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ABSTRACT

This study compared the use of traditional methods and the use of reconstructive elaborations on learning specialized science vocabulary, involving two sixth-grade students with emotional disturbances. The reconstructive elaborations were pictures that linked together information to make it more familiar and meaningful, most commonly through the use of an acoustically similar keyword. The study found that teacher-made mnemonic materials can effectively be used to increase the retention of science vocabulary. The study concluded that mnemonic instruction can enhance instructional programs for students with mild disabilities, and that reconstructive elaborations have a positive effect on motivation. (Contains 15 references.) (JDD)

The Use of Reconstructive Elaborations: Application in Science Instruction

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Abstract

Learning science vocabulary is often a problem for students who have emotional, behavioral, and/or learning disabilities. In this paper, we report on a comparison made between teaching specialized science vocabulary through the use of traditional methods and reconstructive elaborations. In the traditional method, terms and definitions were written on index cards. Under the mnemonic condition, reconstructive elaborations were developed for each of the targeted words. Reconstructive elaborations were used to supplement, not replace, on-going instruction and were found to be superior in enhancing recall by students.

It is a given that students with mild disabilities frequently achieve below ability level expectations in academic content areas. Additionally, it has been observed that students identified as learning disabled (LD) and behaviorally disordered (BD) frequently employ a passive approach to learning (Torgeson, 1982). Scruggs and Mastropieri (1984) identified certain specific problems within these general concerns which are often common to students with mild disabilities. These include deficits in memory, attention, motivation, encoding, and retrieving factual information. These problems can impact on the student's ability to receive, organize, retrieve, and recall academic material.

Consistent with these general characteristics, a particular problem which many students with learning and behavioral problems experience is difficulty in learning content-area vocabulary. Because many science and social studies terms are technical in nature, for example, students with disabilities may lack the experiential background necessary for understanding and remembering information. As a result, Hollaway (1989) suggested that many of these students perform poorly on social studies and science tests. Thus science skills have been found to rank below achievement test scores for math, reading, and vocabulary (Scruggs & Mastropieri, 1986). Regardless of the specific disability, related deficits in study skills may also impact on test performance (Scruggs, Mastropieri, McLoone, Levin, & Morrison, 1987). Finally since these students may be inactive learners, they may lack effective and efficient methods for organizing and retrieving information.

Reconstructive Elaborations

Recent attention has been given to developing memory enhancing strategies in students with mild disabilities. One method found to be effective in facilitating the acquisition and retrieval of vocabulary is the use of **reconstructive elaborations.** Based on Atkinson's (1975) initial work with acoustic keywords, Scruggs and Mastropieri (1984) refined a technique which actively involves the learner while not relying heavily on prior knowledge. With this approach, Mastropieri and Scruggs (1989) indicated that unfamiliar material can be made familiar and nonmeaningful material made meaningful.

There are two central components to learning through the use of reconstructive elaborations. The **reconstruction** involves modifying information to a more familiar and meaningful form, most commonly through the use of an acoustically similar **keyword.** A keyword sounds like a significant part of the individual word to be remembered. In order to be effective, the keyword should be concrete, familiar, and meaningful to the student. In the **elaboration**, critical information is linked together in a picture. Mastropieri and Scruggs (1989) described a reconstructive elaboration as an "interactive illustration that contains the reconstructed term in an elaboration with the to-be-remembered information" (p. 392). This technique can facilitate memory recall by providing both visual and auditory clues to the student. The student uses the keyword to access the picture and then, from the

illustrated interaction, to recall the definition. Several examples are provided in Figures 1 and 2.

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insert Figures 1 and 2 about here

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Because the memory demands for acoustic encoding and pictures are less developmentally sensitive than for semantic encoding, students at variant stages of development can potentially be successfully taught with this method (Scruggs & Mastropieri, 1989). Research supports the effectiveness of reconstructive elaborations across a variety of grade levels and disabilities. Cogent to the present paper, the method has been successfully employed to teach science and social studies vocabulary (e.g., Hollaway, 1989; Mastropieri, Emerick, & Scruggs, 1986; Mastropieri & Scruggs, 1989; Scruggs & Mastropieri, 1992). Additionally, research has indicated that students were able to learn words via reconstructive elaborations when they were presented in prose passages as well as when they were presented in lists (Scruggs, 1987) and that students who were taught vocabulary words with the keyword method outperformed those students taught through the use of illustrations without the keyword (Condus, Marshall, & Miller, 1986). Still other reports have indicated the superior performance of students taught via reconstructive elaborations as compared to direct instruction (Mastropieri, Scruggs, Levin, McLoone, Gaffney, & Prater, 1985), contextual methods (picture context and sentence-

experience context) (Condus et al., 1986), and traditional methods such as textbook and publishers' worksheets (Mastropieri & Scruggs, 1989).

