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ABSTRACT

Two studies were conducted to extend the application and explore the parameters of the concept tree and rational set generator instructional design techniques. The first study was conducted with high school English students. Results indicated that students who studied the concept tree performed no differently on the classification tests than students reading the standard text format. This was the case regardless of ability. The observed pattern of results for use of the rational set generator was the exact reverse of the anticipated pattern. The second study involved application of the concept tree and rational set generator to the teaching of behavior management concepts. Junior and senior teacher education students represented an older population with a wide range of ability. Lower ability students were expected to profit by the concept tree presentation of definitions. The concept tree method may be more effective for some types of content than others. The rational set generator might be used to facilitate concept learning. Further research concerning the effectiveness and parameters of the concept tree and rational set generator is recommended. (DWH)

APPLICATIONS OF THE CONCEPT TREE
AND RATIONAL SET GENERATOR
FOR COORDINATE CONCEPT LEARNING

Draft

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Applications of the Concept Tree and Rational Set Generator for Coordinate Concept Learning

INTRODUCTION

The goal of two studies reported here was to extend the application and explore the parameters of two instructional design techniques proposed and tested in an earlier study (Tessmer and Driscoll, 1985).

The first technique was a means for teaching coordinate concepts, that is, defined concepts related in such a way as to comprise a "family" of concepts. Coordinate concepts are often particularly difficult for students to learn because of the superordinate characteristics they may share. Students tend to attribute critical defining characteristics attached to a concept at a subordinate level to another concept related to the first on a superordinate level.

While various methods for teaching defined concepts have been advocated (eg., Gagne and Briggs, 1979; Merrill, Reigeluth and Faust, 1979; Merrill and Tennyson, 1977; Markle, 1975; Landa, 1974; Park, 1984), few account for differences among types of concepts or learners. To meet the particular problems of teaching coordinate concepts, Tessmer and Driscoll (1985) drew on J. Anderson's (1976) ACT model of long-term retention to devise a new method of presenting concept definitions, called a "concept tree."

According to ACT theory, information is stored as a series of ideas connected to form propositions, which are in turn connected to other propositions by various links or pathways. The ideas are concepts, and it is their meanings, as opposed to their names or labels, that is stored (Klatzky, 1980). For coordinate concept learning, instruction must convey propositional information, or concept attributes, in such a way that the learner can most easily perceive the proper superordinate-subordinate class relationships. In this way, the learner may encode and store the defining attributes of concepts in an accurate associative network.

Tessmer and Driscoll's (1985) concept tree displays the propositional relationships among a set of coordinate concepts in a hierarchical diagram. The diagram sets out the genus and differentia of each concept definition and makes clear the relationships among them. While other design strategies have employed taxonomic illustrations to indicate concept relationships (eg., Markle, 1977; Reigeluth and Stein, 1983; Wilcox, Merrill, and Black, 1981), none have used the genus and differentia components of a definition as part of the taxonomy. Most focus on the concept name as the taxonomic basis or provide decision rules for determining the critical features of a concept.

Finally, the concept tree also provides a prototypic example of each concept being taught. While the tree serves to present the critical attributes of concepts as important nodes to be incorporated into memory, the examples serve to strengthen the pathways between the critical defining attributes.

The second technique proposed and tested by Tessmer and Driscoll (1985) was a method for creating examples of concepts for use in teaching or testing, called a "rational set generator." The method combines example-generating strategies suggested by Markle (1975), R. Anderson (1973), and Merrill and Tennyson (1977) to enable a full "rational set" of examples to be created that will measure a range of discrimination ability (see Driscoll and Tessmer, 1985, for a full description). The rational set generator is predicated on the assumption that concept attainment should be measured in terms of the student's ability to classify concept examples (Gagne and Briggs, 1979; Gagne, 1985) and that both classification should involve both discrimination and generalization (Markle and Tiemann, 1969; Tennyson, Woolley, and Merrill, 1972; Merrill and Tennyson, 1977).

