used as a suppl[illegible] to classroom teaching based on the Houghton Mifflin Reading Series [illegible] used with the experimental group. The programed tutorial teaching materials include the Comprehension and Word-Attack (CAWA) Skills [illegible] The Tutor's Guide Handbook and the Tutor's Guide Item Programs Bookle[illegible]

The CAWA Skills Books are nonconsumable texts that contain prog[illegible] lessons relating to oral reading, comprehension, and word-attack [illegible] The lessons are designed to teach the skills using the same story [illegible] and vocabulary that appear in the Houghton Mifflin Reading Series te[illegible] The lessons in the CAWA Skills Books provides the pupil with experien[illegible] the same skills and in the same sequence as those provided in the cl[illegible]

Procedure Description

The tutoring process was carried out by 36 adult women who were trained to tutor during 15 to 20 hours of formal instruction. Tutor training workshops were first held in the Tippecanoe School Corporati[illegible] in October, 1978, when the Houghton Mifflin Reading Series was adopte[illegible] Approximately sixty percent of the tutors have worked in the Chapter [illegible] tutoring program since its inception in 1978. Two certified element[illegible] teachers are employed by Chapter 1 to directly supervise the reading [illegible]

Tutoring was done on a one-to-one basis between the tutor and student for fifteen minutes each school day throughout the 1982-83 school year. The teaching activities of the tutor were tightly prescribed by:

1. detailed instructions that must be followed explicitly,
2. teaching materials included in the _Comprehension and Word-Attack (CAWA) Skills Books_, and
3. the pattern of the pupil's successes and failures on each lesson.

A master list specifies the order in which the different kinds of lessons are taught by the tutor. The _Tutor's Guide Item Programs Booklet_ gives step-by-step instructions on how to teach each kind of item. There are a total of 11 Item Programs, one of which the tutor is directed to use by a notation on the bottom of a lesson page in the _CAWA Skills Books_.

The procedures the tutors followed were highly individualized so that the student progressed at the maximum rate of which she or he was capable. The pupil was not required to complete any particular number of lessons in one tutoring session. The tutor praised the pupil for every reading task completed successfully by saying "good," "great," "excellent," "super," or whatever words a tutor was comfortable using. If mistakes were made, the tutor said "Let's try that again." The student was given the opportunity to discover the correct pronunciation, response, or answer through a series of specified prompts the tutor gave. Notation was made by the tutor of how many tries or "runs" were necessary for the student to achieve complete mastery.

Instrument Used in This Study

The instrument used in this study was a paper-and-pencil test. The

Reading Comprehension Test (R) of the Iowa Tests of Basic Skills (ITBS) Multilevel Battery, Form 7, Level 10 was the specific instrument employed. The Iowa Tests of Basic Skills Multilevel Battery was designed to provide comprehensive and continuous measurement of growth in the fundamental skills of reading, mathematics, vocabulary, language, and work-study (Hieronymus, Lindquist, and Hoover, 1979a). The Multilevel Battery encompasses Levels 9-14 and was designed for use at Grades 3-9.

There are three major categories of skills objectives for Test R, namely, facts, inferences, and generalizations. There is a total of [illegible] skills objectives that are tested in these major categories.

Collection, Scoring, and Reporting of Data

The Iowa Tests of Basic Skills were administered to fourth-grade students in the Tippecanoe School Corporation within two weeks of the Spring, 1983, empirical norm dates as specified by the test publisher. The tests were administered by the school principal in each individual school building. Scoring of the tests and reporting of the normal curve equivalents scores (NCE's) was done by the Riverside Publishing Company.

The previous Spring (May, 1982) the ITBS Form 8, Level 9 was administered to these same fourth-graders when they were completing the third grade. The NCE's reading comprehension scores from this test were used as a pretest to determine if the experimental and control groups differed in reading comprehension at the onset of the experiment.

The Tippecanoe School Corporation (as do all other Indiana school corporations) reports Chapter 1 gains in normal curve equivalents scores to the Division of Compensatory Education, Indiana Department of Public Instruction on July 1st each year.

The normal curve equivalents (NCE's) score reported by the testing service converts percentiles into a normalized equal interval scale suitable for computing and comparing gains in achievement. The NCE's score has the combined advantage of percentiles and stanines since it can be used for comparing the performance of a group with that of a norm group. It can also be meaningfully averaged.

Research Design

The Stanley and Campbell (1966) Nonequivalent Control Group Design (#10) was selected for this study because students could not be assigned randomly to the experimental and control groups. The Iowa Tests of Basic Skills, Test R, Form 8, Level 9 was used as a pretest to measure the equivalency of both groups in reading comprehension.

The dependent variable was the mean normal curve equivalents (NCE's) test scores. The independent variable was the method of instruction. The experimental group received programed reading tutoring in addition to classroom instruction. The control group received classroom instruction only. Subjects in both groups scored below the 37th percentile on the pretest.

Analysis of Data

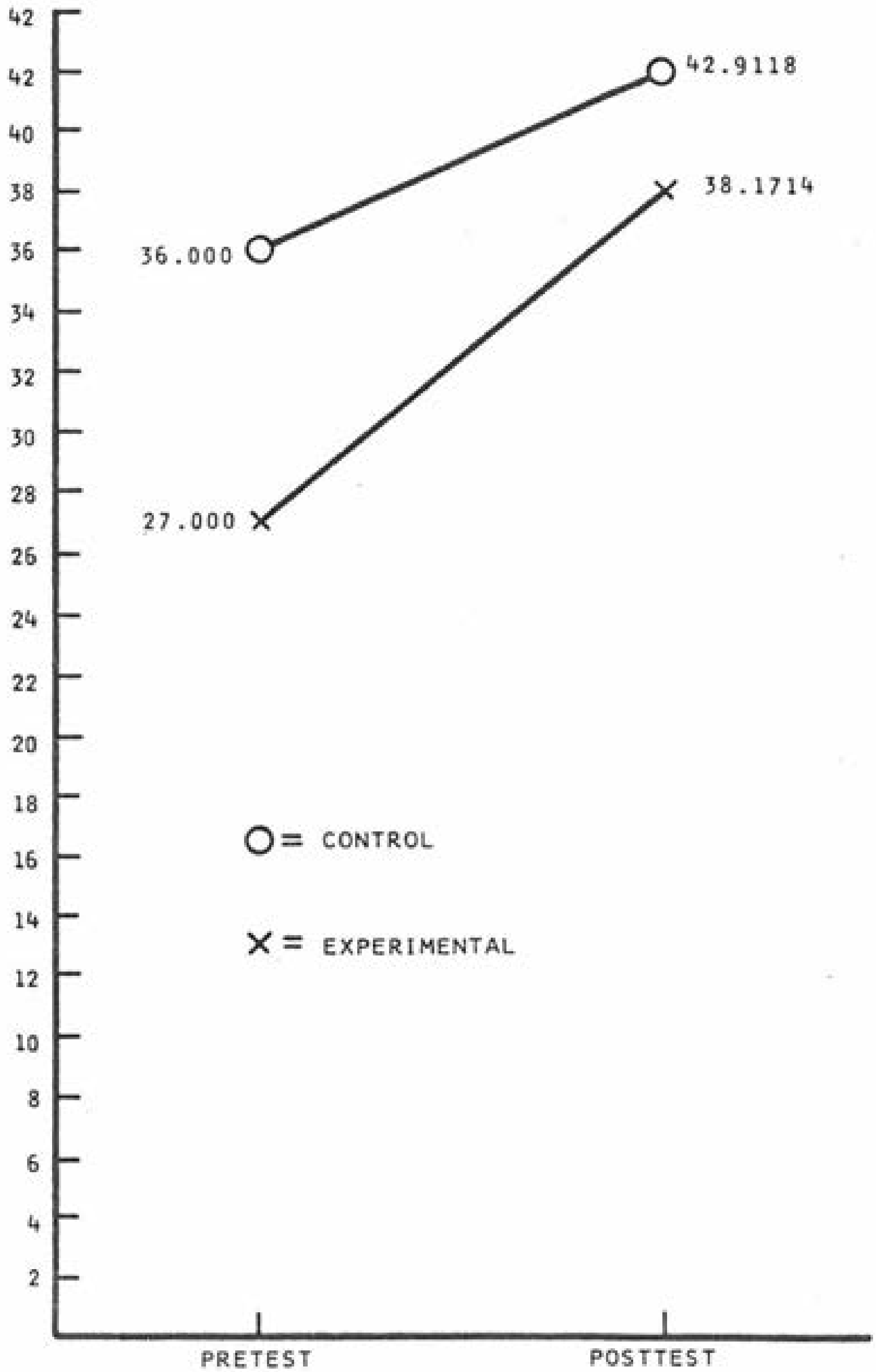
The purpose of this study was to investigate the effect of programed tutoring upon the reading comprehension of fourth-grade students who at the end of the third grade scored below the 37th percentile on the Reading Comprehension Test of the Iowa Tests of Basic Skills, Form 8, Level 9.

The experimental group received fifteen minutes of programed tutoring each day during the 1982-83 school year while the control group received no tutoring.

Reading comprehension of both groups was measured by the Reading Comprehension Test of the Iowa Tests of Basic Skills, Form 9, Level [illegible] Students' scores were reported in normal curve equivalents (NCE's). Normal curve equivalents scores are normalized standard scores with a mean of 50 and a standard deviation of 21.06. The reading comprehension NCE's scores served as the dependent variable.

A comparison of mean NCE's scores for the groups on the pretest and posttest is presented in Figure 1. The mean scores of the two groups were closer on the posttest than they were on the pretest. A general observation could be made that, on the posttest, the experimental group narrowed the gap that existed on the pretest between themselves [illegible] the control group. Median scores provided added weight to this observation since the median score of the experimental group on the pretest was [illegible] compared to a median score of 37 for the control group. On the posttest the experimental group median score was 40 and the control group's was only slightly higher at 40.214.

The frequency distributions display the range of scores as well as symmetry of the distribution of pretest and posttest scores for each [illegible] (see Figures 2 and 3). The range of scores for the experimental group [illegible] 37 on the pretest and 57 on the posttest compared to the control group's pretest range of 17 and posttest range of 49. The change in range of control group's scores indicates a greater varibility which is borne [illegible] by a standard deviation of 5.087 on the pretest and 12.711 on the posttest.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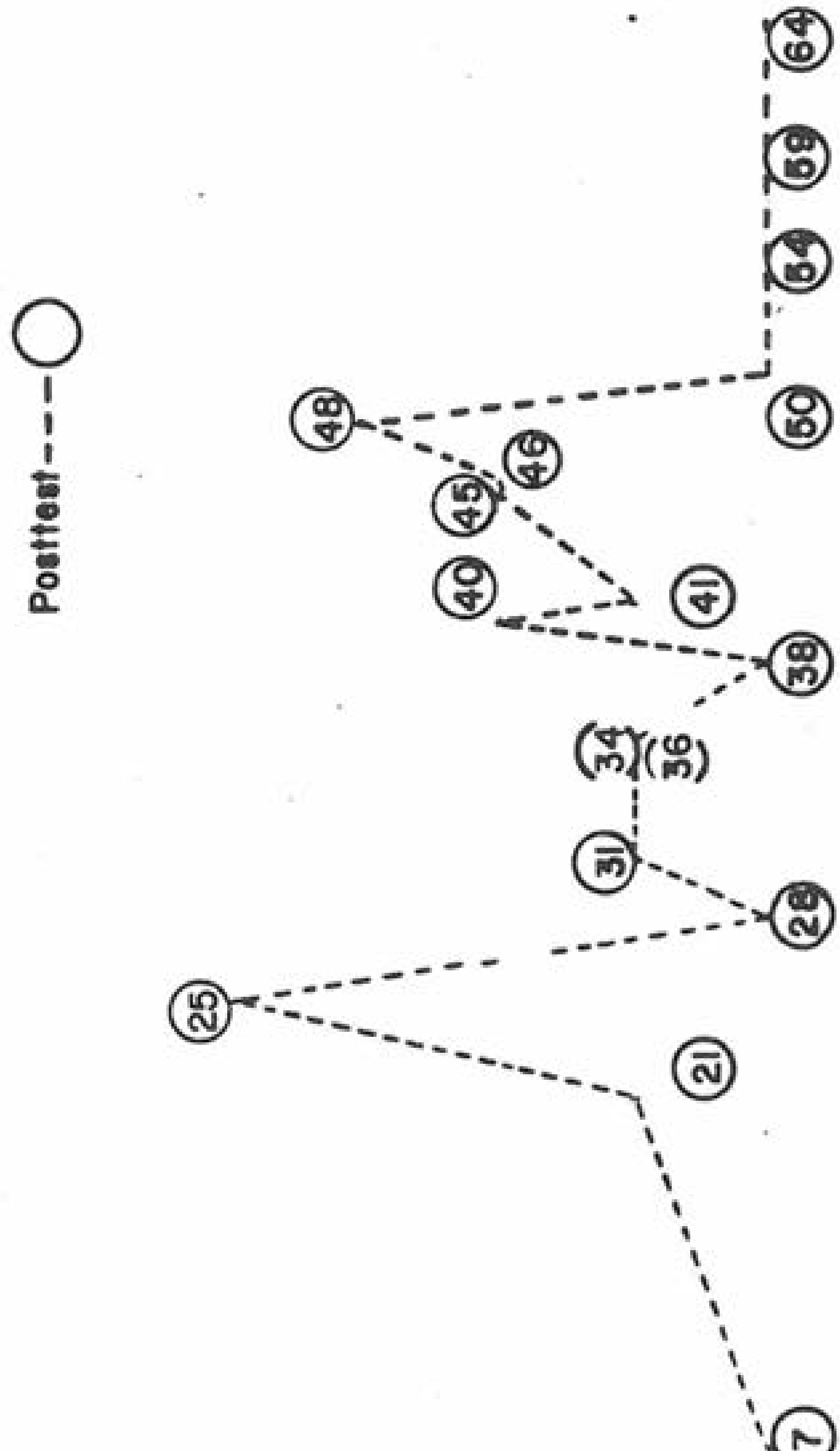
O= CONTROL
X= EXPERIMENTAL
PRETEST
POSTTEST

Figure 1

Figure 2

Frequency Distribution of Experimental Group's
NCE's Scores on the Pretest and Posttest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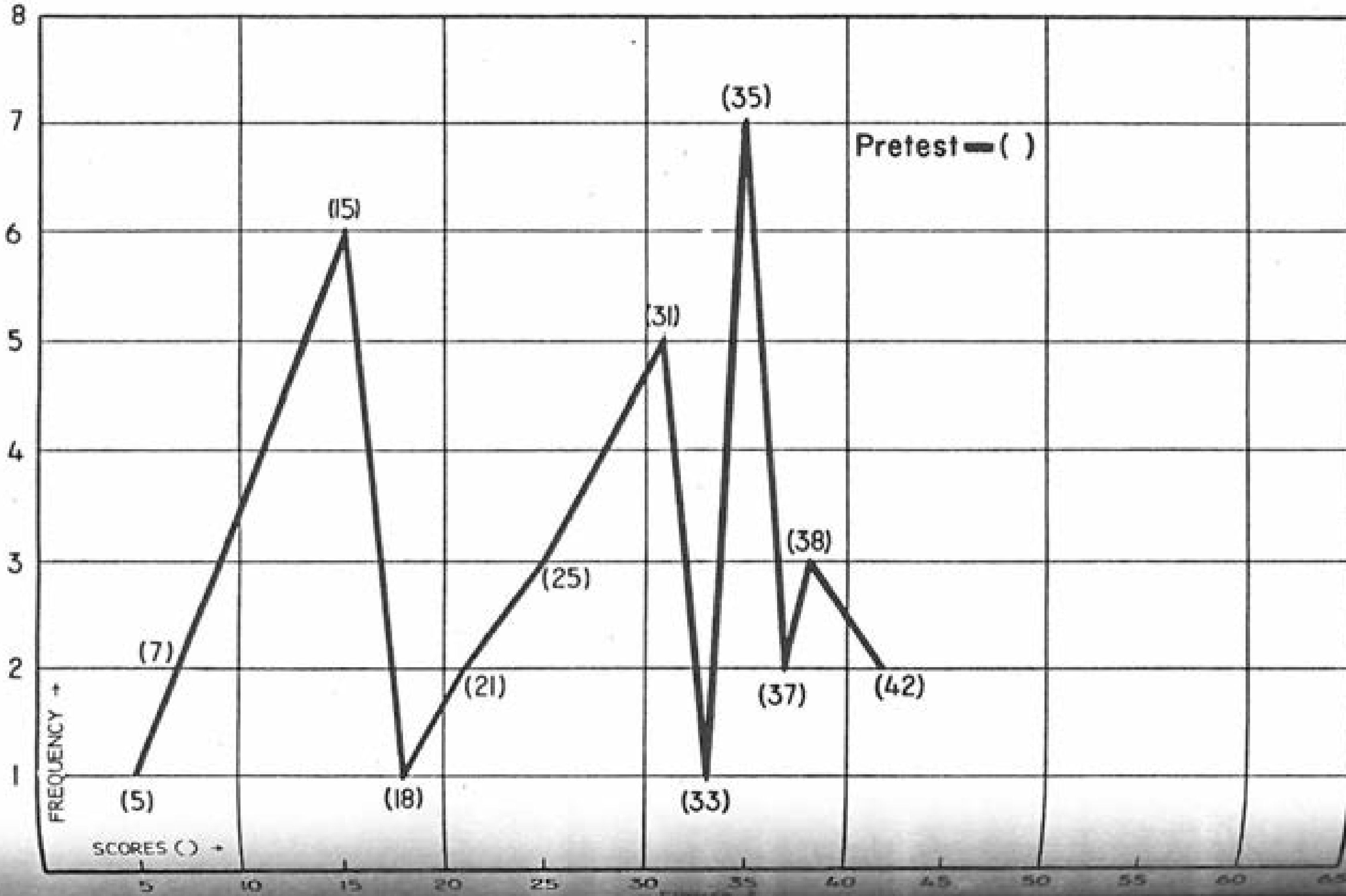
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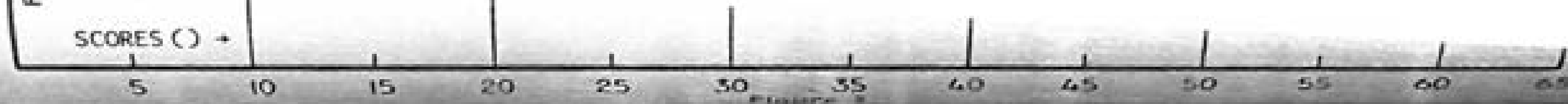
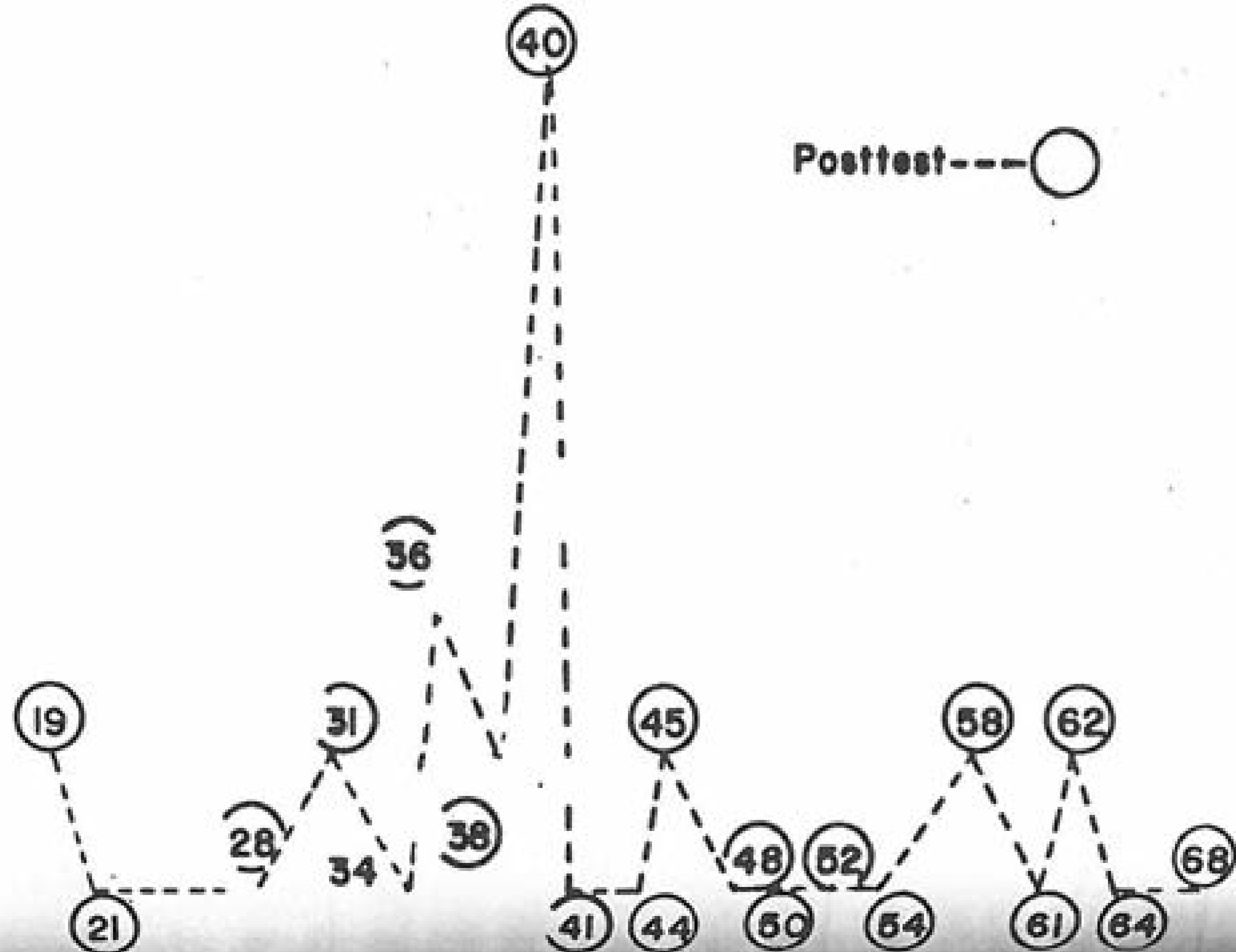


Figure 3

Frequency Distribution of Control Group's
NCE's Scores on the Pretest and Posttest


Posttest
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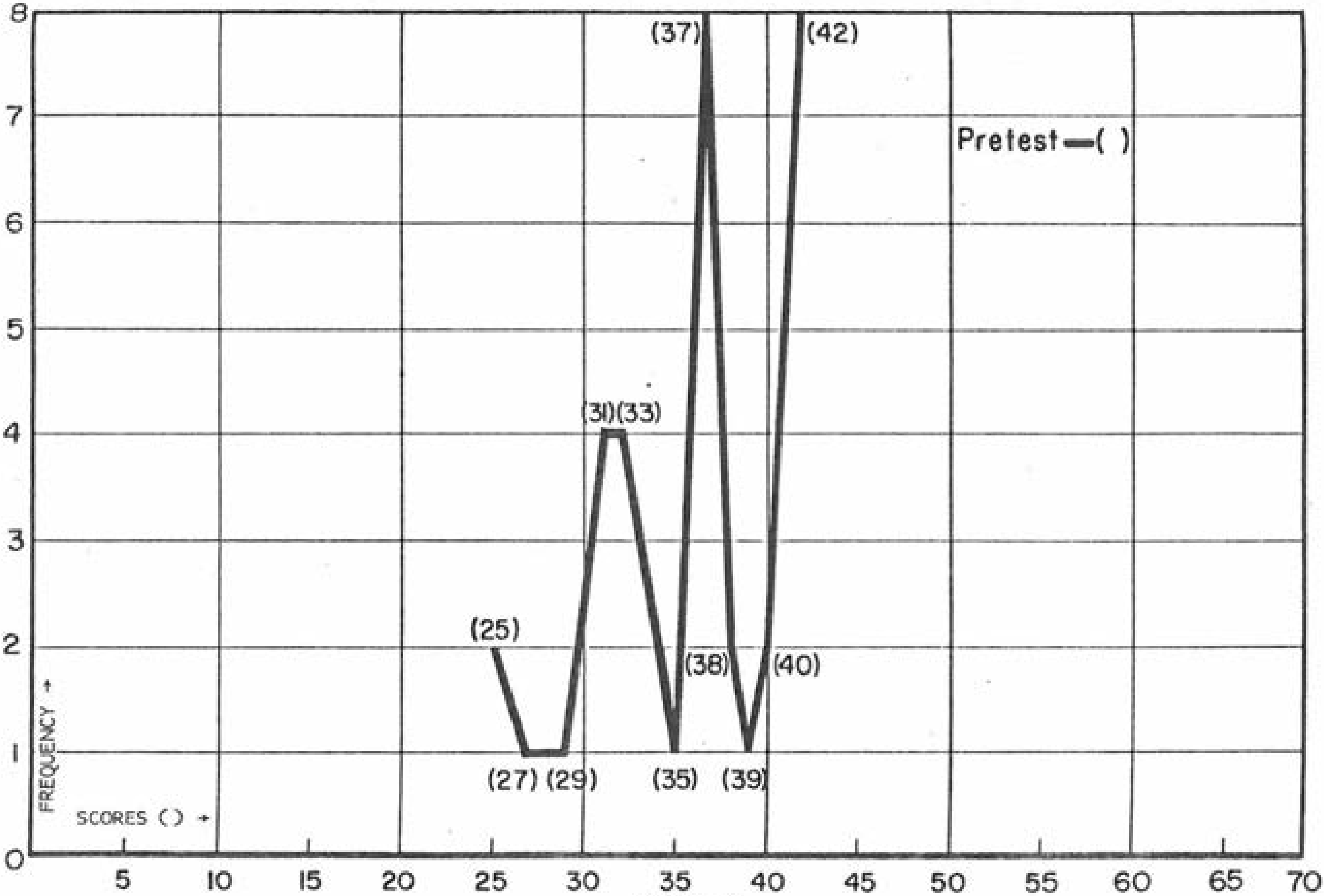

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Figure 3

Both groups' scores on the pretest were negatively skewed. On the posttest, the control group's scores exhibited nonsymmetry and a flatter curve than did the experimental group's scores.

The pretest data were analyzed using Students t-test to determine the equivalence of the groups, since subjects were not randomly assigned to treatment groups. The t-test between the mean NCE's score of 27.11 for the experimental group and 36.000 for the control group resulted in a t of -4.43 which is significant at the .001 level with 48.94 degrees of freedom. This analysis indicated that the groups were not equivalent at the beginning of the study. This initial difference reflected a lower mean NCE's score for the experimental group.

The posttest scores were analyzed using an analysis of covariance. There was no significant difference between the experimental group and the control group on the posttest when the pretest was used as a covariate in the analysis. Therefore, the two groups which differed at the beginning of the study did not differ at the conclusion of the study when the initial difference was taken into account.

Although Cronbach and Furby (1970) have cautioned against using gain scores for a measurement of change, the authors did note that gains or differences are worth estimating to provide an indicator of less-than-normal development so that individuals may be given a special treatment. Cronbach and Furby state that "it is possible of course, given before and after scores on the same instrument, to estimate true gains of individuals and to identify those who did and did not gain" (p. 79).

In view of the fact that all subjects in this study scored below the 37th percentile on the pretest, it could be inferred that the reading comprehension development of these students had not kept pace with their peers. Because of this fact and the additional fact that scores reported by Chapter 1 programs across the country are for mean gain NCE's scores, an analysis of gain scores was performed.

The frequency distribution of subjects' gain scores (pretest score subtracted from posttest scores) is shown in Figure 4. Appendices A and B provide the NCE's scores used for the computations of differences. The frequency distribution in Figure 4 indicated that the control group had eleven subjects whose test scores were lower on the posttest than on the pretest. By contrast, the scores of only three subjects in the experimental group showed a decline. The range of gain scores for the experimental group was 48 while for the control group it was 54.

A *t*-test on the mean gains of the two groups was performed. (See figure 5). No significant difference (t = 1.40, 67 d.f.) was found between the mean gain scores of the groups.

Conclusions

An analysis of the data from this study indicated that programed tutoring did not significantly increase the reading comprehension of Chapter 1 eligible fourth-grade students. The fact that the experimental and control groups were not equivalent at the onset was an initial problem for the study. Since the experimental group's mean scores were significantly lower on the pretest, regression toward the mean cannot be ruled out when examining the gains made by this group.

A trend evidenced by the study, i.e. fewer students who were tutored showing a loss between the pretest and posttest as compared to the untutored

Figure 4

Frequency Distribution of Subjects' NCE's Gain Scores

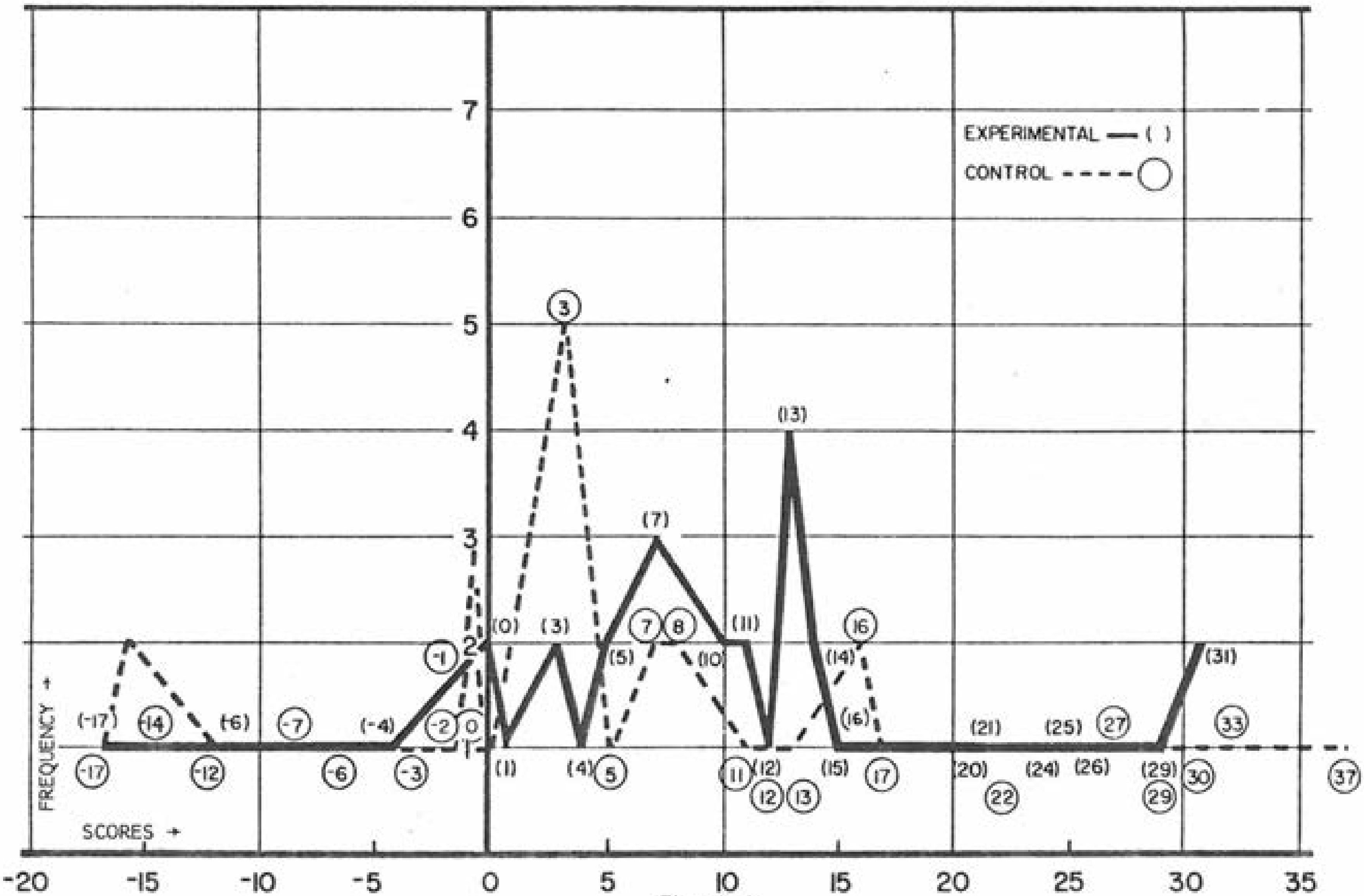

Figure 4

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Figure 5

Comparison Data for Mean Gain NCE's Scores for Both Groups

	Mean	Standard Deviation	Standard Error	Median	Skew-ness	Kurtosis
Experimental	11.057	10.724	1.813	11.250	-0.112	0.334
Control	6.912	13.756	2.359	3.500	0.435	-0.269

students, is supported by past statistics compiled by the Tippecanoe School Corporation. Another trend noted was that students who were not tutored tended to exhibit more variability in their posttest as compared to a lack of variability in their pretest scores. Programed tutoring seems to keep nearly all tutored students moving toward improvement in their reading comprehension scores.

Ellson, et al. (1977b) found programed tutoring to be most effective with students in the primary grades and students who were experiencing difficulty with reading. Wang, et al. (1981) reported that Title 1 programs had a postitive impact on reading achievement in the first three grades only. Therefore, the results of this study gave additional support to the previous findings.

The National Assessment of Educational Progress (1981) spoke of students in Title 1 programs narrowing the gap in reading achievement. The experimental group in this study did narrow the gap between themselves and the control group which began the study with significantly higher scores. However, the gains made in narrowing the gap were not great enough to provide evidence that programed tutoring had a statistically significant effect on reading comprehension.

Campbell (1969) elaborated on the problem of evaluating the effectiveness of programs established by the Great Society legislation in his article on "Reforms as Experiments." He stated "that specific reforms are advocated as though they were certain to be successful" (p. 409). Because Chapter 1 is "believed to be successful," school districts are discouraged from withholding remediation from eligible students by random assignment of students to control and experimental groups. This study would have been strengthened if students in the first four grades could have been randomly assigned to experimental and control groups. A semester long experimental study would have been another preferable alterna- to the study that was undertaken. This would have allowed all students receive at least one semester of tutoring.

The data in this study do not present compelling evidence for the use of programed tutoring with fourth-grade, Chapter 1 eligible students. Trends detected within the constraints of this study seemed to indicate that programed tutoring has a beneficial, though not significant, effect on reading comprehension.

Recommendations

Further research should be undertaken to determine if remedial instruc- tion delivered by a machine; specifically a microcomputer, is more eff at the fourth-grade level for Chapter 1 eligible students. In view of fact that many school districts are purchasing microcomputers with Chap monies, it seems appropriate to evaluate this method of instruction al

Campbell (1969) has suggested that where randomization is not fea or morally justifiable, the regression discontinuity design should be No Chapter 1 or Title 1 program evaluations included in articles or r of research used this design. This design should be used in post hoc search on Chapter 1 programs where local criteria specifies a defi

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eligibility criteria and instructional method have been used for several years.

One can only wonder how long Congress will see fit to fund Chapter 1 programs if research studies do not provide statistically and educationally significant results.

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Appendix A
Reading Comprehension NCE's--Experimental Group

Subject	Pretest	Posttest	Gain or Loss
1	42	25	-17
2	31	25	-6
3	25	21	-4
4	7	7	0
5	25	25	0
6	35	36	+1
7	35	38	3
8	31	34	3
9	21	25	4
10	35	40	5
11	35	40	5
12	38	45	7
13	38	45	7
14	33	40	7
15	38	48	10
16	31	41	10
17	37	48	11
18	37	48	11
19	42	54	12
20	21	34	13
21	18	31	13
22	15	28	13
23	35	48	13
24	31	45	14
25	7	21	14
26	31	46	15
27	15	31	16
28	5	25	20
29	15	36	21
30	35	59	24
31	25	50	25
32	15	41	26
33	35	64	29
34	15	46	31
35	15	46	31

Lowest score - 5	Lowest score - 7
Highest score - 42	Highest score - 64

Appendix B

Reading Comprehension NCE's--Control Group

Subject	Pretest	Posttest	Gain or Loss
1	38	21	-17
2	33	19	-14
3	42	28	-14
4	31	19	-12
5	38	31	-7
6	42	36	-6
7	37	34	-3
8	42	40	-2
9	39	38	-1
10	37	36	-1
11	42	41	-1
12	31	31	0
13	37	40	+3
14	37	40	3
15	37	40	3
16	37	40	3
17	35	38	3
18	40	45	5
19	33	40	7
20	33	40	7
21	40	48	8
22	37	45	8
23	25	36	11
24	42	54	12
25	25	36	11
26	42	58	16
27	42	58	16
28	27	44	17
29	42	64	22
30	25	52	27
31	33	62	29
32	31	61	30
33	29	62	33
34	31	68	37
	Lowest score - 25 Highest score - 42	Lowest score - 19 Highest score - 68	

TITLE: Naturalistic Inquiry: An Example Used in Photographic Research

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Naturalistic Inquiry: An Example
Used in Photographic Research

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Naturalistic Inquiry: An Example Used in Photographic Research

Naturalistic inquiry attempts to describe events in their own terms. Although such methods try to induce as little experimenter bias as possible, early works in anthropology and sociology were primarily descriptive and have been criticized for their lack of objectivity. Experimental studies, while not suffering from the same type of problem, may manipulate variables to such an extent as to lose the integrity of the research question, or to ignore large amounts of available data.

