Comparing the Effectiveness and Efficiency of Two Methods of Teaching Geometric Shape Concepts to Students with Mental Retardation

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Abstract

The purpose of this study was to compare the effectiveness and efficiency of two teaching models, the expository presentation of Merrill and Tennyson's model and Gagne's model, in acquisition and maintenance of square and triangle concepts in students with mental retardation. The participants of the study were chosen from students with mental retardation who attended a private special education center located in Kahramanmaras. Three boys and one girl participated in the research. The design of the study was an adapted alternating treatment design. Two criterion referenced tests were developed and administrated to assess the discrimination levels of square and triangle in participating students. The results of the study showed that the Gagne model was more effective than the Merrill and Tennyson model on the concept acquisition and maintenance in two of the participants. However, the effectiveness of two models did not differ significantly in the remaining two participants. Both models were equally effective with these students. The results also showed that the Gagne model required less teaching time with three participating students compared to the Merrill and Tennyson model. Results of the study were discussed and recommendations for further research were provided.

Key Words

Concept Acquisition, Instructional Effectiveness, Mental Retardation

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Concepts are the building blocks of a person's cognitive structure (Klausmeier, 1992; Medin, 1989). In various instructional models, they are accepted as primary learning outcomes that base the foundation of higher-level learning skills in the learning hierarchy (Gagne, 1968; Merrill, 1987). Thus, concepts are essential to human reasoning including categorization, deductive inference, learning, memory, explanation, problem solving, generalization, analogical inference, language comprehension, and language production (Thargard, 1992).

A concept is a mental construct or representation consisting a person's organized information about an item or a class of items. These items are often referred to an object, event, action, quality, or relationship (Klausmeier, 1992). In order to retrieve information stored in the memory, information must be classified based on its attributions (Banikowski & Mehring, 1999). By using concepts, attributions of these classifications are schematized in a learner's memory. Hence, concepts enable learns economically store the information about objects, events, or entities without encoding each one's information separately (Jonassen, 2006).

Concept learning involves generalization among various examples and discrimination between examples and nonexamples (Hayes & Conway, 2000; Park & Tennyson, 1986). Most students learn many concepts through various activities that involve observation and experience (Markle, 1975). Students with mental retardation display similar concept formation procedures with their normally developing peers and organize concept information in semantic memory (Hayes & Conway, 2000; Sperber & McCauley, 1984; Sperber, Ragain, & McCauley, 1976; Winters, 1985). Since students with mental retardation have limited hands-on experience and impaired intellectual functioning memory and generalization problems (Conway & Gow, 1990; Stokes & Baer, 1977) they fail to learn concepts through observation and daily experiences. In order to overcome this difficulty, concept teaching should be designed in a way that helps students generalize.

A significant body of research demonstrated that different instructional design variables affect the acquisition of concepts (Burts, McKinney, Ford, & Gilmore, 1985; Carnine, 1980a; Carnine, 1980b; Carnine, 1980c; Park, 1984; Park & Tennyson, 1986; Ran-

zijn, 1991; Tennyson, Tennyson, & Rothen, 1980; Tennyson, Youngers, & Suebsonthi, 1983; Williams & Carnine, 1981). Some of these instructional variables are the way of presentation of a concept, the order of presentation of examples and nonexamples, the number of examples, and the features of examples. Effective concept teaching models and empirical research outlined a set of procedures for teaching concepts. These procedures can be summarized as analyzing the concept being taught, formulating a definition of the concept, generating a list of examples and nonexamples, defining instructional objectives, deciding the type of presentation of the concept, selecting the appropriate number of examples and nonexamples, providing corrective and confirming feedback, and assessing with a new set of examples and nonexamples (Özyürek, 1986, 2005; Prater, 1993).

Many instructional design researchers have conducted a significant body of research on the effects of different instructional models on the acquisition of concepts. Some of these models have gain prominence such as the Gagne's model (1965), Merrill & Tennyson's model (1977), Bruner's model (1961), Direct Instruction model and (Engelmann & Carnine, 1982), and schematic presentation of concepts (Driscooll & Tessmer, 1985; Horton, Lovitt, & Bergerud, 1990). The purpose of this study was to compare the effectiveness of the two teaching models, the Merrill and Tennyson's model and Gagne's model, in the acquisition of square and triangle concepts in students with mental retardation. The explanations of the models are as follows:

