INFORMATION TO USERS

This was produced from a copy of a document sent to us for microfilming. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help you understand markings or notations which may appear on this reproduction.

1. The sign or “target” for pages apparently lacking from the document photographed is “Missing Page(s)”. If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure you of complete continuity.

2. When an image on the film is obliterated with a round black mark it is an indication that the film inspector noticed either blurred copy because of movement during exposure, or duplicate copy. Unless we meant to delete copyrighted materials that should not have been filmed, you will find a good image of the page in the adjacent frame.

3. When a map, drawing or chart, etc., is part of the material being photographed the photographer has followed a definite method in “sectioning” the material. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.

4. For any illustrations that cannot be reproduced satisfactorily by xerography, photographic prints can be purchased at additional cost and tipped into your xerographic copy. Requests can be made to our Dissertations Customer Services Department.

5. Some pages in any document may have indistinct print. In all cases we have filmed the best available copy.
KARP, CHERYL LEE DAVISON
BEHAVIORAL AND SYMBOLIC MODELING AS FEEDBACK
IN THE ACQUISITION OF HIERARCHICALLY ARRANGED
SKILLS.

THE UNIVERSITY OF ARIZONA, PH.D., 1978
BEHAVIORAL AND SYMBOLIC MODELING AS FEEDBACK IN THE
ACQUISITION OF HIERARCHICALLY ARRANGED SKILLS

by
Cheryl Lee Davison Karp

A Dissertation Submitted to the Faculty of the
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY
In Partial Fulfillment of the Requirements
For the Degree of
DOCTOR OF PHILOSOPHY
In the Graduate College
THE UNIVERSITY OF ARIZONA

1978
I hereby recommend that this dissertation prepared under my direction by Cheryl Lee Davison Karp entitled Behavioral and Symbolic Modeling as Feedback in the Acquisition of Hierarchically Arranged Skills be accepted as fulfilling the dissertation requirement for the degree of Doctor of Philosophy.

Dissertation Director

As members of the Final Examination Committee, we certify that we have read this dissertation and agree that it may be presented for final defense.

Final approval and acceptance of this dissertation is contingent on the candidate's adequate performance and defense thereof at the final oral examination.
STATEMENT BY AUTHOR

This dissertation has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this dissertation are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: Cheryl L. Karp
ACKNOWLEDGMENTS

I wish to express appreciation to Dr. John R. Bergan for his advice, support, and encouragement. Appreciation is also extended to Dr. Thomas Kratochwill and Dr. Anthony Cancelli for their sincere interest and support during my program of study. Special thanks are due Al Neumann for his assistance in analyzing the data. I would also like to thank St. Cyril's and St. Ambrose schools for their cooperation and for the use of their schools in my study.

Sincere gratitude is extended to my twin sister, Carol Romano, for her endless help in conducting this study. Appreciation is also extended to my parents and children for their understanding and support throughout my studies. My deepest appreciation is reserved for my husband, Len, for his constant encouragement, love, and moral support.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td>v</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>vi</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2. REVIEW OF THE LITERATURE</td>
<td>6</td>
</tr>
<tr>
<td>Studies Demonstrating Evidence of the Efficacy of Modeling Procedures</td>
<td>6</td>
</tr>
<tr>
<td>Studies Reviewing the Effects of Feedback on Learning</td>
<td>8</td>
</tr>
<tr>
<td>Studies Utilizing Modeling as Feedback</td>
<td>13</td>
</tr>
<tr>
<td>Validation Studies on Hierarchically Arranged Tasks</td>
<td>15</td>
</tr>
<tr>
<td>Summary</td>
<td>23</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>23</td>
</tr>
<tr>
<td>3. METHOD</td>
<td>24</td>
</tr>
<tr>
<td>Subjects</td>
<td>24</td>
</tr>
<tr>
<td>Tasks</td>
<td>24</td>
</tr>
<tr>
<td>Procedures</td>
<td>25</td>
</tr>
<tr>
<td>Measures</td>
<td>26</td>
</tr>
<tr>
<td>4. RESULTS</td>
<td>27</td>
</tr>
<tr>
<td>5. DISCUSSION</td>
<td>30</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>32</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Analysis of covariance</td>
<td>27</td>
</tr>
<tr>
<td>2. Tukey test for group levels</td>
<td>28</td>
</tr>
<tr>
<td>3. Tukey test for skill levels</td>
<td>28</td>
</tr>
</tbody>
</table>
This study examined the effects of behavioral (demonstration), symbolic (verbal), and a combination of behavioral and symbolic modeling as feedback in the acquisition of sequentially related skills.

Four sequential learning tasks comprising a fraction hierarchy were utilized in this study. Seventy-two children who possessed none of the skills targeted for investigation were assigned to one of four groups. For children in the first group, responses were followed by feedback in the form of behavioral modeling (demonstration of the correct response). Children in the second group were given symbolic modeling feedback in the form of a verbalized rule for fractions following their responses. Behavioral plus symbolic modeling was given as feedback following responses for children in the third group. Children in the fourth group served as a control and were not given feedback by the examiner following their responses.