Methods used currently in sociology, anthropology and psychology have begun to add scientific and quantitative dimensions to naturalistic data gathering techniques. Kempton (1981) has devised a method for quantifying significant features of ceramic pots. Szalay and Deese (1978) use an experimental method within a subjective framework to study human attitudes and perceptions. Burton and Romney (1975) employ multidimensional scaling and hierarchical clustering for sorting role terms. Such a sorting task combines naturalistic methods of inquiry with quantifiable data analysis techniques. This last method is particularly useful for analyzing visual and perceptual data and presenting it spatially.

Studies exploring the significance of visuals have been plentiful in the literature (Fleming & Levie, 1978) (Dwyer, 1978). However little attention has been paid to the examination of differences in the perceived meaning of pictures or to the cognitive processes used. The present study was designed as the first in a series of inquiries to investigate the use of multidimensional scaling tehcniques for observing and measuring underlying dimensions commonly perceived by viewers.

SUBJECTS

Fifteen university age students, 19 to 45 years old, were selected for the study. They ranged from having - no previous art background to those having 2 years of graduate study in art. Cultures represented were Anglo, Mexican-American and American Indian.

MATERIALS

Stimuli consisting of 34 colored photographs illustrating a variety of concepts were presented to the subjects. Sorting these stimuli into perceptually relevant groups was used as a primary method for recording judgments. Of the original 100 photographs selected to represent 18 visual categories, the 34 pictures receiving the highest similarity ratings in a pilot program were selected for the final study. Stimuli were then presented randomly across pairs and subjects.

PROCEDURES

Three types of data were collected: 1) Similarity judgements between pairs of pictures 2) Interview information including subjects' verbal descriptions of picture groups, and 3) Demographic information about subjects.

Similarity judgments

Similarity judgments formed the bases for a quantitative, experimental analysis resulting in a multidimensional or spatial representation of the stimulus field. Subjects were given 34 pictures to sort and were told to group them together in any meaningful way they chose. When the task was completed the picture numbers were recorded by group and interview information was collected.

A 34 x 34 individual similarities matrix was constructed for each subject. The lower half of the matrix contained the scores and the diagonal was eliminated. A binary code was used. Each of the 561 similarity ratings was coded as either 1 if the stimuli were paired or 0 if they were not. Individual similarity matrices were summed across subjects and a mean similarity matrix for all subjects was obtained using a special SAS® procedure designed to accommodate similarity ratings (Greenberg, 1983).

The resulting proximities, figures representing the amount of similarity between pictures, were used as the data source for a multi-dimensional analysis using the ALSCAL technique (Young & Lewyckyj, 1980). Co-ordinates were derived and proximities were plotted in multidimensional space to allow visual inspection of the data.

Multidimensional scaling (MDS) was chosen over factor analysis because factor analysis assumes a linear relationship between variables which is not always appropriate with perceptual data.

Interview information

Quantative data obtained from similarities measures and multidimensional scaling was matched with verbal descriptors provided by the subjects. This resulted in subject generated labels to describe data groups. Adjective descriptors used alone to define contents of a picture are subjective and without structure. Similarity spaces expressed as proximities, however, are mathematically derived and empirically stable. Adjective descriptors used in conjunction with empirical data are of use in interpreting the resultant multidimensional spaces. In addition judgment of similarities taken directly from subjects is less susceptible to experimenter contamination (Schiffman, Reynolds & Young, 1981.)

Demographic information

Data was collected from subjects regarding age, sex, level of schooling, amount of art background, ethnic community and photographic experience. This information provides data for comparative analysis of perceptual variations between cultures, age groups and educational backgrounds.

RESULTS

The ALSCAL analysis indicated that subjects did indeed group photographs together according to certain similarity traits and that these photographs had recognizable underlying dimensions. The number of co-occurrences of stimulus pairs was determined by first constructing individual similarities matrices for each subject. These individual matrices were then summed across subjects to produce a single matrix of means similarities. The proximities, numbers reflecting the amount of similarity perceived between a pair of photographs, were plotted spatially using the ALSCAL procedure (Young & Lewyckyj, 1980.)

Similarities

Data from the Means Similarities Matrix is summarized in Table 1.

Insert TABLE 1 about here

Of 561 possible pairs, 356 occurred less than 20 percent of the time. However, there were pairs of pictures which consistently were rated together as often as 80 percent of the time. At the upper level, there was 80-100 percent agreement on seven picture pairs. They were

TABLE 1

DATA FROM MEANS SIMILARITIES MATRIX SUMMARIZED BY NUMBER OF CO-OCCURRENCES AND LEVEL

PERCENT	CO-OCCURRENCES
0-19	356
20-39	90
40-59	73
60-79	35
80-100	7
	* 561 Total

* 561 represents the number of pairings in a matrix defined by $\frac{34 \times 34 - 34}{2}$.

numbers 2 and 26, 12 and 17, 12 and 23, 21 and 24, 13 and 17, 20 and 3[illegible], and 21 and 34. Pairs 24 and 34, and 17 and 23 had 73 percent agreement. Pictures 12, 17 and 23, which had similar coordinate values were described by respondents as "closeups of people, some showing lots of emotion, and some just riding on machines" (see Figures 1 and 2). Pictures 21, 24 and 34 also had high proximities and similar coordinate values, (Table 2). Initial subject interviews revealed that these were perceived as "pictures of people ... foreigners...Africans".

<u>Multidimensional scaling</u>

Multidimensional analysis of the individual similarity matrices of respondents indicated that the best conceptual space for the picture differences was three dimensional. There was a rapid drop in stress up to three dimensions and a corresponding improvement in squared correlation. The stress value for the two dimensional interpretation (Kruskal's stress formula 1) was .209. The corresponding Rsq was .830. The three dimensional interpretation contained greater information and also coincided with guidelines for selecting dimensionality (Kruskal & Wish, Higher dimensional solutions did not provide more insight into the data.

The multidimensional results are shown in Table 2 listing stimulus or picture number and corresponding coordinates for each of the three dimensions analyzed.

Insert Table 2 about here

Each dimension was normalized to a mean of 0. The ALSCAL procedure plotted stimulus coordinates and through a succession of iterations fit the proximities to the distances providing a spatial representation of the data, (Figures 1 and 2).

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TABLE 2

STIMULUS COORDINATES FROM COMPOSITE MULTIDEMENSIONAL SPACE SIMILARITY RATINGS

Stimulus	Coordinates		
	Dimension 1 Life	Dimension 2 Nature	Dimension 3 Culture
1	1.33	-0.57	-1.47
2	1.52	1.52	0.47
3	-0.59	-0.98	-0.60
4	-0.65	-0.93	0.89
5	-1.20	-0.19	0.19
6	-1.17	0.15	-0.55
7	-1.44	0.16	0.04
8	-1.38	-0.09	-0.01
9	-0.91	-0.45	0.71
10	1.31	-1.79	0.40
11	-0.98	-0.17	-1.04
12	-1.36	0.36	0.11
13	-1.39	0.17	-0.40
14	1.19	0.10	-1.66
15	1.89	0.58	-0.53
16	-0.02	-0.73	-1.49
17	-1.35	0.30	-0.04
18	1.36	-1.69	0.51
19	1.62	1.52	-0.28
20	1.25	1.68	0.45
21	-0.78	0.55	0.81
22	1.15	-0.01	-1.82
23	-1.25	0.16	-0.49
24	-1.06	0.33	0.73
25	1.51	1.64	0.23
26	1.36	1.53	0.36
27	0.34	0.31	1.04
28	1.12	-1.61	0.54
29	-1.40	0.14	0.15
30	1.66	-1.38	0.53
31	1.69	-1.36	0.19
32	-0.56	-0.21	1.07
33	-1.36	0.24	0.12
34	-0.76	0.71	0.85

Interpretation

When multidimensional scaling properly analyzes proximities data from a means similarities matrix, the resultant configuration produces clusters with common properties which are helpful in interpreting underlying dimensions. In this study, interview information elicited from subjects provided the identification of dimensions and clusters of phrases and concepts for coordinates plotted by the ALSCAL procedure. T produced dimensions 1 and 2 (Figure 1) and dimensions 1 and 3 (Figure 2) Subjective inspection of these figures, combined with subject interview information, produced the interpretation which follows. A regression could not be done on this data since the dependent variables were to be identified by the subjects during the study and were not available a priori.

The first dimension (Figure 1) contains close-up pictures of people smiling and frowning opposite pictures of mechanical objects. This dimension was labeled a "living"--"non-living" dimension, as a result of inspection of the pictures and verbal descriptions from subjects. Along

Insert Figure 1 about here

continuum from left to right are pictures #7 ("close up of a happy couple kissing") and #29 ("medium shot of older woman holding freshly baked muffins and looking worried, apprehensive"). Moving closer to the center is picture #27 ("long shot of person preparing food or cleaning ...other culture...no visible emotion"). Moving to the right along dimension 1 pictures #14 and #22 represent the opposite extreme, perceived as non-living objects. Numbers 14 ("inside of a boat or an airplane")

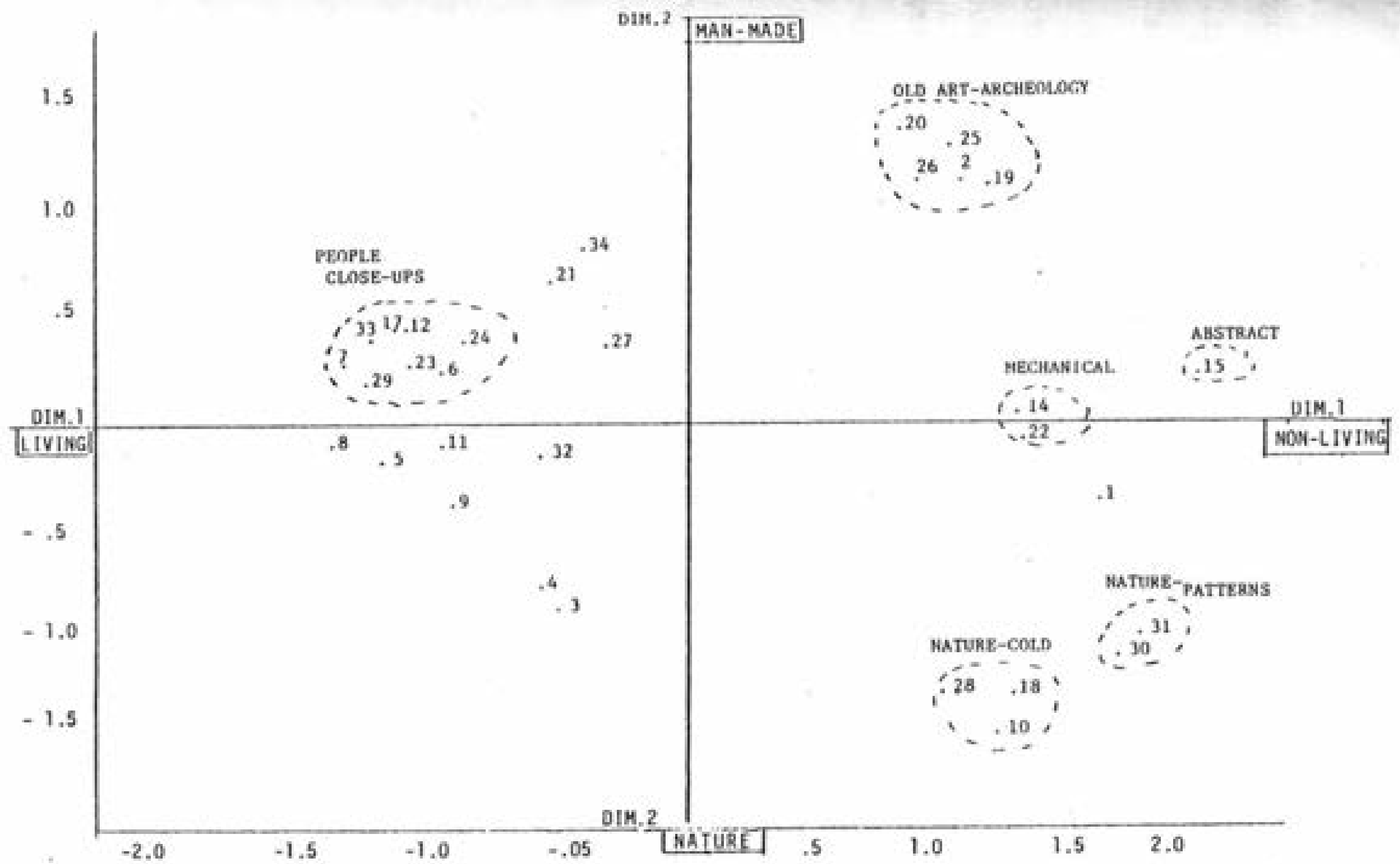

Figure 1. Dimensions 1 and 2 (unrotated) of the three-dimensional space derived by ALSCAL representing relationships between 34 photographs. Interpretation of dimensions and group descriptions obtained from subject interview data.

and 22 (a steam locomotive with lots of energy) represent mechanical, non-living but moving objects. Number 15, the farthest toward the non-living extreme is ("geometric...abstract").

Neighborhood interpretation (Guttman, 1965) reveals that groups of pictures have been described by subjects using similar adjectives. Pictures #33, 17 and 12 are all described as "close-ups of people". Pictures 20, 25 and 26 are seen as "old art and archeology". By further relying on Guttman's (1965) argument for pattern interpretation it can be seen that close-up pictures of people, man-made artifacts, patterns in nature, and nature pictures in snow tend to cluster together in space. Inspection of the data reveals that clusters are small and display a high degree of correspondence. This is verified by the similarities data in Table 2.

Interpretation of the second dimension as "nature---man made" was based on subjects' descriptions and the experimenter's visual inspection of the clusters found at opposite extremes of the dimension (Fig.1). Although farther from the center line, definite groupings are visible. Pictures numbered 20, 25 and 26 represent "a skeleton carved in rock", "a Goya type painting" and "some old pictographs on rock" respectively. Subjects referred to this group as "old artifacts, art and archeology". They are man-made and in the "non-living" quadrant of the dimensional space. As the groupings move from "man-made" to "nature-made", there is a cluster of nature pictures containing leaf patterns and hill contours. Farther toward the extreme, pictures #28, 18 and 10 are nature photographs of "large cold spaces". Dimension 1, the "living---non-living" dimension is complemented by dimension 2 which reveals a "nature-man made" spread.

The 34 pictures group themselves into six neighborhoods thus defining the parameters of the dimensions.

When dimension 1 is plotted with dimension 3 (Figure 2), the pictures of people are broken out into "people like us" and "people not like us". Pictures #21, 34 and 4 suggest people from different cultures.

Insert Figure 2 about here

The dimensional difference is interpreted as "western--non-western" but a broader interpretation for that dimension might be "cultures with modern technology" (pictures 14 and 22) opposed to "cultures without modern technology" (pictures 27 and 32).

Discussion

Dimensions 1 (living---non-living) and 2 (nature---man made) hold up well as shown in the tables and figures. Dimension 3 (western culture ---non-western culture) is weaker but still emerges as a dimension of primary consideration. The results of the analyses suggest that pictures are grouped by viewers according to commonly perceived inherent dimensions within the photograph. Although it is premature to identify the dimensions precisely, areas of universal dimensionality were uncovered which should be tested further.

Three dimensional aspects; life, nature and culture appeared to contain primary visual meaning for the subjects in this study. This suggests the existence of a universality of meaning systems in visuals. Perhaps the structure of connotative meaning in photographs is universal whereas specific visual symbols are culture specific.

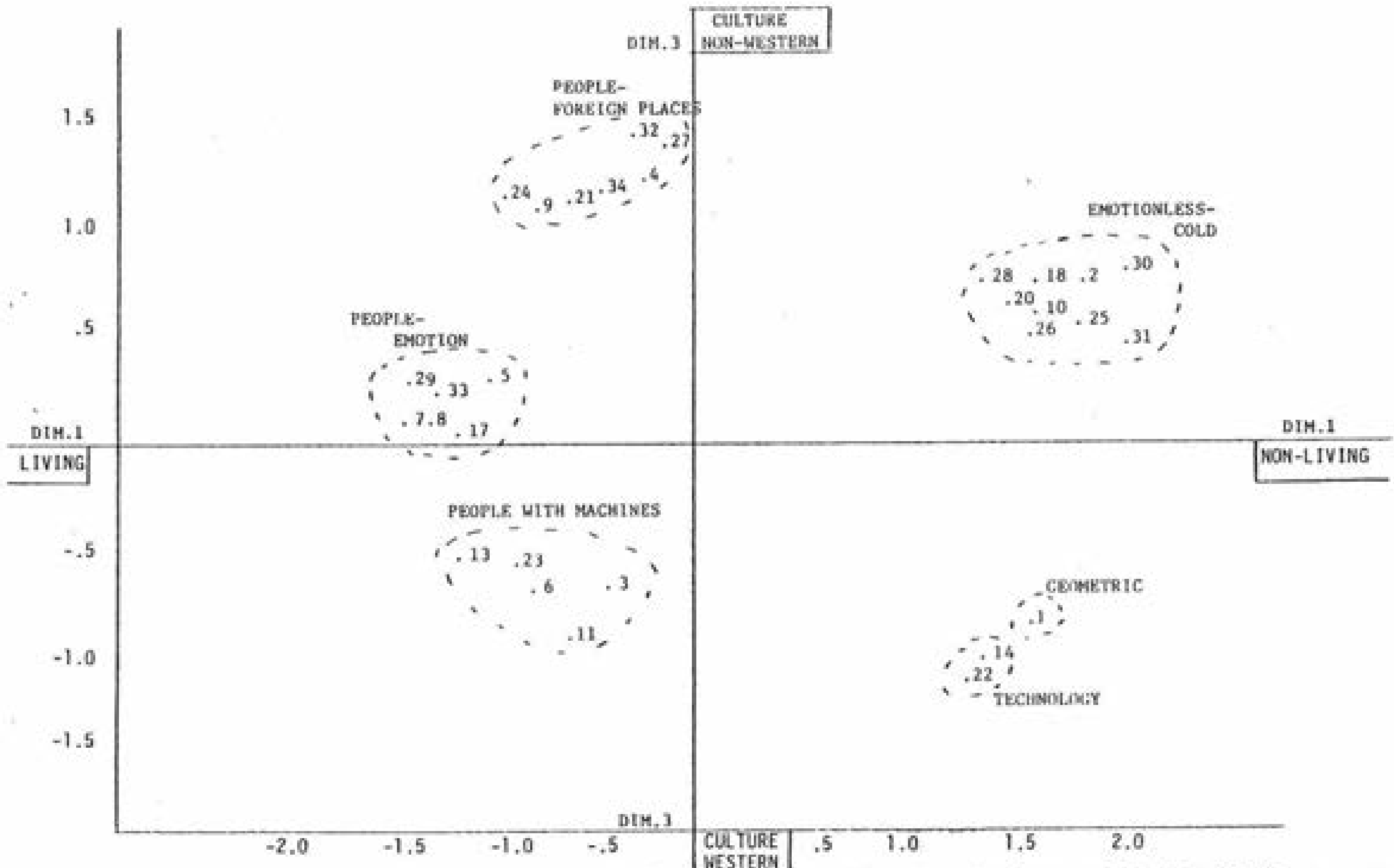

Figure 2. Dimensions 1 and 3 (unrotated) of the three-dimensional space derived by ALSCAL representing relationships between 34 photographs. Interpretation of dimensions and group descriptions obtained from subject interview data.

Concepts similar to this are supported in the areas of linguistics (Osgood, 1963; Miller, 1970) and in visual pattern perception (Deregowski, 1980). Osgood's (1964) semantic differential was the result of discovering three universal factors or dimensions of meaning in the affective domain: evaluative (good-bad), potency (strong-weak) and activity (fast-slow). The results of the present study suggest that there may be universal connotative meanings in pictures as well.

Three directions are suggested for future work in this area. In order to determine whether the dimensions suggested in this study are stable, replication is necessary. First, using the 3 dimensions as 'a priori' categories, the same stimulus set should be used to determine whether subjects continue to place appropriate pictures in the pre-selected categories. Using the 3 dimensions which have emerged in this study as dependent variables, a regression can then be performed to support the multidimensional analysis. Second, another stimulus set of photographs should be selected to include the same wide range of subject matter, and inquiry made to further explore the perceived importance of these dimensions (life, nature and culture) for other visual images. Third, the importance of a cultural dimension suggests eventual cross-cultural studies examining differences in categorization of visual information.

Discovering universal dimensions by which people categorize and attend to visual information is helpful not only in further understanding the perceptual process, but in designing visuals for instruction. Investigating the visual meanings perceived by viewers may lead to a broader understanding of how cognitive processes interact with mediated instruction.

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TITLE: Computer-Assisted Instruction and Continuing Motivation

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COMPUTER-ASSISTED INSTRUCTION AND CONTINUING MOTIVATION

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Paper presented at the annual meeting of the Association for Educational Communications and Technology, Dallas, January 1984.

INTRODUCTION

With the addition of microcomputers into the schools at all levels, computer-assisted instruction (CAI) is being integrated rapidly into the curriculum. Although many students initially are enthusiastic about computers, their continual interest and motivation (ie., continuing motivation) to work with CAI have not been investigated. (Swenson & Anderson, 1982). CAI, however, has been found to reduce instructional time by as much as one-half with no decrease in performance (Dence, 1980; Kulik, Kulik, & Cohen, 1980). Thus, a student's willingness to return to a computer-related task may be as important an outcome as improved performance.

Feedback in CAI has been found to improve student performance as measured by pre- and posttest data. Both relevant, informational feedback and feedback contingent on student performance have resulted in higher performance (Magidson, 1977; Tait, Hartley, & Anderson, 1974). In another study, Anandam, Eisel, and Kotler (1980) reported that students receiving personalized feedback wrote better essays.

Although feedback in CAI and motivation to return to task have not been investigated, evidence from related areas suggests that encouraging comments or praise can influence motivation. In a review of the literature on teacher praise, Brophy (1981) reported that praise should be individualized and should refer to the student's performance on the task in order to be effective. From research in the area of intrinsic motivation, positive comments given in a one-to-one situation led to increased motivation with kindergarten children (Anderson, Manoogian, & Reznick, 1976), fourth graders (Sarafino & Stinger, 1981), and high school students (Harackiewicz, 1979). Comments referring to a student's increased competence at a task also appear to be related to increased motivation. Both elementary and college level students have returned to task at a greater rate as they have felt more competent on the initial task (Arnold, 1976; Boggiano & Ruble, 1979).

There is some evidence that both comments and CAI may have a differential effect based on sex of subject. Males who received positive comments returned to task more frequently compared to males who did not, whereas the opposite occurred with females (Deci, 1971, 1972). Boys and girls also seem to choose different computer-related tasks (Swigger, Campbell, & Swigger, 1983).

Task difficulty, interest, and task enjoyment are other factors which appear to influence continuing motivation. Harter (1975) has found that boys appear to have a greater desire than girls to solve challenging problems, while girls have a greater need for social approval. However, neither boys nor girls will select tasks they think are too difficult (Harter, 1978). In addition, interest and task enjoyment were found to be related to continuing motivation in a study with fifth graders (Mosley, 1983).

The present study was designed to investigate the effects of two feedback conditions on the motivation of boys and girls to continue with computer-assisted instruction. Two comment conditions (comment, no comment) were crossed with sex of subject. As is common in motivation research, subjects who chose the computer for the next task were judged as showing continuing motivation. Questionnaires were used to collect data on other factors related to continuing motivation such as competence, interests, and task difficulty.

METHOD

Subjects

Sixty-two (62) sixth-grade students, 29 boys and 33 girls, from a suburban elementary school participated in the study. The school was in a middle class socioeconomic area. Students were familiar with the operation of the school microcomputers.

Procedures

Trained experimenters administered the study in the school computer lab. Fourteen Atari 800 microcomputers on a networking system were used. Subjects completed a questionnaire and pretest before beginning a CAI unit. They worked on the unit at their own rate. As subjects finished, they were given the posttest and second questionnaire.

Six sessions were conducted, each lasting approximately 30-35 minutes. Students within each of three classes were assigned randomly to one of two treatment groups: comment or no comment. Only one treatment was administered during each session. All subjects completed the same CAI unit on flow chart symbols. They also received knowledge of correct results personalized with their names during the three practices in the unit. In addition, the comment treatment group was given one positive comment related to competence after each practice. A comment also was inserted in the middle of the third practice.

The comments were

1) Good job, (Name of student), you are doing better than many of the other students.
2) (Name), you are getting better at identifying flow chart symbols. Keep up the good work.
3) (Name), many students can't do these problems so you are doing very well.
4) (Name), congratulations. You did better than most other students.

Materials

The unit on flow chart symbols was adapted for the computer from materials previously tried out with fourth- through eighth-grade students. The unit covers six flow chart symbols and their functions: oval, rectangle, diamond, parallelogram, flowline, and bracket. The unit included introduction, objectives and information, examples, practice, and feedback for each symbol. There were three practice activities, one after every two symbols. Items about previously learned symbols also were included in subsequent practices. For each item, students typed a single letter answer.

The experimenters programmed the unit for the Atari using PILOT. One diskette was created for each treatment. The diskette for the comment treatment group included the unit and the four positive comments. The diskette for the no comment treatment group contained only the unit.

Pre- and posttests with questionnaires were developed to assess students' performance and attitudes. Both the pretest and the posttest contained items about the purpose and use of flow chart symbols. The pretest had seven items while the posttest had ten. The first questionnaire consisted of six items related to students' attitudes toward the computer and experiences with it. On the second questionnaire, students responded to seven items about their perceptions of the CAI unit and their competence.

Table 1

Frequency of Return by Student Attitude Responses

Posttest Questionnaire Item	Responses			
	Very Well	Well	Badly	Very Badly
1. I think I did *	15-0[1] (100%)	32-5 (86%)	6-1 (86%)	1-1 (50%)
	Very Interesting	Interesting	Very Boring	Boring
2. This lesson was **	17-1 (94%)	33-0 (100%)	4-3 (57%)	0-4 (0%)
	Very Much	Some	Very Little	Not At All
3. I liked learning on the computer **	26-0 (100%)	28-3 (90%)	0-2 (0%)	0-2 (0%)
	Too Easy	Easy	Hard	Too Hard
4. This lesson was **	4-0 (100%)	30-3 (91%)	20-1 (95%)	0-4 (0%)
	Always	Often	Sometimes	Never
5. I would like to know ... compared to others **	18-1 (95%)	20-2 (91%)	16-1 (94%)	0-3 (0%)

* $p<.03$

** $p<.0001$

1 The two numbers shown are the number of students who returned and who did not return. For example, of the students selecting very well in item 1, 15 returned (100%) and 0 did not return.

Examination of the data for the item "I think I did" reveals that all subjects who thought they had done very well returned to the computer (15/15) while others returned at lower frequencies (32/37, 6/7, 1/2). Analysis of variance yielded a significant difference, $F(3,55) = 3.35$, $p < .03$. Also significantly related to return rate were subjects' interest in the lesson, $F(3,55) = 29.49$, $p < .0001$ and how much they liked learning it on the computer, $F(3,58) = 30.38$, $p < .0001$. Seventeen of 18 subjects who thought the lesson was very interesting and all who thought it interesting (33/33) returned to the computer, while three of seven who thought it boring and none who thought it very boring returned (0/4). Similarly, all subjects (26/26) who very much liked to learn on the computer and 28 of 31 who liked it some returned. No one who liked learning on the computer very little or not at all returned to task (0/2, 0/3).

Subjects' perception of task difficulty was related significantly to rate of return, $F(3,58) = 17.28$, $p < .0001$. None of those who thought the lesson was too hard returned (0/4). Most others who rated it from too easy to hard returned (4/4, 30/33, and 20/21). Eighteen of 19 subjects who always wanted to know how they did compared to others returned to task, while none returned who never wanted to know how they compared (0/3). These responses were found to be significantly related to return, $F(3,57) = 12.76$, $p < .0001$.

It is clear from the data that a very high percentage of all subjects in the study returned to the computer task. This was true for 54 of 62 subjects or 87%. Although only eight subjects did not return, statistically significant patterns occurred in the questionnaire response but not with the experimental variables.

DISCUSSION

The present study was conducted to investigate the effects of positive comments related to competence on the continuing motivation of boys and girls doing a CAI lesson. The relationship of questionnaire responses to continuing motivation also was examined. Results indicated a strong relationship between student attitudes and return to task. Significant attitude factors included students' perception of their performance, interest level of the task, attitude toward computers, perceived task difficulty, and desire to know how they did compared to others. Data also suggest that the use of the computer itself may be a strongly motivational factor. However, no significant relationship with return to task was obtained for comment and sex of subject.

That significant results were obtained for several attitude and task related variables was not surprising. One factor that some researchers have found to be important in continuing motivation is a student's feeling of competence (Boggiano & Ruble, 1979; Deci, 1975; Enzle & Ross, 1978). Student responses to the statement "I think I did...very well, etc." can be interpreted as indicating perception of their own competence on the task. The item, "I would like to know how well I did compared to others" also is related to perception of competence and was found to be significantly related to return. Similarly, task difficulty has been identified in several studies as an important factor in continuing motivation (ie., "this lesson was too easy--too hard"). In a graded situation, students will choose a task which is not too hard for them (Harter, 1978). Similar results were obtained in this study such that only students who rated the task "too hard" did not return. The significant relationship occurring between interest in the task and return seldom has been investigated. Story (Note 1), however, has found an interest in the task to be significantly related to return rate.

Both the overall return-to-task rate and responses to the item "I liked learning on the computer" indicated that the microcomputer itself may be an important factor in motivating students to return to task. Although this study was not designed to investigate experimentally the motivational effect of the computer, results indicate that it may have been the major factor. The overall return-to-task rate of 87% was far higher than the 50%-60% rates of other continuing motivation studies (Hughes, 1982; Mosley, 1983). It seems likely that this higher return rate may have been a result of, in a large part, the desire to continue working on the microcomputer. If this is the case, it is of particular interest because relatively little research has been conducted on the motivational value of the computer, *per se*.

The lack of a significant effect for comments on return to task may have been due to any of several factors. Other researchers (Danner & Lonky, 1981; Deci, 1971; Harackiewicz, 1979) have found that increased return rates occurred when students were given several comments during one task. Similar results may not have occurred in this study because of the depersonalized nature of the computer-delivered comments. In addition, the brief nature of a single task and the relatively short time period may not have been powerful enough to establish a behavior pattern in students. While we like to think comments influence student motivation, a greater number of more personalized comments over a longer period may be required. Finally, the overall high return rates for both the comment and no comment groups, possibly associated with a motivational effect from use of the computer, left little room for comments to have an important effect on return rates.

Results of the present study suggest certain promising directions for further research. One such area relates to use of the computer itself. Research designed to investigate experimentally the effects on continuing motivation of computer-based tasks as contrasted to paper/pencil tasks, etc., would provide needed insight into the motivational value of microcomputers. Investigations which looked at personalized comments over longer time might yield additional information on effects of comments. Questionnaire data suggests that working with variables such as competence, interest in task, and task difficulty levels also could result in useful information. Further investigation of continuing motivation with variables such as these would better enable us to understand methods to help motivate students in the classroom.

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1. Story, N.O. (1984). Factors influencing continuing motivation. Unpublished manuscript.

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TITLE: The Interaction of Cognitive Style and Auditory Learning Via Rate Modified Speech (Compressed and Expanded)

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THE INTERACTION OF COGNITIVE STYLE AND AUDITORY LEARNING

VIA RATE MODIFIED SPEECH (COMPRESSED AND EXPANDED)

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ABSTRACT

The purpose of this study was to investigate the relationship between auditory learning via rate modified speech and the learner's relative degree of field dependence/independence. Research related to the cognitive style of field dependence/independence suggests that the ability of field independents to impose structure upon information may facilitate the processing of auditory information to a greater degree than is possible for field dependent individuals when information is presented at varying rates of speed. Such research may also imply that conceptual density is a more realistic variable for study than is absolute word rate. The population consisted of 80 graduate students. Materials used consisted of normal, compressed and expanded versions of the Dwyer Heart script and the related evaluation instruments. Subjects were assigned to normal rate, compressed rate or one of two expanded rates. After listening to their respective treatments, students were administered the four achievement tests. Analysis of variance procedures and regression analysis were applied to the data.

Purpose

The purpose of this study was to further investigate the relationship between auditory learning via rate-modified speech and the learner's relative degree of field dependence/independence. Considerable research has investigated the comprehension of verbal materials presented by means of compressed or rate controlled speech(Duker, 1974). A comprehensive review of this research (Olson and Berry, 1982) indicated, however, that limited research has focused on the interaction of rate-controlled speech comprehension and various learner aptitudes or perceptual/cognitve styles. Furthermore, such research has given little consideration to the relationship between content complexity and presentation rates. Such research would provide (1) a means whereby a clearer understanding of auditory information processing could be achieved and (2) clarification of the relationship between learner cognitive style and conceptual density.

Rate-Modified Speech

In an everchanging society with an increasingly rapid pace, it becomes more important for an individual to acquire knowledge and information in the most efficient and expedient manner. This imperative is compounded by the fact that individuals learn at different rates. Since time spent in instruction is an important factor in maximizing instructional efficiency, technology has provided various means of altering recorded speech so that the instructor or student may adjust the rate of spoken presentation to suit his needs. This technique has been generally referred to as rate controlled speech or "Compressed Speech." Silverstone (1974) described this method of rate control as the

"...reproduction of an original recording in which the word-per-minute ratio is changed to a slower or faster rate of speech without eliminating the pitch or natural quality of the voice." Silverstone (1972) describes this technique as the process by which consonant sounds are maintained as in the original production, vowel sounds are reduced and pauses are eliminated as often as possible.

Substantial research has focused on both intelligibility and comprehension of rate-modified speech. Intelligibility refers to the extent that one is able to repeat information which was presented or to discriminate what one has heard. Comprehension refers to the ability to extract knowledge or information from what one has heard, usually by completing an objective test. Generally, no significant differences have been found between normal and compressed modes in terms of comprehension or intelligibility at rates up to 250 words-per-minute (Foulke, 1966, 1967). Foulke (1971) suggested that this implies a working, auditory processing limit of 275 words-per-minute.

These findings have, however, been questioned in studies by Adelson (1975) and deHaan (1977). In a comprehensive study, Adelson (1975), utilized hour long lectures rather than short passages, presented as rates of 175 and 275 words-per-minute. The researcher suggested that shorter passages such as those used by earlier researchers do not adequately assess a listener's overall comprehension. Findings of the study indicate that the length of stimulus materials is a critical factor. The traditional measures of intelligibility and comprehension were also investigated by deHaan (1977) in an attempt to determine if an individual's self-selected rate threshold could be used as a measure of either variable. Results indicated that an individual's relative threshold is an extremely reliable indicator of compressed speech intelligibility but not of comprehension.

Foulke (1968b) reported that, with word rates ranging from 125 to 400 words per minute, comprehension was found to be adequate until the word rate exceeded 250 words-per-minute. As the word rate rose higher, the level of comprehension decreases in an inverse proportion. Foulke hypothesized that adequate processing time is needed for perception of words in order for comprehension to occur. If processing time is reduced, a decrease in comprehension results. Lost processing time was indicated to be a contributing factor in the level of comprehension. Hausfeld (1981) presented strong evidence for a working memory processing limit of approximately 275 words-per-minute.

This research did not focus, however, on the affect that expanded speech may have on intelligibility and comprehension. Since a slower rate of speech permits increased processing time, reducing the word-per-minute ratio could allow the listener a means by which auditory information could be processed more fully. Speech expansion is a technique which has been applied to situations where additional processing time is needed. Law enforcement has found this use to be practical in situations where a dispatcher must understand or interpret an hysterical telephone call or a foreign accent. Expanded speech allows the listener more processing time to decipher what was said (The talk of the town, 1978).

Little empirical research has focused specifically upon the use of expanded speech for general instructional purposes. Since it is frequently a goal to minimize the learning time necessary for acquiring information, expanded speech has not provided the most efficient means to attain this goal. However, if the information to be presented is not of a general instructional nature but rather highly technical or complex, expanded speech may provide additional processing time to more effectively acquire the information. Thus, expanded speech may prove to be a more desirable presentation rate for particular learning tasks.