The purpose of the current project was to further investigate the effectiveness of reconstructive elaborations on the acquisition and maintenance of science vocabulary. While some inquiries have addressed this concern, this report extends that body of research by incorporating reconstructive elaborations into an existing science program. The materials created for this purpose were intended to supplement, not replace, on-going instruction. Goals were to provide students with a tool for improving memory retention and recall, provide success with grade level material, and foster independence.

Implementing a Science Program

We evaluated the use of reconstructive elaborations in a science program with two sixth graders who were receiving services in a rural program for students identified as emotionally disturbed. Classification of serious emotional disturbance was made using Virginia state criteria (i.e., a determination was made that emotional factors contributed to the subjects' poor academic performance). Dick was a 13.0 year old male who had a full scale IQ of 82, as measured by the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974). According to the Kaufman Test of Educational Achievement (K-TEA; Kaufman & Kaufman, 1985) (brief form), his reading grade equivalent was 5.2 and math

was 5.5. DeDe was 11.5 years old and had a full scale IQ of 100 according the WISC-R. K-TEA results showed a 7.9 grade equivalent in reading and 9.5 for math, respectively.

According to teacher observation, both students tended to give up easily in the classroom. Performance on tests and quizzes had been erratic. Academic test grades in science for Dick ranged from 22-60%; thus, he had not passed a science test during this academic year. He would frequently leave test and quiz answers blank and mark an "F" on the top of his papers. Test and quiz grades for DeDe ranged from 0-100. When given time to study, both students would say that they did not need to do so. Retention and recall of content material had been a problem for both students. Other observations included problems with comprehension of abstract information and a weak knowledge base on which to attach new information. While both individuals spent greater than 50% of their instructional day in an ED modified self-contained classroom, their learning profiles were consistent with patterns also associated with learning disabilities.

Setting up the Program

Two conditions were compared in this project, traditional and mnemonic instruction. For both conditions, the general principles of effective instruction reflected in similar instructional programs were used. Therefore there was consistency between the two conditions as well as with best practices in instructional delivery. Table 1 outlines the instructional procedures which were followed. Homework was given each night with specific assignments

designed to allow the students an opportunity to practice what they had learned. Prior to daily vocabulary quizzes, students were given five minutes for independent word study.

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insert Table 1 about here
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Intervention occurred over a seven week period. Instruction was delivered in 30 minute classes, four days per week. To account for possible influences of student interest, prior knowledge, and number of abstract terms, the presentation of material alternated between traditional and mnemonic instruction. The first section of each chapter was taught with traditional methods while the second section was taught with mnemonic materials, as discussed below.

The sixth grade Science textbook, Discover Science (Cohen, Cooney, Hawthorne, McCormack, Pasachoff, Rhines, & Slesnick, 1989) was used in both conditions. Vocabulary words were selected from each of three chapters using the following criteria: a) words were included on the end-of-chapter tests, b) words were highlighted in text, and, c) words were on supplementary worksheets provided by the publisher. Materials used in both conditions included the textbook, publisher's worksheets, and teacher-made worksheets designed to reinforce the vocabulary words. Under the traditional condition, targeted vocabulary words were written on the front, and definitions on the back of 3" x 5" index cards. In the mnemonic approach, a reconstructive elaboration was developed for each vocabulary word (see Figures 1 & 2). The term, an acoustic

keyword, and the definition were included on top of the mnemonic illustration. Pictures were displayed on overhead transparencies.

Following teacher presentation of the material, students verbally rehearsed the words and definitions. Under the traditional condition, students were told to practice the definitions with the index cards. With the mnemonic materials, students were told to first think back to the keyword and then to think back to what was happening in the picture. Finally, they were told to define the word. Figures 1 and 2 have previously illustrated several examples of words taught via this approach.