A 4 x 4 repeated measures analysis of variance (groups and skills) with one covariate (pretest score) revealed that the method of feedback given to children regarding fraction concepts has a significant effect on learning.

Post hoc testing using the Tukey Test indicated that behavioral modeling and behavioral plus symbolic modeling was a more effective method of feedback than symbolic modeling and no feedback. The Tukey
Test also revealed pair-wise comparison of the skills to be significantly different, resulting in skills which are distinct from each other, and not collapsing together as the same skill. This is a discriminating and essential factor in sequentially ordered skills.
CHAPTER 1

INTRODUCTION

It has been proposed by Gagné (1968) that development is based upon cumulative learning whereby any subordinate skill in a learning sequence may mediate transfer to a next higher-order, superordinate, skill. The method by which Gagné (1962) suggests ordering these skills is by means of breaking down a designated skill into its component, subordinate, skills. This process results in a hierarchy of intellectual skills, ordered in such a way as to mediate positive transfer from lower-order, subordinate, skills to higher-order, superordinate, skills (Gagné, 1962, 1968, 1970).

Gagné's views have stimulated a great deal of research theory relative to diagnostic teaching as well as curriculum development. The teaching of skills in a sequentially developed program may be accomplished by means of a number of instructional methods. One method that has been demonstrated to be effective utilizes modeling as a teaching technique (Bandura, 1969, 1971; Bergan, Karp, and Neumann, 1978).

Bandura (1977) discusses the effects of modeling to be a highly effective means of establishing abstract or rule-governed behavior (Bandura, 1971). Research studies have shown modeling effective in altering children's sentence construction (Bandura and Harris, 1966; Odom, Liebert, and Hill, 1968), as well as children's sentence pattern

Modeling has also been employed to teach children question-asking skills (Henderson and Garcia, 1973; Zimmerman and Pike, 1973), as well as abstract classes for question asking (Rosenthal and Zimmerman, 1972; Rosenthal, Zimmerman, and Durning, 1970) and question-asking strategies (Laughlin, Moss, and Miller, 1969). Modeling has also proven successful in teaching children criteria for moral judgment (Bandura and McDonald, 1963) and creativity (Zimmerman and Dialessi, 1973). These, as well as other studies, have evidenced modeling as an efficacious method of teaching concepts.

A major function of modeling influences pointed out by Bandura (1977) is to transmit feedback to observers on how responses can be acquired. This information may be communicated by means of physically demonstrating, pictorial representation, or verbal description.

Kulhavy (1977) identifies "feedback" as any of the numerous procedures that are implemented to convey to a learner the correctness or incorrectness of an instructional response. This definition does not limit feedback to "yes-no" responses, but also includes substantial corrective or remedial information that may extend or even add to the content which exists.

A study by Swanson (1976) addresses the issue of performance and feedback in connection with observational learning. The results indicated that modeling combined with performance or modeling combined with performance and feedback was a more effective method of instruction.
than was modeling alone. It should be mentioned that televised modeling as opposed to live modeling was used, which could have a bearing on feedback.

Jeske (1978) utilized live modeling in studying the effects of modeling, imitative performance, and modeling feedback on the acquisition of hierarchical seriation learning. The results of his study revealed that the modeling plus performance and modeling feedback condition had the greatest effect on learning. These results indicate the importance of feedback as a component in teaching sequentially ordered seriation tasks. The feedback in this study was nonverbal. It was suggested by Jeske that the usual verbal feedback may lead to greater gains in knowledge for young children than behavioral modeling alone.

Many studies investigating modeling as feedback utilize sequentially ordered skills in their studies (Swanson, 1976; Jeske, 1978). Although Gagné's basic propositions concerning the nature of hierarchically ordered skills has been widely accepted, there has been a considerable amount of controversy as to how learning hierarchies should be validated.

Resnick, Wang, and Kaplan (1973) implemented a strategy for validation which parallels that of Gagné (1962, 1968) in their study of task analysis in curriculum design. The ordering of objectives within each unit are based on detailed analyses of each task.

According to Resnick, Wang, and Kaplan (1973), the first step in performing an analysis is to describe in as much detail as possible the actual steps involved in skilled performance of the task. The
second stage involves considering each component separately and identifying prerequisite skills. Analysis is terminated when a level of behavior is reached that can be assumed in most of the population in question, or when another terminal behavior in the set under analysis appears as a prerequisite.

Psychometric methods have been suggested to validate curriculum hierarchies (Resnick, 1973; Wang, 1973). Two validation questions were entertained in Wang's (1973) study. The first was addressed to the hierarchical order between the units of instruction; the second question was directed to the sequential order within each unit. Wang (1973) points out that the psychometric method of validation is only indirect, suggesting a likely sequence of acquisition, but not directly testing transfer effects among objectives. Wang (1973) therefore suggests the use of psychometric studies in organizing a general curriculum area, while using transfer of training studies for analyzing the relationships among small subsets of objectives.

White (1974) suggests the implementation of a nine-stage procedure for validating learning hierarchies. This procedure substantiates Gagné's theory that hierarchies do represent patterns of prerequisite intellectual skills leading to the terminal skill or skills inherent in a specific learning task (Gagné, 1962).