It should be noted that current devices used for production of expanded speech have no provision for pitch control. Therefore, the resultant messages tend to be lower in pitch and somewhat distorted. According to the manufacturers of such equipment (VSC Corp.) this distortion does not appear to be deleterious to the comprehension and intelligibility of the material.

Characteristics of the message

Foulke (1968a) indicated that in measuring comprehension, there are two groups of factors which must be taken into consideration: (1) organismic features and (2) characteristics of the signal. Organismic factors include age, sex, intelligence and previous experience with the subject. Characteristics of the signal are concerned with word rate, method of compression and rate of occurrence of the speech sounds.

Relatively few researchers have devoted adequate attention to the characteristics of the message itself. This third area for consideration includes readability, complexity of information and the relative density of ideas or concepts.

Substantial research has focused on both intelligibility and comprehension of time-compressed speech. Generally no significant differences have been found between normal and compressed modes in terms of comprehension or intelligibility at rates up to 250 words per minute (Foulke, 1966,1967). These findings have, however, been questioned by other studies that have examined additional variables that may influence the existing 250 word per minute threshold.

One methodological problem inherent in much of this research was that they used a variety of recorded messages which did not take into account the specific learning objectives or tasks and the complexity of information. The efficiency index of Fairbanks used in past studies assumed that all passages used were of equal difficulty and importance. Factors such as the length of the stimulus materials, density of ideas, items learned and not learner, and the difficulty of items learned and learned were not considered (Adelson, 1975). Other research suggests that regardless of the speaking rate utilized, increasing the difficulty of the stimulus material results in a reduction of the amount of material that is comprehended (Spicker, 1963). Grammatical complexity has also been shown to have an inverse effect on the amount of comprehension of compressed material (Reid, 1968). The type of information used has an effect on comprehension and may also represent related but different aspects of listening comprehension. Regardless of the types of information the threshold for word rate may be lower than what was originally identified (Rossiter, 1971). A listening threshold has been found to a measure of intelligibility but not comprehension. These thresholds are consideredto be sensitive to individual differences and reflect a temporal limit of information processing (deHaan, 1977). Consequently little generalizability from these findings is possible.

<u>Cognitive Style: Field Dependence/Independence</u>

Cognitive styles have been defined by Kogan (1971) as the individual variation in modes of "apprehending, storing, transforming and utilizing information." Ragan (1978) further stated that cognitive styles are "psychological dimensions" which reflect the individual differences for the manner of receiving, processing and utilizing information. Witkin, Moore, Goodenough and Cox (1977) described the characteristics of cognitive styles as: (1) cognitive styles deal with the "form" rather than "content" of cognitive activities, (2) cognitive styles are generally considered stable over time, and (3) cognitive styles are "bi-polar" unlike intelligence or other psychological variables.

One cognitive style which has attracted much research attention has been that of field dependence/independence, identified by Witkin, Oltman, Raskin and Karp (1971). Simplistically, field dependence/independence has been described as the extent to which an individual can disembed a figure from a ground. This perceptual aptitude is, however, indicative of a much more pervasive cognitive ability which enables the field independent individual to impose structure upon perceived information and then use this structure to more efficiently process and store the information. This perceptual ability has been documented extensively by Karp (1963) and Goodenough (1976). Generally, the factor of field dependence/independence is measured by either the <u>Rod-and-Frame Test</u> or one of a number of Embedded Figure Tests (<u>Embedded Figures Test</u>, <u>Childrens Embedded Figures Test</u>; <u>Group Embedded Figures Test</u>). All of these instruments rely upon the visual perceptual system and consequently have most frequently been employed in investigation of visual learning variables. Goodenough (1976), however, suggests the much broader application of these instruments.

Orientation of the Present Study

The general redundancy in language, identified by Shannon and Weaver (1949) suggests great similarities between the auditory perceptual field and the visual perceptual field. In listening to an auditory message, the perceiver must separate out or disembed relevant from irrelevant information then further restructure this information for storage. It would appear then, in terms of auditory learning, that the factor of field dependence/independence would operate on the listener's ability to distinguish and organize the relevant auditory cues and terms. If this rationale isindeed accurate, then field independent individuals could be expected to demonstrate greater ability in imposing such a structure and hence, shouldperform better than field dependent individuals. When the rate of information is increased, as in the case of compressed audio messages, this difference could be expected to increase even further.

According to Flaherty (1979) field independent learners are more capable than field dependent learners of listening for meaning because they can concentrate on the content of the message moreso than the rate of presentation. If field independent learners are capable of extracting more content from a compressed presentation, then it may be concluded they are also capable of gaining more information from a compressed presentation.

With respect to expanded speech, little research has focused on this aspect of rate-modified speech because the slower rates have had little apparent value in improving instructional effectiveness. However the stimulus materials used in previous research efforts have had little or no standardization. The question of idea or information density has also not been addressed to any great detail. When complex information containing a substantial amount of detail with little redundancy is presented at a compressed rate of speed, the result cannot be compared with a passage of less complex information presented at the same accelerated rate. Studies in rate-modified speech thus far have mainly concentrated on the rate of presentation and not the varying amounts of information or idea density presented in different passages. Perhaps for more complex material that contains many items of information a greater amount of processing time is essential to process and understand what is presented aurally. This may be further compounded by the real possibility that individuals who differ in their relative degree of field dependence/independence may also differ in their processing styles or abilities. Differences in idea or information density may also have an effect on how well listeners can comprehend the spoken material.

A second, yet related factor has been discussed in the literature on compressed speech, that of utilizing reliable and valid instruments for the evaluation of listener comprehension. Until the present, no standardized instruments have been developed, and those which had been developed represented a global measure of a variety of learning tasks. Work done by Rhetts (1974) suggest that learning research should also focus on the specific learning task being presented. Such a charge would imply that specific learning tasks presented via auditory channels be evaluated using instruments designed to measure achievement of each of those specific tasks. For this reason, a part of the research and evaluation materials developed by Dwyer (1967, 1972) were employed in this investigation. The evaluation instruments incorporated in this package allow the researcher to evaluate learner achievement relative to four different learning tasks or objectives: drawing or spatially restructuring information, terminology or recall of specific information, identification or spatial analysis and comprehension or interrelating information. In addition, a total test measures overall achievement on all tasks. The use of such materials would seem to represent a more precise method of evaluating achievement or comprehension* of information via the auditory mode.

Method

The stimulus materials used in the study consisted of four audio tapes produced from the 2000 word instructional script on the human heart developed by Dwyer (1967, 1972). This script was recorded by a professional narrator at an average rate of 150 words per minute. The rate was selected as the normal or control rate because it is generally considered to be the average speed used by newcasters. A compressed version at 250 words per minute and two expanded versions of 120 and 90 words per minute were subsequently produced by use of the Variable Speech Control Module (VSC Corporation).

The five achievement test developed by Dwyer (Drawing Test, Terminology

*Note: The term comprehension as used in previous research relating to compressed speech should not be confused with the term identifying the Comprehension Test developed by Dwyer. The term as used by Dwyer refers specifically to the ability to "use information to explain some other phenomenon" (Dwyer 1972) whereas, the general term "comprehension" refers to a more generalized ability which could interchangeably be called learning or achievement.

Test, Identification Test, Comprehension Test and Total Test) to compliment the instructional script were employed as evaluation instruments. In addition, the Group Embedded Figures Test developed by Witkin et al (1971) was used to determine the relative degree of field dependence/independence.

The population for the study consisted of eighty graduate students. Care was taken to exclude any individuals having had prior, formal training in medicine, physiology or anatomy as well as any subjects trained in Cardio-Pulmonary Resuscitation (CPR).

Based upon the results of Witkin's Group Embedded Figures Test, subjects were randomly assigned to either the control (normal rate, 150) or the experimental (compressed, 250 wpm or expanded, 120 and 90 wpm) groups. This factor represents a continuous variable, ranging from 0 to 18. Exact cutoffs for the extremes (high-field independent or low-field dependent) are not clear and are generally considered relative to the population being tested. Based upon previous research conducted on a similar population, cutoffs of 11 and 15 were established. Subjects falling at 11 or below were considered field dependent and subjects scoring at 15 or above were considered field independent. To avoid the statistical problem associated with three level blocking described by Cronbach and Snow (1977), only the extreme groups (field dependent/ field independent) were included in the study.

Groups of four students (one control and three experimental) were seated at a four carrel listening post and listened to their respective versions of the instructional script through individual head phones. Immediately following the audio presentation, each subject completed the four achievement tests.

Data Analysis

The study involved an ATI research design with two levels of the cognitive style variable (field dependence/independence) X four levels of the treatment variable (normal-150 wpm, compressed-250 wpm, expanded-120 wpm, expanded-90 wpm).

Data collected were first analyzed via a two-way analysis of varia[nce] procedure. Subsequently, regression analysis techniques were used to te[st] for uniformity of regression slopes.

Findings

Two-way ANOVA's were performed on the scores obtained from each of [the] four achievement tests as well as on the Total Test scores. The results of these analyses are presented in table 1.

Table 1

Summary of Analysis of Variance Results (n=80)

Source	Drawing Test F	Drawing Test P	Terminology Test F	Terminology Test P	Identification Test F	Identification Test P	Comprehension Test F	Comprehension Test P	Total Test F	Total Test P
Cog. Style (C)	1.27	.263	0.19	.662	0.72	.398	0.99	.322	0.94	.336
Treatment (T)	0.77	.514	3.54*	.019	0.69	.562	3.43*	.022	2.03	.117
C X T	1.71	.172	0.43	.729	0.44	.725	1.47	.231	0.52	.670

*Significant at the .05 level

Significant main effects for treatments were produced for the Terminology and Comprehension tests. Application of the Scheffé proce[dure] for pair-wise comparisons indicated that the normal (150 wpm) group was in both cases, superior to the expanded (90 wpm) group. No interaction or other main effects were found to be significant.

Regression analyses were used to determine if relationships existed between the cognitive styles of the subjects and their scores on the achievement tests. Table 2 shows the results of these analyses.

Table 2

Analysis of Variance of Regression Coefficients for Differences in Intercept and Slopes between Cognitive Styles and Treatments for Achievement Scores on each Test

	F	p	R^2
Drawing Test	1.07	0.390	0.026
Terminology Test	2.12	0.061	0.005
Identification Test	0.57	0.748	0.005
Comprehension Test	1.91	0.090	0.007
Total Test	1.23	0.302	0.013

Results of these analyses showed the interaction of the slopes to be not significantly different. The cognitive style of the subjects explained only 2.6, .5, .5, .7 and 1.3 percent of the variance respectively, making the variable a poor predictor of achievement on the tests.

<u>Discussion and Conclusions</u>

Results generally indicated that the normal rate groups scored higher than all other treatments, however, to a significant extent only in the comparisons of the normal-150 wpm vs. expanded-90 wpm for the Terminology and Comprehension Tests. It would appear, that in most cases, neither the compressed or expanded-120 wpm versions resulted in significanly improved achievement. The only group which achieved significantly less was the group which experienced the greatest degree of expansion. Such a finding would seem to directly contradict the sugesstion made earlier in this paper, that complex information, when given slower presentation rates, should result in improved achievement. This was obviously not the case, but these findings may be more directly attributable to two extraneous factors which are effects of the expansion process itself rather than due to the actual rate of expansion. These factors include (1) listener boredom and fatique and (2) pitch distortion due to the slowed rate. The first of these was observed frequently among subjects receiving the expanded version, and particularly the 90 wpm version. Apparently the slowed presentation of the highly technical information induced a degree of boredom resulting in loss of attention and concentration. The second factor, that of message distortion was readily apparent, both during the experiment as well as being cited by subjects after they completed the project. No provision is made in the design of the speech compression/expansion module to correct the pitch distortion caused by slowing down the tape, such as is done during speech compression. At slight rates of expansion, this distortion may not be a significant factor, but when expansion is carried out to the degree used in this study (90 wpm), extreme distortion occurs thereby affecting the intelligibility of the message as well as comprehension.

The variable of field dependence did not relate significantly to individuals' comprehension of material presented at different rates such as was found by Olson and Berry (1983). Although results were not statistically significant, field dependent subjects generally scored lower on the expanded versions than did field independent listeners. In addition, the normal speed group demonstrated the same reversal of mean scores (field dependents scoring higher than field independent) which was observed by Olson and Berry (1983). Such a finding, again while not of statistically significant magnitude, should be further investigated. This reversal may suggest that field dependent individuals, when presented with a more global or spatial task such as required by the Drawing Test, tend to demonstrate higher achievement and surpass their field independent counterparts. It should be remembered however, that this effect was observed only on the normal presentation rate group.

The findings of this study strongly suggest that further research be conducted to confirm or disconfirm the hypothesis that more complex or technical information requires a slower presentation rate to facilitate optimum achievement. Research should further focus on the question of intelligibility and listener boredom as they relate to learning from expanded materials. Technical correction of the pitch distortion associated with expanded speech should be investigated.

It is also apparent that conclusive proof has not been presented regarding the instructional effectiveness of auditory materials presented at varying rates of compression and expansion to individuals who differ in their relative degree of field dependence.

Similarly, research should further investigate these factors as they relate to the effectiveness of rate-modified instruction presented via both auditory and visual modes simultaneously.

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TITLE: Conceptual Tools for R&D on Applications of Microcomputers to Individualization

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CONCEPUTAL TOOLS FOR R&D ON APPLICATIONS OF MICROCOMPUTERS TO INVIDUALIZATION

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Abstract

This paper introduces the symposium, Cognitive Style and Microcomputers: A Review and Synthesis of Current and Needed Research and Development. It presents issues attendant to research and development in cognitive styles and microcomputer uses within the context of instructional technology. The paper discusses issues of relationship of cognitve style to learners' general ability and prior learning. In discussing needs for research in and on microcomputers in education, the paper discusses the heritage of programmed instruction and teaching machine research of the 1950's and 1960's, as that work relates to currently available practitioner's tools in instructional design and development. A plea is made for increased basic research on learner characteristics and instructinal media attributes of currently available high technology.

CONCEPTUAL TOOLS FOR R & D ON APPLICATIONS OF MICROCOMPUTERS TO INDIVIDUALIZATION

INTRODUCTION

This symposium is about research and development in microcomputers and cognitive styles. A substantial amount of research has been conducted regarding individual differences in receiving and processing information, generally referred to as "cognitive styles" (such as field independence - dependence, leveling - sharpening, and impulsivity - reflectivity). On the other hand, little research is available regarding how the unique attributes of computers may be used to adjust instruction to accomodate individual differences, including cognitive styles. Particularly missing is research on microcomputers in instruction from a theoretically grounded framework. The symposium will clarify major research issues attending these topics within theoretical frameworks provided by cognitive styles. The symposium will provide information on current work and work which needs to be done. The symposium consists of four papers: 1. conceptual tools, 2. instructional design, 3. measurement, and 4. instructional management.

The first presentation, Conceptual Tools, is my own. That presentation will be a general essay on the topic at hand and should serve as orientation for the three papers to follow. Patricia Smith will discuss instructional design issues, Robert Burroway will discuss measurement potentials, and Barbara McCombs will discuss instructional management issues. Our discussants today are Perrin Parkhurst and William Winn. Dr. Ron Burkett, originally to be a discussant, was unable to attend and Bill Winn has graciously agreed to be a discussant in his place.

As a review of this overview, I want to restate: our topic has is the existing and needed research and development in an area of interest created by the combination of cognitive style and microcomputers. After my "Conceptual Tools" presentation, we will take three slices through this topic. We will look at it in terms of instructional design, measurement, and instructional management.

COGNITIVE STYLES

You never know what a person is going to be talking about when he says he is going to talk about "cognitive styles." He might have in mind the "educational cognitive style" or "cognitive style mapping" of Joe Hill or of Kenneth and Rita Dunn's work in this area. Or he might be talking about only the work begun by Herman Witkin and his associates on field independence/ dependence. Or he might be talking about a variety of non-academic learner differences in perception and information processing, as we will. These include not only field independence/ dependence, but also such things as leveling/ sharpening, impulsivity/ reflectivity, visual/ haptic, distractibility, breadth of categorization, scanning, tolerance for unrealistic experiences, cognitive complexity/ simplicity, and conceptualizing styles, to name ten. We, in this symposium, will be talking primarily from this latter frame of reference: those dimensions of individual difference which have been found and labled as a product of systematic study of differences in the way people perceive and process information.

Another way in which people who talk about "cognitive style" differ among one another is with regard to their "purity." Some people are very pure, probably the purest being those who restrict their discussions to only field independence/ dependence. That is a "pure" thing to do because, first, field independence/ dependence is the one which first used the term "cognitve style," and second, because the other style dimensions in my list of ten are actually called things like "perceptual style" in the case of visual/ haptic, "cognitve tempo" in the case of impulsivity/ reflectivity, and "cognitive controls" in the case of leveling/ sharpening.

The least purity, in my view, is found in the "educational cognitive style" and "cognitive style mapping" formulations. For all I know, there may be something to educational cognitive style inventories and the educational prescriptions derived from them, but I cannot find it. Although there is nothing perfect about the more "pure" approaches to cognitive style, there has been, to my knowledge, no establishment of validity to the instruments used by educational cogntive style proponents. In addition, it seems inappropriate and downright invalid to dispense free and easy prescription of broad classes of treatments regardless of learning task, such as: "Well, you are auditory and kinesthetic, so you will learn best from listening and getting in direct touch with things." Such prescriptions smack more of the reading of gypsy tea leaves than of scientific study of instruction or of a technology of instruction.

As you might be able to tell from the forgoing, my own purity quotient and that of the participants in this symposium is about in the middle. In other words, we are purer than some but not as pure as others. None of us restrict our interest to field independence/ dependence on the one hand, and on the other hand none of us can see much value to the Hill, Dunn and Dunn, and other formulations of educational cognitive style. In sum, we do believe that there are a variety of "non-academic" individual differences which are **real** and **relevant** to instructional theory development.

What do we mean by "non-academic" learner differences? I use this term because it is the best thing I can think of to differentiate between what I have in mind and two powerful influences on learning from instruction which are **not** what I have in mind: general ability and prior learning. General ability and prior learning are both academic learner differences. In the case of general ability, the factor is an academic one because of the fact that all measures of general ability are validated in terms of prediction of ability to do school work, and prior knowledge is an academic variable because the prior knowledge of interest is generally in or related to the desired learnings at hand.

General ability and prior learning share one thing in common and are in another regard at opposites to one another. General ability and prior learning share in common a profound influence on learning from instruction. On the other hand, they are qualitatively different factors with regard to the precision with which they can be described and measured and the precision with which we may think about them. We know practically nothing, I would submit, about general ability, except that it must exist and that it varies. Prior learning, on the other hand, is the foundation upon which our most powerful and clearly understood principles of instructional design rest.

In the domain of **non-academic** learner differences lie many factors, among which cognitive styles represent the most-studied. In papers to follow, we will be looking at and thinking about exisiting and needed research in instructional technology which includes cognitive style.

Before I leave the topic of cognitive style, I want to note that for those of you interested in an extensive treatment of cognitive styles and their impact on learning from instruction, I can make available to you a set of technical report reprints from a three year basic research contract in this area, sponsored by the Air Force Human Resources Laboratory. I was Principal Investigator of that project, which includes work which Ausburn and Ausburn did under me as doctoral students at the University of Oklahoma, as well as extensions of that work by them, others, and myself. The Air Force has long since run out of stock of these reports, and since they amount to over 250 pages, I cannot supply them for free. However, if you are interested in receiving them, please come and talk with me at the conclusion of this session.

MICROCOMPUTERS

In the 1950's and 1960's, an enormous amount of research and development was conducted on and with teaching machines and programmed instruction. The teaching machines fad has passed, but it left us with a substantial residue. It is through discussion of this residue that I would like to orient our thinking about instructional technology research involving microcomputers and finally, to both microcomputers and cognitive style.

In my view, the lion's share of our practitioner's tools in instructional technology, including such things as learning task analysis and our models of instructional design and development, are essentially residue from the research and development with teaching machines and programmed instruction. For example, the feedback loop in all our I/D models -- in which we take information about learner performance after instruction and re-inject that into the system as feedback to improve future instruction -- is **essentially** a generalization of the programmed instruction maxim that "thou shalt validate thy program." Instead of just having a critical reader, an expert in your field, review and make editorial judgements about whether the text **seems** clear and about whether or not learners should be able to learn from the material, a procedure which quickly became standard practice in programmed instruction development was to actually **try out** the material with learners to see if it worked. We are so accustomed now to the idea of empirical validation of instructional materials and so accustomed to improvement of materials of all sorts through use of information about their effectiveness, that it is easy to forget where these ideas came from. Little more than twenty years ago these were radical innovations, part of the programmed instruction movement.

Programmed instruction represented our first instance of thinking about an **instrument of instruction**, rather than a medium or aid. The reality of this instrument, this **thing**, that was supposed to teach somebody something, focused the minds of educational developers in new ways. Since an instrument is supposed to teach something, all by itself, developers realized that they had to decide on and describe pretty clearly what that something was. Such was the beginning of behavioral objectives. It is amazing that a tool developed for the express purpose of facilitating development of programmed instruction materials has seen such widespread use over such a long period of time.

In 1967, Arthur Lumsdaine's classic review of research in our field up to that time appeared in the first edition of the Handbook of Research on Teaching, edited by N.L. Gage. That review was entitled "Instruments and Media of Instruction," and in it, Lumsdaine noted that the most significant thing about programmed instruction was its

quality of representing a reproducible, self-contained instrument of instruction, and as such it offered a uniquely powerful handle on **research.** Looking back I think he was right. He was **so** right, in fact, that the influence of research and development with programmed instruction continues to the present and remains a common influence in our current practitioner's tools. When you or I are frustrated with the state of the art of instructional design, when we find that the models we use have a distressing number of "empty boxes" at critical places, such as "devise instructional strategy," what we are essentially frustrated with is models which are extensions of what was learned from research and development with programmed instruction and teaching machines. This is, I am sure, an arguable point but it is certainly how it looks to me. If I am correct, or even half-correct, no wonder state of the art in I/D is beginning to look awfully old, awfully tired, and awfully in need of replacement or supplantation with something new, different, and "better."

It is not that no water has gone under the research and development bridge since the heyday of of programmed instruction. We have new insights into cognition and human information processing, intrests in the study of instructional media attributes, learning strategies employed by learners themselves, and, in short, a large number of new questions and theoretic insights. All the new directions and good work over the past twenty years notwithstanding, it appears to me to **remain** the case that if you are in a school or training setting and you want to do instructional development with the most learning payoff per dollar spent, you should spend your time and money on development of the best single-track instructional materials that you can design and develop. And although we know that a single set of materials can be themselves adaptive to individual differences, it is on the very question "on what bases will we design for adaptive qualities in our materials?" that our high level designer-based answers become common sense at best and weak or foolish at worst. Operationally, our instructional theory is the heritage of what they were doing in the 1950's and 1960's. My own first publication, incidentally, was in 1961, it was about teaching machines. Its title was "Hardware and Hard Work" and it essentially outlined a great deal of what people are worrying with right now in the development of computer assisted instruction materials. We **should** be, I submit, worrying about qualitatively different things...the sorts of things represented by our current research and current instructonal tools.

We do have today, knowledge and tools we didn't have back then. Among those new tools are increased knowledge of some non-academic individual differences in perception and information processing which we call "cognitive styles," and we also have a new device: the microcomputer. Although neither of these things are trivial in themselves, I think it is fair to say that we really do not yet know what to do with either one. If that is an overstatement, I will rephrase to: we don't have a body of systematic knowledge lending prescriptions to instructional designers which involves consideration of human information processing, including cognitive styles, or of many current instructional media attributes, including those of microcomputers. Our best practitioner's tools in instructional technology rest on the behaviorist school of learning theory and upon the instructional media attributes of teaching machines and other media available twenty years ago.

I hope the microcomputer is a technology which will stimulate research and development in instructional technology, much in the way that teaching machines did twenty years ago. I hope microcomputers force researchers to re-examine fundamental tenants of instructional design and development. It is obvious, I think, that microcomputers are being put to trivial uses when they are used to emulate a teaching machine or programmed text. What we have left, when you take away page-turner applications of microcomputers, is a mixed bag of powerful and trivial uses for which our instructional design models end up more or less naked. Naked. I like that metaphor...it seems to fit..."microcomputers have caught us with our pants down." You may quote me on that.

We need, it seems to me, two things: one is heavy, widespread involvement by instructional technology researchers into programmatic basic research on and with high technology, including microcomputers and learner characteristics which interact with instructional treatments. This research will not, as Prof. Gerlach noted in an earlier session, provide practitioners with answers, certainly not quickly. But second, we can and should expect to see, at some point, appropriate and useful synthesis of our more current knowledge. To put it concretely, we will need a Robert Gagne to sift, interepret, synthsize, and model the best of current knowledge.

If we, today's researchers in instructional technology, do what they did in the 1950's and 1960's, we will begin responding to the unique attributes of microcomputers with the best theory available, begin to formulate research and development which may ultimately become far more significant and useful to education and training than the machines themselves ever were.

These then are our topics: cognitive styles and microcomputers

You may think of our topics, in the final analysis, as being examples of what is really at stake. The papers to follow will take their **material** from cognitive styles and microcomputers; what the papers are **about** is much broader. I expect that the symposium will give you ideas you can use in your thinking about research in our field and, what I hope this paper and the symposium as a whole will do is provoke you to think about the **possible** in new and different ways.

TITLE: Availability of Prior Knowledge and Its Effect on Transfer of Learning

AUTHOR: Boyd Richards

AVAILABILITY OF PRIOR KNOWLEDGE AND ITS EFFECT ON TRANSFER OF LEARNING

Paper presented at the AECT conference in January 1983 by

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Transfer of Learning in Education

Royer (1979) defines transfer of learning as a sequential process in which the learning of one passage facilitates the learning of a second conceptually similar passage. Transfer of learning, thus defined, has been demonstrated to occur when learners study two passages close in time and when the passages contain similar terminology for redundant concepts (Abramson, 1965; Scandura and Wells 1967; Merrill and Stolurow 1968; Royer and Cable 1975; Royer and Cable 1976; Ausubel 1978; Mayer 1977; Anderson, 1978; Adams & Collins, 1979; Mayer and Bromage 1980). However, there is little evidence to suggest whether transfer will occur in situations where learners do not read the second passage for several days or weeks, and/or where the passages do not contain the same terms for the concepts taught in both.

According to Mayer (1977) and Royer (1979), the process of facilitated transfer can only occur when the memory structures gained from the first passage are retrieved from long-term memory when the learner reads the second passage. While retrieval is almost certain for contiguous passages (two passages read close in time), empirical results say little about retrieval and its effect on transfer when there is a delay.

Many studies have measured retention of learning on delayed dependent measures and have found that students are able to recall and/or recognize some but not all of the information they evidenced learning on an immediate dependent measure (Pickert and Anderson, 1977; Mayer and Bromage, 1980; Reder and Anderson, 1980). What is remembered seems to be a function of what is originally learned (i.e., facts versus meaningful concepts (Ausubel, 1978)), how it is learned (i.e., conceptual perspective (Pichert and Anderson, 1977)), and what cues are given at the time of recall (Pickert and Anderson, 1977). All three of these factors influencing delayed recall of memory structures have important implications for transfer of learning across two noncontiguous passages.

But, although research with delayed dependent measures shed some insights on how much previously learned information will be remembered when subjects are expressly asked to retrieve it, such research cannot lead to generalizations concerning how much a second passage will stimulate recall of a first passage read several days before. According to Mayer (1977), the availability of prior knowledge, as demonstrated on delayed retention tests, does not ensure that the prior knowledge will be retrieved from long-term memory when the second passage is encountered. There must be a triggering mechanism associated with the second passage which identifies what prior knowledge structures to retrieve (Bransford and Johnson, 1973; Royer, 1979; Rummelhart, 1980).

In my research during the past year I have examined the effects of two triggering mechanisms on tranfer of learning across two noncontiguous passages. They are similar terminology for shared concepts and a brief review of the first passage read immediately before the second passage. Before summarizing that research, however, I will establish a theoretical basis for my inquiry in the context of schema theory.

Contribution of Schema Theory

Schema theory provides a comprehensive framework for studying the effects of similar terminology and reviews on transfer of learning across two passages. Current notions of schema theory incorporate concepts originating as far back as Bartlett (1932) and developed by numerous cognitive theorists (Neisser, 1976; Shank, 1976; Rummelhart & Norman, 1978; Rummelhart, 1980; Spiro, 1980).

According to Rummelhart (1980), a schema is a hierarchical structure interrelating information which constitutes a known concept such as an "object, situation, event, sequence of events, action and sequence of actions." The information in a schema includes data which specifies (1) <u>the common attributes of instances of a concept</u>, (2) variable attributes and the range of permissible variations, and (3) default values for missing attributes.

Any generic data, variable range or default assignment can be expressed in terms of another schema. In this way, schemata (plural of schema) embed one another. Rummelhart (1980) suggests that the "embedding characteristic of schemata" allows schemata to "represent knowledge at all levels--from ideologies and cultural truths to knowledge about what constitutes an appropriate sentence in our language, to knowledge about the meaning of a particular word."

In terms of schemata theory, memory consists primarily of interconnected and embedded schemata (diSibio, 1982). These schemata represent all one's generic knowledge about the world. A subset of them are retrieved, or activated during comprehension to allow a reader to interpret incoming semantic information. When the network of retrieved schemata matches the sensory inputs at all levels of abstraction, comprehension easily follows (Bransford & Johnson, 1973; Shank, 1976; Rummelhart, 1980). When the schemata do not match a portion of the incoming data, either (1) other schemata are activated which match or (2) existing schemata are modified, else (3) comprehension breaks down. Without comprehension, meaningful verbal learning cannot occur (Ausubel, 1978), leaving rote learning or no learning as the only alternatives.

Retrieval of schemata from memory can occur somewhat automatically as incoming data seek to be matched or "instantiated." This describes a data driven, "bottom-up" mode of retrieval (Adams & Collins, 1979). Bottom-up retrieval starts at very concrete levels (word recognition) and works to higher levels (construction of meaning of sentences). An alternate mode, conceptually driven or "top-down" retrieval, activates schemata from an initially high, conceptual level to progressively lower levels in anticipation of incoming data (Adams & Collins, 1979; Runnelhart, 1980). Top-down retrieval searches for schemata which will allow anticipated semantic information to be understood upon arrival.

Both bottom-up and top-down processes contribute to transfer of learning of across passages they influence what schemata related to a first passage are retrieved from long-term memory to guide the learning of the second passage. More specifically, bottom-up processes can influence transfer by triggering the retrieval of available word-level schemata acquired from the first passage which match key words and phrases read in the second. From the word-level schemata, retrieval spreads upwards to more complex schemata. Consequently, when similar terminology is used across two passages, bottom-up processes can more easily target the relevant schemata from the first passage (Kintsch et. al., 1975; Abramson, 1965).

Top-down processes facilitate transfer of learning when two passages are believed to conceptually overlap. That is, when learners recognize that the second passage overlaps with the first, top-down processes automatically retrieve available conceptual-level schemata related to a first passage. At which point, retrieval spreads down-ward to less complex schemata (Adams & Collins, 1979). Students have learned from past experience that two sequential passages (i.e., two chapters from a textbook) often conceptually overlap and that the first passage can provide a conceptual framework for understanding the second. Consequently, even when reading two contiguous passages from different sources (i.e., two journal articles), they will tend to retain many of the ideas from the first passage in working memory in anticipation of using them to better understand the second. However, as time passes between passages, other ideas replace those from the first passage and top-down processes may not be able to automatically ensure the availability of appropriate high-level schemata (Royer, 1979).

Summary of Research by Author

I have conducted three studies thus far in my research effort. The first two studies served to pilot the treatments and dependent measures used in the third and more complete experiment. Consequently, while I'll emphasize the last study of the series, the preliminary ones merit at least a brief review.

Treatment Materials

In all three studies, I employed treatment materials modified from materials developed by Mayer and Bromage (1980). They consisted of two passages about computers. The first passage presented concepts about the parts and locations within a computer. For each part, the passage presented the following information: 1) a simple representation of the part and its relationship to the other parts; 2) an analogy illustrating the form and function of the part in terms of a familiar object; and 3) a few elaborations and details associated with the part and its operation. Mayer and Bromage (1980) used the original form of these materials because they had found that students unfamiliar with computers lacked knowledge about the parts of computers, and as a consequence had a more difficult time learning a programming language. I assumed, therefore, that the knowledge acquired from this passage would serve as a conceptual framework (Frederikson, 1975; Ausubel, 1978; Mayer, 1979) for learning the second passage which was about programming.

The second passage taught seven commands found in many programming languages. The passage presented six types of information about each command: 1) a brief statement about the function of the command; 2) a general statement (including an analogy) about the format of the command; 3) a technical specification of the format; 4) a general statement about what the command causes the computer to do; 5) a technical list of the operations performed by the command; and 6) an example of a command in the correct format and a list of the operations the example command would perform. Material in types 1, 2 and 4 were considered primary content while material in types 3, 5 and 6 were secondary content.

The second passage used technical terms referring to parts of a computer without defining those terms. It referenced operations performed by the commands without describing those operations. In effect, I designed the passage with the assumption that learners will have studied previously the first passage which defined the terms and clarified the antecedents of the operations. I specifically designed the treatment passage in this manner so as to maximize the amount of transfer that would occur. I followed the example set by Royer and Cable (1975; 1976) of using concrete analogies, designed to form a "bridge" to students' existing prior knowledge (Royer, 1979) and thereby give meaning to the technical terms used abstractly in the second passage. Royer and Cable (1975; 1976) observed facilitated transfer of learning across two contiguous passages only when the first passage contained concrete, easily understood information and the second passage contained abstract, hard to understand information.

Dependent Measures

The dependent measures in all three studies consisted of two sets of multiple choice questions. One set consisted of questions testing comprehension of primary ideas (main points) and the other tested comprehension of secondary ideas (details). The number of itmes in each set increased with each study and many of the items were rewritten before being used again. Therefore, the dependent measures across the three experiments were similar but not identical. Furthermore, the two sets were combined into one measure of comprehension in the first study.

Study I

Design

The design of the first study consisted of a single independent variable with two levels. The variable was type of terminology and the two levels were similar terminology and dissimilar terminology. One group received the two treatment passages with identical terminology for shared concepts (e.g., card reader). The other group received the same passages but with different terminology in the first passage (e.g., input tray for card reader). Both groups received the second passage as soon as they had finished reading the first.

The intent of the first study was to measure the effect of type of terminology on transfer of learning across contiguous passages. It was hypothesized the dissimilar terminology would interfere with transfer.

Subjects

Subjects were 21 juniors and seniors from the same high school psychology class. They were randomly assigned to treatment conditions. Subjects had as much time as needed although all finished within 40 minutes.

Results

The posttest scores were much lower than expected. The test was difficult and subjects reported that they had not anticipated having so many questions about "details." Table 1 summarizes the results of the study.

Treatment Condition	Number of Subjects	Mean*	Standard Deviation
Similar Term.	12	7.83	2.40
Dissimilar Term.	9	8.10	3.30

The difference between means is not significant (T = 0.40, alpha = 0.05).

*Total number of items was 30.

Study I: Means and standard deviation

Table 1

The results must be interpreted cautiously because of the potential flooring effect of the test. However, the insignificant differences in the means between the two treatment groups suggests that dissimilar terminology was not debilitating when passages occur close in time. The potential impediment of dissimilar terminology on bottom-up processing may have been compensated for by the facilitating effects of conceptual similarity on top-down processing and/or by the additional efforts of students with dissimilar terminology to cope with their unfavorable condition.

The results also indicate two areas in which the treatment materials and dependent measure needed improvement before used in the second study of subsequent research: 1) The test items needed to be improved (made easier); and 2) The students needed to be alerted to read for details.

Study II

Design

The second study included two out of four treatment conditions corresponding to a 2x2 factorial design. The independent variables in the full design were 1) type of terminology across two passages (similar and dissimilar) and 2) temporal relationship between two passages (contiguous and noncontiguous).

		Temporal Relationship	
		Contiguous	Noncontiguous
Similarity of Terminology	Similar	Study 1 Study 2	
	Dissimilar	Study 1	Study 2

Figure 1.

As can be seen in Figure one, my first study compared a contiguous-similar group with a contiguous-dissimilar group. The second study compared a contiguous-similar group with a noncontiguous-dissimilar group. This study also included a control condition which included only a second passage and the dependent measure.

Subsects

Subjects were 65 high school seniors from three English composition classes. Their participation in the study was an assigned classroom activity. Students assigned to the similar-contiguous condition received the two passages containing similar terminology for all concepts included in both passages and they read one passage immediately after the other. Student assigned to the noncontiguous-dissimilar condition received the same two passages except that the terms in the first passage for concepts also taught in the second passage were changed and that the students did not receive the second passage until six days later.