For evaluation, both short-term and delayed recall measures were used. At the beginning of each class, a quiz covering vocabulary from the previous day's lesson was administered. Each quiz had a minimum of 4 new words. Because not every lesson introduced 4 words, some daily quizzes included words from the previous day's lesson. The quiz consisted of the teacher calling out the words and the students writing down the definitions. On the third day, a cumulative quiz was given to test delayed recall. Two tests were given for each of two chapters. One was administered at the end of the first section and contained terms taught under the mnemonic condition. The final chapter test contained items taught under both the traditional and mnemonic conditions. Vocabulary was measured through the use of multiple choice items.

Program Evaluation

To provide an ongoing evaluation of the program, the instructional conditions alternated between traditional instruction and mnemonic instruction. Preliminary data were collected from performance on daily and delayed recall quizzes. These measures generally reflected superior performance on vocabulary taught through the use of reconstructive elaborations for both students. However, due to a variety of factors such as student absences and ceiling effects on some of the quizzes, these results only provided informal verification of the effectiveness of the mnemonic approach. Thus, evaluation also included four cumulative tests. One test contained items solely taught under the traditional method, two contained items only taught through mnemonic instruction, and one contained items taught under both conditions. The results illustrate the benefits of instruction with reconstructive elaborations (see Table 2). Both mnemonic-based tests were superior to the traditional-based test for both students and, on the combined test, accuracy on the mnemonics-instructed items was superior to accuracy on those taught via the traditional method, again for both students.

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insert Table 2 about here

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Discussion

Our experience with these comparative instructional efforts indicate that teacher-made mnemonic materials can effectively be used to increase the retention of science vocabulary. Results indicated the superiority of mnemonic instruction, particularly on long-term (i.e., test) measures. In addition, classroom grades were necessarily positively impacted since, in the students' current educational placement, tests and quizzes each counted one-third of the final grade.

In some ways, the most interesting evaluative aspect was in the students' response to instruction. They reported that the reconstructive elaborations helped them remember science words and definitions. Both said the method was fun and that they consequently enjoyed science more. When asked if they would rather use the index cards or the pictures, both indicated the pictures. Under the mnemonic instruction, both students studied without teacher direction during the five minutes they were given prior to the daily quiz. They would either call out words to each other, write their notes over, or read their notes. They would do this without teacher direction. After intervention, Dick would answer every question on his tests and quizzes. In addition, he was no longer writing "F" on the top of his papers. Both students were more actively involved in their learning and were more willing to work independently.

Both students did relatively well even after the reconstructive elaborations were no longer formally developed.

This may be attributable to the carry-over effect of the novelty of the approach. It may also be due to the fact that students were able to experience success. Instead of blaming failures and successes on external circumstances, the approach appeared to give them some control over their learning. Another effect which maintained was in the utilization of study time. Prior to intervention, students simply may not have known how to study. With the use of the reconstructive elaboration approach, students were studying concrete, familiar material. They also had to actively pass through several steps in order to arrive at the definition: identify the keyword, recall and describe the picture, and finally come up with the definition. Upon return to traditional materials, students may have generalized that studying required active involvement on their part. Consequently, they rehearsed the terms and definitions, verbally or on paper, even though they did not have a picture to manipulate.

Still warranting further attention is whether this technique can be used as a student-directed technique. Thus an appropriate follow-up would be to address whether reconstructive elaborations can be generated by students. In order to do so, students would need to be provided assistance in generating keywords and incorporating the definition into the picture and then an opportunity could be given for students to use reconstructive elaborations with other subjects. If transfer occurs, the value of the technique would be significantly enhanced as a way to promote success in regular classes.

Our experience with mnemonic instruction as discussed herein suggests that it can enhance instructional programs for students with mild disabilities. Although reconstructive elaborations are somewhat time-consuming to construct and their effectiveness relies on the selection of the keyword and illustration, they have a positive effect on motivation and provide an effective alternative method for students to acquire and recall academic material.

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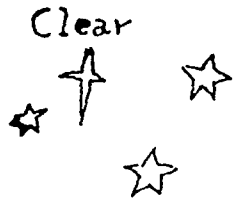
Figure 1: Reconstructive elaboration for "meteorologist"

METEOROLOGIST = A person who studies the weather.
(Meat - Eater)



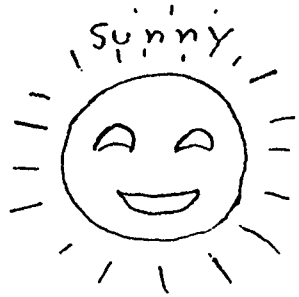


Figure 2: Reconstructive elaboration for "amplitude"

HEIGHT OF A WAVE = Amplitude (Amplifier)