White (1973, 1974) has identified several weaknesses in validation studies of learning hierarchies and suggests either maintaining Gagné's original design, eliminating or at least minimizing its shortcomings or following his more rigorous method.
Past research has failed to investigate the possibility of sequential dependencies among learning tasks not related in a prerequisite manner. This is obviously due to the type of validation procedures chosen in past research studies of the learning hierarchy model. Another shortcoming of the hierarchy model lies in the absence of investigation into the possibility of correlated influences within items of the hierarchy. Research into structural analysis and response scaling (Goodman, 1975) may account for the shortcomings noted in the learning hierarchy model proposed by Gagné. Further research is needed in this area.

The present study examines the influence of feedback variations on the acquisition of hierarchical fraction skills. Behavioral modeling (demonstration), symbolic modeling (verbal), behavioral plus symbolic modeling, are methods of feedback investigated in this study. A group receiving no feedback was also examined.

The present study utilized a hierarchy that had been validated by response scaling (Goodman, 1975) prior to this study. That issue was not investigated in this study, although the four skills are examined as a main effect to determine whether they are significantly different from each other, which would be expected with sequentially ordered skills, or whether they collapse together resulting in less than four distinct skills. A review of the literature examines validation techniques for hierarchically arranged skills.
CHAPTER 2

REVIEW OF THE LITERATURE

Studies Demonstrating Evidence of the
Efficacy of Modeling Procedures

The effectiveness of modeling in altering children's behavior is well documented by both laboratory and field studies. The social-learning theory proposed by Bandura (1969, 1971, 1977) has been used to explain the acquisition of abstract or rule-governed behavior (Zimmerman and Rosenthal, 1974b). A model is observed performing various responses incorporating a certain rule or principle. Observers are then later tested under similar yet unfamiliar situations in which they would apply what they have learned to the new situation. Therefore, the observer is able to abstract and code the rule which governs the model's behavior, and apply this rule to novel situations. This procedure has been evidenced to be effective in altering children's sentence construction (Bandura and Harris, 1966; Odom, Liebert, and Hill, 1968; Liebert, Odom, Hill, and Huff, 1969). Results of the Liebert, Odom, Hill, and Huff (1969) study lend support to the general hypothesis that children's adoption of language rules may be influenced by a combination of modeling and reward procedures and provide data concerning the relationship of this influence to age. This study also indicates the importance of prerequisite skills in processing novel information accurately.
In addition to sentence construction, modeling has also proven effective in influencing children's sentence pattern and verb tense use (Carroll, Rosenthal, and Brysh, 1972; Rosenthal and Carroll, 1972; Rosenthal and Whitebrook, 1970).

Modeling has also been employed to teach children question-asking skills (Henderson and Garcia, 1973; Zimmerman and Pike, 1973), as well as abstract classes for question asking (Rosenthal and Zimmerman, 1972a; Rosenthal, Zimmerman, and Durning, 1970). In examining information-processing in children, Laughlin, Moss, and Miller (1969) studied question-asking strategies. In their research the authors distinguished two basic types of strategies or problem-solving methods used by children: (a) hypothesis scanning, and (b) constraint seeking. Hypothesis scanning referred to asking a series of unrelated specific questions, while in constraint seeking the child asked a question comprehensive enough to include at least two objects. The subjects were first exposed to a model using these question-asking strategies and then the subjects were encouraged to ask questions pertaining to a task they were instructed to complete. The findings in this study were consistent with other studies which emphasized the importance of modeling in learning (Bandura, 1969, 1977). Children exposed to the models were more likely to use the information-processing strategy employed by the model on subsequent trials employed by the child.

Modeling has not been restricted to the areas of language development; it has proven quite successful in teaching children such diverse concepts as criteria for moral judgment (Bandura and McDonald,

A study done by Bergan, Karp, and Neumann (1978) examined the effects of a brief parent training package on parental application of behavioral procedures during child instruction of various modeling techniques, such as behavioral (demonstration), symbolic (verbal) modeling, and prompting. Results of the analyses indicated that parents in experimental and control conditions did differ in their teaching behaviors. Regression analysis showed that parent training produced differences in child learning in one of the two skills targeted for instruction.

These and other studies have evidenced modeling to be an effective method of teaching concepts. A major function of modeling influences pointed out by Bandura (1977) is to transmit feedback to observers on how responses can be acquired. This information may be communicated by means of physically demonstrating, pictorial demonstration, or verbal description.

Studies Reviewing the Effects of Feedback on Learning

Kulhavy (1977) refers to "feedback" as any of the numerous procedures that are used to tell a learner if an instructional response is
right or wrong. This definition would encompass simple "yes-no" responses as well as substantial corrective or remedial information that may extend or even add to the content which exists.

As pointed out by Kulhavy (1977), increments in the complexity of feedback should act to magnify learning yields. Thus far, research in this area yields inconsistent results. Several studies comparing relatively simple feedback to more extensive formats often show no posttest differences (Bisbicos, 1965; McDonald and Allen, 1962; Merrill, 1965; Roe, 1962).

