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ABSTRACT

This final report describes activities of a federally funded project which developed an educational computer-assisted instructional program for persons with severe disabilities. A preliminary review of the literature identified specific inadequacies of most software for this population, such as: too few examples of a task or concept thus limiting generalization; distracting extra-stimulus prompts; and insufficient trials, no criteria for mastery, and inadequate correction procedures. The Task Demonstration Model, a comprehensive model of instruction which provides nearly errorless learning by incorporating features of fading and general case programming, was utilized for the software development. The program which was developed teaches identification of 25 functional words and their symbols, 4 coins and their values, 4 bills and their values, and 4 clock times to the hour (both analog and digital). The program is characterized by: (1) inclusion of age-appropriate, functional tasks; (2) inclusion of the most recent research on effective instruction for persons with severe disabilities; (3) inclusion of the most recent innovations in computer software and hardware technology (written in Pascal; intended for use on Apple IIGs); and (4) use of a test-evaluate-revision process to further improve the program. Evaluation with 10 students found students maintained a high level of correct responding and a high level of active engagement. Development efforts suggest that an investigation of improved graphics or video-based representations is warranted. Also, efforts are needed to improve generalization through both improvement of the instructional medium and improvement of the teacher's use of the software program. (Contains 10 references.) (DB)

Computer-assisted Instruction for Severely Handicapped Persons: A Program Based on Stimulus Control Research Modifying Current Software and Hardware

Final Report
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Educational Research and Services Center
425 Fisk Avenue
DeKalb, Illinois 60115

November 1, 1988 - April 1, 1990

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Final Report

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PREFACE

While computers have been widely recognized as important assistive devices for persons with handicaps, little is known about the role computers can play as the providers of instruction for persons with severe learning handicaps. We have proposed that the computer can be an effective instructor for persons with severe handicaps if the instructional technology based on stimulus control research is integrated into the software programs and if recent innovations in computer hardware and software are incorporated into the development of the programs.

The purpose of this project was to develop an educational software program for persons with severe handicaps. This goal was met by:

1. The development of an educational software program that included an age-appropriate, functional curriculum;
2. The development of an educational software program that included the most recent research on effective instruction for persons with severe handicaps;
3. The development of an educational software program that included the most recent innovations in computer software and hardware technology; and
4. The development of an educational software program that used a test-evaluate-revision process to further improve the program.

ABSTRACT

Limited research is available regarding the effectiveness of computer-assisted instruction for persons with severe handicaps. We suggest that computer-assisted instruction can become an effective adjunct to teacher instruction if the instructional technology based on stimulus control research is integrated into educational software for persons with severe handicaps. This integration of research-based instructional technology is possible because of recent innovations in computer hardware and software.

Recently on another federally-funded project, we have developed a teaching procedure (The Task Demonstration Model) that teaches persons with severe handicaps with very few errors (Karsh, Repp, & Lenz, in press; Karsh & Repp, 1990; Repp & Karsh, in press; Repp, Karsh, & Lenz, 1990). The goal of this project was to develop an educational software program that was based on the Task Demonstration Model and to evaluate its effectiveness for persons with severe handicaps.

The specific purposes of this project were:

1. The development of educational software for persons with severe handicaps that uses an effective, field-tested model of instruction based on the Task Demonstration Model;
2. The incorporation of recent innovations in computer hardware and software that allows individuals to operate a computer without having to read the keys (i.e., a touch sensitive screen); and
3. The testing, evaluation, and revision of the software in educational settings for persons with severe handicaps.

INTRODUCTION

People who possess severe mental handicaps require an inordinate number of trials to learn a broad range of tasks. Within this framework, many professionals believe computer-assisted instruction (CAI) can be a viable educational tool for teaching persons with severe handicaps (cf. Hofmeister & Freidman, 1986). The computer can be an important adjunct to teacher instruction by providing an unlimited number of additional learning trials.