The Merrill and Tennyson model consists of a definition, an expository presentation of "matched" examples and nonexamples that are arranged from easy to difficult and are divergent, and an interrogatory practice presentation of newly encountered and randomly ordered examples and nonexamples. During the expository presentation, the teacher explains whether each instance is an example or nonexample of the concept and then points out the presence or absence of the critical attributes. During the interrogatory practice presentation, students are asked to distinguish examples from nonexamples and give reasons for their answers. Studies demonstrated that expository presentation technique is effective on the formation of conceptual knowledge (Dunn, 1983; Park, 1984;

Tennyson et al., 1983). This technique focuses on directing students' attention to the critical and defining attributes of the concept being presented. It was supported in the studies that expository presentation should be implemented along with the interrogatory presentation in order to facilitate generalization of the concept (Dunn, 1983; Tennyson, Chao, & Youngers, 1981). Studies also suggested that expository presentation should be used to teach constant-dimension concepts whereas expository presentation and interrogative presentation should be used together to teach variable-dimension concepts (Tennyson & Cocchiarelle, 1986).

According to Gagne, Briggs, and Wager (1988), a concept can be learned from a verbally stated definition provided the component concepts, that is, the defining and critical attributes, can be recalled and understood. The Gagne model consists of presenting examples and nonexamples and a statement that each is or is not the concept. No explanation is given about critical attributes during the presentation.

Several studies compared the effectiveness of the Gagne's model and the Merrill and Tennyson model in teaching social studies concepts to elementary level students (Mckinney, Ford, Larkins, & Peddicord, 1984; McKinney, Larkins, Ford, & Davis, 1983; Mckinney, Larkins, & Peddicord, 1982). The first study was conducted by Mckinney, Larkins, and Peddicord (1982). The purpose of the study was to compare the effectiveness of the Merrill and Tennyson model, the Gagne model and reading recitation method in teaching social studies concepts to fourth-grade students. The researchers reported no significant differences among the three treatment groups. These findings, however, were not replicated in the second and third studies. In the second study (McKinney, Larkins, Ford, & Davis, 1983), two social studies concepts were taught to sixth-grade students using the three methods. The findings of the study showed evidence that the Merrill and Tennyson model was more effective than both the Gagne model and reading recitation method. In addition, results of the third study verified the second study results on the fourth-grade students (Mckinney, Ford, Larkins & Peddicord, 1984).

The effectiveness of the Gagne model in teaching mathematics and pre-academic concepts to students with mental retardation was supported in studies conducted in Turkey (Varol, 1992, 1996;

Yıldırım-Alptekin, 2000). An additional study, conducted by Kırcaali-İftar, Birkan, and Uysal, (1998), compared the effectiveness of the structural language use and natural language use in teaching color and geometric shape concepts to students with moderate mental retardation. The structural language use was designed to be implemented just like the Gagne model. The researcher reported that the natural language presentation was more effective than the presentation of the Gagne model. It is important to note that the effectiveness of the Merrill and Tennyson model on students with mental retardation has not been investigated. Besides, there has been no research in the comparison of these two models on mentally retarded students' concept learning. Thus, the purpose of this study is to compare the effectiveness and efficiency of the expository presentation of the Merrill and Tennyson model and the Gagne model in acquisition and maintenance of square and triangle concepts in students with mental retardation. This study will serve as an important source for differentiating the effectiveness of two different concept teaching models and identifying instructional design variables that are effective on mentally retarded students' concept learning.

Method

Participants and Setting

Participants of the present study were chosen from students with mental retardation who attended a private special education center located in Kahramanmaras. Each participant met the following criteria: *(i)* being able to match geometric shapes, *(ii)* ranging in age from 7 to 9, *(iii)* being able to speak three-or-four-word sentences, and *(iv)* not being able to discriminate between square and triangle.

The chronological ages of four participants are as follows: the first participant was 7 years and 2 months old; the second participant was 8 years and 5 months old; the third participant was 8 years and 9 months old, and the fourth participant was 7 years and 10 months old. All four participants' full-scale score on the WISC-R was 55. The first and second participants were enrolled in first grade, the fourth participant was enrolled in second grade inclusive classroom and the third participant was enrolled in first grade self-contained

classroom during the course of the study. The fourth participant was a girl and the remaining participants were boys.

Experimental procedures were conducted individually in a private room located in the center. For the purpose of assessing inter-observer agreement and treatment integrity, a video-camera was used to record all the sessions.

Experimental Design

The design of the study was an adapted alternating treatment design (Holcombe, Wolery, & Gast, 1994). The dependent variable of the study was the level of meeting the goals of square and triangle concepts. The independent variables were the two concept teaching models, the Merrill and Tennyson model and the Gagne model.