While Tessmer and Driscoll (1985) found the concept tree to be a useful method for facilitating concept learning, and the rational set generator a useful method for creating concept examples, conclusions from this study remain tentative until several questions are answered. First Tessmer and Driscoll hypothesized that students with lower reading ability would benefit more from the concept tree format than those of high reading ability. Yet, the students in their study represented a limited range of reading ability, from "slightly below average" to "superior." Therefore, the effects of the concept tree have yet to be fully determined with lower levels of reading ability.

Second, the concept tree and rational set generator were used with only one set of concepts in science instruction and one target population. The range of their applicability, therefore, has yet to be explored. Will they prove to be as useful for concepts in other types of content or for other populations of students?

Two studies were conducted as first attempts to answer these questions. In Study 1, upper and lower level high school English students were selected to enable a broader range of reading ability than reported in Tessmer and Driscoll. In this study the concept tree and rational sec generator were applied to teach five literary devices (eg., assonance, consonance, alliteration, etc.). Study 2 was conducted with college education students, who were taught a set of behavior management concepts (cf., Park, 1984).

STUDY 1

The purpose of Study 1 was twofold: first, to replicate the aptitude-treatment interaction demonstrated by Tessmer and Driscoll (1985); and second, to extend application of the concept tree and rational set generator to a different set of concepts. Ir this study, upper and lower level high school English students were selected as the target population. It was expected that a braod range of reading ability would be represented, by both the span of grades and by the fact that English is a required subject. Students who participated in Tessmer and Driscoll came from physics classes; that being an optional subject, students likely to select it may be expected to have higher reading ability. Finally, a set of concepts in literature--namely, five literary devices (assonance, consonance, alliteration, rhyme, onomatopoeia)--were selected as the instructional content.

Two hypotheses were tested in Study 1, relating to the concept tree and rational set generator, respectively. They were:

H1: Students with lower reading ability should benefit more from the concept tree presentation of definitions over the text format than students with higher re-ding ability.

H2: Students should make more errors on test items that require generalization and fine discrimination than on items requiring no generalization or obvious discrimination.

Method

Subjects

Thirry-one ninth and 23 eleventh grade students were randomly assigned within grade level to one of the two instructional treatments, concept tree or traditional text. The students comprised two classes taught by the same English teacher, in the same room two hours apart. Reading ability of the students was determined by their scores on the reading portion of the California Tests of Basic Skills (CTBS), and these ranged from 755-870 ($\overline{X}$ = 799.1, S.D. = 32.6) for Grade 9 and from 717-845 ($\overline{X}$ = 780.9, S.D. = 37.6) for Grade 11.

Materials

Instructional texts. Two self-instructional texts were developed on the meanings of five literary devices used in poetry (assonance, consonance, alliteration, rhyme, and onomatopoeia). These concepts were ascertained by the students' teacher to be ones he usually taught but had not yet covered in either class. It was reasonable to conclude, then, that students would have low prior knowledge of them.

Both texts contained the same introductory material, which described literary devices in general, how they are used by a poet, and what they enable a poet or speaker to do. Following the introduction, directions specified how students were to study the definitions of five particular literary devices presented on the next page. The presentation of the definitions is what differed between texts.

In the "traditional" text, the definitions for each of the five concepts were presented in a standard prose format (eg., "Alliteration: a literary device in which. . . "). Immediately below each definition was an example of the concept as it has occurred in classical poetry (eg., for alliteration: "Hither sometimes sinne steals and stains. . .").

By contrast, in the "concept tree" text, the genus and differentia of the definitions were diagrammatically displayed in a hierarchical fashion, as shown in Figure 1. The name of each concept appeared in parentheses below its differentia. Beneath it appeared the same prototype example as in the traditional text.

Both texts and the concept tree itself were reviewed by the instructor whose classes were participating in the study. Revisions were made on the basis of his suggestions, and the texts prepared in their final form.