Many of the advantages inherent in computer-assisted instruction (e.g., individualization, appropriate pacing, immediate and frequent feedback, adherence to the structure and sequence of the activity) address the instructional needs of these persons. However, few software programs exist which incorporate the research on effective instruction (Karsh & Repp, in press). Those which are instructionally adequate are not functionally-based or age-appropriate for persons with severe handicaps.

In this project we developed a software program for persons with severe handicaps. It was our intent to develop a program which would be an effective and efficient adjunct to teacher instruction. We argued that the software program could lead to increased learning trials, increased engaged time, reduced maladaptive behavior, and improved maintenance of skills.

REVIEW OF THE LITERATURE

Researchers who have investigated the effectiveness of educational software for individuals with handicaps have expressed concern regarding the adequacy of the instructional design of the software (Karsh & Repp, 1990). Specific inadequacies of software used by persons with severe handicaps include:

1. Insufficient pretraining that establishes compliance to the computer's directions before beginning actual implementation of the program;
2. "Trial and error" learning which results in many errors;
3. Only one or two examples of a task or concept which limits generalization;
4. Extra-stimulus prompts which distract the students;
5. Background frames, colors and graphics which distract the student;
6. Omission of match to sample activities before providing identification activities;
7. Insufficient trials, no criteria for mastery, and inadequate error correction procedures; and
8. Simultaneous presentation of several concepts rather than achieving mastery on a single concept.

The inadequacies of the software are particularly noteworthy because of the well-documented finding that individuals with severe handicaps do not attend to important antecedent stimuli consistently, and therefore, fail to respond to the critical stimuli on learning tasks (cf. Rincover & Koegel, 1975). The problem for these individuals often is that their responses have been brought under the control of inappropriate or irrelevant stimuli.

The Task Demonstration Model (Karsh & Repp, 1990; Karsh, et al. in press; Repp & Karsh, in press; Repp, et al., 1990) has been developed as a comprehensive model of instruction so that the learner's attention is directed to the relevant aspects of a stimulus. The model produces nearly errorless learning by copying Terrace's (1963 a,b) fundamental premise of fading, beginning with an easy discrimination and progressing to a more difficult one. The Task Demonstration Model also incorporates feature of general case programming (Albin, et al., 1988) by presenting examples that sample the range of S+ and S- in the natural environment in order to ensure attention to the relevant dimension. The following format depicts the Task Demonstration Model to teach individuals with severe handicaps a discrimination.

TASK DEMONSTRATION MODEL

Step	Present S+	Present S-	Maintain Learning on
1.	Multiple (15) examples of $S+^1$	(no S-s present)	
2.	Multiple examples of $S+^1$ of $S+^1$	Very different examples of S-	
3.	Multiple examples of $S+^1$	Moderately different examples of S-	
4.	Multiple examples of $S+^1$	Slightly different examples of S-	
5.	Multiple examples of $S+^2$	(no S-'s)	$S+^1$
6.	Multiple examples of $S+^2$	Very different examples	$S+^1$
7.	Multiple examples of $S+^2$	Moderately different examples	$S+^1$

8.	Multiple examples of $S+^{2}$	Slightly different examples	$S+^{1}$
9.	Multiple examples of $S+^{3}$	(no S-'s)	$S+^{1}$ and $S+^{2}$
10.	Multiple examples of $S+^{3}$	Very different examples	$S+^{1}$ and $S+^{2}$
11.	Multiple examples of $S+^{3}$	Moderately different examples	$S+^{1}$ and $S+^{2}$
12.	Multiple examples of $S+^{3}$	Slightly different examples	$S+^{1}$ and $S+^{2}$
13.	Multiple examples of $S+^{4}$	(no S-'s)	$S+^{1}$, $S+^{2}$ and $S+^{3}$
14.	Multiple examples of $S+^{4}$	Very different examples	$S+^{1}$, $S+^{2}$ and $S+^{3}$
15.	Multiple examples of S+	Moderately different examples	$S+^{1}$, $S+^{2}$ and $S+^{3}$
16.	Multiple examples of $S+^{4}$	Slightly different examples	$S+^{1}$, $S+^{2}$ and $S+^{3}$

On another federally-funded project we demonstrated the effectiveness of the Task Demonstration Model as compared to a standard prompting procedure during both teacher-based individual instruction (Karsh, et al., in press; Repp, et al., 1990) and group instruction (Karsh & Repp, 1990; Repp & Karsh, in press). In this project we used the format of the field-tested Task Demonstration Model to develop a software program. In the next section we will describe the software program and the activities undertaken to develop the software.