Results

Table 1 contains the means and standard deviations of the three condition groups on the dependent measure. Planned comparisons using the T statistic revealed several significant differences between means as indicated in Table 2.

Treatment Condition	n	Primary Mean	Primary SD	Secondary Mean	Secondary SD
1) Contiguous-Similar	18	6.5*	3.31	5.6+	2.61
2) Noncontiguous-Disimilar	16	4.80	1.42	3.9	1.54
3) control	11	4.5	1.92	5.6+	1.69
Total number of items		14		12	

* Different from groups 2 and 3 ($p < .05$).
+ Different from group 2 ($p < .05$).

Study II: Means and Standard Deviations.

Table 2.

On the total test, students in the contiguous-similar group scored significantly better than students in both the noncontiguous-dissimilar treatment and control conditions ($t(32)=5.24$, $t(27)=2.35$, respectively). An interaction occurred between type of test and treatment condition. On the primary test, students in the contiguous-similar condition performed significantly better than the other two groups ($t(32)=3.25$, $t(27)=2.51$, respectively), which groups did not differ from each other ($t(24)=0.32$). On the secondary subpart, the contiguous-similar group and control group did not differ from each other and both groups scored significantly better than students in the noncontiguous-dissimilar group ($t(32)=3.46$, $t(27)=3.40$, respectively).

The differences between means from the contiguous-similar condition and the noncontiguous-dissimilar group suggest that dissimilar terminology combined with a lack of temporal contiguity impedes transfer of learning of both primary and secondary content. As found in the first study, dissimilar terminology might not have the same negative effect with contiguous passages.

The differences between means on the secondary test of the noncontiguous-dissimilar and control groups suggests that the unfavorable condition of dissimilar terminology in noncontiguous passages may actually interfere with certain kinds of learning.

The lack of differences between the means on the secondary test of the contiguous-similar and control conditions suggests that students without access to a conceptual framework (i.e., the knowledge structure acquired from reading the first passage and retained in working memory) may resort to rote learning (Mayer and Bromage, 1980; Mayer, 1977). This conclusion seems justified because secondary, factual information tends to be more easily learned by rote learning than primary, abstract information (Ausubel, 1978).

Study III

Design

The design of the third study consisted of two variables with two levels. In addition to type of terminology (similar and dissimilar), there was position of a review of the first passage (before or after the second passage).

The review of the first passage consisted of one or two sentences about each part of the simplified computer. These sentences made reference to the analogies and main ideas; but did not restate any details. The review also contained the diagram used in the first passage representing the simplified computer.

In addition to the four treatment groups formed by the 2x2 design, I included 2 control groups. One control group received contiguous passages with similar terminology and the review before the second passage (best conditions for transfer). The other control group received only the second passage (worst conditions for transfer).

The intent of this study was to test six hypotheses:

H1: Students reading noncontiguous passages with similar terminology will experience more transfer than students reading the same passages with dissimilar terminology.

H2: The effects of similar or dissimilar terminology will be equal for transfer on primary and secondary ideas.

H3: Students reading a review of primary content from a first passage immediately before a noncontiguous second passage will experience more transfer than students reading the same review after the second passage.

H4: The effects on transfer due to when students read a review of a first passage will be greater on primary ideas than on secondary ideas.

H5: Students reading noncontiguous passages with both similar terminology and a review will experience greater transfer than students reading passage with only one of the two conditions

H6: Students reading noncontiguous passages with a review but without similar terminology will experience more transfer than students without a review.

Results

The results failed to support the hypotheses because (1) there were no significant main effects, (2) there was a significant interaction among treatment groups, and (3) the differences between the best case and worst case control groups for comprehension of both primary and secondary ideas were small and not significant. Table 3 reports the means and standard deviations and Table 4 summarizes the analyses of variance among the four treatment conditions.

	Primary Ideas		Secondary Ideas	
	Review before	Review after	Review before	Review after
Similar terminology	9.95 2.43 (20)	7.41 2.55 (19)	8.25 2.78 (20)	6.74 2.49 (19)
Dissimilar terminology	6.95 8.95 (21)	10.74 3.53 (19)	8.14 3.65 (21)	10.00 4.16 (19)
Contiguous passages control		10.91 2.69 (22)		8.73 2.87 (22)
Second-only control		9.52 2.96 (21)		8.95 3.24 (21)

Study III. Means and Standards Deviations

Table 3.

Source of Variance	df	Primary Ideas: Sums of Squares	Primary Ideas: F	Secondary Ideas: Sums of Squares	Secondary Ideas: F
Main Effect	2	24.07	1.46	45.88	1.96
Terminology	1	21.87	2.04	45.29	[illegible]
Review	1	2.03	.25	.73	.06
Interaction	1	69.46	10.82*	55.99	4.77*
Explained	3	113.55	4.58	1.1.87	2.55
Residual	75	620.32		880.01	
Total	78	733.87		981.87	

*Significant at $p < .05$.

Study III. Analysis of Variance

Table 4.

Overall, students performed much lower than expected on the dependent measure. This unanticipated poor comprehension may be attributed to the difficulty of the reading materials and the ability of the subjects. Because the study was focused on transfer in the context of "technical material," I intentionally made the materials dense with both primary and secondary content. This density of unfamiliar, technical concepts possibly overwhelmed the learners and caused them to lose interest in what they read. I should note, however, that the passages are at an th grade reading level according to the Flesch Kincaid procedure. The subjects were 8 to 20 months younger than subjects used in the second study. While age alone is not a significant factor, ability to read, reason, and learn may be different between the two age groups.

The meaning of the significant terminology by review interaction becomes difficult to explain in light of the comprehension scores of the two control groups. According to the theory outlined earlier, the contiguous control group should have experienced maximum transfer while the second-only control group should not have experienced any transfer. Because the control groups did not differ from each other, I cannot say that the differences among the treatment groups was due to transfer. Clearly, other learning conditions were in operation--some of which might have been influenced by treatment manipulations. For example, the performance of the contiguous control group may be attributable to transfer while the performance of the second-only control group may be attributable instead to rote learning procedures (Ausubel, 1978). Similarly, the treatment groups may have been differentially influenced by transfer and/or rote learning procedures. The similar-before group probably experienced more transfer than the other treatment conditions while the dissimilar-after group probably utilized more rote learning procedures. In the section that follows, I further discuss these tentative conclusions and provide a theoretical basis for them.

General Discussion

I had theorized in earlier that familiarity of technical terminology and a single organizing structure (i.e., existing schemata at both the word and concept levels) were prerequisite for comprehension and transfer. In retrospect, I believe I made a couple of erroneous assumptions: I assumed that because the passage had familiar words (e.g., card and reader) being used in a very technical manner (i.e., card reader) that the terms would not invoke top-down or bottom-up processing. Furthermore, I assumed that because the passages integrated the terms into a novel conceptual structure (i.e., internal makeup of the computer) that unless that structure was present during reading, the process of comprehending those terms and deriving meaning from the text would break down. While Study II supported these assumptions, Study III provided conflicting evidence.

Rummelhart and Norman (1978) provide a theoretical explanation of the outcomes in Study III. They suggest that when adequate schemata cannot be found to account for incoming data via top-down or bottom-up processing, then the passage "can be understood only in terms of a set of disconnected subsituations (facts)--each interpreted in terms of a separate schema." In other words, many students probably comprehended individual terms or concepts in isolation of each other rather than integrating them within one meaningful structure. According to Ausubel (1978) and others (Mayer, 1979; Mayer & Bromage, 1980), learners without a meaningful structure can, in the short term, evidence as much learning (by rote procedures) as can learners with meaningful structures.

Furthermore, evidence from the second and third studies suggests that weak organizing schemata can actually impede positive transfer and rote learning. If learners are led to believe that a comprehensive, unifying structure is available to better learn and integrate new and difficult ideas, the learners are likely to forgo retrieving a series of disjointed structures. Rather, they will make the new structure do the best it can. However, if that structure is not well developed, (does not contain solid hooks in the right places) then a decrement in leaning over the rote learning procedure is possible.

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TITLE: The Impact of Television Literacy: An Investigation of Narrative and Television Comprehension

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The Impact of Television Literacy

An Investigation of

Narrative and Television Comprehension

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Background and Introduction

Visual communications inundate today's students, and the ability to interpret and utilize these messages is important to the learning process. While educators study the effect that commercial television and film has had on children, several national groups seriously pursue the goal of creating a more technologically aware and media literate society, in an attempt to nullify the perceived negative effects of viewing television and film (Kahn, 1979, Potter, 1982). The growth of film and television study has lead to the development of both research and application of programs designed to enhance what many are calling "visual literacy".

Sharing many elements with media appreciation or film criticism, visual literacy has been variously defined, and theoretical principles of visual literacy are being developed (Hortin, 1980). Visual literacy is: the ability to process elements and interpret visual messages; the ability to understand and appreciate the content and purpose of any image, the structural and aesthetic composition in visual communication (Esdale and Robinson, 1981). An understanding of the structural devices basic to all television and films is one of the main skills in acquiring visual literacy (Foster, 1979).

> "An understanding of how the structural devices of composition, lighting, color, movement, editing, and sound are used to influence audience reactions is the minimal requirement for becoming visually literate.
>
> Students who spend more time watching films and television than they do reading books or sitting in classrooms need to know that films and television are more

> than instruments of entertainment, information, and artistic expression - they are powerful media, capable of influencing viewer's thoughts and actions. As a first step toward becoming visually literate, students should therefore learn to analyze the structural devices and production techniques of filmmaking and their ability to affect a viewer's responses." (Foster, 1979, p.12)

Educators are acknowledging the increasing importance of including visual literacy or media competencies in the basic communications skills of students. Many educators have identified the need for visual literacy and have suggested activities to encourage its development (Potter, 1982; Kahn, 1982; England, 1982; Foster, 1979; Sohn, 1978; Logan, 1977). However, most curricular materials suggest little assessment of skills which could establish base line data or allow for the assessment of growth. While visual literacy has been clearly defined, it has been much less clearly investigated. What is the level of visual literacy of students? How can visual literacy be assessed? Can the various visual abilities be differentiated?

Only recently has one standardized assessment of visual literacy skills been developed (Turner, 1979). Turner reported that this test was validated for high school students and adults. While curricular materials have been developed to enhance the viewing skills of elementary school age students, no validated assessment has been made available for that age group. The purpose of this study was to refine this standardized visual literacy assessment (Turner, 1979) to allow its utilization with a younger audience. Through a pilot use of this new assessment, the visual literacy of students was evaluated to obtain data for further development of both this instrument and its utilization. Some naturalistic inquiry methods were also piloted.

Methods

Participants

All the students in five eighth grade speech communication classes in a small town in Illinois were selected, a total of approximately 75 students. Parental consent forms were sent home and 12 students were either denied permission or were absent days of the study.

Materials

Turner's (1980) instrument was adapted for use with eighth grade students. The vocabulary and reading level were checked by a reading specialist. The instrument was limited to those questions dealing with motion media, in an attempt to both shorten and focus the instrument on television-related items.

A half-hour narrative television program was chosen for the focus of discussion on structional devices of television, and the narrative elements of the program. All the students were asked to list their five favorite programs. "M.A.S.H." was chosen as the most watched and most popular choice.

Procedures

The Turner instrument was refined utilizing a reading specialist and a classroom teacher to serve as a review panel, checking both the language level and the content of all the items. Ten items were selected to represent various elements of visual ability. Questions dealing with student comprehension of the narrative elements were also written and checked by the panel. A group of personal questions were added (sex, viewing habits and preferences, reading habits) to provide data on student's viewing and production of media. (See Appendix I)

The instrument was pilot tested utilizing a presentation-quiz-discussion format familiar to students as normal classroom procedures. In each class, the investigator was introduced, explained the procedures, and distributed the instruments. Students responded first to the visual literacy questions. A videotaped episode of "Mash" was shown on the school's equipment, and students then completed the questions. The last questions (32-38) were used as a basis for discussion which the investigator lead, audio taping all activities.

Results

The results of the pilot testing of the instrument are reflected in the post-pilot version attached to this report (Appendix II). In general, Turner's (1980) instrument was found to b. much too long, difficult, and beyond the abilities of most eighth grade students. The questions developed by the researcher (#11-end) were too open-ended, and resulted in extremely general, "non-answer" responses which indicated that students were not certain what was being asked. Questions which elicited appropriate and more clear responses were retained; others were eliminated or altered. Teacher researcher observations were also incorporated into the post-pilot instrument.

The data actually collected from the instrument dealt with 1) the pilot nature of instrument development and 2) the actual responses students provided.

Instrument Pilot

The standardized test questions from Turner were found to be much too difficult for the students. For each question, almost half the students responded "I don't know" or "I don't understand the questions." Using student discussion, and questions and responses from the instrument, new visual literacy questions were developed which focused on the production techniques used to present the narrative. (Appendix II)

Questions about the narrative elements of plot, setting, characters, and conflict were clarified and forced choices were developed for some. Some knowledge of student's comprehension of narrative elements could be extrapolated to their visual literacy ability, but questions involving the two were not pilot-tested. Many students did not finish the instrument.

Student Responses

Students did not know the correct answers to the Turner instrument questions. No more than 10% of those responding to a choice selected the correct response (number 1-10).

Personal data was also collected. Of the 64 students, 38 were boys, 26 were girls. They saw an average of one-two films per week in school, less than two per month at a theater, and over five per week on television. They almost all owned a camera, and over 85% knew how to take photographs. Most (75% and [illegible]) had no movie or video camera at home; 88% did not know how to use either one. Over 50% had studied TV in school. Reading habits varied widely; hours per week ranged from 0-20, with an average of 6 hours. Over a third of the students (38%) watched two-three hours per day of television, but 15% watched over six hours per day and 20% watched less than one hour.

This data could be utilized to formulate a media familiarity profile for students, and these questions were retained.

Discussion

Much information was gained from this project. The primary focus of the activity was the development of an acceptable instrument to assess the visual literacy of pre-high school students. However, the larger question addressed the actual methodology and research instruments utilized in investigating visual literacy. While attention was directed at the development, pilot-testing, and refinement of an assessment instrument, the results involved more than the refinement of the instrument.

The pilot test of the assessment involved employing participant - observation methods of data collection. The researcher was directly involved in guiding students and observing their behavior while testing the instrument. Because of this direct involvement, the researcher had an opportunity to interact with students, observe the questions raised, and observe reaction to problems students encountered with their tasks. Consequently, while gaining excellent data pertaining to the development of an assessment instrument, the researcher also gained experience with observation methodology and the problems of investigating or researching visual literacy.

Proponents of visual literacy research have addressed themselves to some of the problems involved in the investigation of visual literacy factors. Cochran (1983) has challenged researchers to consider several important factors in future research. Among these was the idea that naturalistic inquiry methods should be utilized to investigate individual meaning derived from visuals. An interdisciplinary approach was recommended, and research on topics such as the developmental levels of visual literacy skill attainment was suggested.

With this challenge to consider naturalistic inquiry and to investigate levels of visual literacy attainment, the researcher focused not only on the development of an assessment instrument but also on the methods of collecting data which could accompany and actually strengthen the utilization of the instrument.

In addition to the new instrument, the project derived much information on naturalistic inquiry. While students were unable to correctly answer "visual literacy" conceptual questions, they were very able to discuss film and television elements. The students revealed, through class discussion and the open-ended questionnaire, a varied understanding of television production elements such as laugh tracks, multiple camera shooting, backdrops, sets, lighting, and sound effects. They could also delineate areas of literary understanding from television, including such elements as plot, characterization, setting, climax, and theme. Overall, students were enthusiastic and cooperative, and many were interested in the results of the investigation. They revealed an active involvement with television and film, and were interested in better understanding the media.

This pilot revealed that another researcher's validated test was inappropriate to the task. The observed discussion revealed a great deal more about student's visual comprehension; the "situation in which people use visual materials" (Cochran et.al. 1980) was rich in information not available from the test." While the instrument had been validated, it was not clear and not usable.

The richest responses were verbal and were recorded for further study. Kerr (1983) recommended that guidelines be developed for the structuring and categorizing of a mass of such data. Perhaps the categories provided on the new version of the instrument would facilitate successful categorization of interview or discussion data. Guba (1981) has recommended several methods to enhance the trustworthiness and especially the dependability and transferability of data collected in naturalistic inquiry. The results of this pilot suggested that triangulation of technique, overlap (repeated) methods, and an audit trail would all be possible improvements in the method of data collection. (Guba, 1980) Results did not indicate that a better written instrument for individual response would provide all the data desired.

Experimental methods could be used to investigate some of the questions addressed in this study. Messaris (1975) has used one such design to investigate viewer's styles of film interpretation (real or created) as they relate to the viewer's familiarity with film study, only to find that "a viewer's past experience does not appear to deflect interpretational styles...." (p. 16) It would seem that more work, both experimental and naturalistic inquiry, is needed.

Summary

In conclusion, the following tasks were completed: an instrument was redeveloped for a younger audience; the new version was pilot-tested using five classes of eighth graders at Sycamore Jr. High School; the instrument was further refined utilizing the teacher and researcher, visual literacy literature, and the pilot data. In addition, information about utilizing a naturalistic approach to investigating visual literacy was generated from the project, and the possibilities for future research were explored and extended.

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VISUAL LITERACY TEST

Try to answer these 10 film/TV questions. If you do not understand the question, please write ? in the margin.

1. Depth is created in TV by using ________________.
   a. straight on filming
   b. off side angles
   c. rear view filming
   d. angle on angle positions

2. Which of the following techniques is not used to connect sections of shows to create meaning?
   a. shots are put together into scenes
   b. use of cut shots one after another
   c. sequence of establishing, medium and short shots
   d. none of these

3. Tradition creates rules for media use. We have even developed a language of cartoons. A series of small smoke puff circles instead of a tail pointing to the character indicates ________________.
   a. thoughts
   b. dreams
   c. both a and b
   d. swearing

4. How is the sound recorded for a fight on TV?
   a. synchronously - at the same time the fight is recorded
   b. dubbed in afterwards
   c. I do not know

5. __________ are colors that are used in backgrounds.
   a. red, green, blue
   b. red, yellow, orange
   c. violet, dark green, blue
   d. black, violet, green

6. Most filming uses the technique of basic shot sequence. That sequence is ____
   a. close up, cut-away, long shot
   b. fade in, close up, fade out
   c. long, medium, close-up
   d. zoom, close-up fade

7. It is as important to expand as to compress time in film. To do so, you would use ______________.
   a. cut-ins to specific action
   b. film at greater speed
   c. time lapse photography
   d. both a and b

Film techniques like zoom shots or fast editing work best when ______________

a. not used too often
b. varied
c. the audience recognizes them
d. the audience is not aware of them
e. other reason

The film "Fiddler on the Roof" was shot almost entirely with the camera lens covered by an ordinary nylon stocking. Why would you <u>not</u> use this procedure?

a. to enhance colors
b. to diminish the sharp focus
c. to establish mood
d. to make the film warm and earthy
e. I do not know

Time in film is both shortened and expanded. How would you show a boat steaming up a river for 20 minutes and docking if you wanted to make it happen in a few minutes of film?

a. shot of boat, cut-away to wharf and back to boat
b. slow the filming to speed up actual action
c. time lapse filming
d. none of these
e. I do not know

Please try to answer each question honestly, to the best of your ability.

1. I thought this show was:

   very good   good   OK   not very good

2. I understand this show:

   very well   well   not very well   not at all

3. When I came to class, before viewing this show, I felt:

   happy   fairly happy   not very happy (unhappy)   depressed

4. After watching this show, I felt:

   happier   the same   less happy   sad   depressed

5. Describe each of the main characters of this show--who was the show about?

6. What was the plot of this film? What happens, briefly? From whose point of view do we see the story? Who is telling the story?

7. Where and when does this story take place? What clues do you see to help you

8. What was your favorite part or scene? Why? What was your least favorite, and why? Describe each as clearly as you can.

9. Is there one scene that remains in your mind? Describe it.

10. a. What was the mood of this show? How did the show make you feel?

    b. What emotion or mood do you think the show's producers wanted you, the audience, to feel? Did they succeed?

Did you like the sound track--the music? What effect did the music have?

Did the characters seem real to you? Why, or why not?

Can you describe anything about how the show was put together? Were any important times left out? Did time seem to move quickly or slowly?

Did anything about the show bother you? Did you like the show? Did it "work" as a story for you?

My age is ________.

I am male _____ female_____.

I live:

in town   outside of town   on a farm

How many films do you see in school, in all of your classes?

1 or more per week   about 1-2 a month   less than 1 a month

How many films do you see outside of school?

at any theater, how many per month? less than 1-2   3-4   5 or more

at home, on TV per week? 0   1-2   3-4   5 or more

How much TV do you usually view?

less than 1 hour per day   4-5 hours per day

2-3 hours per day   6 or more hours per day

Do you have a camera at home? yes no

What kind? ______________________

Do you know how to take photographs? yes no

Do you often take photographs? yes no

Do have a movie camera at home? yes no

Do you often take movies? yes no

23. Do you have a video camera at home?
Do you know how to use it?
Do you often use it?

24. Have you studied film making in any class? yes no
which one(s) ______________________________

25. Have you studied TV production in any class? yes no

26. Do you like watching films in school? yes no
Why?

27. Do you like watching videotapes (TV) in school? yes no
Why?

Which do you like better? Why?

28. Do you play video games at home? yes no
How many hours per week?

29. Do you play video games at arcades? yes no
How many hours per week?

30. Do you watch TV at home with lights on or off?

31. How much do you read outside of school? _____ hours per week?
Books? _____ hours per week? Magazines? _____ hours per week
Newspapers? _____ hours per week?

32. How do you feel when you watch TV at home?

33. Why do you watch TV?

34. How do you know when the "climax" of a TV story takes place? Are there clu

35. How do you know when the funny parts of a TV story take place? Are there cl

Can you

Did you

Anythin

Any que

Can you define: <u>shot</u> -

<u>edit</u> -

<u>zoom in</u> -

<u>pan</u> -

Did you notice anything about the lighting in this show?

Anything else you would like to comment on?

Any questions you would like to ask?

Appendix 11

(New Version)

VISUAL LITERACY TEST

Please try to answer each question honestly, to the best of your ability. If you do not understand the question, please write a ? in the margin.

1. I thought this show was:

   very good   good   OK   not very good

2. I understood this show:

   very well   well   not very well   not at all

3. When I came to class, before viewing this show, I felt:

   happy   fairly happy   not very happy (unhappy)   depressed

4. My mood after seeing the show was:

   happier   the same   less happy   sad   depressed

5. The main character was:
   (name choices)
   a.
   b.
   c.
   d.

6. The other characters were:
   (name choices)
   a.
   b.
   c.
   d.

7. The following events may or may not have been parts of the plot of this show. Place numbers in front of these in the order they occured. Cross out any that did not occur.

1.	5.	9.
2.	6.	10.
3.	7.	
4.	8.	

8. This story (show) took place in:
   a.
   b.
   c.
   d.

9. One clue to show this place was:
   a.
   b.
   c.
   d.

10. Is there one scene that remains in your mind? Describe it.

11. What emotion or mood do you think the show's producers wanted you, the audience, to feel?

a.
b.
c.
d.
e.

12. Can you recall music or sound effects from the show? If yes what effect did the music have?

___Yes
___No

13. Did the characters seem real to you? Why?

Yes _____ NO _____

14. What color/colors were used the most:

a.
b.
c.
d.
e.

15. My age is ________.

16. I am Male _____ female _____.

17. I live:

in town outside of town on a farm

18. How many films do you see in school, in all of your classes?

1 or more per week about 1-2 a month less than 1 a month

19. How many films do you see outside of school?

at any theater, how many per month? less than 1-2 3-4 5 or more

at home, on TV per week? 0 1-2 3-4 5 or more

20. How much TV do you usually view?

less than 1 hour per day 4-5 hours per day

2-3 hours per day 6 or more hours a day

21. Do you have a camera at home? yes no

What kind? ________________

Do you know how to take photographs? yes no

Do you often take photographs? yes no

22. Do you have a movie camera at home? yes no
    Do you often take movies? yes no

23. Do you have a video camera at home? yes no
    Do you know how to use it? yes no
    Do you often use it? yes no

24. Have you studied film making in any class? yes no
    which one(s) ______________________________

25. Have you studied TV production in any class? yes no

26. Do you like watching films in school? yes no
    Why?

27. Do you like watching videotapes (TV) in school? yes no
    Why?

    Which do you like better? Why?

28. Do you play video games at home? yes no
    How many hours per week?

29. So you play video games at arcades? yes no
    How many hours per week?

30. Do you watch TV at home with lights on or off?

31. How much do you read outside of school? ____ hours per week?
    Books? _____ hours per week? Magazines? _____ hours per week?
    Newspaper? _____ hours per week?

32. How do you feel when you watch TV at home?

33. Why do you watch TV?

34. How do you know when the "climax" of a TV story takes place? Are there cl

35. How do you know when the funny parts of a TV story take place? Are there cl

36. Can you define: <u>shot</u> -

<u>edit</u> -

<u>zoom in</u> -

<u>pan</u>

37. Did you notice anything about the lighting in this show? What?

38. Anything else you would like to comment on?

Any questions you would like to ask?

TITLE: Cognitive Styles Research:
Implications for Instructional Design?

AUTHOR: Patricia L. Smith

Cognitive Styles Research: Implications for Instructional Design?

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Abstract

Microcomputers have presented instructional designers with an ideal tool with which to deliver individualized instruction. With a few exceptions, however, the results of cognitive styles research do not provide sufficient conclusions upon which to make design decisions. Critically missing in many studies is an explication of the conceptual binding among the information processing "deficits" of a particular style, the information processing requirements of a specific task, and the mechanism within an instructional intervention which reconciles the two. In order to form this foundation of research, programmatic research into a particular style, task, or intervention and qualitative studies which examine in depth how students with particular styles process information are needed.

Cognitive Styles Research:
Implications for Instructional Design?

Learner analysis is an integral stage in most models of systematic instructional design. During this stage, the designer investigates those characteristics of the target audience that should be considered in the development of instruction. Traditionally, prior knowledge of content has been the critical learner characteristic analyzed. In addition, features such as interests, general abilities, and physiological characteristics have been given attention. In some cases, designers have been pressed within the the delivery systems available to them to individualize instruction to accommodate even variations in entry level skills and knowledge. The addition of yet another dimension -- cognitive style -- to consider in design has further complicated the situation.

However, the advent of a microcomputer technology makes an individualized delivery system possible. Such a technology makes accommodations to a range of individual characteristics, including cognitive styles, feasible. Microcomputer-based instruction can administer initial and periodic batteries of assessments and deliver consequent branched adaptations to critical learner characteristics. Such adaptations might include variations in attention focusing devices, informational chunk sizes, sequence, structure of graphics, and response time and types--to name but a few. Computer-based instruction has some unique attributes--high level of interaction, branching capabilites, rapid judgment capacity, dynamic text and illustration potentials, and strategy individualize instruction. As in many other situations, however, the mechanical technology has outstripped the field's knowledge base with which to answer questions regarding its most effective use. In the case of cognitive styles the question remains, what kind of adaptations to instruction should be made for what types of learners under which circumstances?

In the late seventies Cronbach and Snow (1977) and Ausburn and Ausburn (1978) pointed out that research certainly had not established a foundation of replicable, generalizable results regarding interactions between traits, treatments, and, occasionally, tasks. Cronbach and Snow, Shapiro (1975), and Ausburn and Ausburn suggested how such research might be conducted in the future in order to obtain more conclusive results--results upon which design principles might ultimately be established.

What has been the progress in cognitive styles research since the reviews of the late seventies? Have research results built a firmer base upon which accommodations to learning styles may be based? This presentation will review some cognitive style by treatment interaction research from the past five years and suggest some alternative methodologies and questions for future research in the area.

Review of Recent Research

A review of the Current Index to Journals in Education and Dissertation Abstracts revealed hundreds of studies and articles regarding cognitive style. Many of the studies were examinations of the correlations between cognitive style and other styles, other learner characteristics, or performance in particular subject areas. However, the studies examined for this particular presentation were those which hypothesized interactions between instructional treatments and cognitive styles. This review was by no means an intensive analysis, nor was it an exhaustive review of all studies in the area in the past five years. The purpose of this particular investigation was merely to examine which styles and treatment variables, particularly those variables pertinent to instructional design, are being investigated and what results are being reported. The hope was that the type of task could also be identified, but too often the learning task was not clearly explicated in the research reports.

Findings from a selection of fifty of these studies are generally inconclusive, contradictory, and, occasionally, surprising. However, a few observations can be based upon such review:

1. Field independence/field dependence appears to be the most commonly examined cognitive style.

2. Some treatment variables included in these studies were:

-presence/absence of behavioral objectives
-expository/discovery instructional strategy
-group/individual pacing
-high/low structure
-explict/implicit feedback
-random/nonrandom sequence
-simultaneous/sequential presentation of visuals
-overt/covert response mode
-advance/post/no organizer
-presence/absence of attention directing cues
-motion/still visuals
-normal/compressed auditory rate
-positive/postive and negative examples
-pre/post question position
-photo/line drawing in illustration

-alternative media, e.g., print/film

3. Twenty-six of the fifty studies reported statistically significant style by treatment interactions.

4. Generally, a structured approach--instructor pacing, expository strategy--seems to promote better performance in field dependents than an unstructured approach. Regression slopes for field independents were much less steep than those for field dependents. In some cases interactions were disordinal, with independents performing more poorly under a structured approach.

5. Most studies were weak in explicating the specific theoretical binding among information processing traits of individuals with particular styles, information processing requirements of particular tasks, and the accommodating mediation of the instructional treatments.

Some studies did, however, attempt to hypothesize these interrelationships. Four particularly interesting studies of this category are briefly described in the following paragraphs.

<u>Exemplary Studies</u>

Ausburn and Ausburn (1978) report a study in which Ausburn (1975) examined the relationship between the visual/haptic processing style, a task that required the "mental comparison of images for retention," and two image presentation modes--sequential or simultaneous. Ausburn found that while both styles benefited more from the simultaneous mode of presentation, the regression slope for the haptic learners was much steeper. Ausburn concluded that the simultaneous presentation of images supplanted haptics need to perform the complex operation of retaining multiple mental images.

Satterly and Telfer (1979) report a study in which the interaction between field independence and inclusion of an advance organizer on verbal information learning was examined. The organizer variable included three levels: no advance organizer, advance organizer, and advance organizer plus specific references to the organizing properties of the organizer throughout the lesson. Finding a statistically significant interaction between cognitive style and treatment, the researcher concluded that field dependent learners benefited more from the treatment which included the advance organizer plus specfic references to it than did their field independent counterparts. Evidently field dependent learners needed to have the implications of the advance organizer made explicit.

Spiro and Tirre (1980) found that field dependent students, unlike their field independent peers, were unable to utilize a schema to aid their recall and retrieval of information. The researchers conjectured that field dependent learners were unable to impose a previously-acquired, applicable schema on a new form of information--that the field-dependent students were more "text-bound" than the field independent students.

Finally, Konkiel (1981) found that color cueing aided field dependent students to acquire map skills. The facilitative effect of color-cueing was not as great for field independent students. Konkiel concluded that the color cueing helped field dependent students to disembed critical features of the map from the complex map field.

All four studies are of interest not so much because they found statistically significant interactions, but because they had a clear and specific conception of a) the cognitive requirements of the learning task, b) the processing "deficits" of learners at the extremes of a cognitive styles continuum, and c) the facilitative mechanism of the instructional treatment. Such studies have more clear implications in design of instruction to accommodate individual learning styles than studies that merely "fish" for interactions with a very general treatment and many measures of cognitive styles. In order to build studies with a sound conceptual binding, future researchers in the area may consider branching into alternative methods of research design.

<u>Suggestions for Future Research</u>

Clearly the first branch of future research is the continuation of experimental studies that select task, style, and intervention on clear and specific hypotheses of the cognitive processing involved. Programmatic experimental research which intensely examines the characteristics of a specific style, task, or intervention would build up a core of research results that would aid future researchers, and, ultimately, designers. These researchers may wish to employ a greater variety of measurement techniques such as eye movement studies, that would obtain more precise and "in process" assessments of learners' mental activities.

To provide information about the cognitive processing involved in task, treatment, and style, some researchers may wish to consider studies utilizing qualitative, naturalistic methods. Such studies might include

1. investigations requiring learners at extremes of a cognitive style continuum to be introspective and retrospective while completing tasks which require complex transformations of instructional stimuli;

2. observations of the manner in which master teachers naturally adjust their instruction on complex tasks for students who fall at the extremes of a particular cognitive style;

3. analysis of peer tutoring by students at the extremes of cognitve style, identifying how students with particular styles suggest attacking specific learning tasks; and

4. studies of the validity and feasibility of models for analyzing the cognitive processing requirements of learning tasks.

As a pool of information is gathered, results may provide sufficient evidence to support modifications of instruction for particular types of learners for specific types of tasks. As the foundation of information is built, there are some general questions that should be continually considered across all studies.

<u>General Research Questions</u>

Though individual studies may answer specific questions regarding the interactions of treatments and styles for particular tasks, in order for designers to be able to make use of the information some general questions must also be addressed:

1. How do prior knowledge and general ability affect the interactions between cogntive styles and accommodating treatments?

2. Are styles stable across tasks and content areas?

3. Do essentially perceptual-organization styles generalize to proposition organizing tasks?

4. Is it economically feasible to provide accommodating instruction? What is the cost-benefit ratio of accommodating versus nonbranching instruction?

5. What are the long term effects of supplanting information processing requirements for particular learners? Does this accommodation have long term deleterious effects?

6. Are learners senstive to and able to take advantage of accommodations which are included in instruction?

7. Are there instructional delivery systems which are antithetical to the personological dimensions of certain cognitive styles--e.g., is CBI deleterious to field dependent students who may depend upon a social context for learning?

<u>Summary</u>

Microcomputers have presented instructional designers with an ideal tool with which to deliver individualized instruction. With a few exceptions, however, the base of cognitive styles research does not provide sufficient conclusions upon which to make design decisions. Critically missing in many studies is an explication of the conceptual binding among the information processing "deficits" of a particular style, the information processing requirements of a specific task, and the mechanism within an instructional intervention which reconciles the two. In order to form this foundation of research, programmatic research into a particular style, task, or intervention and qualitative studies which examine in depth how students with particular styles process information are needed.

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TITLE: Processing Time and Question Type in the Comprehension of Compressed Speech with Adjunct Pictures

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Processing Time and Question Type in the Comprehension of Compressed Speech with Adjunct Pictures

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Running head: PROCESSING TIME AND COMPRESSED SPEECH

Time

1

Abstract

The effect of adding time for processing compressed speech and the effects of questions that gave adjunct pictures either a redundant or a contextual function were determined. Subjects were 144 fourth- and fifth-grade students assigned randomly to 24 groups. They listened individually to a 20-sentence story at either 225 or 300 words per minute (wpm). Also, they either looked at pictures as they listened or only listened. Questions in cued recall gave the pictures either a redundant or a contextual function. Alpha was set at .05. Increase in recall was significantly greater at the higher than at the lower wpm rate when pause time was added between sentences as well as when pictures were added to the story. Questions that made pictures redundant improved recall, whereas pictures that made them contextual did not. The results with respect to pause time supported several prior studies. The results with respect to the use of redundant pictures suggested that pictures can preclude a reduction in comprehension at higher wpm rates.

Processing Time and Question Type in the

Comprehension of Compressed Speech with Adjunct Pictures

Information is processed primarily by either listening or reading. Reading is often thought of as the primary mode of communication. However, listening is also an important mode. Furness (1971) agreed with Early (1971) that students at all age levels spend a larger proportion of their time in and out of school in listening than in reading. In addition, Duker (1971) summarized the results of several studies showing that, "About 60% of the elementary day is spent in listening of one sort or another" (p. 103). Listening is involved in many kinds of learning. Various kinds of teaching methods involve speaking and listening as the primary mode of communication--for example, lectures, discussions, peer learning, certain simulation games, etc. The use of audio materials in classrooms has increased in recent years with the greater availability of educational technology, leading to even more emphasis on listening. Moreover, mass communication via radio and television has made listening more important to every person. Recently, a number of new technological developments has increased further the incidence of speech communication. Examples are talking calculators and clocks and special devices to teach elementary skills to children. Pisoni (1982) has been doing research concerned with the production of synthetic speech by computers and anticipates that such research will lead to more natural communication between people and machines.

In spite of the importance of listening in communication, listening is ordinarily less efficient than reading. Whereas in reading one can take in entire phrases and even sentences in a single glance, in listening one must respond to single words in sequence. As a consequence, listening proceeds much more slowly than reading. In reading, people often "scan" material with which they are familiar, achieving very high words-per-minute rates.