On the other hand, other work has shown an increase in performance by making feedback so extensive that it constitutes a partial review of the lesson (Block and Tierney, 1974; Merrill and Stolurow, 1966).

In reviewing the subject of feedback, the principle of reinforcement is often explored. It appears that the defining characteristics of the term "reinforcement" determine its function in regards to feedback. If one defines reinforcement as increasing the probability that a response will be repeated on subsequent occasions, it is understandable that feedback is often viewed as a reinforcer (Skinner, 1968; Krumboltz and Weisman, 1962). However, Kulhavy (1977) contends that research does not support the notion that feedback typically acts in a reinforcing manner (Anderson, 1967; Annet, 1964; Smith and Smith, 1966). According to Kulhavy and Anderson (1972), if feedback was reinforcing, immediate feedback would be expected to increase the likelihood of repeating correct responses. This was not found to be the case in
their research findings. Skinner (1968), on the other hand, stressed
the reinforcing qualities of feedback in teaching machines.

Bandura (1969) cites research stressing the important role
reinforcement plays in feedback. Several studies pointing out the con­trol exercised by interviewers over the verbal behavior of subjects
were examined (Kanfer, 1968; Krasner, 1962; Salzinger, 1959). These
studies utilized selective responding (nodding, smiling, repeating, or
paraphrasing the subject's remarks, or simple verbal utterances with
positive connotations).

Staats' (1965) study found reinforcement procedures used in
conjunction with programmed instructional materials to be very effective
in the acquisition of reading behavior. Immediate and continuous feed­
back of the correctness of the response was given, as well as an incen­
tive system to maintain attention. The added dimension of the incentive
system makes it difficult to ascertain whether feedback in itself was
reinforcing.

Therefore, it seems possible that what needs to be explored is
the defining characteristics of feedback. It appears quite evident
that the type of feedback may be the issue rather than whether or not
to label it generally as a reinforcer or not. It is also quite apparent
that, according to the definition of reinforcement, sometimes feedback
may be reinforcing, while other times it may not be. What is reinforc­ing to one person may not be to another person. This factor could
influence the outcome of several studies examining incentives in rela­
tion to changes in behavior.
In examining why many studies show that feedback does not increase learning (Feldhusen and Birt, 1962; Hough and Revsin, 1963; Krumboltz and Weisman, 1962; McDonald and Allen, 1962; Moore and Smith, 1961, 1964; Rosenstock, Moore, and Smith, 1965; Sullivan, Baker, and Schutz, 1967; Sullivan, Schutz, and Baker, 1971; Wentling, 1973), Kulhavy (1977) points out that in most of these studies yielding no effect for feedback, the subjects were either allowed to see the feedback before responding or were so heavily cued and prompted that they were able to answer correctly with only a cursory reading of the content. A second problem examines the availability of correct answers. When presearch availability is high, students are able to simply copy the responses and bypass most of the instruction, yielding little learning. On the other hand, when availability is low, students must study the material in order to produce an answer, yielding greater learning (Kulhavy, 1977). Therefore, Kulhavy concludes that availability of the material must be low and the instructor should do all in his power to reduce presearch availability so that feedback works primarily to teach content, not copying.

In examining how feedback facilitates learning when factors such as presearch availability are controlled, Kulhavy (1977, p. 219) suggests that feedback functions in two ways: "as a device for acquiring data about how accurately a system is working, and as a means for identifying and correcting error messages." Kulhavy (1977, p. 219) goes on to say that "feedback will have one of two effects on each response that a student makes: (a) to let him know when he is right, and
(b) to correct him (or let him correct himself) when he is wrong."

This information-processing model assumes that the student possesses, and is capable of using, at least some prior knowledge related to the material being studied. This takes into account the concept of generalization and positive transfer (Gagné, 1968).

As will be discussed later in reviewing hierarchy studies, Gagné (1968) proposes that skill acquisition is based on a cumulative learning model whereby any stage of a learning sequence may mediate transfer to a next higher-order, superordinate, skill.

In a comparison of feedback regarding correct and incorrect responses on concept acquisition, Buss and his associates repeatedly found that telling a subject when he was wrong yielded higher criterion performance than confirming correct answers (Buss, Braden, Orgel, and Buss, 1956; Buss and Buss, 1956; Buss, Weiner, and Buss, 1954). Another study examining the corrective effect of feedback was done by Travers, Van Wagenen, Haygood, and McCormick (1964). Various feedback combinations to teach school children German vocabulary words were examined. Results indicated that children who were told that a response was wrong and who were then corrected did far better than children who received a simple "yes" or "no" following each response.

Kulhavy (1977, p. 224) contends that, in terms of instructional characteristics, "one should assure that the material used is appropriate for the learner population, and that the learners possess the necessary entry information to begin instruction. Next, feedback having a low availability profile should be provided following each response."
Kulhavy (1977) touches on the idea that a student arranges a hierarchy of confidence in the alternatives presented, and based on the interaction between their initial confidence level and the accuracy of their answer, the behavior they engage in will be directly related to the feedback required. In other words, if they have a high level of confidence, they will require little or no feedback. This has been supported by a research study conducted by Kulhavy, Yekovich, and Dyer (1976). Further research into the area or the type or intensity of feedback and the complexity of the skill involved is warranted to explore this area.