ORGANIZED PROJECT ACTIVITIES

Following is a delineation of the specific goals of the project and the activities that allowed those goals to be met.

Goal 1: **To develop educational software for individuals with severe handicaps which includes age-appropriate, functional tasks.**

In order to identify specific skills to be taught with the software program, a curriculum-based series of probes were administered to students at the project sites. From an analysis of these probes and a needs assessment of teacher priorities the following curricular areas were identified: (a) functional words and symbols, (b) coin and bill recognition, and (c) time-telling. The teaching sequence for these skills had previously been field-tested and validated during teacher-based instruction on another federally-funded project.

As a result of the curriculum-based probes and teacher priorities, software was written to teach identification of 25 functional words and their corresponding symbols, 4 coins and their corresponding values, 4 bills and their corresponding values, and 4 times to the hour (both analog and digital).

Goal 2: **To develop educational software for severely handicapped individuals which includes recent applied research on instructional technology.**

A shell program was written based on the Task Demonstration Model. The features of the shell program include:

(a) A series of compliance trials to ensure that the student can follow the computer directions;

(b) Beginning with an easy discrimination, fading the S- to be more like the S+ until the S+ and S- vary only on the relevant dimension;

(c) Nine examples of each S+ and 9 examples of a very different S-, 9 examples of a moderately different S-, and 9 examples of a slightly different S-;

(d) A sequence for teaching both match to sample and identification;

(e) A format for baseline probes and maintenance probes;

(f) An error correction procedure whereby the student is guided to respond correctly before a new trial is presented;

(g) Digitized voices which name the stimuli with a variety of intonations and inflections;

(h) A variety of reinforcing statements that follow each correct trial in a random sequence;

(i) At the end of each level of difficulty a thermometer on the screen which provides feedback to the student on his performance and includes sound effects;

(j) A "Help" sign that appears on the screen when the student has made a predetermined number of errors; and

(k) The opportunity to select the intertrial interval.

The shell program was written to function as follows. First, the teacher loads the TDM program shell into an Apple IIGs computer. Once the program has been loaded the teacher is given options which allow the program to be individualized for a given student. These options include:

(a) number of compliance trials to ascertain that the student can follow the computer directions;

(b) number of trials in the very different, moderately different, and slightly different levels of the TDM sequence;

(c) number of correct trials required before the program proceeds to the next level of difficulty;

(d) number of seconds between the end of one trial and beginning of another (intertrial interval);

(e) whether the TDM sequence should be match to sample (where a sample of the S+ always appears on the screen) or identification; and

(f) maximum number of errors allowed before a "Help" sign (a hand) appears on the screen and the student is directed to request help from the teacher.

The teacher may save the selected options on the student data disk so that this information does not need to be entered each time the student uses the software program. After the TDM shell program has been loaded and the selections have been made, the teacher loads the graphics program specific to the discrimination to be taught and instruction begins.

First, the computer delivers a series of 10 baseline trials. If the student scores 90% or above, instruction is discontinued. If the student scores below 90%, instruction continues until the student has reached the predetermined criterion on all levels of difficulty or the "Help" sign appears on the screen. At the end of instruction the screen displays the number of trials presented at each level of difficulty, the number and percent correct trials at each level of difficulty, and the duration of the session. This data is saved on a student data disk and may be retrieved at a later point. If the teacher wishes, a printout is provided which shows the student's responses on a trial-by-trial basis so that an error analysis can be made. At any time following instruction the teacher may administer a series of 10 maintenance trials and also record these results on the data disk.