A number of technological developments over the past 30 years has made listening considerably more efficient when the material listened to has been tape recorded. The general term for the process that increases efficiency is "time-compressed speech." Time-compressed speech--also called compressed speech-- was anticipated in a sense by Miller and Licklider (1950). Taking advantage of the knowledge that normal speech is redundant, that is, that speech contains more information than is necessary for its being understood, they periodically eliminated portions of recorded speech. This was accomplished by having an automatic switch turn the speech of and off. When the number of interruptions per second was 100, they found that the speech was understood almost perfectly. Their procedure was modified by Garvey (1953) who eliminated small portions of an audio tape on which a number of unrelated words had been recorded, using a razor blade, and spliced the remaining portions together. He had people listen to the words one at a time. He found that the intelligibility of the words was unaffected until they had been shortened to one-third of their original length. This "chop-splice" method was the first one used for producing compressed speech. Fairbanks, Everitt, and Jaeger (1954) described an electro-mechanical device that produced materials very much like those produced by Garvey. Their procedure as well as Garvey's resulted in speech that retained the original voice frequencies. Other such electro-mechanical devices were produced both in the United States and in Germany over the next two decades. These devices were characterized by their bulk, high cost, and complexity. More recently, a new type of compressor has appeared on the market that is portable, inexpensive, and simple. This compressor has been made possible through the use of large-scale integrated circuits that are characteristic of modern technology. Thus, it is now feasible for individuals to have their own personal speech compressor, just as it is feasible for them to have their own pocket calculator. If a learner has purchased or prepared tape recorded educational material, by playing back this material using a modern speech compressor, he can continually adjust the speed at which he listens to suit his own needs.

The development of speech compressors and the consequent option on the part of the listener to listen to recorded materials at various rates has prompted a number of studies of variables affecting the intelligibility of individual words as well as the comprehension of connected discourse. A substantial amount of this research was described at three national compressed speech conferences held in 1966, 1969, and 1975. A review of much of this research was published by Foulke and Sticht (1969). An extensive anthology and annotated bibliography in three volumes was published by Duker (1974). Much of the research that has been done is dependent on studies done earlier involving speech at normal rates. Therefore, such concepts as that of information processing have been useful in compressed speech research. No attempt will be made here to summarize all of the research concerned with compressed speech, but rather only the research that has led up to the present study.

The comprehension of discourse has been a primary empirical domain of concern to cognitive theorists (e.g., Just and Carpenter, 1977). Most of the research has been concerned with reading, although it is not uncommon for listening to discourse to be included within theoretical formulations (e.g., Kintsch, 1977). The fundamental variable that defines time-compressed speech is the words-per-minute (wpm) rate at which recorded material is presented. As would be expected, given a sufficiently high wpm rate, comprehension declines drastically. Foulke and Sticht (1969) wrote, "The increase in rate at which comprehension declines beyond 275 wpm suggests that when a certain critical word rate is reached, a factor in addition to signal degradation [i.e., distortion introduced by the process of time compression]begins to determine the loss of comprehension. The understanding of spoken language implies the continuous registration, encoding, and storage of speech information, and these operations require *time* (italics added). When the word rate is too high, words cannot be processed as fast as they are received, with the result that some speech information is lost" (p. 60). Hughes and Foulke (1975) found that one effect of signal degradation is to *slow down* the processing of speech information, thereby contributing to the total time required for the understanding of spoken language. In their experiment, highly compressed isolated words were identified less rapidly by listeners, and it was concluded that this result supported further the position of Foulke and Sticht (1967) that the decrement in comprehension of connected speech as wpm rate increases is at least in part a function of the increasingly limited time available to the listener to process speech information. This result is consonant with Aaronson's (1967) conclusion based upon the results of several studies that "experimental evidence indicates that processes continue to occur after the physical stimulus presentation--either auditory or visual--is terminated. Interference with or termination of these post-presentation perceptual processes can lead to decreased recall accuracy" (p. 136). An example of these studies was one done by Aaronson (in Aaronson, 1967, p. 134). She compressed spoken digits in sequences of seven but left the rate of their presentation unchanged. Recall of the sequences was more accurate for the compressed than for the original digits. She presumed that providing more silent time allowed more adequate perceptual processing and hence more accurate recall.

Chodorow (1979) has made use of time-compressed speech in an attempt to detect and differentiate lexical and syntactic processing when isolated sentences rather than isolated words or digits are used. In reviewing prior research, he drew attention to the conclusion that lexical processing occurs only in close proximity to a given word, while syntactic processing may be "strung out." He reasoned that he could track the processing of an auditory sentence occurring after that sentence had been completed by following the sentence with an auditory word list having its onset after various lengths of pauses between the conclusion of the sentence and the onset of the word list. Presumably, with a shorter pause, processing of the sentence would tend to compete with listening to the subsequently presented word list, and both the recall of the sentence and the recall of the word list would show decrements. He was especially interested in such effects resulting either from (a) an ambiguous word in a sentence or from (b) syntactic complexity. Also, he reasoned that in using time-compressed speech where the wpm rate is high, presumably the processing of a concluded sentence would be even more likely to continue during the period when the word list was being presented. With an ambiguous word in each sentence, he found that a decrement in recall of the ambiguous word resulted from "premature truncation of some ambiguity resolution procedure" (p. 100). Although a longer pause between sentence and word list improved performance, this effect was not statistically significant. However, with a variation in syntactic complexity (in his words, structural indeterminacy), it was found that with more complex sentences, a shorter pause time produced a significant decrement in recall of the word list, consistent with the view that with increasing complexity, processing continues longer after the sentence is over. Also, a longer pause improved sentence recall following less complex sentences when they were compressed, but not following more complex sentences. Apparently the more complex sentences required more pause time than the longer of the two values of pause time that were used.

Overmann (1971) also investigated the effect of introducing pauses in compressed speech, but she introduced them between phrases and sentences in discourse rather than in relation to single sentences. She divided the time saved in the process of compression among phrase and sentence junctions, thus replacing the processing time lost through compression. The result was that performance was improved significantly compared with compression without such replacement. However, there was still some decrement in performance in relation to the control (normal rate) condition. Presumably, this remaining decrement was due to both signal degradation and to consequent insufficient time for identifying individual words, as suggested by Hughes and Foulke (1975).

The results of Aaronson (in Aaronson, 1967), Chodorow (1979), and Overmann (1971) suggest that providing additional processing time improved recall of either a sequence of digits, an isolated sentence, or discourse.

There is evidence that the amount of processing time needed for adequate retention following the brief presentation of pictures is approximately 1 sec and under some conditions even less (Sheikhian, Fleming, & Hughes, 1975). Presumably, knowledge about such processing requirements in discourse can provide ways of improving its comprehension.

Even though an adequate amount of processing time is available at sentence boundaries, the unintelligibility of individual words may interfere with adequate comprehension of discourse. As indicated above, this may be both because of a degraded signal per se and because such a signal results in an inordinate consumption of time even if it is finally identified. It will be recalled that Chodorow (1979) pointed to evidence that lexical processing occurs only in close proximity to a given word. On that basis we might speculate that words that require an inordinately long time for identification will simply be missed. However, this may not happen if redundancy is increased by some means, for Sticht (1969) found evidence that signal distortion is of less consequence when redundancy is increased. Levin and Lesgold (1978) have reviewed research concerned with the presentation of pictures that are considerably redundant with respect to concurrent auditory discourse at normal wpm rates. A number of studies has shown that young children's comprehension in these circumstances is consistently improved. Hughes, Langdon, and Kim (1981) measured such an effect at various wpm rates and obtained results confirming those described by Levin and Lesgold (1978). They had speculated that the use of redundant pictures would facilitate comprehension to an even greater degree at higher wpm rates.

This speculation was based upon Hughes and Foulke's (1975) finding that more highly compressed words are identified more slowly. It seemed likely to them that the redundant information in pictures would increase the probability that critical words in the discourse would be identified within the relatively brief amount of time during which this would be possible. They spoke of the possible replacement by redundancy in pictures of the redundancy in discourse that was lost through time compression. Their results were in the predicted direction in three experiments, but they were not statistically significant.

An alternative view to that taken by Hughes, Langdon, and Kim (1981) is that a picture may itself transmit information that allows the viewer to answer a question that has been composed to test a listener's comprehension of a sentence which that picture accompanies. That is to say that the picture may not act to make an auditory sentence more comprehensible, but instead may transmit information contained in that sentence while the sentence itself remains incomprehensible. In the Hughes et al. (1981) study, some of the third grade children listened to discourse at a very high rate, namely, 375 wpm. The usual conditions of listening to the discourse alone and listening to discourse accompanied by pictures were used, but also the pictures that had been used previously only in conjunction with the recorded discourse were for the first time presented alone, at durations that were the same as when they were presented along with the discourse. The results were that subjects who saw the pictures alone performed equally as well as those who both saw the pictures and listened to the discourse at 375 wpm.

However, those who only listened to the discourse performed at such a low level that they seemed to be understanding virtually nothing of what they heard. This result suggests that the pictures may, indeed, have been primarily transmitting information directly rather than acting to make the discourse understandable. Of course, at the rate of 375 wpm it could be that the discourse could not have been made understandable by any means whatsoever. In the present study, rates lower than 375 wpm were used, and therefore it seemed necessary to include the condition of presenting the pictures alone.

Further, we might say that if the character of the pictures were such as to provide a context for the information contained in the discourse rather than to provide that same information, then perhaps the discourse would be made more comprehensible, making a claim for the pictures' bringing about greater comprehension of the text more believeable. In research discussed by Chodorow (1979), subjects' interpretation of a lexically ambiguous sentence could be biased toward either sense of the ambiguity by providing an appropriate context sentence to one of their ears while they listened to the ambiguous sentence in the other ear. The use of a picture that provides context for a sentence is aomewhat analogous to Chodorow's procedure.

The decision was made to attempt to change the questions for some subjects in such a manner as to make the pictures contextual rather than redundant--that is, to change them such that it seemed likely that they could not be answered on the basis of seeing the pictures but could be answered on the basis of hearing the discourse. In some instances it was not possible to make such changes. However, enough such changes could be made to make it seem reasonable to incorporate as a fourth independent variable the nature of the relationship between the discourse and the pictures. That is, the pictures would function either as a source of redundant information with respect to the sentences or else the pictures would function as a context for the sentences, with the presumption that in either case the sentences would become more comprehensible as a result. However, it seemed likely that redundant pictures would improve comprehension more than contextual pictures would. A redundant picture provides information that may not have been transmitted successfully by a time-compressed sentence, while a contextual picture only increases the probability that the sentence transmits its information. Guttman, Levin, and Pressley (1977) found results consonant with this conjecture when kindergarten children were subjects but not when second and third graders were subjects. Their redundant ("complete") pictures depicted a critical object while their contextual ("partial") pictures depicted only the environment of the object. An experiment with similar results was done by Pressley, Pigott, and Bryant (1982). Of course, in the present experiment, higher-than-normal wpm rates were used, and even for older children it seemed likely that redundant pictures would improve comprehension more than contextual pictures would in view of the redundant pictures' providing information that may have not been transmitted successfully at the higher rates.

As indicated in the preceding paragraph, some of the questions were to be changed to give the pictures a contextual function rather than a redundant function. The question arose as to whether the two forms of the questions were of equal difficulty. If they differed in difficulty, then difficulty and function of the two forms would be confounded. A determination of the relative difficulty of these two forms was made during the course of the experiment, as will be described later.

The purpose of the present research was to explore the extent to which the usual decrease in the comprehension of recorded discourse by young children as wpm rate of the discourse increases is less as a result of (a) adding pause time at sentence boundaries, (b) providing redundant pictures, and (c) providing contextual pictures.

Method

Subjects

Participants were 144 fourth- and fifth-grade students in local and area schools. The participants were randomly assigned in equal numbers to each of 24 experimental conditions resulting from the combination of two pause times, two rates, two presentation conditions, and two question types, and to eight control conditions where only the pictures were presented.

Apparatus

The experiment was conducted at each of four schools. The experimental room was a room that was made available at each school. Each room provided a quiet and private environment.

A Dukane Micromatic II Sound Filmstrip Projector was used to project filmstrips. The discourse was recorded on Maxell cassette tapes. Two sets of high quality earphones together with a junction box were used to allow both the subject and the experimenter to listen to a story.

<u>Materials</u>

The discourse, pictorial, and test materials of Bender and Levin (1978) were used. The discourse and pictorial materials consist of a 20-sentence, fictitious story titled "Joseph, the Border Guard" together with 20 line drawings with watercolor embellishment, one for each of the sentences. For each sentence there is a question that can be answered with a word or a short phrase. These questions correspond to a level of comprehension of discourse described by Perfetti (1977) as questions that "require information based on a semantic-syntactic analysis of the sentence and are the kind of 'literal questions' (referential, not inferential) that test construction is familiar with" (p. 22). For example, the first sentence is, "Once upon a time there was a small kingdom ruled by a king who lived on a hill outside of the kingdom." However, eight of these questions were changed for some subjects to create contextual pictures as opposed to redundant pictures. For instance, subjects were presented a picture of a castle on a hill outside of a kingdom. Subjects in the redundant pictures condition were asked, "Where did the king live?" In the contextual pictures condition, subjects were asked, "Who lived on the hill outside of the kingdom?" The picture did not show the king but only the place where he lived. The first question made the picture redundant since it required the subject to provide information in the picture (place lived). The second question made the picture contextual since it required the subject to provide information not in the picture (who lived in that place). Rules were adopted to define correct responses to the questions. Practice materials consist of a three-sentence story together with three line drawings with watercolor embellishment. The sentences had been tape recorded for use in the Hughes et al. study, with broadcast quality at 150 wpm by a professional reader. This tape was compressed to each of two rates, 225 and 300 wpm, using a Varispeech II Speech Compressor. Following each recorded sentence, there was a single 50 cps tone on the tape for the experimental conditions where the pause was 0 sec. This tone advanced a filmstrip consisting of the 20 line drawings to the next frame. However, for the experimental conditions where the pause was 4 sec, following each recorded sentence there were two successive 50 cps tones on the tape. The two tones were separated by 4 sec in terms of tape transport time. Each of these tones advanced the filmstrip projector by one frame. A second filmstrip consisting of the 20 line drawings was constructed such that there was a blank frame between successive drawings. In this way the first of the pair of 50 cps tones advanced the filmstrip to a blank frame and thus removed the current drawing, while the second tone advanced the filmstrip to the next drawing. The filmstrip projector is constructed such that the 50 cps tone is inaudible.

Procedure

The projector was set up at a distance of 5.5 ft (1.7 m) from a wall of the experimental room to produce a 12 x 18 in (30 x 45 cm) image. The image was projected on a piece of 22 x 28 in (56 x 71 cm) white cardboard that was mounted on the wall. Subjects participated one at a time. Order of experimental conditions was random with the restriction that there were six replications of each condition. The subjects were seated on the right side of the projector and were 7 ft (2.1 m) away from the screen. The subjects were given instructions in keeping with experimental conditions to inform them that they would be listening to a story, with or without accompanying pictures, or would be watching a series of pictures that in themselves tell a story, and that afterwards they would be asked some questions about it. They were given practice materials, including questions, under the same condition to which they had been assigned. After the instructions and examples had been provided the subjects, they listened to the sentences, with or without accompanying pictures, or saw the pictures alone, and then were asked questions. Questions were asked and answered orally in the same order as the sentences. The experimenter wrote down the answers on answer sheets. When each subject finished, s/he was asked not to talk about the story with friends until the study had been completed at that particular school.

Design

The four independent variables--pause time, wpm rate, presentation condition, and question type--were combined in a 2x2x2x2 factorial design.

The reason that the design implies only two values of the presentation condition variable is that the condition of presenting pictures alone was treated as a control condition for the purpose of comparing the amount of information transmitted by the pictures alone with the amount transmitted by the discourse alone, in a separate analysis. A second control analysis was done to determine whether the two sets of eight questions each, that differed in their function of making the pictures either redundant or contextual, were of equal difficulty. For this purpose, the data from subjects who only listened to the discourse was used. A third and final control analysis was done to verify that the questions designed to give the pictures different functions did, indeed, give them those functions. Data from subjects who had seen the pictures but had not listened to the discourse were used. Clearly, the redundant questions should result in more correct answers than the contextual questions because the redundant questions pertained to information contained in the pictures, while the contextual questions did not. The level of significance adopted for all statistical analyses was .05.

Results

The results will be described in terms of performance on the 8 questions of the original 20 in order that direct comparisons involving the redundant and the contextual functions of the pictures may be made. Also, as it turned out, results involving all 20 of the questions were equivalent to those involving only the 8 questions and would provide only redundant information.

Table 1 shows the mean number of correct answers out of eight for the various combinations of values of the four independent variables. The results of an analysis of variance for these data are shown in Table 2.

Insert Table 1 and Table 2 about here

The main effect of pause time was not significant (Table 2). The mean number of correct answers for a 4-sec and a 0-sec pause were, respectively, 4.89 and 5.04. However, a question of greater interest was whether as the rate of discourse increased, adding pause time resulted in less loss in comprehension than when pause time was not added. This question corresponds to the rate-by-pause-time interaction, which was significant (Table 2). As shown in Table 3, the nature of that interaction was that, whereas with a 4-sec pause the decrease in mean number of correct answers as rate increased was 1.37, with a 0-sec pause the decrease was 2.75. A simple main

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Insert Table 3 about here

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effect test of the significance of each of these two differences showed that each was significance (F = 8.97 and 36.16, respectively). Thus, with increasing rate, the 4-sec pause resulted in a significantly smaller loss in comprehension than did the 0-sec pause. Pause time was thus shown to be of consequence in spite of not being a significant main effect.

Unlike the main effect of pause time, the main effect of wpm rate was significant (Table 2). The mean numbers of correct answers for the two wpm rates of 225 and 300 were 6.00 and 3.94, respectively. As just described, wpm rate interacted with pause time. In addition, rate interacted with presentation condition (Table 2). As shown in Table 4, the nature of that interaction was that, whereas the increase in mean number of correct answers at the lower rate when pictures were added was 1.08, the increase at the higher rate was 2.38. Thus, the

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Insert Table 4 about here

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facilitating effect of pictures was approximately twice as great at the higher rate as at the lower rate. Each of these increases was significant ($\underline{F}$ = 5.58 and 27.08, respectively), in keeping with the significance of the main effect of presentation condition (Table 2). The mean numbers of correct answers for the discourse-alone condition and the discourse-and-pictures condition were 4.15 and 5.84, respectively.

Although the main effect of question type was not significant, it interacted with presentation condition (Table 2). Table 5 shows the nature of that interaction. Improvement in mean performance was

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Insert Table 5 about here

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about four times as great in the case of questions that made the pictures redundant, 2.75, as in the case of questions that made the pictures contextual, .71. The first of these two mean differences was significant (F = 36,16), while the second was not significant (F = 2.41). Thus, adding pictures that had a redundant function was facilitative, while adding pictures that had a contextual function was not.

It will be recalled that three analyses were done for control purposes. In the case of the presentation-condition variable, a question of considerable interest concerns the extent to which subjects were able to answer the questions after having seen the pictures without having heard the discourse. As pointed out earlier, the pictures-alone condition may therefore be characterized as a control condition. The mean number of correct answers out of a total of eight for subjects who listened to the narrative was 4.21, while the mean number for subjects who saw the pictures was 3.29. The difference between these means was significance (F = 6.86). However, it is clear that performance by subjects who saw the pictures was substantial.

The second control question was whether the two sets of eight questions each, that differed in their giving the pictures the function of being either redundant or contextual, were of equal difficulty. To answer this question, an analysis was done using data from those subjects who only listened to the discourse. For redundant questions, the mean number of correct answers was 3.75, while for contextual questions, the mean was 4.46. The difference between these means was not significant (F = 2.18). Thus, it appeared that the intended function of the pictures, redundant or contextual, was not confounded with the variable of level of difficulty.

The third and final control question was whether the redundant and contextual questions actually resulted in the pictures' having these respective functions. To answer this question, an analysis was done using data from those subjects who only saw the pictures. For redundant questions, the mean number of correct answers was 4.83, while for contextual questions, the mean was 2.21. Thus, the questions appeared to have given the pictures their intended functions, in general. The failure of the mean number of correct answers for contextual questions to be equal to zero would seem to have been due to subjects' prior knowledge and to lack of independence of the content of the various pictures.

Discussion

One of the more notable results of the present study is that all four of the independent variables were involved in one or more significant interactions, whereas only two of the main effects were significant. These two effects, wpm rate and presentation condition, were each involved in two of the three interactions. Thus, under the conditions of the present study, answers about the effect of individual independent variables must be qualified with respect to the specific values of one or more other independent variables.

It will be recalled that several studies were described earlier that were concerned with the general hypothesis that under some circumstances people continue to process verbal stimuli after these stimuli have been terminated. It was these studies that led to the investigation in the present experiment of the effect of introducing additional processing time between successive sentences in connected discourse. The results of these prior studies were confirmed in the present study but only under certain conditions, as implied in the statements above about interactions between the independent variables. The present study was related procedurally more to some than to others of the prior studies, but from the point of view of the general hypothesis identified above, it would seem to be related to all of them equally. In the Hughes and Foulke (1975) study, there was evidence that the processing of individual words to be identified continues for some time after the words have been presented, when the words are highly compressed. This evidence was based upon longer times taken to identify the words at higher values of compression. In the study described in Aaronson (1967) there was evidence that each of a series of numerical digits continues to be processed after its presentation. This evidence was based upon greater recall of the digits after they had been time compressed to create additional time between them. In the Chodorow (1979) study, there was evidence that the processing of a time-compressed sentence continues after its presentation. This evidence was based upon greater recall of the sentence as well as greater recall of a list of words that followed the sentence when the interval of time between the end of the sentence and the beginning of the list of words was longer. Finally, in the Overmann (1971) study, there was evidence that the processing of phrases and sentences in time-compressed discourse continues after their termination. This evidence was based upon greater comprehension of the discourse when the time saved through time compression was distributed at phrase and sentence boundaries. It will be recalled that in the present study there was evidence that the processing of sentences continues after their completion inasmuch as at the higher wpm rate, the mean number of correct answers was significantly less with a 0-sec pause than with a 4-sec pause between sentences, while at the lower wpm rate, the effect of length of pause was not significant. This result in the present study is unique in that a rate by pause time interaction was found, although it seems that this is so only because rate and pause time had not been manipulated independently with the exception of the Hughes et al. (1981) study where a similar although non-significant result occurred. It is of some interest to compare the present study with other studies from the point of view of experimental design.

In the Hughes and Foulke (1975) study, the procedure was such that neither rate nor pause time was involved as a variable. Words were presented at fixed intervals, several seconds apart, and the identification of a word almost invariably would be made long before the end of the interval. The only sense in which rate could be said to be involved was that the words had been time compressed in a manner corresponding to what would have been various wpm rates if discourse had been the material that was compressed. This might be described as a momentary rate. The only sense in which a pause was involved was that the dependent variable was reaction time in identifying the words, a "pause" on the part of the subject--that is, the subject needed a longer "pause" when rate was higher.

In Aaronson's (in Aaronson, 1967) study, rate of occurrence of the digits was fixed. Compression of the digits improved performance, the interpretation being that more time was left for processing each individual digit before the next one was presented. If rate is equated with amount of compression (momentary rate), in this procedure rate and "pause time" were positively and perfectly correlated.

In Chodorow's (1979) study, it would have been possible to combine rate and pause time factorially, but this was not done. He used normal and twice normal wpm rates of presentation of sentences but used two values of pause time only at the twice normal rate.

In Overmann's study, rate and pause time were positively and perfectly correlated as in Aaronson's (in Aaronson, 1967) study. She compared comprehension of discourse with and without added pause time at each of three rates, but she was unable to evaluate rate and pause time independently because at higher rates, pause times were longer.

The finding in the present study that pictures improved comprehension more at a higher wpm rate than at a lower one is of considerable interest. If the present finding is confirmed in further research, it may have importance not only in the context of compressed discourse but also in other adverse listening conditions. It is interesting to speculate how Overmann's results might have been affected by the use of pictures. At two lower values of compression she found that the addition of pause time between phrases and between sentences resulted in a level of performance not significantly lower than that of subjects who listened to the original (uncompressed) version of the discourse. However, at a higher value of compression, performance was significantly lower. The results of the present study suggest that with pictures available to this latter group, performance might have been maintained at the level of that achieved by subjects who listened to the original version.

The finding in the present study that adding redundant pictures to discourse improved comprehension more than adding contextual pictures was similar to that of Guttman, Levin, and Pressley (1977), obtained with kindergarten children and to that of Pressley, Pigott, and Bryant (1982), obtained with 3- and 4-year-old children. In the Pressley et al. (1982) study, adding contextual pictures did not improve comprehension, while in the Guttman et al. (1977) study, contextual pictures improved comprehension in third-grade students but not in kindergarten and second-grade students. It will be recalled that contextual pictures did not improve comprehension in the present study. There is not a consistent relation in these studies, taken together, between the effect of contextual pictures and chronological age. It would seem that either chronological age is not a relevant variable or else that materials, procedures, etc. varied among the studies in a way to obscure any such relationship.

The manner in which pictures were given a contextual function in the present study is somewhat unsatisfactory. It necessitated confounding the function of the pictures and the very content of the questions. Although the outcome of an analysis suggested that changing the content of the questions did not change their difficulty, a more direct way of giving pictures a redundant or a contextual function would be preferred, and this would also allow a comparison of the functions of 20 pictures instead of just 8. Rather than changing the questions, a new set of pictures could be created that were contextual rather than redundant with respect to the discourse.

The finding that subjects who only saw the pictures answered a substantial portion of the questions makes it evident that the improvement of performance through the use of pictures may not be due at all to the pictures' making the discourse more comprehensible. However, it is conceivable that whereas some pictures transmitted the relevant information independently of the discourse, other pictures did function in a way to make the discourse more comprehensible. Also, it is conceivable that a given picture may have functioned in a different way for different subjects. The issue can be resolved only by designing pictures that do not transmit the information necessary for answering the questions.

Finally, it would seem of interest to modify the present procedures in such a way as to allow subjects to "ask for" pictures as well as for periods of pause time. It might be that the most efficient use of the subject's time can best be ascertained by allowing him such choices. For example, equipment could be arranged such that a subject who was listening to discourse could obtain brief access to a related picture by pressing a button once, or more extended access by pressing the button several times at short intervals. A procedure of this kind in studying the contribution of the audio and video portions of televised instruction was used successfully in a study by Ksobiech (1976).

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Table 1

Mean Number of Correct Answers to the Eight Questions for Combinations of Values of the Four Independent Variables

Presentation Condition	Rate / Pause Time / Question Type	225 wpm 4 sec	225 wpm 0 sec	300 wpm 4 sec	300 wpm 0 sec
Discourse Alone	8 Redundant	4.00	5.83	2.83	2.33
	8 Contextual	5.33	6.67	3.33	2.50
Discourse and Pictures	8 Redundant	7.17	7.17	5.33	6.33
	8 Contextual	5.83	6.00	5.33	3.50

Table 2

Analysis of Variance for Number of Correct Answers to the Eight Questions

Source of Variation	SS	df	MS	F
Between Cells	244.41	15	16.29	
Pause (A)	0.51	1	0.51	<1
Rate (B)	102.10	1	102.10	40.68*
Presentation Condition (C)	71.76	1	71.76	28.59*
Question Type (D)	2.35	1	2.35	<1
AB	11.34	1	11.34	4.52*
AC	2.35	1	2.35	<1
AD	4.59	1	4.59	1.83
BC	10.01	1	10.01	3.99*
BD	1.25	1	1.25	<1
CD	25.01	1	25.01	9.96*
ABC	4.59	1	4.59	1.83
ABD	3.02	1	3.02	1.20
ACD	0.51	1	0.51	<1
BCD	1.26	1	1.26	<1
ABCD	3.76	1	3.76	1.50
Within Cells	200.50	80	2.51	
Total	441.91	95		

*Statistically Significant

Table 3

Mean Number of Correct Answers to the Eight Questions for Combinations of Values of Rate and Length of Pause

Pause Time	4 sec	0 sec
Rate		
225 wpm	5.58	6.42
300 wpm	4.21	3.67

Table 4

Mean Number of Correct Answers to the Eight Questions for Combinations of Values of Presentation Condition and Rate

Rate	225 wpm	300 wpm
Presentation Condition		
Discourse Alone	5.46	2.75
Discourse and Pictures	6.54	5.13

Table 5

Mean Number of Correct Answers to the Eight Questions for Combinations of Values of Presentation Condition and Question Type

Question Type	8 Redundant	8 Contextual
Presentation Condition		
Discourse Alone	3.75	4.46
Discourse and Pictures	6.50	5.17

TITLE: Theoretical Bases for Research in Media

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Theoretical Bases for Research in Media

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Theoretical Bases for Research in Media

A persistent problem facing teachers and researchers alike is finding the answer to the question: What point of view should I assume and what evidence should I use to determine the effects of media upon learners and the ways that learners utilize media to perceive and process information? After many years of research in media this same question is still being asked and is still largely unanswered, at least to the degree that there are absolutes to guide educators in making decisions. Yet, looking at this situation from an historical perspective, developments over the past ten to fifteen years give promise of more definitive directions.

My intentions in this presentation are three-fold. One is to make a few observations about the major paradigms and assumptions that have shaped research in the past. A second is to encapsulate the activities, thinking, paradigms of the present. A third is to report on the results of asking 100 theoreticians and researchers to respond to 50 hypothetical statements about media in the learning process as a way to sample current points of view.

It is probably fair to say that most studies of media applications to instruction in the first five or six decades of this century were built upon limiting theoretical positions. That is, the effects of media upon learners were analyzed primarily as stimulus presentations which were to have a direct influence upon subsequent behavior. Learners were assumed to be reactive and under stimulus control. For example, in 1963, Finn, in his definition of the field as "instructional technology," suggested that it was ". . . a branch of educational theory and practice concerned with the design and use of messages which control the learning process." But there were others who had a different view. Several years earlier than Finn, Carpenter (1957) contended that ". . . teaching materials are effective . . . depending on the degrees of their personal relevance to learners . . . . The organism or individual interposes its entire relevant life history between the stimulus material and his or her response." In a similar vein, Hartman (1963) in a review of learning theory, emphasized ". . . facilitation or interference with learning that arises from the cognitive organization the respondent imposes upon the message."

While there were others thinking as Carpenter and Hartman, most media studies were characterized in the familiar "gross comparisons" format. Such research seemed a natural reaction to the expanding availability of media through federal funding and the eagerness of producers to push for adoption. It seemed that there was more of a need to prove the utility of media for the improvement of education than there was a need to analyze the peculiar characteristics of media themselves. Much research studied learning with media rather than studying about media effects upon learning. All of us are familiar with the oft-repeated phrase "no significant differences" that has characterized such research. Subsequent analyses have criticized the assumption that global forms of media, such as television or films, could be regarded as unambiguous entities that somehow could be described and controlled to determine a cause and effect relationship with any precision. Additional criticism focused on the theoretical assumption that regarded learner responses as being directly influenced by the stimulus input, with little regard for either the contributions to outcomes of learner idiosyncracies or the peculiar characteristics of the media themselves.

More recent analyses of viable ways to conduct research and to define the nature of fundamental research questions have focused on the confounding effects of uncontrolled variables. Clark (1983) for example, has suggested that much of media research--that is, that which has been reported as media research--has actually been a study of variable methodologies and settings in the uses of media. I would tend to agree, but with a recognition that there have been exceptions. One that comes to mind is the film studies done under Carpenter's directions in the Instructional Film Program at Penn State back in the 40s and 50s. In some of those studies there were deliberate analyses of variables within films themselves as these affected the performance of subjects. On the other hand, subjects were not questioned to determine which variables were preferred; neither were learner repertoires explored to determine what affected their interpretation of stimulus elements.

Added to the problem of determining defensible theoretical paradigms for research in media are assumptions about the conditions necessary in a research setting to derive generalizations from methods and statistical analyses. I refer to the controversy between the assumptions and arguments of those who take a reductionist view of research and those who advocate naturalistic inquiry as a more realistic approach to what life is outside the laboratory setting (Magoon, 1977; Guba, 1981). I do not intend to discuss the intricacies of each point of view, but rather to suggest that our initial orientations to what needs to be investigated and under what conditions quite logically affects our theoretical orientations. For example, our attempts to control all conditions, either by statistical manipulations or tight controls of the situation and subjects, are based on assumptions that such controls are possible in the first place and that validity and generalizability are possible outcomes, thus explaining plausible defensible cause and effect relationships. An assumption is also made that reactions of learners as groups are indicative of the true picture about individuals in that group. The opposite view by those who advocate naturalistic inquiry is that the assumptions of the reductionists are untenable, given the reality of the interaction of social, contextual, and personal factors that affect learner response. Each approach to inquiry assumes its own conceptualization of the nature of learners and becomes the starting point for judging what should be observed. On the other hand, both methods study the effects of variable media characteristics for determining optimum learning and conditions. But the extent to which each method takes into account relevant factors becomes an argument that inevitably leads to judging whether all things needed for a comprehensive answer were included in the research activity.

Most of us are probably familiar with the conditions that have brought about changes in our views about media/learning relationship since the days when media were considered as control mechanisms for learner behavior. For purposes of continuity, let me recall briefly some significant forebears of current rationales in our field.

Support for a refined look at media/learning relationships came from a number of quarters. Government sponsored research through the National Defense Education Act supported the traditional gross comparative studies, but also fostered investigations into the programming of instruction, which in turn had an important influence on the questioning of how learners perceived and processed information. While there was an emphasis in programmed instruction research that compared linear or branching methods for presenting information, there was also, through the so-called 90-90 criterion for the validation of programmed material, attention paid to the reactions of individual learners to information displays.

A more recent movement, Trait-Treatment-Interaction (ATI), is based on the premise that having knowledge of the interactive effects of learner aptitudes with instructional treatments would make it possible to predict the proper types of methods and materials to insure desired learner responses. But ATI has been criticized for basing measurement on a "moment-in-time" in the life of a learner as a defensible basis for predicting future performance. The continuing problem not only for ATI but for all types of research methodologies and theoretical orientations, is that learners are dynamic individuals changing constantly as more information is processed each passing day. What continues to cause idiosyncratic responses of learners is still quite elusive.

Clearly, the major focus today is upon the processes by which a learner perceives the environment, processes and stores information, and retrieves it for use in communication. This emphasis has come about because of the recognition that learners are indeed idiosyncratic, that each learner is a product of many experiences which compose a life; and that messages appear only to be meaningful as each person gives them meaning. Relevant to this refined look at media/learner relationships, Glaser (1976), almost a decade ago proposed that there were four components of a psychology of instruction: the analysis of competent behavior, the description of initial states, the acquisition of competence, and the assessment of instructional implementation. While all are relevant in their own way for determining theoretical bases for media use, the last one--instructional implementation --is of direct interest.

There are current theses about media which say that media, in fact, do not make any difference in learning--at least as measured by typical research paradigms that tend to manipulate the situational variables more than the intrinsic attributes of the media themselves. But there is a shift occurring. This shift is moving from the more incidental role of media in instruction to a greater emphasis upon the interacting relationships among the content and symbol systems of media with specific learner characteristics. A case in point is the hypothesis of Salomon that the greater the similarity between the coding systems in the message and the coding system in the repertoire of the learner, the more likely learning will occur. Such a shift is also seen in Olson's (1972) theory of instructional means, derived in part from Bruner and McLuhan which says that technologies and techniques used with learners are accompanied by the development in learners of relevant cognitive skills.

What, then, are the most prominent theories that have evolved in the last decade? For current opinions, I am indebted to Clark and Salomon (1984) for a chance to read the final draft of a manuscript they have prepared for the _Third Handbook of Research on Teaching_. Those of you who have studied the 1974 _National Society of the Study of Education on Media and Symbols_ will find some of these theories familiar.

The first has to do with the nature of symbol systems, the avenues through which all of us must perceive our environments and gain our information. It offers a theoretical foundation for differentiating among symbol systems and may provide a systematic way for defining those aspects of symbols that may be not only pertinent to certain types of information, but also that may serve as devices by which learners may process information. I am referring to Goodman's Symbol System Theory, discussed by Gardner and others (1974).