Experimental Procedures

For each student, experimental procedures were applied three days a week. The experimental process was completed in one month, with two sessions conducted per day. All participating students were assessed during a baseline, an instruction and a maintenance phase. In the baseline condition, a criterion reference test was administrated at least three times to each student individually to assess his/her levels on the square and triangle concepts. In the intervention phase, square and triangle concepts were taught to each student individually by administrating the two concept teaching models alternatingly once in every two sessions. A criterion reference test was individually administered at the end of the each session. The maintenance measure was taken two weeks after the conclusion of the intervention for each participant

Instructional Procedures

Before the implementation of the models, a two-hour training session on the instructional techniques of the models was provided by the principal researcher to a graduate student (second researcher) who would implement the models. The trained second researcher worked with each student individually throughout the study. In addition, a series of lesson plans were developed for each model to en-

sure consistency in the delivery of the models. The Merrill and Tennyson model included explanations of examples and nonexamples which are matched on the basis of the concept attributes that direct the students' attention to the concepts. During the instructional presentations, the researcher explained the students whether each example was an example or nonexample and pointed out the presence or absence of the critical attributes. On the other hand, the Gagne model consisted of presenting examples and nonexamples and a statement that each was or was not the concept. No explanation was given about critical attributes during the presentation. During the intervention sessions, four examples and nonnexamples were used in the instruction of both models. At the end of each presentation of example and nonexample, the participants were asked to identify the examples and nonexamples of concept.

Data Collection and Scoring Procedures

In order to collect the data, two criterion reference tests were developed to assess the participating students' discrimination levels of square and triangle. In each test, there were nine statements and four questions for each statement and a criterion was set at 75% for each statement. The tests were administered individually to each participant in the baseline, intervention and maintenance phases. For data scoring, the students were expected to respond correctly to at least three out of four questions. At the end of each assessment, data collected on the instruction goals were recorded to the graph.

Inter-observer Agreement and Treatment Integrity

Inter-observer agreement data was collected during 21% of the assessment sessions for each participant, respectively. The mean agreement coefficient was 100%. Treatment integrity was verified through experimental conditions and assessed from 25% to 66% of the total sessions including each participant. Independent observers evaluated the experimenter's video performance using a procedural integrity checklist. Treatment integrity ranged between 85% to 88% across all sessions.

Results

The results showed that student achievement for the Gagne model was greater than the achievement reported for the Merrill Tennyson model in improving concept acquisition and maintenance of the first and third students. Evidence also indicated that the two models did not differ significantly from each other with the second and fourth students. Indeed, evidence supported that both models facilitated concept acquisition and maintenance. The results also showed that the Gagne model required less teaching time with three out of four participants compared to the teaching time used for the Merrill and Tennyson model.

Discussion

The purpose of the present study was to compare the effectiveness and efficiency of the expository presentation of the the Merrill and Tennyson model and Gagne model in acquisition and maintenance of square and triangle concepts among students with mental retardation. Results indicated that the Gagne model was more effective than the Merrill and Tennyson model in teaching concepts to the first and third participants. Results also demonstrated that neither model showed differentiation with the second and fourth students. Both models were equally effective with these students. In addition, the evidence from this study suggested that the Gagne model required less instruction time with the first, third, and fourth participants.

In general, the results indicated that the Gagne model was effective on the concept acquisition and maintenance for all students. These results might be related to the language used in the Gagne model. Previous studies showed that if the language used in concept instructions is clear and straightforward, students' ability to focus on the attribution of examples and their overall attention increase (Engelmann & Carnine, 1982; Tuncer & Altunay, 2004). In this study, a simple and clear language was used during the instructional process of the Gagne model. Due to this reason, the students were able to pay more attention on the examples. In contrast, during the instructional process of the Merrill and Tennyson model, associated attributions of the concept were verbalized and demonstrated on the only positive examples. Specifically, the first and third

students were not able to identify the concepts after they were presented each one of the four example and nonexample pairs. Because students were not able to identify the concepts, the presentation was repeated and the students were asked to identify the examples and non examples once again. Overall, it has been thought that long instructional statements may have caused to redirect students' attention to various stimulus instead of the concept examples.

In conclusion, evidence from this study supported the use of the Gagne model in teaching pre-academic concepts to students with mental retardation. These results are consistent with the previous findings reporting that the Gagne model was effective in teaching pre-academic concepts to students with mental retardation (Varol, 1992, 1996; Yıldırım-Alptekin, 2000). However, different from the existing studies, this study compared the two models, the Gagne model and Merrill and Tennyson model, and found that even though the Merrill and Tennyson model was effective in teaching concepts to two participating students, the Gagne model was facilitated the concept learning of all participants. In future research, the effectiveness of both models in teaching different concepts should be compared with students from different age groups. Additionally, long term effects of these instructional models should also be investigated.

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