Goal 3: **To incorporate the use of recent innovations in hardware and software technology into the development of the educational software.**

The TDM shell program was written in Pascal and intended for use on an Apple IIGs computer. The sound component of the program which included directions (e.g., "Touch the _____"), reinforcement or corrective feedback ("That's right), and sound effects (e.g., an ascending musical scale as a thermometer filled to indicate percent correct) were produced by the sound digitizing capabilities of the Apple IIGs. The results were clear, easily understood voices and sounds.

The graphics for the software program were produced by scanning pictures or words (e.g., with Thunderscan) from existing teaching materials, editing, and saving the scanned graphics on disk or by generating graphics with the Paintworks Gold graphics program and saving those on disk.

Student input was provided by a Touch Window which attached to the screen of the Apple IIGs monitor. In the TDM shell program the computer screen was divided into 9 invisible squares. The correct answer (S+) randomly appeared in one of the 9 squares, the distractor (S-) randomly appeared in a different square, and if match to sample instruction was occurring, the sample appeared in the center square.

The students responded by touching one of the graphics displayed on the screen. The students were able to use the Touch Window with ease, and the squares were large enough that the students' motor coordination was sufficient for accurate responding.

Hard copies of the computer graphics were produced on the Image Writer II printer. These hard copies were used to assess the students' ability to match computer graphics to real objects. If a student could not match the computer graphics to real objects, he/she was not included in the project.

As previously discussed under Goal 2, the options available on the Apple II GS were used to incorporate the stimulus control literature into the software program. For example, the teacher is allowed to select the intertrial interval (i.e., the number of seconds between the end of one trial and the beginning of the second) for each student.

Goal 4: To test, evaluate, and revise the educational software that is developed in Goals 1, 2, and 3.

A teacher manual was written for implementation of the software program. Teachers who had agreed to participate in testing the program were given instruction and technical support on the use of the program, the instructional features of the program, the data recording capabilities of the program, and suggestions for generalization activities in the natural environment.

During the development of the software program both students who had and had not been exposed to teacher-based TDM instruction were asked to use the program. Computer-generated data (e.g., percent correct, trials to criterion) and observational data (e.g., active engagement, maladaptive behavior) were collected on Epson HX-20 notebook computers (Repp, Harman, Felce, Van Acker, & Karsh, 1989; Repp, Karsh, Van Acker, Felce, & Harman, 1989) and were analyzed in order to revise the program. Teachers were also asked to administer generalization probes to the students and to rate the program and make suggestions regarding the specific strengths and weaknesses of the software program.

At the end of the grant period an evaluation of the final revised version of the software program was conducted. Data are presented here for 10 of the students who used the final version of the program. For six of the subjects the mean percent correct during teacher-based training was 96% and for computer-based training was 88%. Four of the subjects did not reach criterion on the computer-based training program (see Figure 1) and for those students who did reach criterion on the computer program, more trials were required than during teacher instruction (see Figure 2).

Insert Figure 1 and 2 About Here

In spite of the increased number of errors in computer-based TDM, 9 of the 10 students exhibited more active engagement during computer-based TDM than during teacher instruction. The mean percent active engagement for teacher instruction was 50 percent and for CAI was 87 percent (see Figure 3).

Insert Figure 3 About Here

Results of the generalization probes for the six students who completed both instruction conditions were a mean of 87% for teacher instruction and a mean of 73% for computer-assisted instruction (see Figure 4).

Insert Figure 4 About Here

The data on maladaptive behavior during instruction are unclear. One student exhibited over 80% in both conditions while some students (3) exhibited maladaptive behavior only during teacher instruction and other students (3) exhibited maladaptive behavior only during computer-assisted instruction. This data will require more sophisticated analysis (e.g., lag sequential analysis) to determine whether the maladaptive behavior is directly functionally related to any feature of the program.

Insert Figure 5 About Here

GENERAL SUMMARY

The goal of this project was to develop an educational software program for individuals with severe handicaps. Our intent was to develop a software program that was based on a functional, age-appropriate curriculum, that integrated stimulus control research on instructional technology for persons with severe handicaps, and that incorporated recent advances in computer hardware and software technology.