A symbol is defined as anything that can be used in a referential way and that can be organized into systems. Goodman divides symbols into two large categories of being either notational or non-notational. By notational, he means that a symbol must meet the criteria of being unambiguous, such as the concept "one is always one"; it must be semantically disjointed--that is, no two characters can have a common referent--and it must have a finite differentiation. For example, the signs for the bass or treble clef in musical notation are finite differentiations and remain so, assuming no other meaning. Non-notationality, on the other hand, suggests symbols that are dense, replete with information, and subject to a variety of interpretations. A picture may be classified as non-notational because it may be interpreted in a variety of ways. There can, however, be symbols within the picture that can be finite in their meaning and designation, and hence notational. While this presentation is not the place for a detailed discussion of Goodman's model, there is an additional model worth mentioning which complements Goodman's work. It is also discussed in the NSSE Yearbook. It is Gross's identification of various information modes that contain symbol systems peculiar to given sets or types of information. The modes, which he calls primary, are linguistic, socio-gestural, iconic, logico-mathematical, and musical. Each of these categories provides a system for differentiating the specificity of certain symbols. Of interest to us is that these may provide a systematic basis for answering questions about the types of symbols required by learners to acquire and process certain kinds of information. They may also be useful for determining whether learners utilize these symbols as tools in their own cognitive processing.

Gross has also formulated two other general symbol classifications which utilize primary modes in idiosyncratic ways. One is the derived mode, such as poetry, dance, and film. The other is the technical mode, suggesting the peculiar language of the sciences, engineering, technologies, and architecture.

A second prominent theoretical formulation of current use is that of Olson (1972, 1974), referred to earlier. Calling his theory one of instructional means, Olson suggests two aspects of media that affect learning. One is that the content of a medium relates to the knowledge acquired. That is, the content may assist in the acquisition of rules and principles that are invariant features across different activities, a kind of transfer of knowledge generated by the medium. The other aspect relates to the acquisition of skills that are required to utilize the information presented in the medium. The coding system and means of presenting the information may become tools for utilizing similar coding systems or means.

Olson also suggests that there is a significant difference between an "utterance" and "text" which have direct implications for our understanding of the functions of media. Olson characterized an utterance as oral language that is flexible, unspecified, with a low degree of conventionalization, and that is negotiable in a social setting. Written language, on the other hand, demands precision and explictness of meaning. It serves to maintain philosophical, scientific, analytic knowledge. Thus, as learners are schooled in written language, they develop the skill and habituation to textual material, or a literacy bias, as Olson describes it. Thus, it may be that long training and practice in text materials may inhibit learning from other than text. This may be a partial explanation for the finding of Guba when he observed the visual attention of subjects who watched science demonstrations on television. At times their eyes went out of focus and they tended to watch the mouth of the demonstrator more often than the details of the demonstration. It may be that we perpetuate dependence upon text by utilizing it continuously in our testing procedures and thus condition learners not to observe other forms of information.

The third theoretical model is Salomon's Media Attribute Theory (1979, 1981), which he has developed over a number of years. The theory says, in effect, that both media and the human mind employ symbol systems for acquiring, storing, and manipulating information. Also, he contends that some of the tools of cognition are the consequence of employing symbols that were inherent in media. In essence, he has suggested a supplantation theory which says that it is possible for technological devices, such as a zoom lens, to provide an observable analogy to the mental process of proceeding from a generalization to a particular and back to a generalization again. The use of a zoom lens to assist field-dependent students to observe details in a picture is offered by Salomon as tentative evidence of this phenomenon. Clark (1983) on the other hand, contended that zooming is not a media attribute, but a method for enlarging and focusing.

In addition to these three theories, there is also the current question that cuts across all of them. It is the controversy about whether humans process information through images or propositions. Those who support the imaging hypothesis contend that a mental image is analogous to the perception of the actual object. In the opposite camp, those who deny the possibility of imaging contend that there is no direct connection between what one observes and the final knowledge acquired, because all stimulus situations are affected by beliefs, goals, previous knowledge, experience, and emotional states. Final knowledge is governed by rationality--that is, all stimuli are acted upon by the learner's repertoire of the moment.

Also related to these three theoretical positions is the question whether media attributes or codes are in fact unique in conveying information. Since learners acquire knowledge through many different forms of media, there must be something operating beyond the hoped-for uniqueness of specific media. Researchers apparently must look to the cognitive processes learners use to manipulate information, or search for factors that may have nothing to do with media directly.

There is some evidence supporting the notion that factors other than media have more influence on learner responses to media that the element or coding systems within media themselves. Clark and Salomon (1984) suggest that one relates to the effects of learner anticipation of media in terms of efforts that must be invested in their use. It appears that where media are perceived as critical to future performance, learners will expend more effort. Where media are perceived as entertainment, less effort is expended. Twenty years ago Greenhill (1967) pondered why television instruction did not often prove superior when compared with traditional university instruction. He hypothesized that good television instruction required less expenditure of effort by students; therefore, they put more time into traditional courses which were less well presented. Thus, television instruction was not given a fair test, leading to the "no significant difference" conclusion.

Clark (1983) reviewed a number of studies having to do with student effort. Among his findings was the phenomenon of high-ability students choosing structured methods and media because they perceived that they would have to expend less effort. Lower-ability students, on the other hand, chose less-structured media and more discovery-oriented methods because they wished to avoid the failure that may have come from being unable to fulfill the requirements of the structured and directed situation. In a recent letter to me, Clark (11/15/83) has this to say: "I have arrived at a very reluctant conclusion that media do not contribute much to learning . . . and only minimally to decoding. I do think that the symbol system approach has promise for instructional design but not much theoretical importance. . . ." He thinks that media contribute only "indirectly through variations in persistence which are contributed by our subjective compressions of how much effort is required to learn from various media."

Where, then, are we in our search for theoretical foundations that have viability? I would encapsulize directions in the theoretical bases of our research from one of regarding the learner as being reactive and under stimulus control, to one in which the learner is much more a participant in determining what effects media have upon the transmission of information, upon learner perceptions, and upon cognitive processes themselves. It is not only a matter of how learners perceive the messages conveyed via media, but also one of discovering whether and how learners utilize the coding systems of media as tools for manipulating information. In essence, the attempt to prove media utility is a dead issue, as is the attempt to depend upon gross comparative studies as sources for definitive answers about media characteristics and their influences upon the specifics of learner behavior. Some fruitful questions to ask may be:

-- Do the coding systems of media actually serve as tools for various aspects of cognition, or do they not?

-- Do skills required for utilizing content and methodologies associated with media become skills in cognition?

-- What methods might we generate to make efficient and effective collaboration with learners in discovering the uniqueness of media?

-- Can the inherent qualities of media and related technological devices act to supplant and/or complement given mental activities?

-- Are the concepts of notationality and non-notationality viable paradigms for determining the specific functions of media coding systems?

-- What methodologies best complement the uses of media?

-- Are there unique qualities of given media that fit particular learning needs, or is it only a case of differing methodologies that make the differences in learner responses to media?

-- In the final analysis, are learner attitudes and efforts in using media as contended by Clark the only evidence we can depend on to account for media effects?

Turning finally to the questionnaire, it was devised by four graduate students and myself as a way of sampling the opinions of theoreticians and researchers in media. The attempt was to select fifty statements that seemed to appear in current literature and did not pretend to be exhaustive or foolproof. While the questionnaire was titled, "Theories About Media and Learning," some respondents suggested--and perhaps rightly--that the statements were really hypotheses. The argument is somewhat semantic and dependent upon the definitional line between a hypothesis and a theory.

All but nine of the hundred persons who were sent the questionnaire were on the membership list of RTD. Forty-two returns were received in time for inclusion in calculations. Since the questionnaires were anonymous responses, there is no way of knowing who were involved, with the rare exception of a signature or two accompanying a comment.

Frequency data were determined for each of the seven categories in the "Valid to Not Valid" scale and for the choices of whether a particular statement was important or not important for research in our field. Means and standard deviations were calculated, as well as a correlation coefficient for the relationship between the not important category and each statement frequency data. The handouts provide a compilation of the data that you may match with a copy of the questionnaire.

Looking first at the statements that respondents regarded as not valid, thirteen had large enough frequency to quality. My intention is not to engage in a lengthy discussion of these statements, but simply to raise your consciousness of what 42 colleagues think.

<u>Statements Judged Not Valid</u>

3. Developing "literacy" in the interpretation of non-verbal information by learners is more a matter of being exposed to a wide variety of non-verbal experiences than it is a matter of being taught to observe nuances in non-verbal materials.

7. Media are capable of insuring anticipated learning outcomes.

9. Media attributes affect learners in the same way.

11. Structuring media experiences insures common learning of information.

16. Random behavior in human performance is due to the way people interpret media.

20. Multiple image instruction contributes to greater learning and retention than single image instruction.

25. Each message has a best message form and carrier.

27. The technical quality of the conveyance system does not affect the fidelity of the original message.

31. There is no competition when similar information is presented in two media.

36. The less the information in a medium is like the "reality" it represents, the less the student will learn about reality."

42. Verbal memory and pictorial memory are independent of each other.

44. Recall of pictorial information requires verbal processing for retrieval.

48. Information overload is essential to impress or exhilerate the learner.

<u>Statements Judged Valid</u>

At the opposite end of the scale, there were fourteen statements that were regarded by the respondents as valid and important for research. Each of these had significant correlation coefficients.

2. The greater the match between learner experience and media attributes, the greater the likelihood of learner acceptance of media content.

4. Overt/covert responses of learners to "media" experiences are more likely to result in greater memory storage than covert/passive responses.

5. The more a symbol system matches the critical features of an idea or event, the more appropriate it is.

6. Fitness of a message form depends upon the characteristics of the information.

12. Negative teacher attitude toward a media presentation creates negative student attitudes.

14. Presenting various forms of media provides the greatest compatibility with the nature of idiosyncratic brains.

15. It is critical for effective media usage to know the range of coding elements available in each learner's repertoire.

17. Sequential build-up of illustrations leads to better understanding.

19. Excessive detail interferes with transmission of intended information.

21. The advantage of visual over auditory materials increases for more difficult materials.

24. The more similar the coding schemes in the teacher's and student's repertoires the greater the possibility for learning to take place.

26. Messages, message forms, and conveyance systems interact to convey the intended message.

29. Cultural differences affect learner interpretations of media.

34. Learners have difficulty discriminating between subjectivity and objectivity in their interpretation of messages.

It is evident from the questionnaire that the largest number of statements refer to media as instruments that affect learner performance. Only one in the not-valid category, number 16, may be consonant with Clark's views that there are factors, other than media characteristics, that affect learner responses. Most of the statements that were regarded as valid and important for research followed the research paradigm which is looking for a match between the coding, critical elements in media, and the repertoire of the learner.

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Appendix

1. Questionnaire
2. Data for 42 respondents to questionnaire

THEORIES ABOUT MEDIA AND LEARNING

	VALID	UN-DECIDED	NOT VALID	NOT IMPORTANT	IMPO
1. Learning is enhanced when the student controls at least part of the presentation of information.					
2. The greater the match between learner experiences and media attributes, the greater the likelihood of learner acceptance of media content.					
3. Developing "literacy" in the interpretation of non-verbal information by learners is more a matter of being exposed to a wide variety of non-verbal experiences than it is a matter of being taught to observe nuances in non-verbal materials.					
4. Overt/active responses of learners to "media" experiences are more likely to result in greater memory storage than covert/passive responses.					
5. The more a symbol system matches the criterial features of an idea or event, the more appropriate it is.					
6. Fitness of a message form depends upon the characteristics of the information.					
7. Media are capable of insuring anticipated learning outcomes.					
8. Media related to similar information converge knowledge and diverge as to skills required by learners to process different media.					
9. Media attributes affect learners in the same way.					
10. Certain media may accelerate learning by providing tools or analogs for mental activities.					
11. Structuring media experiences insures common learning of information.					
12. Negative teacher attitude toward a media presentation creates negative student attitudes.					
13. Teacher follow-up to a media presentation affects how much students learn from it.					

	VALID	UN-DECIDED	NOT VALID	NOT IMPORTANT	IMPORTANT
Presenting various forms of media des the greatest compatibility the nature of idiosyncratic s.					
t is critical for effective media to know the range of coding nts available in each learner's toire.					
Random behavior in human perfor- is due to the way people inter- media.					
Sequential build-up of illustra- leads to better understanding.					
Reinforcing questions dispersed gh instructional material are not ly effective for all learners.					
Excessive detail interferes with mission of intended information.					
ultiple image instruction contri- to greater learning and reten- than single image instruction.					
The advantage of visual over ory materials increases for more cult material.					
Visual information is remembered r than aural information.					
ender differences can be expected learner responses to media.					
The more similar the coding es in the teacher's and student's toire the greater the possibility earning to take place.					
Each message has a best message and carrier.					
Messages, message forms, and con- ce systems interact to convey the ded message.					
The technical quality of the yance system does not affect the ity of the original message.					
Media in combination are superior single medium.					

	VALID UN-DECIDED NOT VALID	NOT IMPORTANT IMP
29. Cultural differences affect learner interpretations of media.		
30. Integrated code strategies enhance acquisition and retrieval of concepts.		
31. There is no competition when similar information is presented in two media.		
32. Instructional visuals for use with highly anxious students should contain critical information salient to the students.		
33. Both author and audience contribute to a message.		
34. Learners have difficulty discriminating between subjectivity and objectivity in their interpretation of messages.		
35. Separate information received via separate media tends to be processed independently, but integrated with difficulty.		
36. The less the information in a medium is like the "reality" it represents, the less the student will learn about "reality."		
37. Irrelevant cues in message forms interfere with learning.		
38. To store information, learners filter out irrevelant cues.		
39. Learner differences account for varying responses to media more than differences among media attributes.		
40. Instructional procedures which complement media usage are less beneficial to high ability students than to low ability students.		
41. High ability learners, more than low ability learners, need high density and complex information to challenge their abilities.		
42. Verbal memory and pictorial memory are independent of each other.		

	VALID	UN-DECIDED	NOT VALID	NOT IMPORTANT	IMPORTANT
Verbal interference conflicts less pictorial information than with al information.					
Recall of pictorial information ires verbal processing for ieval.					
The human perceptual system de-s sufficient fixation time for il to be observed.					
Fixation for pictorial material ires less time than for verbal rials.					
The amount of information an rver can absorb depends on the l of analysis required.					
Information overload is essential mpress or exhilerate the learner.					
Redundant information in multi-e presentations shortens fixation for observing detail.					
The perception and storage of rmation is a dual coding process ges and symbols).					

Please use the space below to add any theories which you think might have overlooked in this brief survey.

RESULTS - QUESTIONNAIRE ⌉ THEORIES (HY
(42 returns out of 100) ⌋ MEDIA AND LE

UPPER NUMBER = N
LOWER NUMBER = % of total

G.M. TORKELS

QUES. No.	VALID			UN DECIDED	NOT VALID			N	MN	STD DEV	NOT IMPORTANT	IMPORTANT	N	MN	STD DEV
1	17 41.5	11 26.8	4 9.8	5 12.2	1 2.4	1 2.4	2 4.9	41	2.341	1.667	4 9.8	37 90.2	41	1.902	.30
2	8 20.5	10 25.6	8 20.5	8 20.5	2 5.1	2 5.1	1 2.6	39	2.897	1.533	7 19.4	29 80.6	36	1.806	.401
3	2 5.0	5 12.5	5 12.5	9 22.5	3 7.5	10 25.0	6 15.0	40	4.500	1.826	9 24.3	28 75.7	37	1.757	.435
4	15 37.5	12 30.0	3 7.5	2 5.0	2 5.0	3 7.5	3 7.5	40	2.625	1.970	3 7.5	37 92.5	40	1.925	.267
5	8 20.0	11 27.5	6 15.0	8 20.0	2 5.0	2 5.0	3 7.5	40	3.075	1.789	9 23.7	29 76.3	38	1.763	.431
6	9 23.7	15 39.5	3 7.9	8 21.1	1 2.6	1 2.6	1 2.6	38	2.579	1.482	7 18.9	30 81.1	37	1.811	.397
7	1 2.6	7 17.9	3 7.7	3 7.7	0 0	8 20.5	17 43.6	39	5.205	2.105	12 30.8	27 69.2	39	1.692	.468
8	1 4.2	3 12.5	2 8.3	14 58.3	1 4.2	1 4.2	2 8.3	24	3.917	1.412	11 50.0	11 50.0	22	1.500	.512
9	0	2 5.3	1 2.6	3 7.9	3 7.9	10 26.3	19 50.0	38	5.974	1.423	17 43.6	22 56.4	39	1.564	.504
10	15 35.7	10 23.8	10 23.8	5 11.9	0	1 2.4	1 2.4	42	2.333	1.408	2 5.1	37 94.9	37	1.949	.22
11	5 12.5	1 2.5	5 12.5	6 15.0	3 7.5	10 25.0	10 25.0	40	4.775	2.044	11 29.7	26 70.3	37	1.703	.463
12	14 33.3	10 23.8	6 14.3	6 14.3	4 9.5	1 2.4	1 2.4	42	2.595	1.609	5 13.5	32 86.5	37	1.865	.347
13	13 31.0	15 15.7	6 14.3	6 14.3	0	0	2 4.8	42	2.357	1.462	4 9.8	37 90.2	41	1.902	.300
14	5 14.7	3 8.8	6 17.6	10 29.4	2 5.9	5 14.7	3 8.8	34	3.824	1.834	12 36.4	21 63.6	33	1.636	.48
15	6 15.0	8 20.0	8 20.0	8 20.0	5 12.5	4 10.0	1 2.5	40	3.350	1.657	12 31.6	26 68.4	38	1.684	.47
16	3 7.3	1 2.4	4 9.8	11 26.8	0	9 22.0	13 13.7	41	5.024	1.904	17 50.0	17 50.0	34	1.500	.505
17	3 7.7	17 43.6	8 20.5	8 20.5	1 2.6	0	2 5.1	39	2.872	1.380	6 16.7	30 83.3	36	1.833	.37
18	7 17.5	17 42.5	4 10.0	4 10.0	1 2.5	6 15.0	1 2.5	40	2.925	1.774	6 17.1	29 82.9	35	1.829	.38
19	14 33.3	14 33.3	5 11.9	5 11.9	1 2.4	1 2.4	2 4.8	42	2.429	1.610	8 20.5	31 79.5	39	1.795	.40
20	0	3 7.1	2 4.8	10 23.8	7 16.7	9 21.4	11 26.2	42	5.190	1.534	11 29.7	26 70.3	37	1.703	.463
21	6 14.6	6 14.6	8 19.5	11 26.8	0	6 14.6	4 9.8	41	3.659	1.879	5 13.5	32 86.5	37	1.865	.347
22	4 10.0	10 25.0	2 5.0	11 27.5	4 10.0	3 7.5	6 15.0	40	3.850	1.942	3 8.6	32 91.4	35	1.914	.28
23	1 2.4	7 17.1	5 12.2	12 29.3	6 14.6	4 9.8	6 14.6	41	4.244	1.700	10 28.6	25 71.4	35	1.714	.45
24	12 30.0	9 22.5	11 27.5	2 5.0	2 5.0	1 2.5	3 7.5	40	2.700	1.757	11 28.9	27 71.1	38	1.711	.460

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UPPER NUMBER = N
LOWER NUMBER = % of total

RESULTS - QUESTIONNAIRE
(42 returns out of 100)

THEORIES (HYPOTHE
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MN	STD DEV	VALID			UNDECIDED	NOT VALID			N	MN	STD DEV	NOT IMPORTANT	IMPORTANT	N	MN	STD DEV	SIGNI CHAN (NOT WITH
1.902	.300	0	3 7.3	5 12.2	9 22.0	5 12.2	7 17.1	12 29.3	41	5.073	1.664	12 34.3	23 65.7	35	1.657	.482	
1.806	.401	11 26.8	17 41.5	8 19.5	2 4.9	1 2.4	1 2.4	1 2.4	41	2.317	1.350	9 24.3	28 75.7	37	1.757	.435	.(
1.757	.435	1 2.5	3 7.5	5 12.5	5 12.5	5 12.5	10 25.0	11 27.5	40	5.100	1.766	7 19.4	29 80.6	36	1.806	.401	
1.925	.267	2 5.0	6 15.0	3 7.5	9 22.5	6 15.0	4 10.0	10 25.0	40	4.575	1.920	7 18.4	31 81.6	38	1.816	.393	
1.763	.431	21 50.0	13 13.0	7 16.7	0	0	1 2.4	0	42	1.762	1.008	4 10.3	35 89.7	39	1.897	.307	.0
1.811	.397	7 19.4	5 13.9	9 25.0	12 33.3	1 2.8	2 5.6	0	36	3.028	1.383	6 20.0	24 80.0	30	1.800	.407	
1.692	.468	2 5.0	2 5.0	4 10.0	8 20.0	5 12.5	11 27.5	8 20.0	40	4.925	1.730	7 20.0	28 80.0	35	1.800	.406	
1.500	.512	8 20.0	11 27.5	6 15.0	9 22.5	3 7.5	2 5.0	1 2.5	40	2.950	1.584	8 23.5	26 76.5	34	1.765	.431	
1.564	.502	19 46.3	10 24.4	9 22.0	2 4.9	0	1 2.4	0	41	1.951	1.139	5 13.9	31 86.1	36	1.861	.351	
1.944	.223	8 19.5	8 19.5	11 26.8	10 24.4	3 7.3	1 2.4	0	41	2.878	1.327	7 21.2	26 78.8	33	1.788	.415	.0
1.703	.463	3 7.5	2 5.0	6 15.0	10 25.0	5 12.5	10 25.0	4 10.0	40	4.450	1.709	7 21.2	26 78.8	33	1.788	.415	
1.865	.347	4 9.8	7 17.1	2 4.9	8 19.5	4 9.8	6 14.6	10 24.4	41	4.439	2.098	7 19.4	29 80.6	36	1.806	.401	.0
1.402	.300	18 42.9	9 21.4	6 14.3	2 4.8	1 2.4	4 9.5	2 4.8	42	2.500	1.877	3 8.6	32 91.4	35	1.914	.284	
1.636	.485	8 19.0	13 31.0	2 4.8	7 16.7	8 19.0	2 4.8	2 4.8	42	3.160	1.798	5 13.5	32 86.5	37	1.865	.347	
1.684	.471	12 30.0	8 20.0	7 17.5	9 22.5	2 5.0	2 5.0	0	40	2.675	1.492	3 8.6	32 91.4	35	1.914	.284	
1.500	.508	8 19.5	7 17.1	3 7.3	12 29.3	2 4.9	5 12.2	4 9.8	41	3.585	1.962	7 17.9	32 82.1	39	1.821	.389	
1.833	.378	5 12.5	10 25.0	8 20.0	9 22.5	1 2.5	6 15.0	1 2.5	40	3.325	1.670	6 15.4	33 84.6	39	1.846	.366	
1.829	.382	2 5.0	5 12.5	2 5.0	10 25.0	2 5.0	12 30.0	7 17.5	40	4.725	1.840	3 7.9	35 92.1	38	1.921	.273	
1.795	.409	2 4.9	13 31.7	10 24.4	9 22.0	2 4.9	2 4.9	3 7.3	41	3.341	1.575	7 18.4	31 81.6	38	1.816	.393	
1.703	.463	2 4.9	4 9.8	3 7.3	10 24.4	3 7.3	10 24.4	9 22.0	41	4.805	1.835	5 13.5	32 86.5	37	1.865	.347	
1.865	.347	12 29.3	14 34.1	6 14.6	2 4.9	5 12.2	2 4.9	0	41	2.512	1.519	5 12.8	34 87.2	39	1.872	.339	
1.914	.284	5 12.5	4 10.0	5 12.5	12 30.0	5 12.5	5 12.5	4 10.0	40	3.975	1.804	5 13.5	32 86.5	37	1.865	.347	
1.714	.458	11 28.2	7 17.9	12 30.8	5 12.8	1 2.6	2 5.1	1 2.6	39	2.692	1.542	4 10.3	35 89.7	39	1.897	.307	
1.711	.460	0	0	1 2.4	4 9.8	4 9.8	10 24.4	22 53.7	41	6.171	1.116	13 33.3	26 66.7	39	1.667	.478	
		1 2.6	3 7.7	8 20.5	15 38.5	1 2.6	4 10.3	7 17.9	39	4.333	1.0662	14 40.0	21 60.0	35	1.600	.497	
		4 10.0	10 25.0	6 15.0	14 35.0	2 5.0	3 7.5	1 2.5	40	3.325	1.492	6 15.0	34 85.0	40	1.850	.362	

TITLE: Formative Evaluation in Instructional Design: Theory Versus Practice

AUTHOR: John A. Williams, Jr.

FORMATIVE EVALUATION IN
INSTRUCTIONAL DESIGN:
THEORY VERSUS PRACTICE

BY

JOHN A. WILLIAMS, JR.

INTRODUCTION

Technological advances and new devices have been introduced to the world community at an ever increasing rate since the turn of the century. In order to properly understand and operate these new technologies, personnel training has become increasingly important. Within this domain, a systematic approach of monitoring the effectiveness of instructional training has been developed termed formative evaluation.

Leslie Briggs (1974) defined formative evaluation as "tryouts and revisions of components of an instructional system before operational use. It includes tryouts of materials with individual learners and small groups, as well as with entire classes in the school sitation" (Briggs, 1974, p.288).

The application of formative evaluation procedures has gained increasing support in the educational community, provoking an observable trend toward the use of this technique, reflected in events such as:

1. The incorporation of formative evaluation as a main step in almost all models used for the systematic design of instruction (Branson, Raynor, Coe, Turman, King, and Hannum, 1975; Briggs, 1970; Briggs and Gagne, 1974; Dick and Carey, 1978).

2. The abundance of articles and books proposing differing methods for formatively evaluating instructional materials (Abedor, 1972; Baker, 1974; Borich, 1974; Briggs and Gagne, 1974; Dick and Carey, 1978; Kaufman and Thomas, 1980; Sanders and Cunningham, 1970; Singer and Dick, 1974).

3. Increasing interest in reporting evaluation studies, their strategies and results (Abedor, 1972; Baker, 1974; Bank and Fink, 1976; Dick, 1968; Lawson, 1974; Light and Reynolds, 1972; Lindvall and Cox, 1970; Markle, 1967).

Important early researchers in the history of educational technology, such as Dale, Kinder, Hoban, Lazarfeld, Lumsdaine and Carpenter "unanimously supported the value of and need for evaluation during production of instructional materials" (Cambre, 1978, p. 2).

In a study conducted in 1974, out of "300,000 commercial instructional materials available at that time, only about 3,000, or one percent, 'demonstrated one or more of the attributes of empirically developed and improved material'" (Komoski, 1974, p. 357).

In Popham's view (1970), the research related to curriculum development suffered from serious deficiencies. He indicated, neither improvement of materials based on empirical data, nor the manner in which revisions could be made have been clearly demonstrated.

Besides limited empirical evidence supporting formative evaluation models - other problems exist that act as a constraint to its usage.

1. There is a lack of accepted definitions (Baker and Alkin, 1973; Sanders and Cunningham, 1970).

2. During the instructional design process, formative evaluation is attempted primarily after the prototype has been developed. There is extensive analysis; however, there are usually no checks for validity, reliability, or suitability of the product.

3. Gephart (1976) indicated that although various models exist, one step invariably seems to be missing. This refers to what to do with the data after it has been collected.

4. Most of the formative evaluation models currently utilized have not been empirically tested (Martelli, 1979). The problem of formative evaluation models which are lacking empirical support has been discussed by Smith and Murray (1975), who indicated that: "there is little or no information about the relative efficiency of alternative evaluation techniques and, therefore, there is a need for evaluation research on the models themselves" (p. 5).

A recent article by David Forman stated that "in the field of training, evaluation is rarely conducted" (Aversa and Forman, 1978, p. 16-18). He also stated that there were three reasons for this state of affairs:

1. Unlike education, a great deal of training occurs in the private, as opposed to the public sector. Since the government and public foundations are not supporting these training programs, they cannot mandate evaluations.

2. There is a general feeling that educational methods are not often well-suited to the real, every-day, outcome-oriented world of business. These people tend to distrust educational methods and techniques borrowed without adaption and revision; they want training evaluation to develop a character of its own.

3. The field of training is in a state of tremendous growth and development. The demand for training is great, and trainers are thinking more about developing their next project as opposed to evaluating and improving their present one.

Statement of the Problem

There was a need for the development of a formative evaluation paradigm gleaned from the literature which would be applicable to the educational, as well as the industrial setting, and would provide information for the advancement of knowledge about the instructional process.

Purpose of the Study

The purpose of this study, therefore, was to: 1. Investigate the appropriate evaluation literature and develop a formative evaluation model. 2. Investigate the formative evaluation procedures utilized by Advanced Systems, Incorporated and develop a model based upon these procedures. 3. Compare and contrast the two resultant models for commonalities and differences.

Research Questions

One means of investigating this particular issue of theory versus practice was to focus upon one successful producer of training materials (Advanced Systems, Inc.), in an effort to discover how closely the formative evaluation techniques are related to actual standards preset by the training corporation. Through detailed analysis of actual procedures in a major production entity, some insight into the question of formative evaluation procedures was gleaned.

In order to complete this task, the researcher answered four specific questions:

1. What is the current state of formative evaluation theory as developed in past and present professional literature?

2. What is the procedure of formative evaluation utilized by Advanced Systems, Inc., and what are the results of this procedure?

3. What is the relationship between existing formative evaluation theory and formative evaluation of training materials and programs as reflected in the comparison of (1) and (2)?

4. What conclusions can be reached as a result of this comparison?

Research Procedure and Design

In order to complete the preceding tasks, a case study approach was utilized, combined with an extensive review of the literature. The research was divided into two distinct phases. The first phase involved a literature review of current formative evaluation procedures and theory. An attempt was made to identify noted authorities through indices, computer data bases, bibliographic data, and primary as well as secondary sources related to the problem. After sufficient data was gathered using these tools, a formative evaluation model was generated based upon the general state of the art derived from the literature. This model served as a basis of comparison for the procedures and resultant model utilized by Advanced Systems, Inc. This was accomplished through a description of the systems in use today. Following this description, the two approaches were analyzed for similarities and/or differences. The final end product of this particular phase was a model based on existing theory, suitable for comparison with a model derived from procedures used by Advanced Systems, Inc.

The second phase of the research consisted of gathering data through observation of evaluation procedure and through extensive visitation and an in-house survey of ASI employees involved in the product development process. Initially, any printed material relevant to product development and particularly formative evaluation was searched out and analyzed. An in-house survey was distributed to further verify these procedures and to ascertain employee attitudes in regard to the product development process.

Background

Until 1968, International Business Machines (IBM) was the dominant force in the training of employees in the utilization of computer technology, simply because they provided free training with the purchase of a computer. Sometime later, corporations were required to pay for training, and at this juncture, three individuals left IBM to form their own corporation to provide training in data processing.

The initial method of instruction was stand-up lecture. The three individuals were intrigued by video, and soon began to videotape their instruction and sell their videotapes.

In 1970, the corporation was named Advanced Systems, Incorporated, which then provided training by videotaping stand-up lectures with the support of IBM training manuals. From 1970-1973, Advanced Systems, Inc., developed an approach to instruction that produced a packaged product: a staged presentation supported by textual materials including illustrations, exercises, performance objectives and summative evaluation (Westgaard, 1981).

In 1975, ASI grossed $8,000,000, employed 250 personnel, and grew to 14 domestic as well as 7 foreign offices. In 1980, ASI grossed $35,000,000, employed 400 personnel and had 28 domestic offices and 32 foreign offices (Annual Report, 1980).

The reasons for this growth rate were threefold: 1. The result of a quality control process. 2. A tightening up of student evaluation procedures. 3. Improvement in information presentation techniques, including video scripting, front-end analysis, instructional design and instructional packaging (Westgaard, 1981).

Contemporary Evaluation Models

The models for evaluation which were described differed from descriptions of actual evaluations in the following ways: no actual program, curriculum or material were evaluated in the model; no specific contents, situations, or contexts were considered and the level of generality was high; generally, no specific instruments, designs, or mechanisms for data collection, analysis, etc., were considered; the special problems which arose in a particular study could not approached in the evaluation model. There were, however, important ways in which the evaluation model represented the actual evaluation studies which it modelled: the stages and components of the actual evaluation were accurately reflected in the model; the types of relationships and data which were analyzed in the evaluation were carefully represented in the model; the general plan and strategy of evaluation which were used in the study can be clearly portrayed in the model.

Comparison - Evaluation Approaches in Education and Training

Eleven evaluation design systems were presented in detail covering the mid-1960's to the present. For purposes of the research, it was vital to establish their similarities and differences by comparing and combining the various designs and stages into a single comprehensive design.

The Combined Educational and Training Evaluation Paradigm

The dissertation was a discussion of formative evaluation in three domains; education, military training and industrial training. The next segment of the discussion will consist of an outline combining the three areas, with assistance being provided in the identification of contributions by "placing an 'E' for education, 'I' for industry/military, or 'EI' for mutual contributions after the item or entry" (Barnum, 1979, p. 150). The entire outline for the evaluation procedure is as follows:

I. Analysis of Evaluation Requirements

A. Define and describe problem (E)

B. Analyze evaluation setting (E)

1. Needs assessment (E)

2. Focus evaluation (E)

3. Identify decision-making levels (E)

4. Identify goals (E)

5. Identify general program components (E)

6. Identify what is versus what should be (E)

7. Describe package components (E)

C. Plan the evaluation activities (E)

1. Evaluate needs (E)

2. Project decision alternatives (E)

3. Define decision criteria (E)

4. Define policies (E)

5. Identify the following: (E)

a. Longitudinal effects (E)

b. High payoff transactions (E)

c. Entry level behavior and characteristics (E)

6. Prioritize needs (E)

7. Select needs for action (E)

8. Abstract project (E)

9. Determine intents from (I)

a. Planners (I)

b. Designers (I)

c. Developers (I)

10. Analyze the training environment (I)

II. Designing the Evaluation System

A. Identify evaluation objectives in terms of: (E)

1. Audiences (E)

2. Educational philosophy (E)

3. Decisions (E)

4. Subject matter (E)

5. Rationales (E)

6. Staff aims (E)

B. Perform a task analysis of objectives (I)

1. Subtasks into performance objectives (I)

2. Criterion items for each objective (I)

3. Course final exam (I)

C. Construct course evaluation instruments (I)

D. Determine curriculum outline (I)

E. Sequence objectives (I)

F. Select instructional materials (I)

G. Determine terminal outcomes (I)

H. Determine information stages (E)

1. Collection

2. Organization (E)

3. Analysis (EI)

4. Reporting (E)

I. Determine statistical method (I)

1. Descriptive statistics (I)

2. Predictive statistics (I)

3. ANOVA or ANCOVA (I)

4. Canonical correlation (I)

5. Multiple discriminant analysis (I)

6. Path analytic methodology (I)

7. Non-parametric statistics (I)

J. Analyze objectives and information (E)

1. Logical analyses (E)

2. Empirical analyses (E)

3. Prerequisites (E)

4. Measuring instruments (E)

K. Develop instructional strategy (E)

L. Determine "high and low fidelity" transactions (I)

M. Prepare first draft of (I)

1. Script (I)

2. Sketches (I)

3. Storyboard (I)

4. Materials (I)

III. Implementing the Evaluation Design

A. Determine evaluation dimensions (I)

B. Review prior to evaluation (I)

C. Conduct self-evaluation of material (I)

D. Evaluate rough draft of material (I)

E. Provide expert appraisal (I)

F. Complete internal review (I)

G. Develop natural language questions (I)

H. Check evaluation design for:

1. Pervasiveness (E)

2. Reliability (E)

3. Validity (E)

4. Credibility (E)

5. Timeliness (E)

I. Administer initial evaluation (EI)

1. Individual trial (one-to-one) (EI)

2. Pilot test (E)

3. Formative interim (E)

J. Revise and recycle (EI)

K. Conduct group trial (EI)

L. Revise and recycle (EI)

M. Field test (EI)

1. Formative product (E)

2. Goal free (E)

N. Revise (E)

O. Prepare final form

1. Scripts (I)

2. Storyboard (I)

3. Visuals (I)

4. Master tape (I)

P. Operational tryout (I)

Q. Analyze evaluation data (E)

1. Program outcomes (E)
2. Relationships and indicators (E)
3. Judgements (E)
4. Objectives met (E)
5. Unexpected results (E)
6. Utilization plan (E)

R. Revise as necessary - long term (EL)

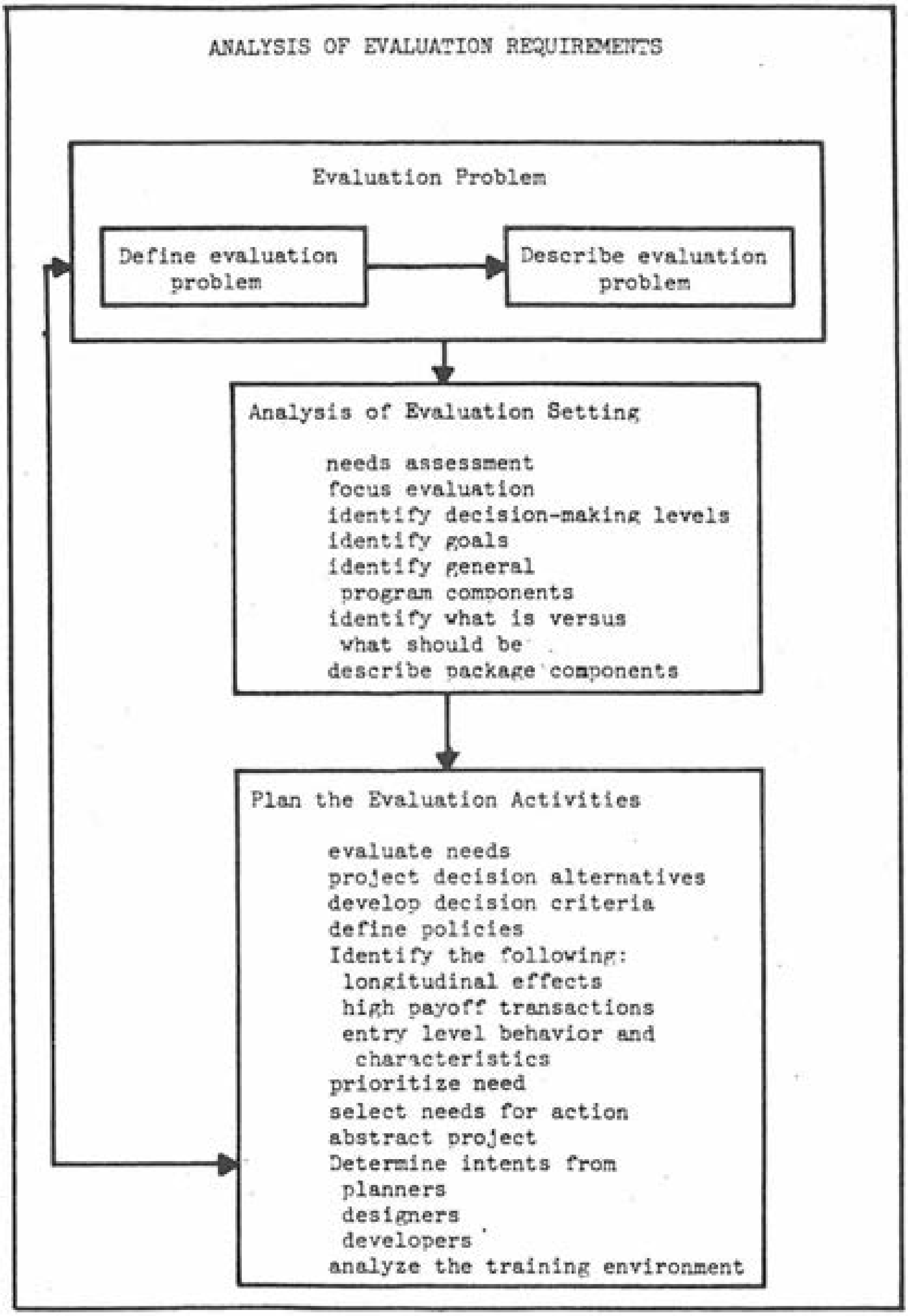
The final flowchart design representative of the evaluation process, and based upon the outline, is presented in figures 1, 2, and 3.