**Studies Utilizing Modeling as Feedback**

A study examining relational learning of a size concept (Gollin, Moody, and Schadler, 1974) utilized informative feedback in their research with four and five year old children. Their method consisted of instructing children to find a terminal position object (smallest) and then instructing them to find a middle position object (next smallest) and giving them feedback as to the correctness or incorrectness of their choices. Results indicated that four and five year olds were able to identify middle position objects when they used a reference point and received corrective feedback.

Merrill (1965), in a study utilizing programmed instruction, used symbolic modeling as feedback by means of a written response indicating correctness or incorrectness of the learner's responses and provided review. Merrill's method of feedback/review included general review after the first error and specific review after the second error.
This procedure continued until the learner responded with the correct answer. This method was found in a later study by Merrill and Stolurow (1966) not to be as effective as feedback with specific review without general review. Merrill, Barton, and Wood (1970) eliminated general review and used only feedback with specific review in repeating Merrill's first study (Merrill, 1965). This time results were opposite of those found in the previous study. The results in this study indicate that compared with the no review group, the group receiving feedback with specific review took successively less time per frame and also increased learning efficiency.

Swanson (1976) addressed the issue as to the role that variables such as feedback and performance play in the acquisition of knowledge. The purpose of her study was to discover whether or not training in a seriation task would facilitate performance on a transitivity task. Four groups were used. Children in the first group observed a videotaped model and were allowed to covertly rehearse what they had observed. Children in the second group viewed the same videotapes and were allowed to overtly rehearse what they observed. Children in the third group observed the videotaped model, overtly rehearsed what they had viewed and were given feedback concerning their responses. The fourth group served as a control. Results indicated that modeling combined with performance or modeling combined with performance and feedback revealed a significant gain while modeling alone did not result in significant gains. Jeske (1978) points out that televised modeling as opposed to live modeling was used, therefore, feedback may have been
somewhat redundant since subjects could have compared their responses to a frozen video image.

Jeske (1978) utilized live modeling in studying the effects of modeling, imitative performance, and modeling feedback in the acquisition of hierarchical seriation learning. Results of the treatment conditions revealed that the modeling plus performance and modeling feedback condition had the greatest effect on the learning tasks. These results indicate the importance of feedback as a component in teaching sequentially ordered seriation tasks. The feedback in this study was nonverbal. It was suggested by Jeske (1978) that the usual verbal feedback may lead to greater gains in knowledge than demonstration alone for young children.

These and other studies have indicated the importance of modeling feedback in the acquisition of knowledge and therefore appears to be a viable format for the research undertaken here.

Validation Studies on Hierarchically Arranged Tasks

Gagné introduced the concept of a learning hierarchy in 1962 when he and his co-workers, beginning with a final task, asked the following question: "What kind of capability would an individual have to possess if he were able to perform this task successfully, were we to give him only instruction?" (Gagné, 1962, p. 356). By means of this process, the task is broken down into simpler and more general subordinate skills, constituting a hierarchy of knowledge.
In discussing his theory of knowledge acquisition, Gagné (1962) proposed that the learning sets in a hierarchy are mediators of positive transfer from lower-level learning sets to higher-level tasks. He hypothesized that specific transfer from one learning set to another standing above it in the hierarchy will be zero if the lower one cannot be recalled and will range up to 100% if it can be.

Gagné's views have stimulated a great deal of research relative to diagnostic teaching and curriculum development. Although his basic propositions concerning the nature of learning hierarchies has been widely accepted, there has been a considerable amount of controversy as to how learning hierarchies should be validated.

Task analysis, which is an informal, logical process, is generally used as a starting point to the validation of learning hierarchies. Glazer and Resnick (1972) use the term task analysis to describe tasks in terms of the demands they place on such basic psychological processes as attention, perception, and linguistic processing. They stress the need to move from "how" learning occurs, to techniques for determining the content and properties of "what" is learned.

Resnick, Wang, and Kaplan (1973) discuss how the ordering of objectives within each unit is based on detailed analyses of each task in their study of task analysis in curriculum design. The aim of their research was to develop a systematic method of validating learning hierarchies so that instructional programs could be designed that would provide an optimal match for a child's natural sequence of acquisition. The strategy implemented parallels that of Gagné (1962, 1968), which
involves positive transfer from lower-level tasks to higher-level tasks and higher-level performance reliably predicting ability to perform lower-level tasks.

According to Resnick, Wang, and Kaplan (1973), the first step in performing an analysis is to describe in as much detail as possible the actual steps involved in skilled performance of the task. The second stage involves ordering these skills by means of breaking down a designated skill into its component, subordinate, skills. This identifies the prerequisite skills. The next step would be to further analyze the prerequisite skills. Analysis is terminated when a level of behavior is reached that can be assumed in most of the population in question, or when another terminal behavior in the set under analysis appears as a prerequisite.