Tests. To construct the classification posttest and retention test (to be administered as a delayed test), six examples of each concept were created with the rational set generator, covering three subject matter contexts. The first subject matter context matched that of the prototype teaching examples (i.e., classical poetry) while the other two called for generalization to "nursery rhymes" and "conversation and jingles" (see Figure 2). The examples were reviewed by the instructor and several deleted and replaced on the basis of his suggestions.

The 30 examples were then separated into two sets of 15, such that each concept was represented by three examples, one from each context. One set became the Posttest, the other the Retention Test. For both tests, the 15 examples were randomly ordered to make up two forms, in order to prevent cheating.

Procedure

The instructor administered the treatment materials to both classes on the same day during their regular, 50-minute class periods. He informed the students that their lesson for the day involved learning some new concepts in poetry, and that a quiz would be given after they had finished studying the instruction. He also told them they would have 20 minutes to study the instruction and 15 minutes to complete the quiz.

The instructor then handed out the text materials, upon which the names of the students had been previously written. After 20 minutes, he collected the texts and administered the posttest. When students had completed the test, he collected all materials and returned them to the experimentors for scoring.

One week later, the instructor administered the retention test. Students had been given no advance warning that a follow-up test would be administered. They were given the same time to complete this test as they had for the posttest.

Results

Posttest and Retention Test

Table 1 displays the mean posttest and retention test scores achieved by students in both treatment groups and according to their grade level. A typographical error that caused a change in meaning of one of the posttest items resulted in its being dropped from the analysis. As a result, mean scores on the posttest are based on a total of 14 possible items, while mean scores on the retention test are predicated on 15 items.

As can be seen in Table 1, little difference appears to exist among groups for either test. Since the effect of interest was an aptitude-treatment interaction, the posttest and retention test scores were separately submitted to

ATI linear regression analyses with CTBS as the aptitude variable. No significant effects were found in either analysis.

Rational Set Generator

According to the hypothesis regarding the rational set generator, students were expected to make more errors on test items that required them to generalize to new contexts different from the context of the prototype teaching examples. They were also expected to make more errors of fine discrimination than obvious discrimination. To test the generalization part of the hypothesis, the items students missed were grouped according to whether the subject matter context of each item was the same as or different from the prototype teaching examples. Since the number of items in each group was different, student raw scores were converted to percentages.

To test the discrimination part of the hypothesis, students' incorrect responses to test items were examined for whether they made errors of obvious discrimination or errors of fine discrimination. Then, for both sets of error scores, a t-test of dependent observations was used to analyze the test results (see Table 2). Results indicated that a pattern of errors occurred that was the direct opposite of what was predicted. Students missed a significantly greater percentage of items requiring no generalization than those requiring medium or high generalization ($t = 3.08$, $p < .01$), and they made significantly more errors of obvious discrimination than fine discrimination ($t = 5.82$, $p < .001$).

Discussion

The first purpose of this study was to replicate the aptitude-treatment interaction demonstrated by Tessmer and Driscoll (1985). They found that students with lower reading ability benefitted to a greater degree by a concept tree presentation of definitions over a text presentation than students with higher reading ability. A weakness of this study, however, was that no students fell into the range of "low" ability; rather they represented a range of low-average to high ability, according to a grade-level interpretation of their CTBS reading scores. In this study, then, a wider range of ability was expected that should result in a clearer demonstration of the hypothesized interaction.

Unfortunately, this hypothesis was not confirmed. Students studying the concept tree performed no differently on the classification tests than students reading the standard text format, and this occurred regardless of ability. A prime reason for this lack of interaction, however, is likely to be the fact that, again, no "low" ability students participated. In fact, the overall average CTBS reading score of the classes in this study exceeded that of the classes in the Tessmer and Driscoll study by one-half standard deviation!

The data from this study, then, do not provide an adequate test of the hypothesized benefits of the concept tree. In a future study, a full range of reading ability should perhaps be assured before the study is undertaken.