Our efforts have demonstrated that a program of this type can be developed and can be successfully used by individuals with severe handicaps. A formal systematic evaluation of the final version of the software program showed that students can maintain a fairly high level of correct responding during CAI and that they maintain a high level of active engagement during CAI. Results also indicate that as an instructional medium further research and development is appropriate. Specifically, an analysis needs to be made regarding how to reduce errors. Our development efforts suggest that an investigation of improved graphics or video-based representations is warranted. Additionally, efforts are needed to improve generalization through both improvement of the instructional medium and improvement of the teacher use of the software program. The computer software must become an integral of the teacher's overall instructional program and provisions must be made for planned generalization activities in the natural environment following the student's use of the software program.

APPENDIX A

A brief videotape is included with this report. This videotape was filmed by the teachers at the project site after the project had ended as a follow-up measure. Four students with severe handicaps are shown using the software program in its final form.

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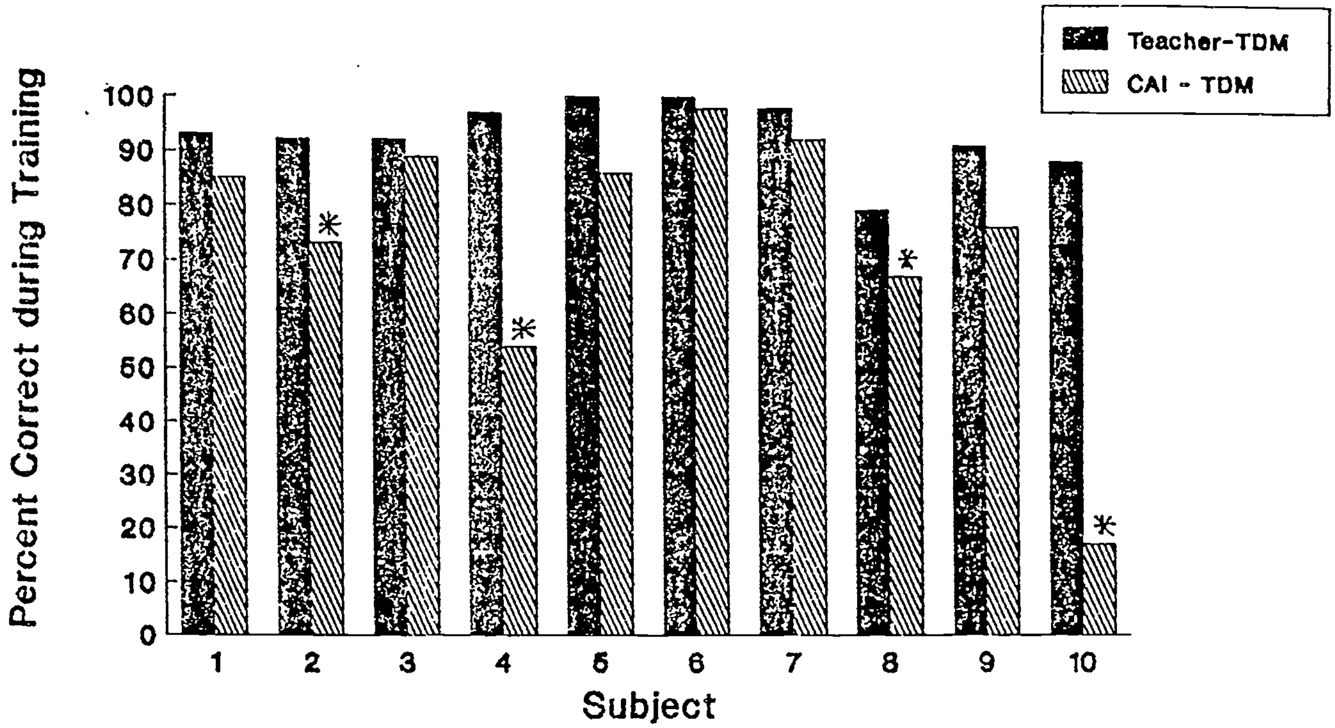
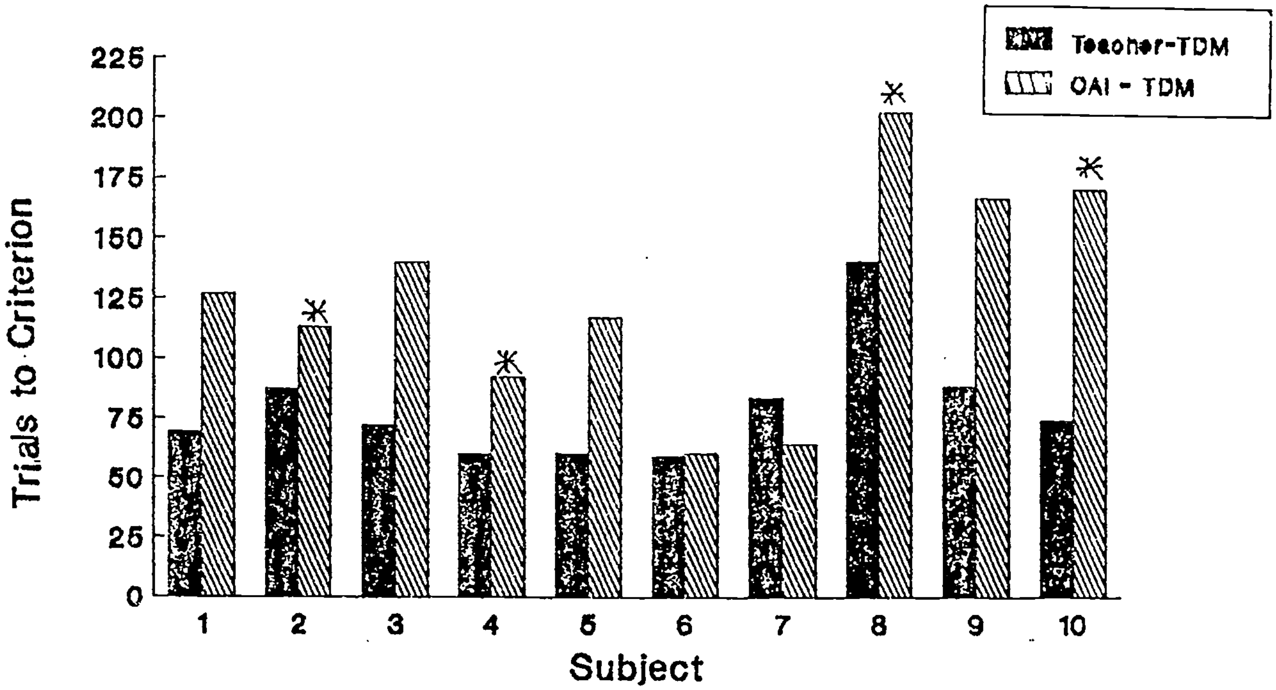