By means of this systematic process, Gagné (1962) identified nine separate entities of subordinate knowledge, arranged in a hierarchical order leading to the terminal task. Gagné (1962, p. 356) hypothesized that: "(a) no individual could perform the final task without having these subordinate capabilities, and (b) that any superordinate task in the hierarchy could be performed by an individual provided suitable instructions were given, and provided the relevant subordinate knowledges could be recalled by him." After teaching the skills to seven children, Gagné (1962) observed that none of them acquired a skill without also acquiring all of the skills that were hypothesized as subordinate to it in the hierarchy, substantiating his hypothesis.
In a study of mathematics learning, Gagné and Paradise (1961) investigated some hypotheses about productive learning. While explaining exceptions to the hierarchy in the research they conducted, Gagné and Paradise (1961, p. 9) outlined three causes of apparent exceptions as "(a) errors of measurement, (b) delay in testing, and (c) errors in the particular hierarchy which had been constructed." White (1973, p. 363) makes note that "the nature of hierarchy research tends to produce a proportion of invalid connections in postulated hierarchies, because investigations can only lead to the rejection of connections, not to identification of previously overlooked ones."

Gagné, Mayor, Garstens, and Paradise (1963) created another hierarchy for mathematical subject matter. The purpose of their study was to test the effects of variation in certain theory-relevant features of a learning program on the progress of learning and resulting performance of individuals to whom the program was administered. The variables of recallability and integration were examined. The results of this study support previous research (Gagné, 1962; Gagné and Paradise, 1961) that acquisition of learning sets at successively higher stages of the hierarchy is dependent upon prior mastery of subordinate learning sets. Evidence has also been presented to show that the subordinate learning sets in a hierarchy function to mediate positive transfer to higher-level learning sets.

Wang (1973) discusses the use of psychometric methods to validate curriculum hierarchies. Two validation questions were entertained. The first was addressed to the hierarchical order between the units of
instruction; the second question was directed to the sequential order within each unit. The particular curriculum sequences discussed here are drawn from the 1969-1970 revision of the Primary Education Project's Quantification Curriculum (Wang, 1973).

According to Wang (1973, p. 56), "the applicability of psychometric data to instructional design is only indirect, suggesting a likely sequence of acquisition, but not directly testing transfer effects among objectives. Psychometric studies, however, have the advantage of being able to test relationships among a relatively large number of learning objectives within a single study." For this reason, Wang (1973) suggests the use of psychometric studies in organizing a general curriculum area, while using transfer of training studies for analyzing the relationships among small subsets of objectives.

In his review of validation studies of learning hierarchies, White (1973, 1974) identified five weaknesses:

1. The component elements that comprised the hierarchy were often loosely defined.

2. Some of the studies suffered from a small sample size.

3. Often, the use of only one question per element tested the subject's acquisition of a task. This does not take into account the element of chance errors or successes.

4. In some studies the elements of the hierarchy were taught to a group of subjects, who were then tested on all the elements together after the teaching was completed. In other studies instruction was omitted and subjects were only tested on their
possession of the elements. Results obtained by Gagné and Bassler (1963) suggest that under either of these procedures it is probable that postulated connections between elements may be wrongly accepted or rejected.

5. The studies lack a test of hierarchical dependence which takes account of errors of measurement.

White (1973) mentions three reasons why there may be exceptions to a hierarchy. First, exceptions to the hierarchical connections could have been a result of errors of measurement. Second, random forgetting could have taken place as a result of a delay between learning the elements and the test of their possession. Third, errors in the particular hierarchy which has been constructed could account for exceptions. White mentions the possibility of a fourth overriding source: complete failure of the hierarchy model.

White (1973) summarizes that no meaningful quantitative conclusion has been reached about the validity of even one step in any hierarchy. He suggests either maintaining Gagné's original design, eliminating or at least minimizing its shortcomings or to follow his more rigorous method.

White (1974) suggests the implementation of a nine-stage procedure for validating learning hierarchies:

Stage 1--Define in behavioral terms the element that is to be the pinnacle of the hierarchy.

Stage 2--Derive the hierarchy by asking Gagné's question, "What must the learner be able to do in order to learn this new element, given
only instruction?" of each element in turn, from the pinnacle element downwards.

Stage 3—Check the reasonableness of the postulated hierarchy with experienced teachers and subject matter experts.

Stage 4—Invent possible divisions of the elements of the hierarchy, so that very precise definitions are obtained.

Stage 5—Carry out an investigation of whether the invented divisions do in fact represent different skills.

Stage 6—Write a learning program for the elements, embedding in it test questions for the elements.

Stage 7—Have at least 150 subjects, suitably chosen, work through the program, answering the questions as they come to them.

Stage 8—Analyze the results to see whether any of the postulated connections between elements should be rejected.

Stage 9—Remove all rejected connections from the hierarchy. The connections that led up to a verbalized knowledge element were all rejected, while most of the connections that led up to an intellectual skill were accepted.