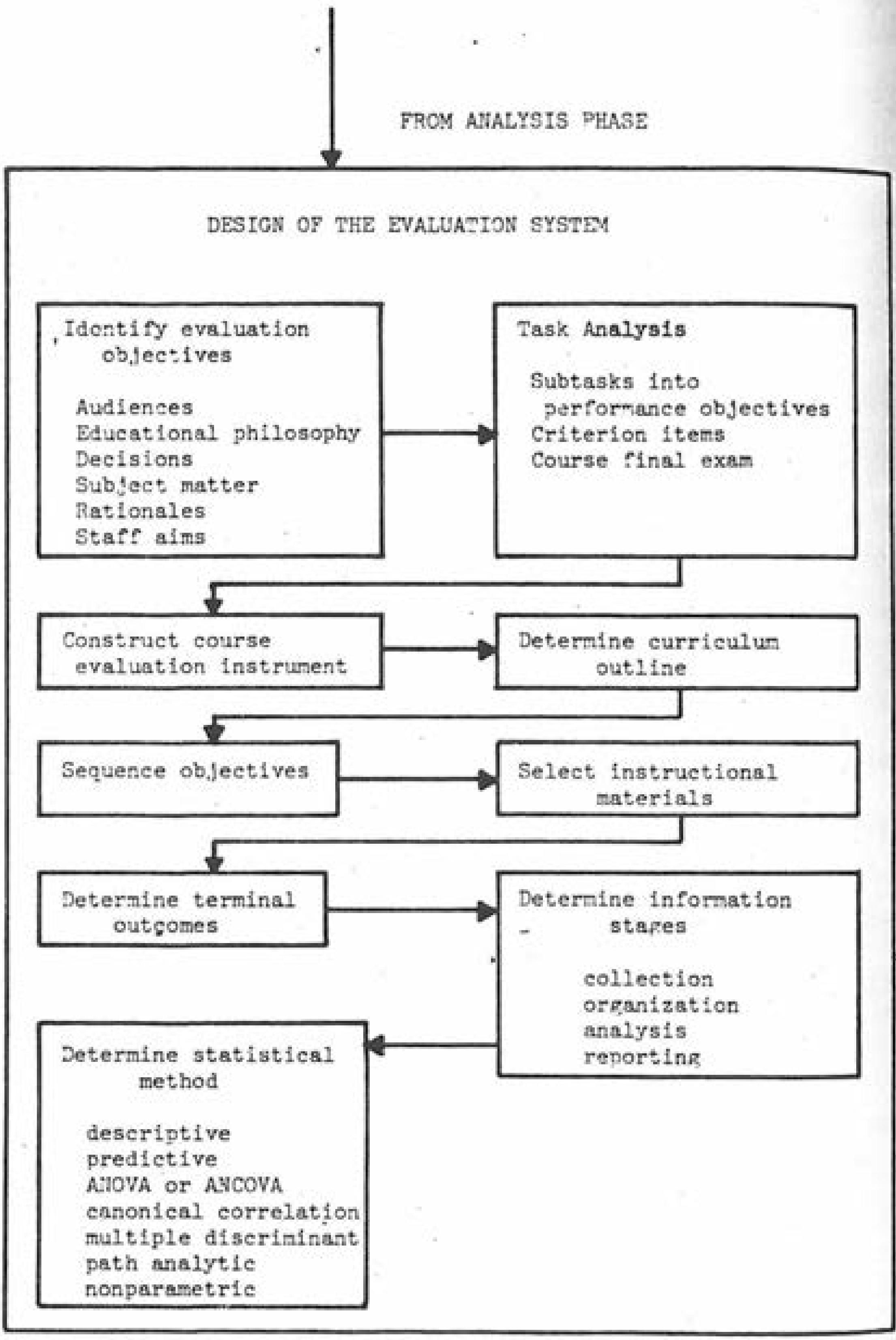
Summary

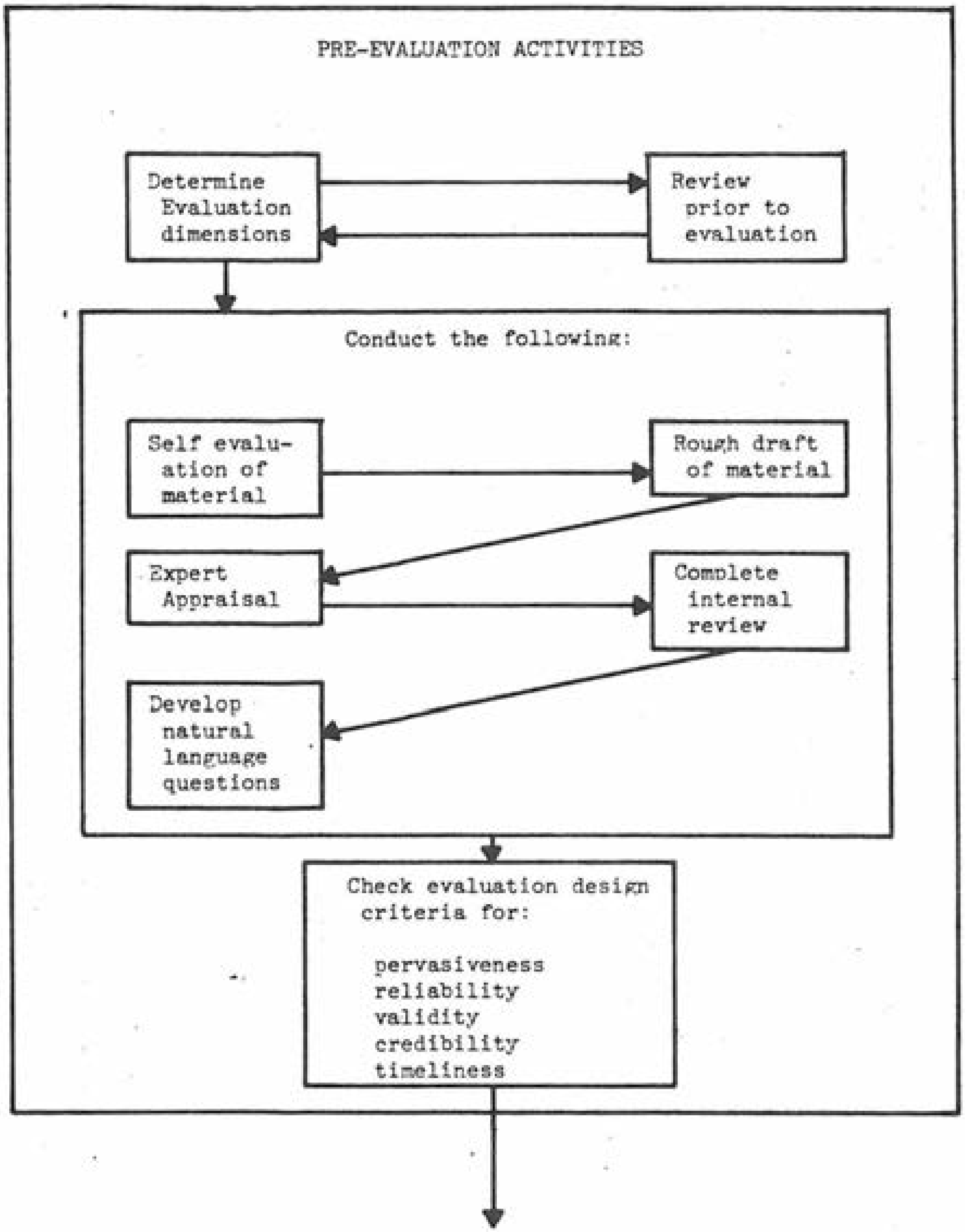
Several evaluation systems representative of the educational, industrial and military domains were presented in great detail. Within each of the various domains, the individual schematas of evaluation were analyzed for consistent and unique characteristics that were useful in the development of a comprehensive evaluation system.

The final evaluation system was used to analyze the instructional design and evaluation process used at Advanced Systems, Incorporated.

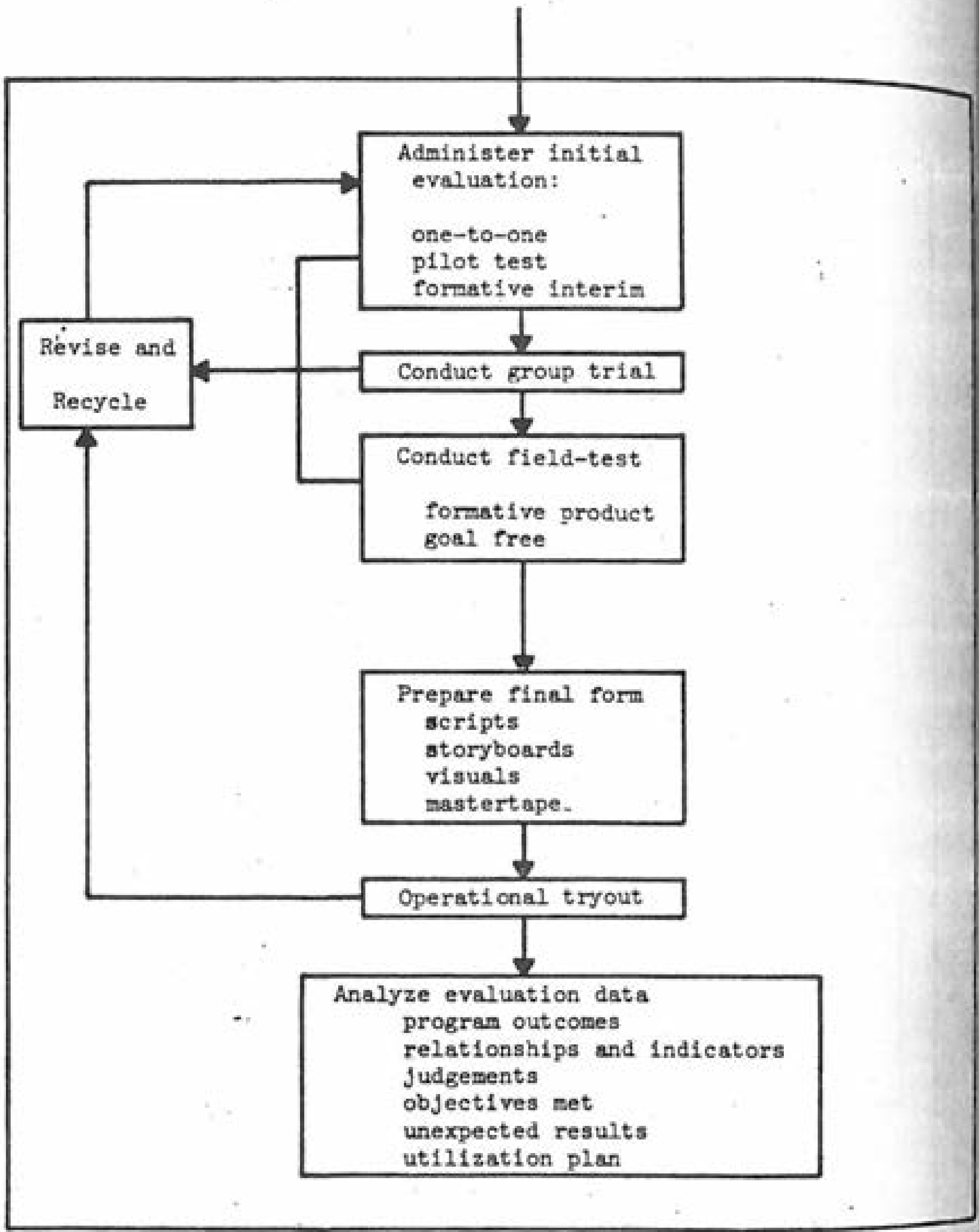
A brief history of the ASI corporation was delineated in the initial segment of the dissertation. This data was de-


ANALYSIS OF EVALUATION REQUIREMENTS
Evaluation Problem
Define evaluation problem
Describe evaluation problem
Analysis of Evaluation Setting
needs assessment
focus evaluation
identify decision-making levels
identify goals
identify general program components
identify what is versus what should be
describe package components
Plan the Evaluation Activities
evaluate needs
project decision alternatives
develop decision criteria
define policies
Identify the following:
longitudinal effects
high payoff transactions
entry level behavior and characteristics
prioritize need
select needs for action
abstract project
Determine intents from
planners
designers
developers
analyze the training environment


FROM ANALYSIS PHASE
DESIGN OF THE EVALUATION SYSTEM
Identify evaluation objectives
Audiences
Educational philosophy
Decisions
Subject matter
Rationales
Staff aims
Task Analysis
Subtasks into performance objectives
Criterion items
Course final exam
Construct course evaluation instrument
Determine curriculum outline
Sequence objectives
Select instructional materials
Determine terminal outcomes
Determine information stages
collection
organization
analysis
reporting
Determine statistical method
descriptive
predictive
ANOVA or ANCOVA
canonical correlation
multiple discriminant
path analytic
nonparametric



PRE-EVALUATION ACTIVITIES
Determine Evaluation dimensions
Review prior to evaluation
Conduct the following:
Self evaluation of material
Rough draft of material
Expert Appraisal
Complete internal review
Develop natural language questions
Check evaluation design criteria for:
pervasiveness
reliability
validity
credibility
timeliness


Administer initial evaluation:
one-to-one
pilot test
formative interim
Revise and Recycle
Conduct group trial
Conduct field-test
formative product
goal free
Prepare final form
scripts
storyboards
visuals
mastertape.
Operational tryout
Analyze evaluation data
program outcomes
relationships and indicators
judgements
objectives met
unexpected results
utilization plan

rived from in-house documentation and Barnum (1979). The narrative reflected the rapid growth of ASI as a viable entity.

The next segment of the dissertation provided a detailed documentation of the ASI six-phase course development process. When necessary and appropos, appendices were added to provide further clarification and for easy reference. As in the preceding segment, the process was consolidated into a flowchart diagram of the events leading to course completion and implementation as shown in figure 4.

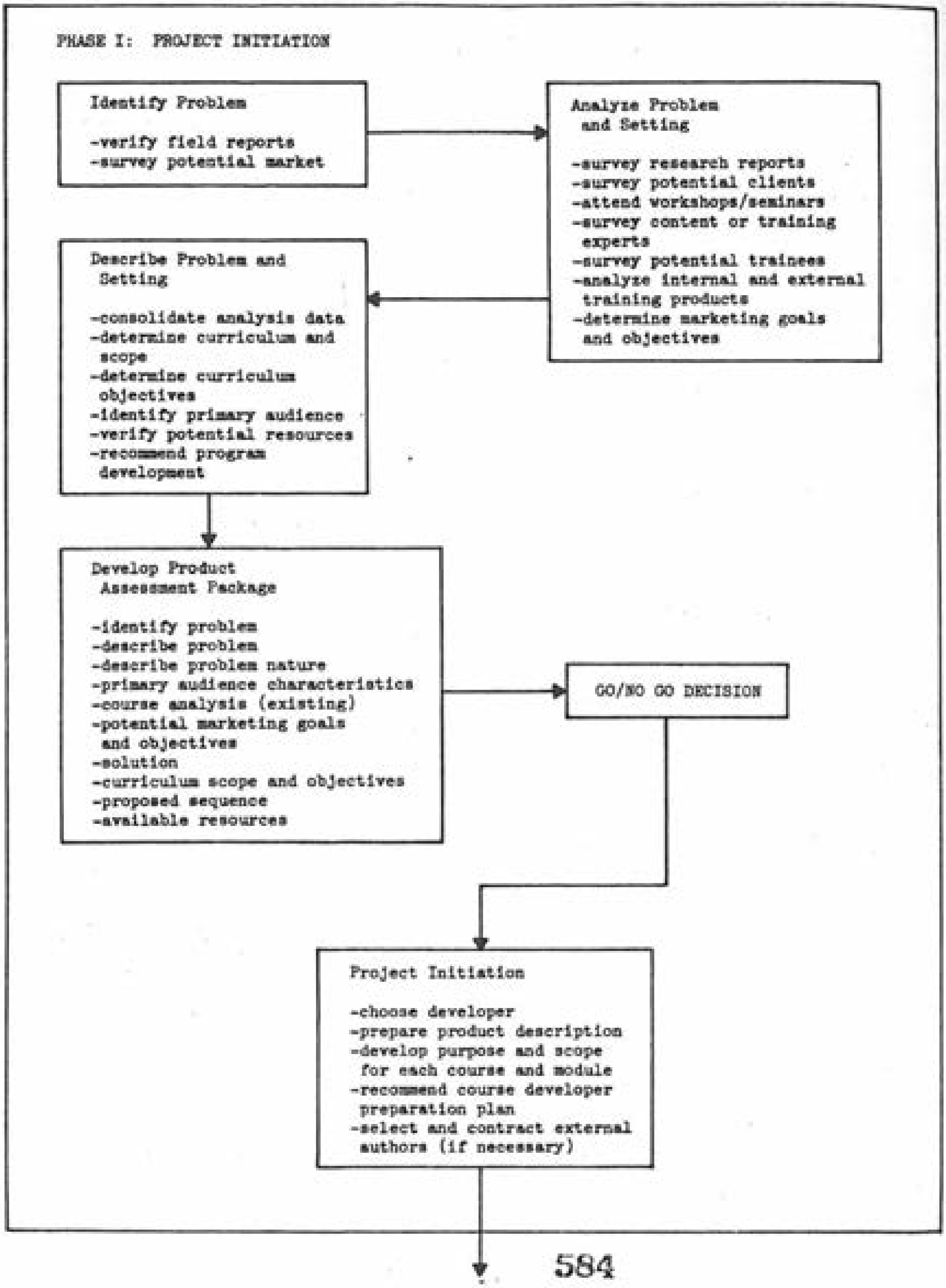
The final segment discussed the rationale, methodology and tabulated results of a questionnaire designed to further verify and evaluate the ASI model from an in-house perspective.

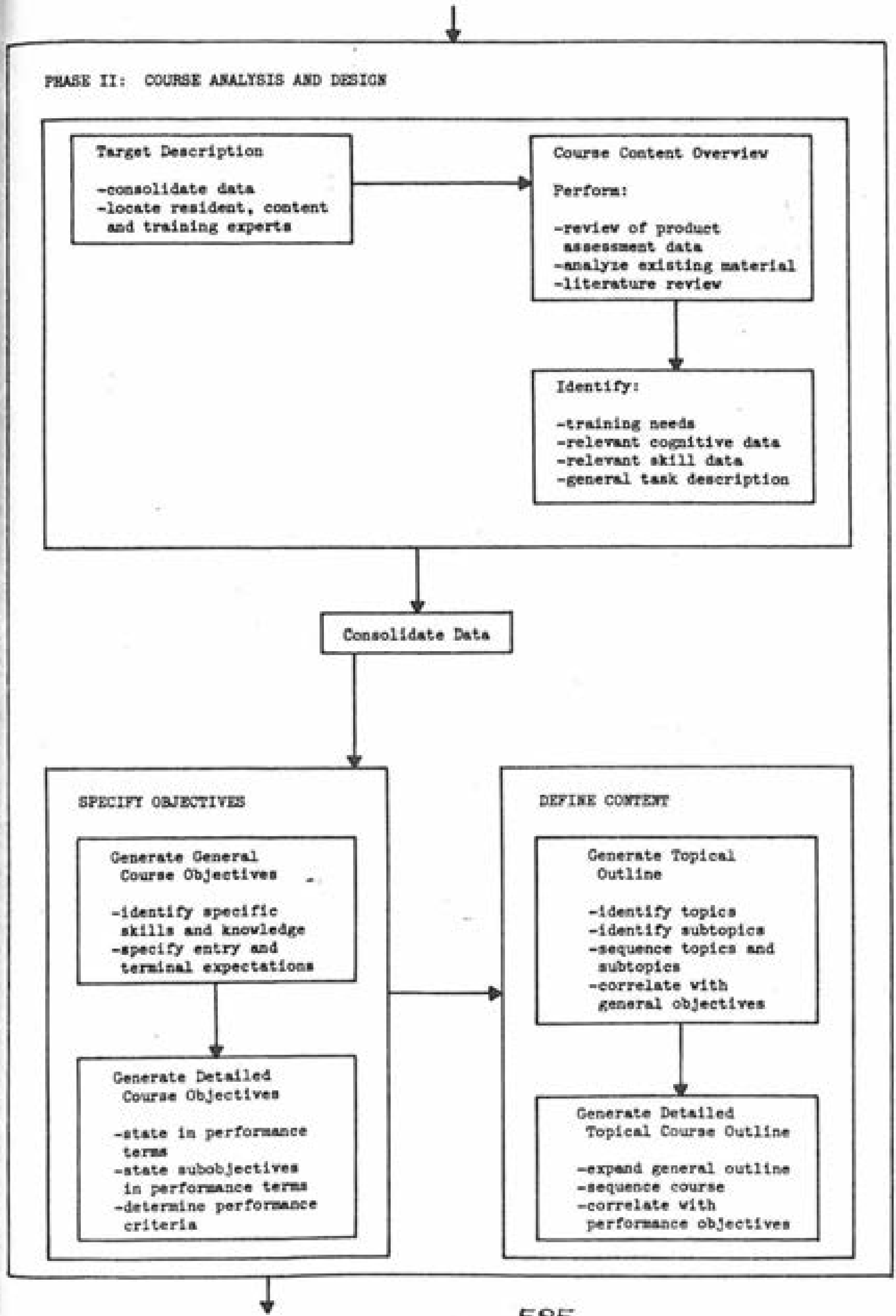
Conclusions

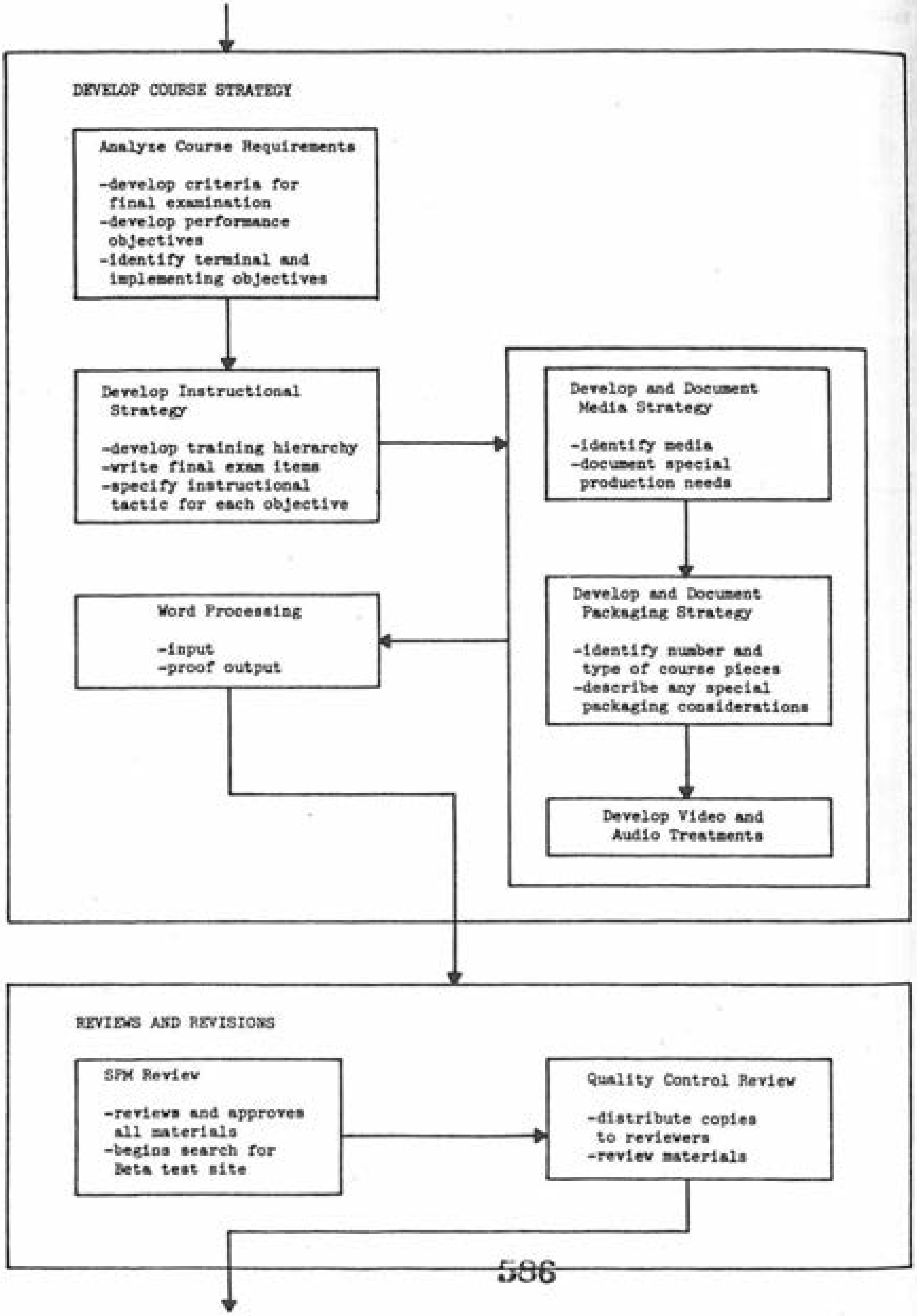
Nine conclusions were generated as a result of the investigation. Essentially, these are related to the state of the art of formative evaluation as delineated in Chapter II, the model derived from the theory, the ASI procedure and survey results described in Chapter III, and the comparison of the two models in Chapter IV of the dissertation.

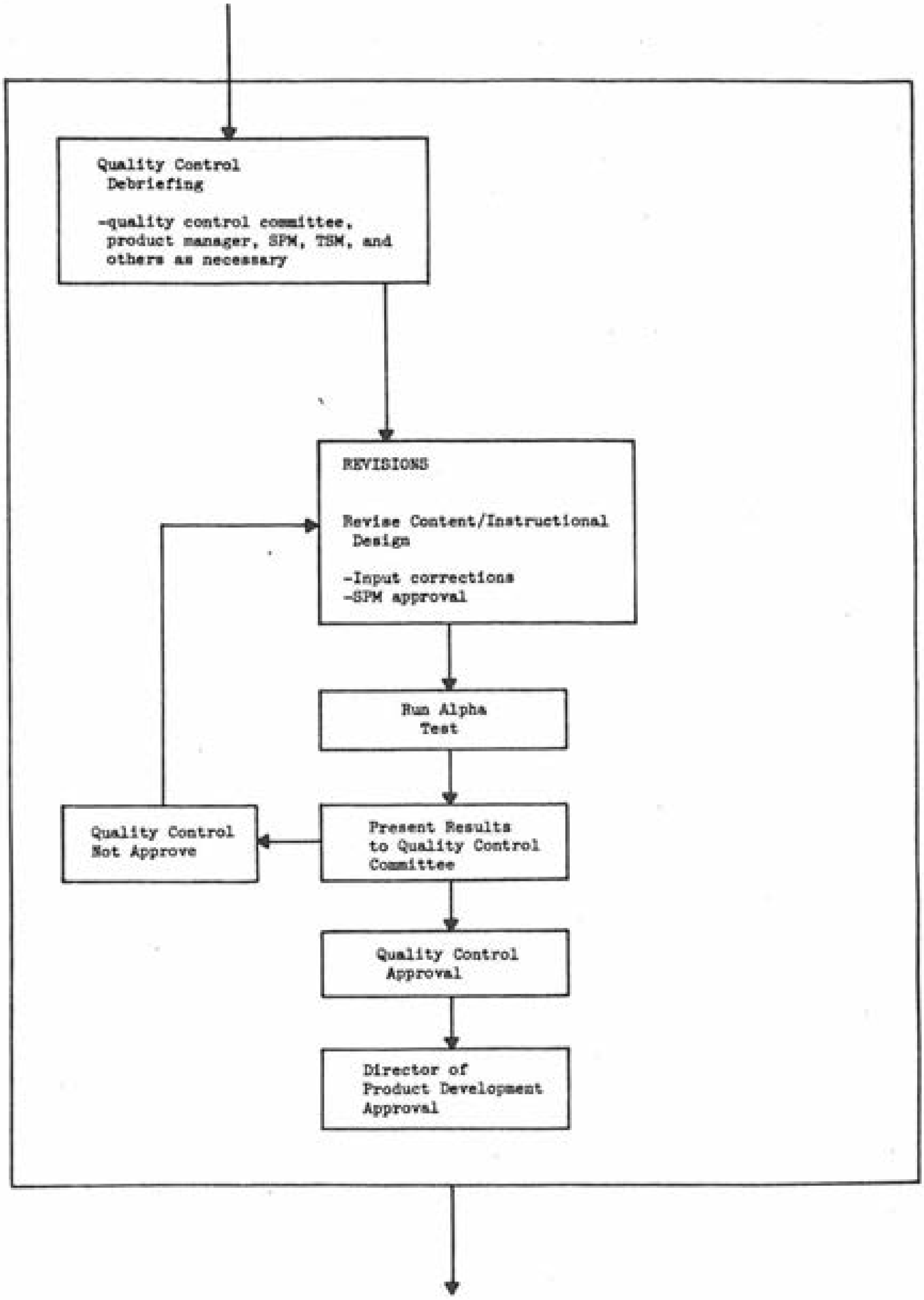
Formative Evaluation - State of the Art

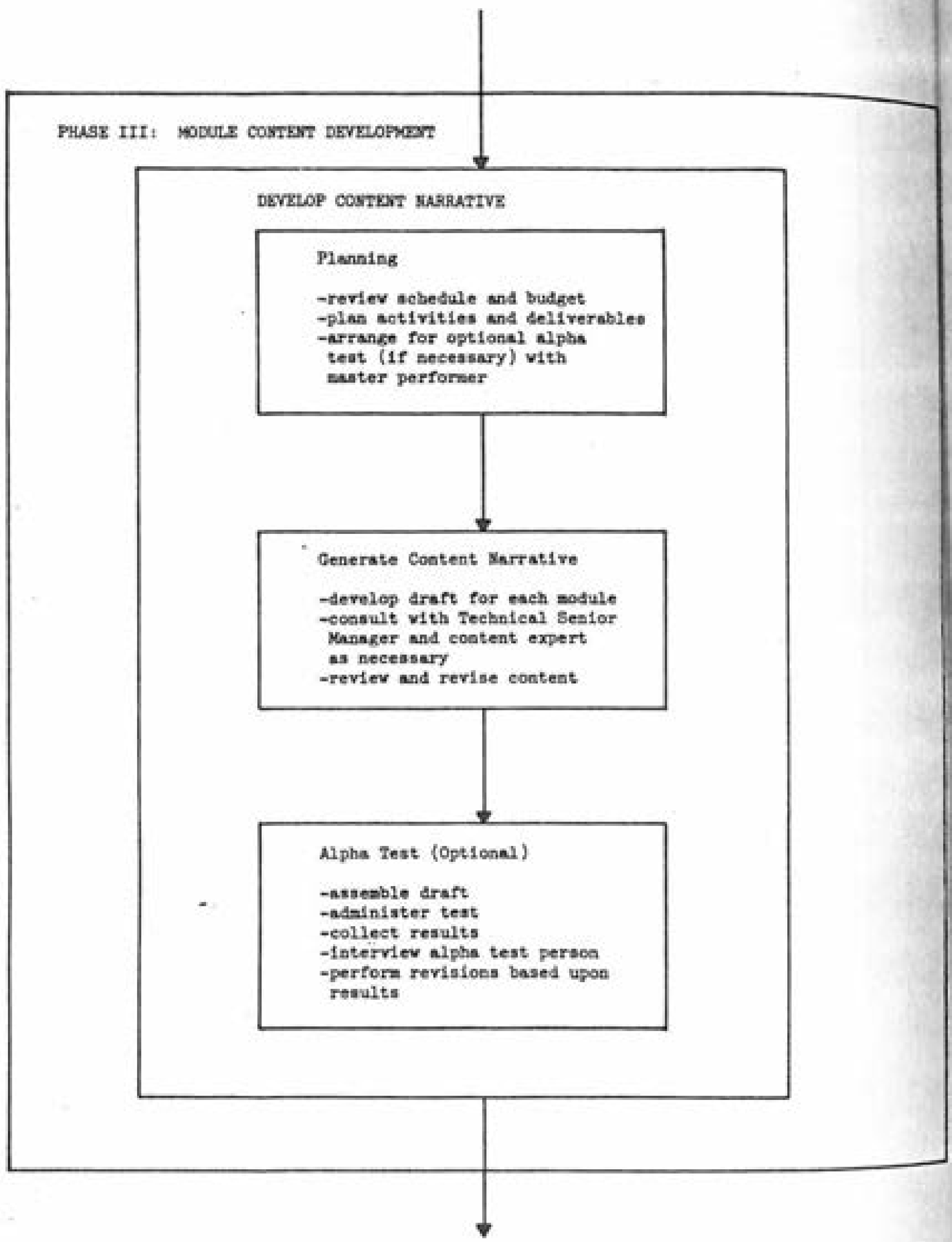
Four conclusions were generated from the literature review in Chapter II. They are as follows:


PHASE I: PROJECT INITIATION
Identify Problem
-verify field reports
-survey potential market
Analyze Problem and Setting
-survey research reports
-survey potential clients
-attend workshops/seminars
-survey content or training experts
-survey potential trainees
-analyze internal and external training products
-determine marketing goals and objectives
Describe Problem and Setting
-consolidate analysis data
-determine curriculum and scope
-determine curriculum objectives
-identify primary audience
-verify potential resources
-recommend program development
Develop Product Assessment Package
-identify problem
-describe problem
-describe problem nature
-primary audience characteristics
-course analysis (existing)
-potential marketing goals and objectives
-solution
-curriculum scope and objectives
-proposed sequence
-available resources
GO/NO GO DECISION
Project Initiation
-choose developer
-prepare product description
-develop purpose and scope for each course and module
-recommend course developer preparation plan
-select and contract external authors (if necessary)