* Student did not reach criterion during training. Instruction discontinued.

Figure 1



* Student did not reach criterion during training. Instruction discontinued.

Figure 2

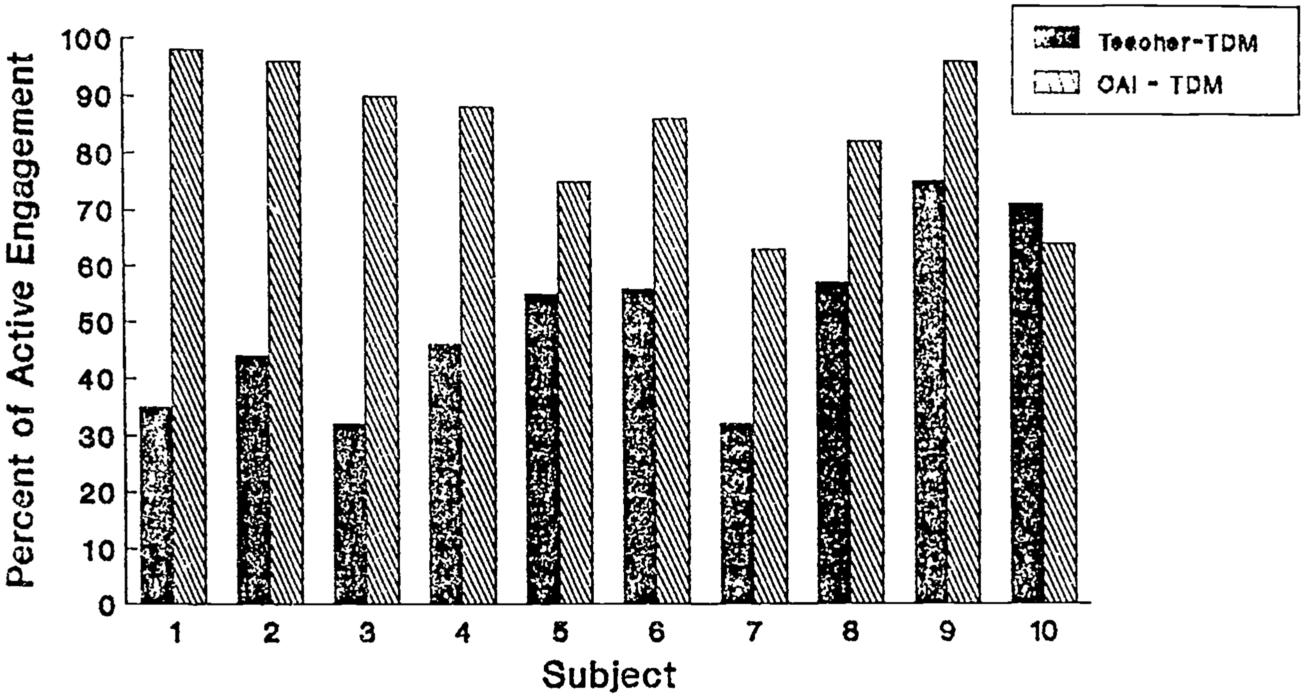
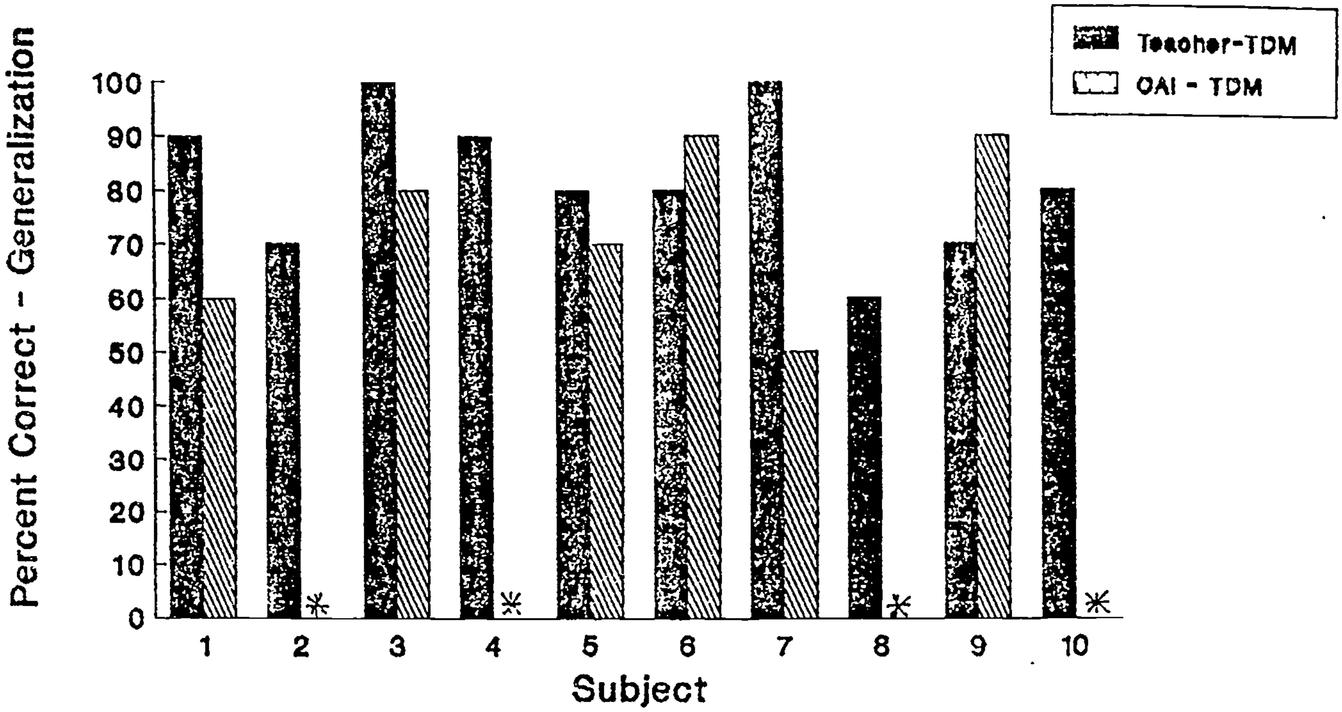