White's procedure described above substantiates Gagné's theory that hierarchies do represent patterns of prerequisite intellectual skills leading to the terminal skill or skills inherent in a specific learning task (Gagné, 1962). The results of the above mentioned study strongly support Gagné's (1968) statement that intellectual skills are acquired hierarchically through verbalized knowledge. According to
White (1974), this implies that instructional sequences for subject matter containing intellectual skills should be more effective when they are based on a valid hierarchy. He goes on to explain that hierarchies should be useful in assessment since it is simple and direct to construct tests of the elements when they are so clearly defined. White (1974) suggests testing the entering behavior to ascertain the learner's level, and therefore, where instruction should commence. He then suggests the use of diagnostic testing to check progress as the learner ascends the hierarchy. This would enable identifying points where remediation might be indicated. White's nine stages for validating the hierarchy leave no hidden prerequisites unidentified; this allows for optimal learning of a specific intellectual skill.

Bergan (1976) contends that the above mentioned techniques have significant shortcomings and finds the learning hierarchy model quite limiting. He suggests the use of structural models, developed by mathematical sociologists and based on Sewall Wright's (1921, 1960) work on path analysis as an alternative to Gagné's model for the representation of causal relationships among intellectual skills. This would allow relations among variables to be accounted for in a more complete fashion. A study by Bergan, Karp, and Neumann (in press) utilized multiple regression procedures to conduct a structural analysis to determine the direct and indirect effects of individual characteristics on hierarchical skill performance. More work in this area is needed to address the problems outlined here regarding validation procedures. Goodman's (1975) response scaling technique attempts to address many
of the questions raised here since it has the capability to test both prerequisite and nonprerequisite relations.

Summary

This review of the literature suggests modeling to be an effective method of instruction. However, different forms of modeling are not always equally effective. Several studies have utilized televised and live models in examining feedback mechanisms, although symbolic (verbal) modeling as feedback has not been very closely examined.

This review also reveals the efficacy of utilizing sequentially related tasks in conducting between group comparisons as well as examining the concept of positive transfer. Several validation techniques are examined.

Purpose of the Study

The purpose of this study is to examine the influence of feedback variations on the acquisition of hierarchical fraction skills. Behavioral modeling (demonstration), symbolic modeling (verbal), behavioral plus symbolic modeling, are three methods of feedback investigated in this study. A fourth group receiving no feedback will serve as a control group.

This study will also examine four sequentially ordered fraction skills as a main effect, to examine whether they are in fact significantly different from each other.
CHAPTER 3

METHOD

Subjects

Seventy-two children, including 42 girls and 30 boys, who ranged in age from 88 months to 139 months, were selected to participate in this study. These children were selected from a larger sample on the basis of pretesting revealing that they possessed none of the skills targeted for investigation in the study. Seventy of the 72 children attend parochial school. The subjects attending parochial school ranged from third to sixth grade. The two other children attend public school and are in second grade. The children came from homes in middle class neighborhoods.

Tasks

Four sequentially related learning tasks comprising a fraction hierarchy were used in this study. Task A required selecting a designated unit fraction (1/5) of objects from a set of five different objects. Task B required children to select a designated multiple fraction of objects (2/5) from a set of five different objects. Task C required selecting a designated fraction of objects (1/5) from a set of ten ordered dissimilar objects, and task D required children to select a designated multiple fraction of objects (2/5) from a set of ten ordered dissimilar objects. The four tasks were presented in the form of a
pencil and paper test individually administered. The children were asked to make an "X" on a designated fraction of the objects.

**Procedures**

A pretest on each of the tasks mentioned above was administered to 285 children to determine eligibility to participate in the study. The 72 children who failed all of the pretests were divided into four equal groups, with the children randomly assigned to the four groups. The 18 children in each group received instruction on the four fraction tasks. There were three trials for each task, totalling 12 tasks. These 12 tasks were randomly ordered to control for order effects by balancing them across treatments (Kirk, 1968; Winer, 1971; Myers, 1972).

Instructions for the four tasks were presented the same for all four groups. For children in the first group, responses were followed by feedback in the form of behavioral modeling (demonstration) of the correct response. The child would mark his/her paper and then the examiner would say, "Now watch me." The examiner divided the objects into five groups, separating each group by drawing lines, and then marked an "X" on the designated fraction of objects. This would be followed by no verbal response and the page would be turned for the next problem.

Children in the second group were given symbolic (verbal) modeling feedback following the child's responses. Feedback was in the form of a rule verbalized by the examiner; for example, the examiner would repeat the following rule for 1/5: "1/5 is one part of
five parts." A combination of behavioral and symbolic modeling was
given as feedback following responses for children in the third group.
The examiner would say, "Now watch me" and then verbalize the rule for
the particular fraction.

The fourth group of children served as a control group and were
not given any feedback from the examiner for their responses.

Measures

Two measures were used in this study. One measure was the pre-
test score a child received and the second was the total correct re-
sponses for each task on the posttest.