With respect to the rational set generator results, students were expected to perform best on items requiring obvious discrimination and on items that were examples from classical poetry (i.e., a subject matter context that matched the prototype teaching examples). They were expected to make more errors on items requiring generalization to new contexts and on items calling for fine discrimination. Neither the discrimination nor the generalization parts of the rational set generator hypothesis were confirmed. In fact, the observed pattern of results was the exact reverse of the expected pattern. Students made more errors of gross than fine discrimination, and they performed better on items that were examples of the concepts in nursery rhymes and in conversation than they did on examples from classical poetry.

With respect to generalization, we suspect that a familiarity factor overrode the predicted error pattern. That is, students are far more familiar with rhymes such as "Here's the church, there's the steeple; open the doors and see all the people" and conversational slogans like "All the way with LBJ," which are highly memorable, than they are with examples of classical poetry. And two exposures to examples from poetry, once inthe instruction and once on the test, was not enough to affect the familiarity of the other two contexts.

This result might also suggest a revision of our procedures for teaching such literary devices to high school students. All of the textbooks and supplementary materials we reviewed as sources for our instruction gave examples of these concepts in classical poetry. Perhaps students would have an easier time of learning them if examples from familiar rhymes and sayings were given first, before classical poetry is studied.

With respect to discrimination, the observed error pattern may suggest a problem with the relationships among the concepts as they are depicted by the concept tree and presented in the concept definitions. As currently shown, rhyme, for example, is more discriminable from alliteration than it is from onomatopoeia. Yet some advanced prosody textbooks call alliteration a type of rhyme, which would mean that the distinction between rhyme and alliteration would be one of fine discrimination. This discrepancy in the definitional relationships among the concepts, then, could account for the results observed in this study, both for the lack of effect of the concept tree and for the rational set generator results. A probable next step to take on the basis of these results might be to independently validate, or revise and validate, the concept tree for this set of concepts.

STUDY 2

The main purpose of Study 2 was to apply the concept tree and rational set generator to the teaching of behavior management concepts (cf., Park, 1984). In this study, college students represented a different and older target population with an anticipated wide range of ability. As in the previous studies, it was expected that lower ability students would profit by a concept tree presentation of definitions to a greater degree than higher ability students, who should learn as well with either a text or concept tree presentation.

In addition, this study sought to investigate a variable that might enhance the effect of the concept tree. Research suggests that activities calling for students to elaborate on instructional material may facilitate their processing the material in a more active, or deeper, way (cf., Craik and Lockhart, 1972; Bransford, 1979). Moreover, asking students to generate their own examples of defined concepts has been advocated as a way to enhance concept learning (Merrill and Tennyson, 1977; Merrill, 1983). Therefore, to induce students to elaborate in this study, half were directed to generate their own examples of the concepts being studied. The other half were told to take whatever notes they normally would while studying; these students, it was expected, would be likely only to repeat information, rather than elaborate on it, with the result being a more superficial processing of the material.

To summarize, two factors were investigated in this study: type of definition presentation (concept tree vs. traditional text) and type of processing induced (by take notes vs. generate example). In addition, verbal ability was expected to be an intervening aptitude variable. Therefore, the specific hypotheses to be tested were:

H1: Lower ability students should profit by a concept tree presentation over a text presentation to a greater degree than higher ability students.

H2: Students who generate examples should more deeply process, and thereby perform better on a test of the concepts taught in the instruction than students who simply take notes.

H3: All students should make more errors on test items requiring generalization and fine discrimination than on items requiring no generalization or requiring obvious discrimination.

Method

Subjects

Seventy-nine junior and senior level college students who were enrolled in an applied educational psychology course were randomly assigned to the four treatment groups. Since students majoring in Special Education were expected to have had prior exposure to the instructional material (ascertained by the course instructor), the scores of these students were omitted from the data analysis. This meant that 13 students were eliminated from the study, and they were approximately evenly distributed across groups. Of the remaining 66 students, about 90% were other majors within education, for whom the course is a requirement, and about 10% represented a variety of other majors taking the course as an elective.

Materials

Instructional texts. Two self-instructional texts were developed on the meanings of five behavior management procedures (positive reinforcement, Premack principle, negative reinforcement, punishment and extinction). Both texts contained the same introductory material, drawn from Royer and Feldman (198-), that generally described behavior management, the theoretical basis of it, and the various general uses to which behavior management procedures have been put. Then both texts gave directions for studying the meanings of five specific procedures, to follow on the next page.