PHASE II: COURSE ANALYSIS AND DESIGN
Target Description
-consolidate data
-locate resident, content and training experts
Course Content Overview
Perform:
-review of product assessment data
-analyze existing material
-literature review
Identify:
-training needs
-relevant cognitive data
-relevant skill data
-general task description
Consolidate Data
SPECIFY OBJECTIVES
Generate General Course Objectives
-identify specific skills and knowledge
-specify entry and terminal expectations
Generate Detailed Course Objectives
-state in performance terms
-state subobjectives in performance terms
-determine performance criteria
DEFINE CONTENT
Generate Topical Outline
-identify topics
-identify subtopics
-sequence topics and subtopics
-correlate with general objectives
Generate Detailed Topical Course Outline
-expand general outline
-sequence course
-correlate with performance objectives


DEVELOP COURSE STRATEGY
Analyze Course Requirements
-develop criteria for final examination
-develop performance objectives
-identify terminal and implementing objectives
Develop Instructional Strategy
-develop training hierarchy
-write final exam items
-specify instructional tactic for each objective
Develop and Document Media Strategy
-identify media
-document special production needs
Develop and Document Packaging Strategy
-identify number and type of course pieces
-describe any special packaging considerations
Develop Video and Audio Treatments
Word Processing
-input
-proof output
REVIEWS AND REVISIONS
SPM Review
-reviews and approves all materials
-begins search for Beta test site
Quality Control Review
-distribute copies to reviewers
-review materials


Quality Control Debriefing
-quality control committee, product manager, SPM, TSM, and others as necessary
REVISIONS
Revise Content/Instructional Design
-Input corrections
-SPM approval
Run Alpha Test
Present Results to Quality Control Committee
Quality Control Not Approve
Quality Control Approval
Director of Product Development Approval


PHASE III: MODULE CONTENT DEVELOPMENT
DEVELOP CONTENT NARRATIVE
Planning
-review schedule and budget
-plan activities and deliverables
-arrange for optional alpha test (if necessary) with master performer
Generate Content Narrative
-develop draft for each module
-consult with Technical Senior Manager and content expert as necessary
-review and revise content
Alpha Test (Optional)
-assemble draft
-administer test
-collect results
-interview alpha test person
-perform revisions based upon results

PHASE IV: MEDIA DEVELOPMENT

Planning

-select production team
-determine visuals
-establish priorities

↓

Scripting

-develop production
ready scripts
-video treatments
-audio treatments

↓

Reviews and Revisions

-Senior Product Manager review
-Product Manager review
-Quality Control Committee
review
-revisions based upon
previous reviews

↓

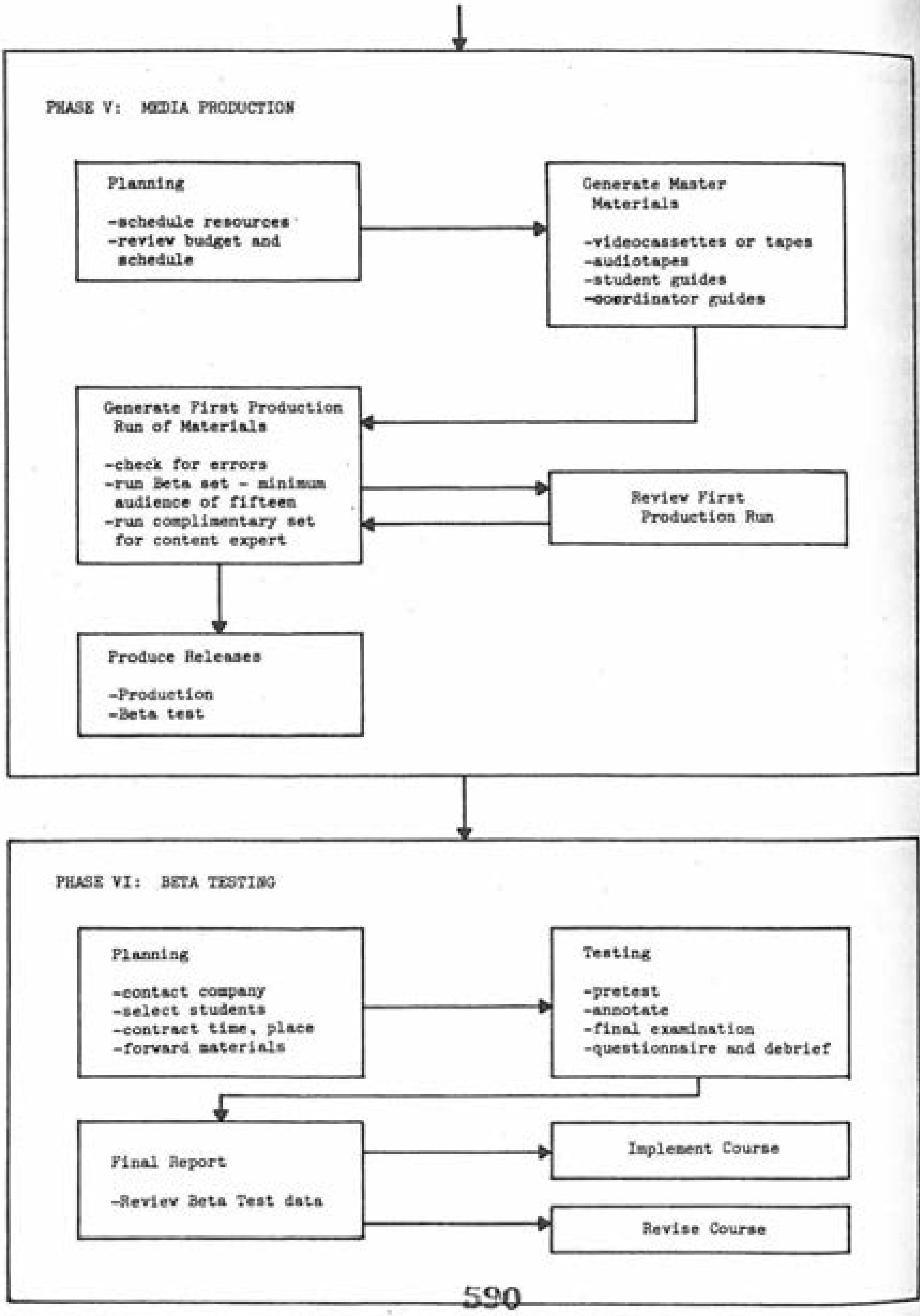
Alpha Test

-find representative student
within or outside of the
corporation
-administer test
-evaluate results and
revise based upon results

↓

Review

-review and approval based
upon results by Director
of Product Development


PHASE V: MEDIA PRODUCTION
Planning
-schedule resources
-review budget and schedule
Generate Master Materials
-videocassettes or tapes
-audiotapes
-student guides
-coordinator guides
Generate First Production Run of Materials
-check for errors
-run Beta set - minimum audience of fifteen
-run complimentary set for content expert
Review First Production Run
Produce Releases
-Production
-Beta test
PHASE VI: BETA TESTING
Planning
-contact company
-select students
-contract time, place
-forward materials
Testing
-pretest
-annotate
-final examination
-questionnaire and debrief
Final Report
-Review Beta Test data
Implement Course
Revise Course

1. Formative evaluation theory was based upon the audiovisual instruction movement of the 1920's and the psychometric movement of the 1930's.

2. Practical uses of formative evaluation was derived from research conducted in the armed forces during World War II.

3. Formative evaluation theory models were not developed until the late 1960's.

4. The industrial and military domains did not provide many models of formative evaluation.

The ASI Process and Model

The fifth and sixth conclusions were based upon the results of Chapter III. They are as follows:

5. The ASI model reflected the corporation's desire to present a systematic approach to the development and evaluation of training materials.

6. The employees of ASI did not always agree with ASI's method of course development and evaluation based upon the results of the survey detailed in Chapter III.

The Theory Model/ASI Model Comparison

The seventh, eighth, and ninth conclusions are based upon the comparison of the theory model in Chapter II and the ASI model in Chapter III. The three conclusions are as follows:

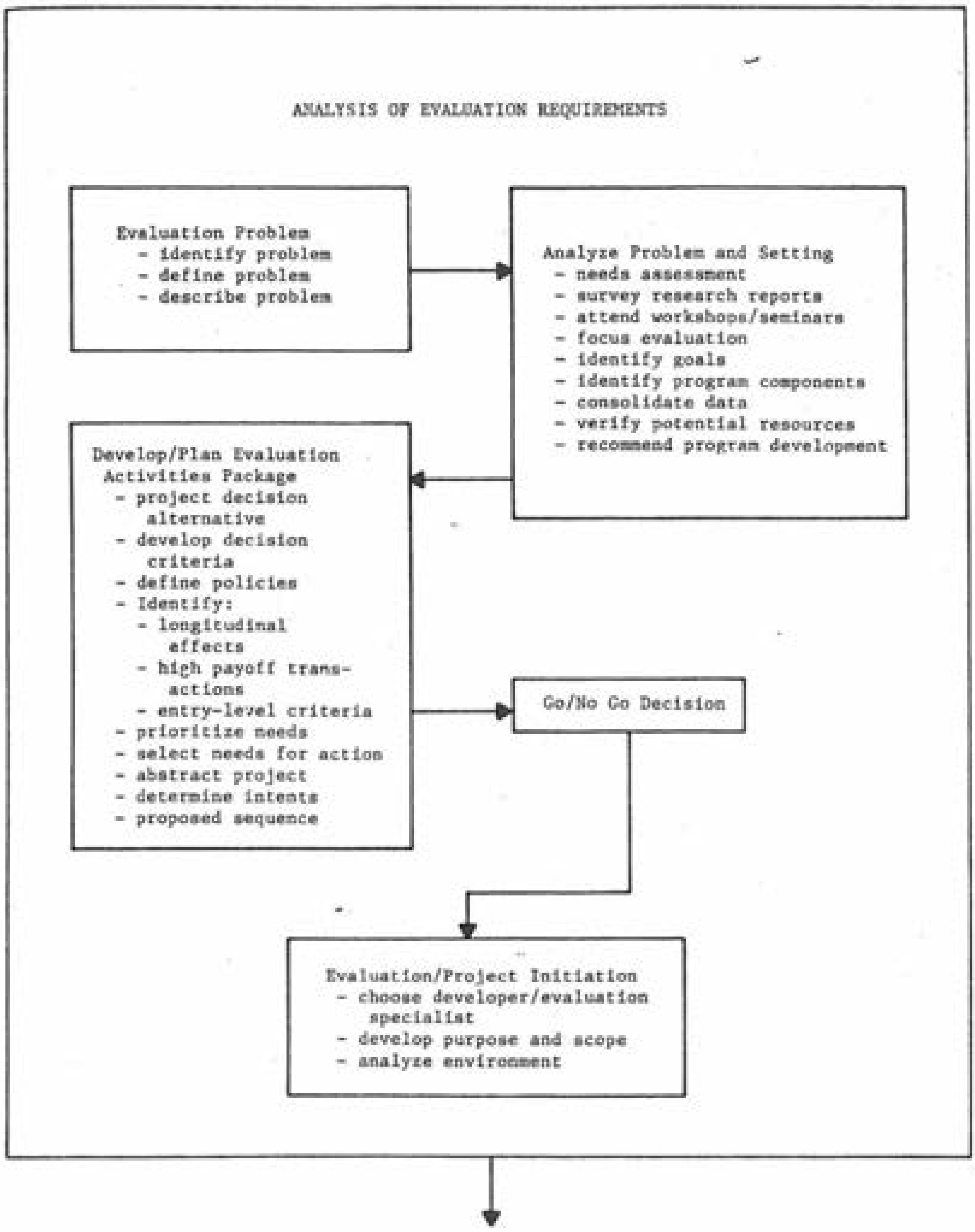
7. On the basis of the findings in Chapter IV, the theory model could have benefitted from interface with the ASI model. The Go/No Go decision point in the ASI model was one of the more significant areas in which the theory model would receive substantial benefit. A second benefit found in the ASI model, but not in the theory, is the step of identifying needs.

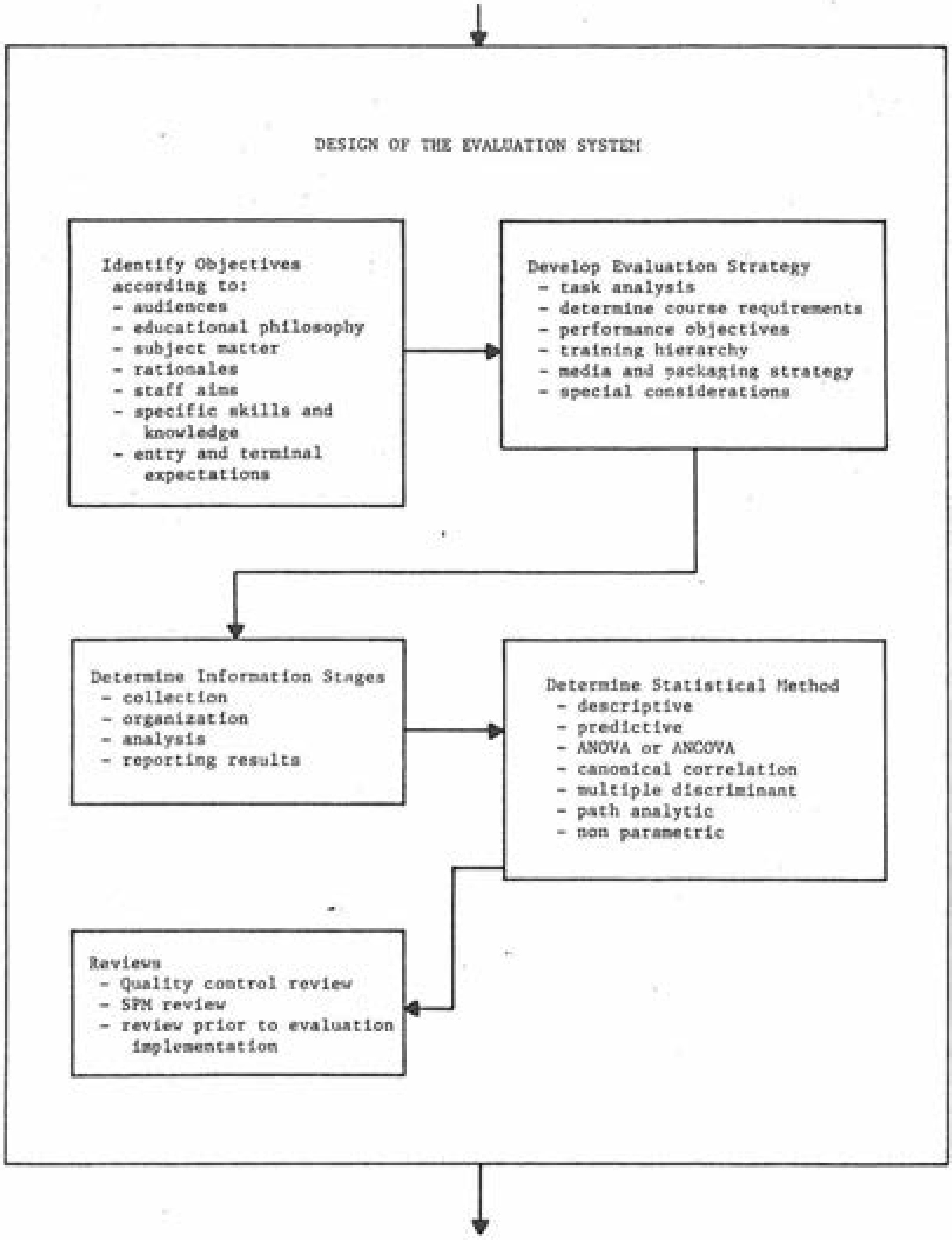
8. Another conclusion gleaned from the results of Chapter IV was that the theory model and the ASI model were similar in significant areas. This was most apparent in the implementation and evaluation stage, as the steps followed in each of the models were roughly equivalent to one another.

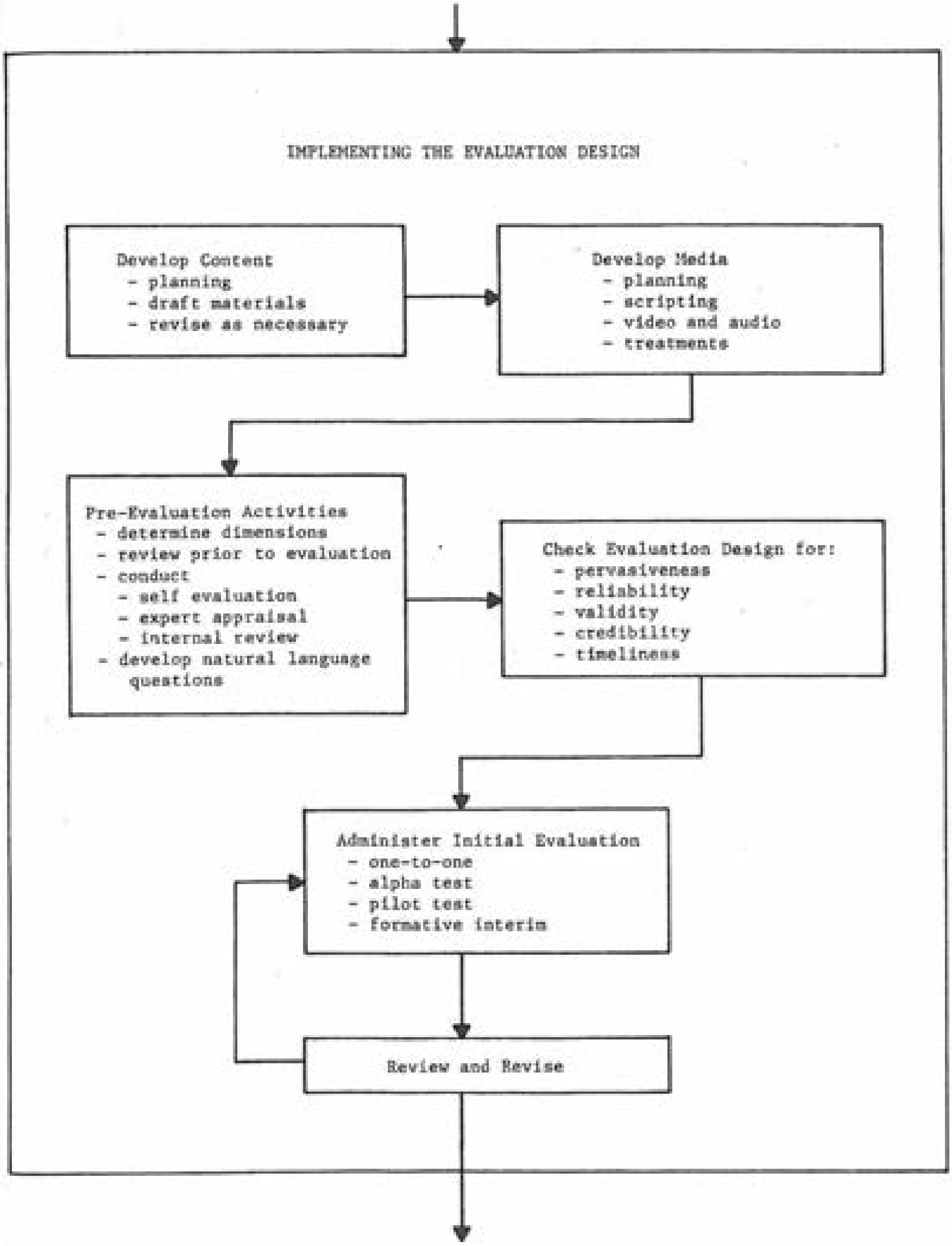
9. The ninth conclusion of this study concerned the ASI design. Based upon the results of Chapter IV, there were a number of steps within the ASI model which could have benefitted from the formative evaluation theory model.

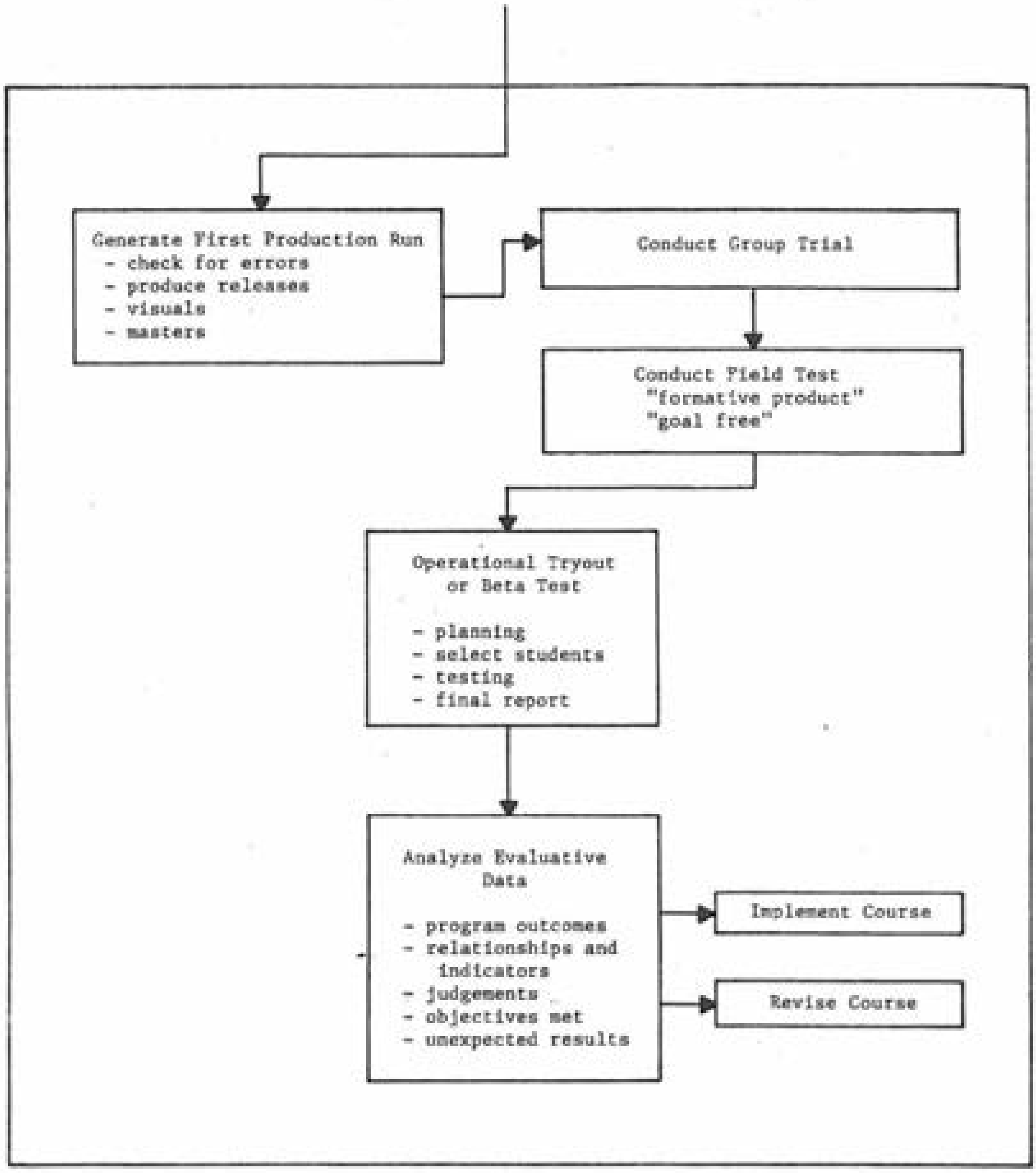
The Combined Formative Evaluation Model (CFEm)

Using the data and incorporating the above conclusions, a combination of the theory model and the ASI model was developed. The result is shown in Figure 5. The advantage of this model is that it is based on research theory and proven applicability in the field.


ANALYSIS OF EVALUATION REQUIREMENTS
Evaluation Problem
- identify problem
- define problem
- describe problem
Analyze Problem and Setting
- needs assessment
- survey research reports
- attend workshops/seminars
- focus evaluation
- identify goals
- identify program components
- consolidate data
- verify potential resources
- recommend program development
Develop/Plan Evaluation Activities Package
- project decision alternative
- develop decision criteria
- define policies
- Identify:
- longitudinal effects
- high payoff transactions
- entry-level criteria
- prioritize needs
- select needs for action
- abstract project
- determine intents
- proposed sequence
Go/No Go Decision
Evaluation/Project Initiation
- choose developer/evaluation specialist
- develop purpose and scope
- analyze environment


DESIGN OF THE EVALUATION SYSTEM
Identify Objectives according to:
- audiences
- educational philosophy
- subject matter
- rationales
- staff aims
- specific skills and knowledge
- entry and terminal expectations
Develop Evaluation Strategy
- task analysis
- determine course requirements
- performance objectives
- training hierarchy
- media and packaging strategy
- special considerations
Determine Information Stages
- collection
- organization
- analysis
- reporting results
Determine Statistical Method
- descriptive
- predictive
- ANOVA or ANCOVA
- canonical correlation
- multiple discriminant
- path analytic
- non parametric
Reviews
- Quality control review
- SPM review
- review prior to evaluation implementation


IMPLEMENTING THE EVALUATION DESIGN
Develop Content
- planning
- draft materials
- revise as necessary
Develop Media
- planning
- scripting
- video and audio
- treatments
Pre-Evaluation Activities
- determine dimensions
- review prior to evaluation
- conduct
- self evaluation
- expert appraisal
- internal review
- develop natural language questions
Check Evaluation Design for:
- pervasiveness
- reliability
- validity
- credibility
- timeliness
Administer Initial Evaluation
- one-to-one
- alpha test
- pilot test
- formative interim
Review and Revise


Generate First Production Run
- check for errors
- produce releases
- visuals
- masters
Conduct Group Trial
Conduct Field Test
"formative product"
"goal free"
Operational Tryout
or Beta Test
- planning
- select students
- testing
- final report
Analyze Evaluative
Data
- program outcomes
- relationships and
indicators
- judgements
- objectives met
- unexpected results
Implement Course
Revise Course

Recommendations for Use

The results of this study yielded three recommendations for future research or applications. They are as follows:

1. One recommendation for use of the results would be that the historical development presented in Chapter II provides an immediate understanding of formative evaluation. Enough information was provided to enable the researcher or practitioner to have a solid understanding of the formative evaluation process and its roots in the educational, industrial and military domains.

2. A second recommendation for use of this study would follow the comparison and contrast of representative systems. Initially, a move toward standardizing the terms and process of formative evaluation could be established. Secondly, existing or future systems could be compared with or modified by the formative evaluation theory model developed in Chapter II.

3. A third recommendation for future use of the study would be to use the results of Chapter II as a text in an evaluation curriculum or course for curriculum developers, curriculum evaluators, instructional design specialists, or anyone involved in the production of instructional packages.

Recommendations for Future Research

The directions of future research in terms of this particular study are many and varied. These may be taken as bases for research in the theoretical as well as the practical domains.

1. The most important direction for future research would be to perform a formative evaluation of any instructional program or package with the combined model presented in Chapter V.

2. Secondly, the theoretical model developed in Chapter II may provide the basis for additional comparisons with the formative evaluation procedures presented in other future models. This would only enhance the literature available on formative evaluation.

3. Thirdly, another direction for further research would to be to design and execute a cost/benefit experimental study involving the theoretical model in Chapter II or the combined model in Chapter V. This would determine whether the added expense of formative evaluation is worth the cost.

4. A fourth area of potential study would be to expand and/or modify the theoretical model presented in Chapter II as well as the combined model presented in Chapter V. This would coincide with establishing a standard formative evaluation model suitable for use in a variety of settings.

5. A fifth area of potential study would be to compare and contrast the formative evaluation procedures of other corporations involved in producing training packages with the theoretical model developed in Chapter II.

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TITLE: ECTJ and Research in Educational Technology

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ECTJ and Research in Educational Technology.

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This brief paper will reflect upon two things. The first is educational technology research and its present state. The second is the role of ECTJ. The paper is not to be construed in any way as official Journal editorial policy, but rather as some personal reflections about where we are and where should be be going.

Dare I begin with a definition? I think it might be useful. For me, educational technology is centrally concerned with design, with, as Simon (1969) puts it, the main focus on the optimization of alternative paths of action. I do not think that this definition is in any way heretical. It is, of course, very close to a definition of technology, given by Galbraith (1967): "The systematic application of scientific or other organized knowledge to practical tasks." This definition suits me well. Galbraith and Simon are essentially saying the same thing. That we have to make the best possible decisions for action, given a particular set of circumstances; and that we have to have a body of knowledge to guide us. While this approach to what we do in our field is clearly rooted in positivism and determinism, the limitations of which are becoming increasingly apparent to educators, it is nonetheless the paradigm that, for now, continues to dominate our activities as educational technologists.

Educational technologists succeed in what they do to the extent that they have access to and understand the body of "scientific or other" knowledge that underpins our field, to the extent that they accurately analyze and understand the practical tasks they are expected to deal with, and to the extent that they are aware of and can use the "systematic" procedures that lead to the best decisions. Educational Technology is an eclectic, even better a systemic discipline in that the strength of the discipline is determined by the strength of its weakest component. In other words, without a sound body of knowledge, techniques for analysing practical tasks, or a set of optimizing procedures, the whole endeavor grinds to a halt. The weakest one of these three components will determine the strength of the entire discipline and the success of the design process.

What is the body of scientific knowledge that we apply systematically to practical tasks? My position is that it is instructional theory. However, when you consider what I believe to be valid sources of instructional theory, you will realize that my position is not as narrow as you might first have thought. Instructional theory can, of course, be built from experimentation, either directly from controlled studies of instruction, or indirectly from controlled studies of learning. Implied here is a fundamental distinction between theories of learning, which are descriptive, and theories of instruction, which are prescriptive. On the other hand, theories of instruction can be built from naturalistic observation of what goes on when students learn and instructors teach, in classrooms or wherever. (A point to be made here is that the impending shift from experimental to naturalistic research methods, while influencing instructional theory, will not necessarily change the deterministic pratices of designers. The way in which knowledge is derived does not effect the use to which it is put.)

As the body of knowledge contained in instructional theory grows, there are two major points that are becoming increasingly clear. The first is that media and communications technologies, as delivery systems, do not make one iota of difference to learning. What do make a difference are features of the formats in which information is cast, and instructional methods, which are both mostly indepedent of media, but which both engage cognitive processes that do have an impact on learning. The second point is that, because human behavior is so utterly unpredictable, the discovery of the optimal method of instruction is well nigh impossible. We can certainly improve the ways in which we select the best method for the given circumstances. However, the chances are that this method will not apply in other situations. As Clark (1983) pointed out recently, we usually deal with sufficient conditions of learning, not necessary conditions. This, of course, points to a weakness in instructional theory in its current state. Ideally, instructional theory should embody necessary conditions of learning. But for now we will have to make do with what we have.

In addition to instructional theory, derived from controlled experiments and from observation of learning and instruction, educational technologists also build theories of design. These are concerned with analyzing and describing the "practical tasks" faced by educational technologists, and with techniques for decision-making. Interestingly, techniques of task and learner analysis are intimately tied to developments in cognitive approaches to instructional theory. As our picture of how people learn is gradually pieced together, so our knowledge of how students learn and use algorithms and how this is affected by the skills and strategies they bring to bear, is improved. The deeper we dig into cognitive processes and skills, the harder it becomes to separate content from mental skill, task from learner analysis. Instructional research informs instructional design.

Instructional decision-making, on the other hand, is considerably complicated by advances in theory. When I look at media selection (method selection?) models, they are all extremely oversimplified in the face of what we now know about learning and instruction. I should add that, in their recent book, Reiser and Gagne (1983) recognize this, and imply that while a selection model will make life easier for designers of certain kinds of tasks, it will not make life perfect. To do this would require that, indeed, instructional theory describe all the necessary conditions of all types of learning, a situation which is a long way off in the future, if we are ever to achieve it.

To summarize, then, we are still flying by the seat of our pants to a degree. Our three tasks of building instructional theory, of developing techniques for analysis of practical tasks, especially learners and cognitive processes, and of developing effective decision-making techniques still have a long way to go. We are at least off the ground. But we have still have to climb to cruising altitude.

ECTJ has a contribution to make in the dissemination of information about all three of our tasks. The journal publishes articles that contribute to instructional theory, either by reporting experiments or by putting forward theoretical positions. It also publishes articles on design theory, that is on how we analyze practical tasks and how we make instructional decisions. However, to date, there has been a tendency to publish far more articles of the instructional theory type than of the other types.

There are a number of reasons for this. First, there is still the perception that for purposes of promotion in universities the empirical "hard science" paper is somehow more respectable than papers to do with practice. However, what Schon (1983) has dichotomized as "Technical rationality" and "Reflection in action" are both equally important ingredients in our profession. Unfortunately professional schools are usually low on the totem pole in universities, which means that it will take time and effort to get contributions to practice recognized as equal in value to contributions to theory.

Second is the vicious circle in which journals tend to get caught up. A journal's editorial policy is inferred mainly from what people see it publishing, and only minimally from policy statements that it prints, usually under "Instructions to authors". I think ECTJ is seen to be a place to publish articles contributing to instructional theory. This is certainly true if the proportion of manuscripts that are submitted is anything to go by. It is not that articles in the other categories (analysis, design and so on) are rejected more frequently by the reviewers. We just do not get them. I would like to add a word about articles on computer applications to education. We should be publishing papers in this area. But to date we have not received one good report of a computer study or project. I find this surprising, if not alarming. Again, I am sure this is because we are not thought of as a "computer journal".

As a final example, we have received a number of manuscripts about naturalistic research methods. However, we have not received one good report of a study that used them! Either lots of people are talking about these methods, and no-one is doing naturalistic research. Or people are sending their manuscripts elsewhere. I suspect the latter, again because we are not seen to be the place to publish naturalistic studies. I should also add that a lot of people (until recently myself included) still consider such research to be less rigorous and of a lesser quality. There is work to be done here, and I think RTD has an important role to play.

If ECTJ is seen to be, and by virtue of that fact actually is a journal that reports mostly instructional theory, then how is it different from other journals that do this, such as JEP? I think in two ways. The first is, ironically, the residue from the "Audio-Visual" orientation that our field used to have. The research we publish tends frequently to investigate the "message format" variables of instructional theory. We carry a lot of articles on pictures, visualization, audio, and so on. So, for people who want to read about or publish a paper on how the form given to information affects learning, ECTJ is the first place to turn.

The second difference between ECTJ and other journals is the degree of emphasis given the extension of results into the design process. I have noticed that, for the most part, our authors tend to pay attention to application of their research to the practical tasks of education. This is encouraging, because it has within it the germ of that shift from the theoretical to the practical, from "Technical rationality" to "Reflection in action", that I alluded to above. I am particularly pleased to see an author do a super job of presenting a study conducted in a "real world" setting, and saying so. Of course there is a trade-off of internal for external validity. But provided this is made known to the readers with all frankness, then I have no problem with it. As we see more naturalistic research, this matter will crop up more often.

My optimism about the future of the Journal, after almost a year as its editor, is average to above average, though not wildly positive. This note of caution has its roots in what I have just said: we are not publishing enough articles in the analysis and design categories which makes our field unique; we are not doing so because we we are not getting the manuscripts; people are not submitting the manuscripts because we are seen to be primarily a journal of instructional theory, and because papers of this type are not thought of as highly as basic research papers in academic communities. Let me add straight away that there is nothing wrong with us publishing instructional theory. I just feel that we need to publish more in design and application as well.

I have ignored the type of manuscript that we also receive from time to time to do with the scociological aspects of our discipline. I am referring to articles on the social impact of educational technology, the whole area of innovation and change, organization and management, the history of our field, and so on. I must apologize if in leaving these areas to last I have seemed to belittle them. That is not my intention. It seems that any discipline will do well to examine itself and its impact from time to time. ECTJ must support these efforts. But again, we receive far fewer submissions of papers dealing with these topics than of papers on other topics. That is a fact over which we have little control.

As an editor, I often wish I could make people write and submit manuscripts. Of course, we have the annual review papers, funded by ERIC at Syracuse. But these do not allay my frustration. An editor can solicit, can weadle and encourage. But an editor cannot compel. The future of the Journal is therefore in the hands of the members of AECT and of the broader research and development community that feeds it. We must all encourage these consituencies to allow us to publish what it is they are up to. The journal, after all, has a responsibility to communicate to members of AECT the latest ideas and discoveries of the field. These may not be occuring under the auspices of people who think of themselves as educational technologists before all else. But they are doing work of importance to our profession and we must pass it on to our colleagues.

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