A permanent record in the form of the response sheets was
assigned to observers to check scoring as a form of observer reliabil-
ity. Reliability was computed by dividing the number of agreements on
the occurrence of correct responses by the total number of agreements
and disagreements and multiplying this by 100 to obtain a percentage.
The resulting reliability was 100%.
CHAPTER 4

RESULTS

A 4 X 4 repeated measures analysis of variance (groups and skills) with one covariate (pretest score) yielded the results indicated in Table 1. Analysis of covariance (ANCOVA) was chosen to control for the factor of the pretest used in this study. The assumptions for this test were met.

Table 1. Analysis of covariance

<table>
<thead>
<tr>
<th>Source (Adjusted)</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between Subjects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Groups</td>
<td>72.94</td>
<td>3</td>
<td>24.31</td>
<td>17.49*</td>
</tr>
<tr>
<td>Subject W. A</td>
<td>93.17</td>
<td>67</td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td><strong>Within Subjects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Skills</td>
<td>64.40</td>
<td>3</td>
<td>21.47</td>
<td>27.88*</td>
</tr>
<tr>
<td>AB</td>
<td>9.96</td>
<td>9</td>
<td>1.11</td>
<td>1.44</td>
</tr>
<tr>
<td>B X (Subject W. A)</td>
<td>155.67</td>
<td>203</td>
<td>.77</td>
<td></td>
</tr>
</tbody>
</table>

*p < .01
Two main effects (groups and skills) were examined. Following Winer (1971) ANCOVA revealed both main effects to be significant at the .01 level as hypothesized. The interaction was not significant, as was expected.

An additional post hoc test was done to analyze the effects on the skill levels and group levels. After adjusting the means for the effect of the covariate and adjusting the error term for the effect of the covariate, a Tukey Test was done (Kirk, 1968) between each pair of means, as revealed in Table 2 (groups) and Table 3 (skills).

Table 2. Tukey test for group levels

<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>84.41*</td>
<td>.4175</td>
<td>90.69*</td>
</tr>
<tr>
<td>2</td>
<td>82.35*</td>
<td>13.6*</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>98.08*</td>
<td></td>
</tr>
</tbody>
</table>

*p < .01

Table 3. Tukey test for skill levels

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>23.19*</td>
<td>98.96*</td>
<td>141.20*</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>48.65*</td>
<td>83.62*</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td>18.47*</td>
</tr>
</tbody>
</table>

*p < .01
As Table 2 reveals, group factors are examined at four levels, behavioral modeling (group 1), symbolic modeling (group 2), behavioral plus symbolic modeling (group 3), and a control group (group 4). Pair-wise comparisons revealed significance at the .01 level for all comparisons except behavioral modeling and behavioral plus symbolic modeling. This comparison did not reach significance (p < .01).

Table 3 examines skill factors at four levels (A, B, C, D). Task A required selecting a designated unit fraction (1/5) of objects from a set of five different objects. Task B required children to select a designated multiple fraction of objects (2/5) from a set of five different objects. Task C required selecting a designated fraction of objects (1/5) from a set of ten ordered dissimilar objects, and task D required children to select a designated multiple fraction of objects (2/5) from a set of ten ordered dissimilar objects. As revealed by examining Table 3, all pair-wise comparisons were significant at the .01 level.
CHAPTER 5

DISCUSSION

The results of this study clearly indicate that the method of feedback given to children regarding fraction concepts has a significant effect on learning this task. According to the results of the Tukey Test, behavioral modeling and behavioral plus symbolic modeling appear to be more effective methods of feedback to children than either symbolic modeling or no feedback in facilitation of learning fraction concepts. These results support the hypothesis that according to which group a child was placed in was an important factor in this research.

The skills examined in this study have been previously validated as forming a learning hierarchy by means of Goodman's (1975) response scaling technique. The results of this study reveal these skills to be significantly different from each other and not collapsing together as the same skill. This is a discriminating and essential factor in sequentially ordered skills.

The data in this study support informal observation of the children's behavior while responding to the tasks requested of them. When given behavioral modeling and behavioral plus symbolic modeling, it was apparent when a child started to understand the task by means of his/her verbal behavior. Examples would be, "Oh, now I see how you do it!" or "Now I understand!" These verbalizations were not evidenced
by either the group which received only symbolic modeling as feedback or the control group which received no feedback.

The test results of this study revealed no apparent difference between behavioral modeling and behavioral plus symbolic modeling as feedback, although informal observations of the children's reactions evidenced a difference in verbal responses.

Contrary to Jeske's (1978) suggestion that verbal feedback may lead to greater gains in knowledge, it was found in this study that although better than no feedback, verbal modeling feedback was not a very effective modeling technique when used without demonstration in teaching fractions to children.

The present study introduces several options for future research. The question of positive transfer from similar tasks, which was examined here, to more dissimilar tasks needs to be explored. Another possibility for future research is the aspect of utilizing behavioral and symbolic modeling with tasks other than fraction skills. One other possibility for research would be whether or not feedback effects are similar for subordinate and superordinate skills.

In summation, it is quite apparent that symbolic modeling (verbal) was not near as successful as a teaching method as behavioral modeling in this study. This points out just how powerful demonstration is as a method of feedback for teaching children fraction skills.
REFERENCES


Wright, S. Correlation and causation. Journal of Agricultural Research, 1921, 20, 557-585.