The presentation of the concept definitions is what differed between the two texts. In the traditional text, the definitions for each of the five procedures were given in a standard prose format (eg., "Positive reinforcement: a procedure used to increase the frequency of a behavior in which. . ."). Each concept definitions was followed by an example of the concept in a teaching context (eg., for positive reinforcement: "Juan's teacher awards him a smiley face on his chart everytime he. . .").

By contrast, in the concept tree text, the genus and differentia of each concept were diagrammatically displayed in a hierarchical fashion, as shown in Figure 3. The name of each concept appeared in parentheses beneath its differentia and beneath it appeared the same prototype example as used in the traditional text.

The processing factor was implemented by instructions in the texts to either generate an example of each concept or to take notes as students studied the definitions. In both types of texts, space was provided for these activities, labelled either "Notes" or "Your example."

All instructional materials were subjected to review by a second content expert (the materials developer being the instructor of the course). In addition, the concept tree was reviewed by several graduate student members of a learning theories course. No revisions were suggested by these reviews.

Posttest. Fifteen concept examples comprised the classification posttest, three examples of each of the five concepts. The examples were randomly ordered on two different forms to prevent possible cheating. All examples were created according to the rational set generator to allow for a full range of discrimination and generalization items to be used. Besides examples drawn from a teaching context, which matched the prototype examples appearing in the instruction, examples were created in the contexts of behavior management in the home or workplace and personal self-control.

Procedure

Prior to the conduct of the study, students were told they would be participating in a research study as a regular class exercise. The exercise would o-cur at the point in the course when the function of research in education was being discussed. The purpose of the exercise was to acquaint them with the process of research and the kinds of conclusions that might be drawn from it. Students were also told that the exercise would involve their learning a set of concepts, for which they would be responsible on the course final exam. To alleviate any fears students might have had about the effects of the experimental manipulation, the instructor assured students they would receive copies of all materials at the conclusion of the study.

The study took place during one 50-minute class session, specifically assigned for the research exercise. Before handing out materials, the instructor briefly described the general purpose of the study and the basic procedures to be followed. She reminded students that not everyone would be doing the same thing, so each should do the best he our she could, without paying attention to anyone else. She also informed them they would have approximately a half-hour to study the materials, after which they would take a quiz on what they had learned.

The instructor then answered any preliminary questions, handed out materials, and told students to begin working. She gave a 5-minute warning before the end of the study period, collected materials when 30 minutes had transpired, and administered the posttest. Students were allowed to leave as soon as they had finished the posttest.

During the very next class session, the instructor handed back all materials, ensuring that students had copies of both the text and concept tree and knew of the "notes" vs. "your example" manipulation. She described the results (i.e., mean scores) of each group and invited discussion. The remainder of the period was spent relating the study to teaching and making clear the distinctions between the concepts taught in the instruction.

Results

Success of the Treatment Manipulations

Prior to submitting the results to statistical analysis, some assurance should be given that the intended treatments were, in fact, implemented. To this end, the instructional materials were inspected for the "take notes" vs. "generate example" manipulation. In most cases, taking notes took the form of underlining parts of the text and definitions. In some cases, students also repeated in the given space words or phrases taken from the instruction. In one instance, a student attempted to generate examples of the concepts, but for only two of the five concepts.

Students in the "generate example" condition did generate examples. Moreover, on the average, they generated four or five correct examples. Thus, it appears that the direction intended to differentially affect students' processing of the material was successful in influencing their behavior.

Posttest Performance

Table 3 displays the average posttest scores achieved by each of the four groups in the study. Because an interaction was anticipated between performance on the task and ability, an ATI regression model was used to analyze posttest results. While verbal ability was the aptitude variable considered the most closely associated with performance, scores on the verbal section of the Scholastic Aptitude Tests were not available for many of the students participating in the study. Thus, student grade point average (GPA) was used as the ability measure in the analysis. The GPA scores for all groups ranged from 1.313 to 4.000 ($\bar{X}$ = 2.848, S.D. = .64).