Percent of Active Engagement
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
Subject
Teacher-TDM
OAI - TDM

Figure 3



* Student did not reach criterion during training. Instruction discontinued.

Figure 4

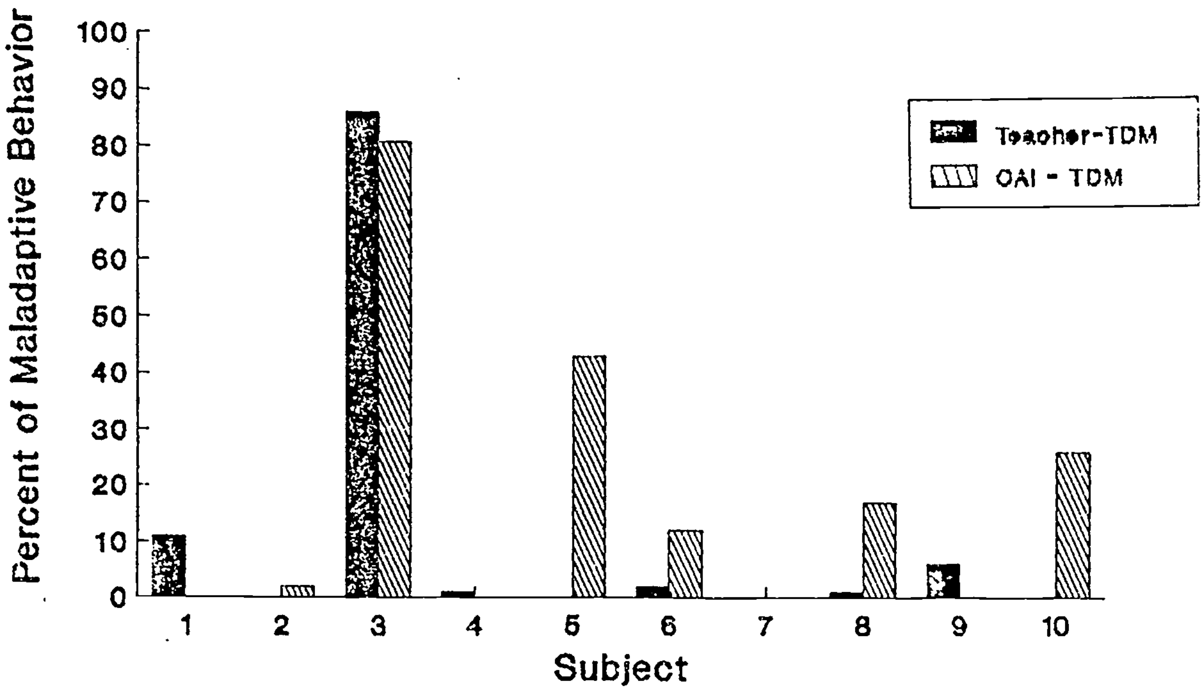

Percent of Maladaptive Behavior
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
Subject
Teacher-TDM
OAI - TDM

Figure 5