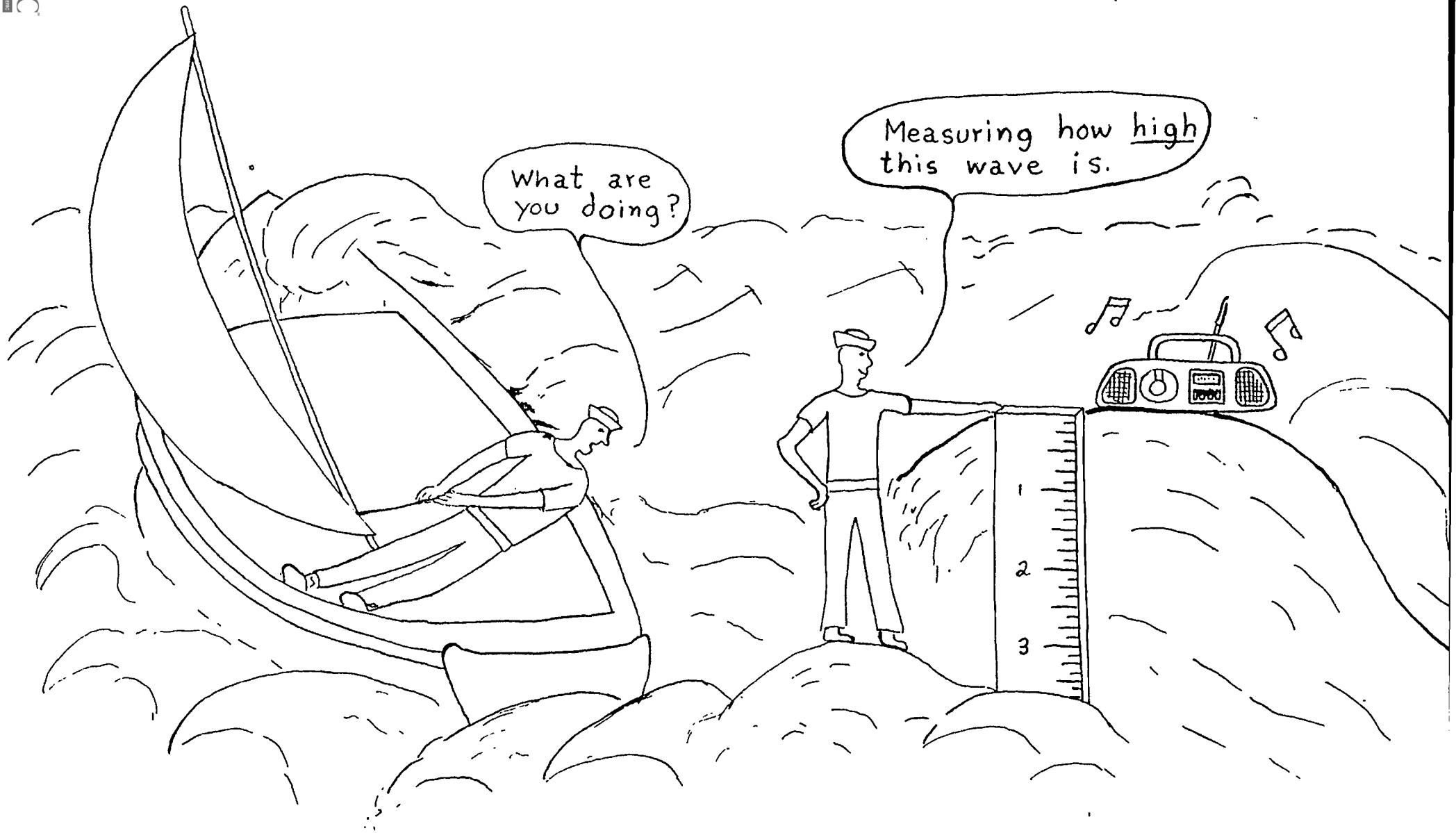


Table 1: Instructional sequence for traditional and mnemonic instruction

1. daily review of content
2. clear statement of objective
3. teacher-directed presentation of material
4. guided student practice (for verification of learning)
5. independent practice

Table 2: Student test scores

	Traditional	Mnemonic		Combined Test	
		Test #1	Test #2	Traditional Items	Mnemonic Items
A. Dick	56%	90%	86%	68%	88%
B. DeDe	80%	95%	93%	68%	100%