The test of the linear regression model as a whole indicated significance at the .05 level [$F(7,58) = 2.15$; $p = .05$], accounting for 21% of the variance. None of the predicted interactions (ability by treatments, type of text by level of processing) were significant at the .05 level ($F < 1$ in all cases), nor were either of the main effects [type of text, $F(1,64) = 1.06$, ns; level of processing, $F(1,64) = 2.73$, ns]. The main effect for level of processing approached significance, however, and accounted for 2% of the variance, while the main effect for type of text, combined with all the interactions, accounted for 1% of the variance. The only significant effect found was for GPA [$F(1,64) = 12.99$, $p < .005$], which accounted for 17% of the variance.

Rational Set Generator Results

Hypothesis 3 predicted that students would a) make more errors on test items requiring generalization to contexts different from the prototype teaching examples, and b) make more errors on test items requiring fine (or high) discrimination. To test the generalization part of this hypothesis, the percentage students missed of items requiring no generalization (i.e., items of the same context as the teaching examples) was compared to the percentage they missed of items requiring medium or high generalization.

To test the discrimination part of the hypothesis, students' incorrect responses to test items were examined for whether they made errors of obvious discrimination or errors of fine discrimination. Then, for both discrimination and generalization, a t-test of dependent observations was used to analyze the test results (see Table 4). Results indicated that students missed a significantly greater percentage of items requiring medium or high generalization than those requiring no generalization ($t = 4.13$, $p < .001$), and they made significantly more errors of fine discrimination than obvious discrimination ($t = 7.64$, $p < .001$).

Discussion

The purposes of Study 2 were to apply the concept tree and rational set generator to the teaching of behavior management concepts and to investigate a variable that might enhance the effect of the concept tree. It was expected that lower ability would profit by the concept tree presentation of definitions to a greater extent than higher ability students (Hypothesis 1). According to Hypothesis 2, students who generated examples were expected to more deeply process the concepts,and thereby perform better on the test, than students who only took notes during instruction. Finally, all students were expected to make more errors of generalization and fine discrimination than errors of no generalization or obvious discrimination (Hypothesis 3).

Neither Hypothesis 1 or Hypothesis 2 was statistically confirmed. While it was true that ability significantly affected performance, it did not appear to interact with the treatment variables. And the treatment variables themselves did not significantly affect performance.

Of interest, perhaps, is the fact that the effect of level of processing (as influenced by taking notes or generating examples) approached significance. The mean scores reflect some differences among groups and indicate that having to generate examples while studying the traditional text depressed performance of this group relative to the others. During the discussion that followed the study, the instructor asked students about this apparent effect. A majority of students in the text plus generate example group reported that they spent so much time trying to think of examples, they did not go back and review the text as they otherwise would. By contrast, many students in the concept tree plus generate example group reported no interference from having to write their own examples. The concept tree, they felt, made the definitions clear and actually helped them create new examples.

Although the anticipated effects of the concept tree were not found, those of the rational set generator were (Hypothesis 3). Students did, in fact, make more fine discrimination errors than errors of obvious discrimination, and they made more errors on items requiring generalization than on items whose subject matter context matched the teaching examples.

GENERAL DISCUSSION AND CONCLUSIONS

On the basis of the studies conducted thus far, the effectiveness of the concept tree method for teaching coordinate concepts appears, at first glance, questionable. In only one study (Tessmer and Driscoll, 1985) has it been shown to facilitate concept acquisition for lower ability students. But the problem may not lie in the concept tree itself so much as in the tests of the concept tree as a technique for aiding low ability students to learn concepts. All three studies hypothesized that students with low reading ability would benefit by the concept tree, but in Tessmer and Driscoll and the first study reported here, there were no students participating who could be said to be low ability readers. In the second study reported here, reading ability was not measured; for the lack of a reading ability measure, student GPA was used as an estimate of ability. While GPA is no doubt correlated with reading ability, it does not provide a clean measure of the aptitude of interest.

The results of Study 1 also indicate that the concept tree method may work better for some kinds of content than others. This could be true for at least two reasons. First, in the development of the instructional materials to teach the literary devices (Study 1), for example, the relations among these concepts were less clear, and thus harder to depict, than those among the behavior management concepts of Study 2 or the physics concepts taught in Tessmer and Driscoll (1985). It seems likely, then, that the more arbitrary the concept tree seems, the less it is apt to facilitate learning of the information it depicts. Second, it is possible that students are more used to diagrams like the concept tree in content such as physics but are not accustomed to seeing them in content such as literature. Thus, using concept trees over a longer time period and a range of concepts in content such as literature may result in a facilitating effect becoming apparent as students grow used to them as a device.

In contrast the concept tree, the rational set generator has received support as a useful and valid tool for instructional designers to create examples for teaching and testing concepts. The results of both Tessmer and Driscoll (1985) and Study 2 reported here empirically support the designer's ability to create, via the rational set generator, a set of examples that measure a range of discrimination and generalization capability in the student. The results of Study 1 suggest further that the rational set generator might be helpful in defining, as well as confirming, discrimination and generalization within a given set of concepts. That the error pattern observed in Study 1 was opposite to prediction suggests, for example, that the intended relationships among concepts were not made clear to students and that the context in which the concepts were illustrated was not the most obvious to students. Both indicate possible revisions to the instructional and test materials, revisions that could be verified empirically in a future study.

Finally, since practice with examples from a variety of contexts helps students to learn to generalize (Gagne, 1985), the rational set generator might be used to facilitate concept learning, either by the instructor presenting a rational set of examples for a given family of concepts or by the students generating their own rational set, with feedback from the instructor. Both possiblities remain to be tested.

In conclusion, for the effectiveness and parameters of the concept tree and rational set generator to be explored fully, research seems warranted in the following directions. First, to adequately test the reading ability by concept tree interaction, a wide range of ability among those participating in the study must be assured. Then, studies could investigate possible interactions between the concept tree and various types of content to which it might be optimally applied, as well as the effect of using a concept tree approach over an extended period of time. Finally, a variety of uses for the rational set generator should be explored, from facilitating concept learning to diagnosing learner weaknesses in understanding concepts.

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TABLE 1

Mean Posttest and Retention Scores for Classifying Examples of Literary Devices

Treatment		Posttest[a] Mean	Posttest[a] S.D.	Retention Test[b] Mean	Retention Test[b] S.D.
Concept Tree	Gr. 9	8.38	3.24	7.64	2.99
	Gr. 11	8.67	2.78	7.45	2.54
Text	Gr. 9	8.71	2.23	7.00	2.76
	Gr. 11	8.30	2.79	8.56	3.72

[a]Number of items on posttest: 14

[b]Number of items on retention test: 15

TABLE 2

Generalization and Discrimination Performance
on Examples of Literary Devices

	Variable	Mean	S.D.	t
1.	% of items requiring no generalization answered incorrectly	46.2	24.9	3.08*
	% of items requiring medium or high generalization answered incorrectly	36.7	21.0	
2.	# of errors of obvious (low) discrimination	4.08	.32	5.82**
	# of errors of fine (high) discrimination	1.90	.23	

*p .01

**p .001

TABLE 3

Average Posttest Scores for Classifying Examples of Behavior Management Principles

Treatment	Mean[a]	S.D.
Tree + $\overline{EG}$	10.38	2.47
Tree alone	10.37	2.66
Text + $\overline{EG}$	8.67	2.59
Text alone	10.17	2.23

[a]Total score possible: 15

TABLE 4

Generalization and Discrimination Performance on Examples of Behavior Management Principles

Variable	Mean	S.D.	t
1. % of items requiring no generalization answered incorrectly	26.8	18.9	4.13**
% of items requiring medium or high generalization answered incorrectly	35.9	19.4	
2. # of errors of obvious (low) discrimination	1.62	1.3	7.64**
# of errors of fine (high) discrimination	3.30	1.9	

**p .001

FIGURE CAPTIONS

Figure 1. A concept tree for literary devices (Study 1).

Figure 2. A rational set of examples of literary devices (Study 1).

Figure 3. A concept tree for behavior management principles (Study 2).

LITERARY DEVICES

- Literary effect of letters
  - Same consonant sound repeated
    - At the beginning of words. (Alliteration)
      - example: "Hither sometimes sinne steals and stains..."
    - At the end of words. (Consonance)
      - "Oh! That I may rise, and stand, and bend."
  - Same vowel sound repeated
    - After different consonants. (Assonance)
      - "Live within the sense they quicken."
- Literary effect of words
  - Words similar in sound are repeated. (Rhyme)
    - "Had we but world enough and time, This coyness, lady, were no crime."
  - Words similar in sound to word or meaning they symbolize. (Onomatopoeia)
    - "The hissing of those vipers,..."

Study these definitions and examples.

	CLASSICAL POETRY	NURSERY RHYMES	CONVERSATION & JINGLES
ALLITERATION	Roses like a rainbow wrought of roses rise. Five miles meandering in a mazy motion.	Sister Sally sold seashells by the seashore. Perspicaceous Polly bought Peter Piper's pickles.	Dad does the dishes while Mom makes the money. They sat in their coats and caps and mufflers and snowboots, snug now, secure, savoring comfort.
CONSONANCE	Remote exhaustion had lined, scratched, and burned. Life's but a walking shadow. A play that struts and frets...	Then Kermit the frog said, "What's all this uppety-flippety rackety noise?" Once upon a time there were two yaks, Mr. Shruks and Mr. Claks.	I laughed, and she got miffed and left. Whether he's first or last, he's always best.
ASSONANCE	Entreat me not to leave thee. In the distance, the hunter's trumpet sounded its olden, gold notes.	There once was a bum, who found a gun in a rut. I'm behind the wheel of my screamin' Ford in green.	He made his name famous in baseball. How can you slap that cat?
RHYME	Ah! Distinctly I remember it was in the bleak December. Will you, nill you, I will marry you.	Here's the church, there's the steeple; open the door and see all the people. Hush, my baby, don't say a word; Papa's goin' buy you a mockingbird.	For all you do, this Bud's for you. All the way with LBJ!
ONOMATOPOEIA	And off, in a whirr of wings. The treetops faintly rustle beneath the breeze's flight.	With an oink-oink here and a quack-quack there... The Jabberwock came whiffling through the tulgey wood.	The hot wax slowly bubbled in the pot. That old biddy had the nerve to cackle to me about her new quilt.

PRINCIPLES OF BEHAVIOR MANAGEMENT

Procedures used to increase or strengthen behavior

Pleasant consequence is presented

Pleasant consequence is external to the person (positive reinforcement)

Juan's teacher awards him a smiley face on his chart every time he raises his hand in class and participates appropriately. Soon, Juan is raising his hand and participating a lot in class.

Your example:

Pleasant consequence is another behavior of the person (Premack principle)

Helga likes to play records. Her teacher allows her to play records every time she completes 10 math problems correctly. Soon, she has done her math assignment for the whole week.

Your example:

Negative consequence is removed (negative reinforcement)

Tim & Joe's horseplay in class keeps interrupting Steve's work, and then the teacher yells at him. She suggests that if he sits at the other side of the class, he will avoid the problem. Soon, he sits away from Tim and Joe during every class.

Your example:

Procedures used to reduce or eliminate behavior

Negative consequence is presented (punishment)

Every time Suzanne talks out of turn in class, the teacher frowns at her severely. Soon, she does not speak unless she is called upon.

Your example:

Positive consequences are stopped (extinction)

Georgann likes to tell jokes in class to make other students laugh. Since this disrupts class, the teacher asks the other students not laugh. When they pay no attention to Georgann, she soon stops telling jokes in class.

Your example: