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ABSTRACT

The current study was devised to determine the short-term (1 month) and long-term (4 months) effects of having students generate their own examples of selected concepts. More specifically, focus was on determining how self-generated examples might enhance the learning and retrieval of concepts. Subjects were 55 (54 female and 1 male) undergraduate students enrolled in a child development course at a state university. Over 95% of the students were elementary education and special education students. Instruments used were multiple-choice examinations that tested for the students' retention and understanding of major psychological concepts. From lists of social development and cognitive development concepts, the students found relevant examples using real-life children. On both the short-term and long-term measures of retention, subjects performed better on items they had included in their own list of generated examples (same category of concept types) than on items from the same pool of items and on items from another pool of items (different category of concept types). Additionally, a comparison of the performance of example generators versus non-generators on the short-term retention examination showed higher performance for those who generated examples. Lists of 17 social/personality development concepts and 22 cognitive/linguistic development concepts used in the study are appended. (Author/TJH)

Effects of Self-Generated Examples on Retention of Selected Concepts

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Paper Presented at the Meeting of

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Abstract

The current study was devised to determine the short- and long-term effects of having students generate their own examples of selected concepts. Subjects were 55 undergraduate students enrolled in a child development course. From lists of social development and cognitive development concepts, the students found relevant examples using real-life children. On both the short-term and long-term measures of retention, subjects performed better on items they had included in their own list of generated examples (same category of concept types) than on items from the same pool of items and on items from the another pool of items (different category of concept types). Additionally, a comparison of the performance of example generators vs. non-generators on the short-term retention examination showed higher performance for the group that generated examples.

Effects of Self-Generated Examples on Retention of Selected Concepts

Teaching concepts involves two main instructional processes: presentation of the defining characteristics of the concept and presentation of positive and negative exemplars. Presumably, exposure to the positive and negative exemplars enables learners to encode the salient features of the concept, thereby developing conceptual knowledge that can be applied appropriately (Tennyson & Cocchiarella, 1986). For the learner, the concept-acquisition process involves formation of conceptual or declarative knowledge and subsequent development of procedural knowledge that enables the learner to classify new examples of that concept correctly (Anderson, 1982). It is generally understood that encoding defining characteristics of a concept without linking those characteristics with appropriate exemplars or examples stops short of the goal of reaching true comprehension and facility in manipulating that concept intellectually (DiVesta & Peverly, 1984; Nitsch, 1977; Tennyson & Park, 1980).

Examples of concepts function as mediating elements in the learning and application of conceptual knowledge. This mediating function appears to be due to the elaborative nature of concept examples, which provide additional information that enriches the learner's schema associated with the concept. If we consider that the learner is storing information concerning a concept's defining characteristics in terms of particular examples that have been presented formally or informally, we can see that the retention of appropriate exemplars of the concept elaborates meaningfully upon it.

Elaborations upon concepts that are being acquired improve retention and retrieval by providing alternative paths for accessing the information and by providing extra information upon which one may form representations later (Anderson, 1985; E. Gagne, 1985; Hyde & Jenkins, 1973). It has been shown in several learning contexts that self-generated elaborations lead to better retention (Bobrow & Bower, 1969; Reese, 1977; Slamecka & Graf, 1978; Stein & Bransford, 1979) than not using elaborations or using elaborations provided by others. Research on memory training has shown that practice in generating mnemonics in the keyword method improves the transfer of that strategy to other contexts (Pressley & Dennis-Rounds, 1980). Additionally, retention and comprehension of textual information is improved when readers generate associations to the text as they read (Linden & Wittrock, 1981). The suggestive nature of studies on elaborations in various contexts raises the possibility that self-generated examples, those that have been found or invented by the learner, might provide the learner with meaningful elaborations. These self-generated examples may constitute extra, and potentially more personal, experiences with the concept and thus could lead to better retention of the concepts.

In addition to the elaborative nature of acquiring examples of concepts, evidence from research on conditions related to learning declarative knowledge suggests that deeper processing of information and variable contexts for processing information enhance the transfer of information. Deeper processing of concepts using semantic representations should enable a learner to retrieve information by means of more complex sets of associations (Bradshaw & Anderson, 1982; Craik & Tulving, 1975). The presentation of meaningful concepts by means of variable contexts during the acquisition phase leads the learner to being able to recognize broad applications of the concept (DiVesta & Peverly, 1984).

It seems likely that storing a variety of self-generated examples of concepts would entail deep processing by creating personal associations between the examples and the formal representation of the concept. Also, time spent in generating examples provides extra practice of the concepts, and eventual expansion of schemas because of the variable contexts related to the examples provided by the learner. Thus, these supportive processing features of providing one's own examples may contribute to later retrieval. Personal elaborations developed through associations with particular examples or prototypical examples, related to the concept as it is being learned and modified should provide additional structures for retrieving that concept in appropriate future contexts.

Consideration of the number of reasons that self-generated examples might enhance the learning and retrieval of concepts led to the initiation of this study, which was conducted during a regular semester of instruction in child development. It was thought that an _in vivo_ study of this nature would contribute more to the practical issues of concept learning via self-generated examples than one that controlled variables fully in exchange for creating an artificial learning environment (the laboratory) which would lose the sense of a real classroom. The primary hypothesis was that subjects would perform better on sections of an examination related to definitions and recognition of exemplars of the concepts for which they found their own examples than on sections related to comparable concepts for which they did not generate examples. A secondary hypothesis was that subjects who generated examples would perform better overall on an examination of the same and related concepts than would subjects who generated no examples at all.

Method

Subjects

Subjects were 55 undergraduate students enrolled in a child development course at a state university. All but one of the subjects were female, ranging in age from 20 years of age to the mid-forties. The vast majority of students (over 95%) were elementary education and special education students.

Instruments

Instruments were multiple choice examinations that tested for retention and understanding of major psychological concepts. Each examination contained a multiple-choice item related to each of the targeted psychological concepts. The questions required the subject to select an appropriate exemplar of a concept from a variety of choices or to select the appropriate concept that best represented an example presented in the stem of the question. There were different forms for each examination.

Procedure

Education students enrolled in a child development course were allowed the option of finding real-life examples of selected psychological concepts and submitting them as partial fulfillment of the requirements for the course. From the lists of available concepts, the students had to find relevant examples using children within or outside of their families; they could elect either to find examples of concepts related to social development or related to cognitive development. There were 17 social development concepts and 22 cognitive development concepts from which they could elect to find a maximum of ten examples to be turned in as part of their course grade. Lists of the concepts for each category are presented in the Appendix.

Scoring of the examples was based upon the appropriateness of the example to the concept being illustrated. Only those examples that were appropriate instances of the targetted concepts were considered. If a subject submitted an inappropriate example, the concept to which it was attached was placed on the list of non-generated examples for that individual. In other words, if a subject submitted a wrong instance, it was considered to be the same as if the subject had not generated an example at all.

On the final examination of the course, one multiple-choice item was included for each of the concepts on both lists. This examination constituted the short-term retention measure of the concepts.

Three months following the completion of the course (four months after the assignment), 24 students from the course were asked to take a follow-up, non-graded examination on the same concepts, using a different set of multiple-choice items. This examination constituted the long-term retention measure of the concepts. Those students who agreed to take the examination also agreed to have their scores on the final examination included in an analysis of retention of concepts. Those are the only scores reported in this study.

Results

In order to make meaningful comparisons within each subject, a complete record of examples they generated and a record of which ones were appropriate was kept. These lists were matched with the specific items on the sub-tests (Social or Cognitive), deriving for each subject three scores: percent correct on the sub-test overall, percent correct among the "self-generated" concepts, and percent correct among the "non-generated" concepts. Since each participating subject found no more than 10 relevant examples within the particular category chosen, comparison could be made within the selected category (self-generated vs. non-generated) and also across category boundaries. Percent correct had to be derived as the working value, since each student had different combinations of concepts selected from the approved list, and since some students ended up with fewer than ten acceptable examples. For example, one student may have generated examples for 10 out of 22 Cognitive concepts, while another student may have generated examples for 8 out of 17 Social concepts.

Within-Subjects Analysis

Two primary questions were addressed by the within-subjects analysis. First, do subjects who generated their own real-life examples of psychological concepts recall them better than they recall concepts for which they did not generate examples? Second, do subjects who generated examples for concepts perform better on a test of those plus related concepts than do subjects who did not generate examples at all or who generated examples for a separate pool of concepts?

Short-Term (1 month) retention. A 2 (generated vs. non-generated items) x 2 (social vs. cognitive concepts) repeated measures analysis on the short-term examination yielded a statistically significant main effect for performance on generated vs non-generated items, $F\ (1,30) = 26.20$, $p < .001$. Subjects performed better on items they had included in their own list of generated examples ($\bar{X} = 90.8$) than on items from the same pool of items (same category items: Cognitive or Social) ($\bar{X} = 75.9$).

A similar repeated measures analysis found a main effect for generated items over other items on the examination, $F(1,30) = 7.01$, $p < .05$. Subjects performed better on items they had included in their own list of generated examples ($\bar{X} = 90.8$) than on items from the other pool of items (different category items: Cognitive or Social) ($\bar{X} = 78.6$). The analysis also revealed no statistically significant difference between subjects' performance on non-generated items from the same pool of items (as the ones for which they found examples) than they did related to items from another pool of items. Figure 1 shows the means for performance on the short-term and long-term retention examinations.

Insert Figure 1 about here

Long-term (4 months) retention. Four months following conclusion of the treatment 24 of the original subjects completed a second version of the examination. A 2 (generated vs. non-generated items) x 2 (social vs. cognitive concepts) repeated measures analysis, with those who had generated examples four months earlier, yielded a statistically significant main effect for performance on generated vs non-generated items, $F(1,17) = 21.11$ $p < .001$. Subjects performed better on items they had included in their own list of generated examples ($\bar{X} = 90.9$) than on items from the same pool of items (same category: Cognitive or Social) ($\bar{X} = 63.0$).

A similar repeated measures analysis found a main effect for generated items over other items on the examination, $F(1,17) = 20.34$, $p < .001$. Subjects performed better on items they had included in their own list of generated examples ($\bar{X}$ = 90.9) than on items from another pool of items (different category: Cognitive or Social) ($\bar{X}$ = 72.2). Analysis also revealed that subjects performed no differently on non-generated items from same pool of items (as the ones for which they found examples) than they did related to items from another pool of items. Table 2 shows the means for performance on the long-term retention examination.

Between-Groups Analysis

A further analysis tested whether subjects who generated examples for concepts performed better on examinations of those particular concepts plus all of the related concepts (Social or Cognitive) than do subjects who did not generate examples at all or who generated examples for a separate pool of concepts. In order to perform this analysis, subjects who did not generate examples for a particular pool of concepts (Social or Cognitive) were combined into one group for comparison purposes. On the first measure, using all subjects, a oneway ANOVA comparing example generators (N=31) with non-generators (N=24) showed a statistically significant difference between the two groups, $F(1,53) = 6.33$, $p. < .05$, favoring those who generated examples.

A related analysis that broke the total scores into the separate sub-tests revealed a statistically significant effect for the Social sub-test on the short-term retention examination, $F(1,53) = 6.33$, $p. < .05$. Those who generated examples in the Social category ($\bar{X}$ = 80.7) performed better overall on the Social sub-test than those who did not generate examples related to that category or did not generate examples at all ($\bar{X}$ = 73.1).

There were not enough non-example-generating subjects located three months later to perform a meaningful between-groups analysis on the long-term retention test. Only seven subjects who did not generate examples were located, compared to 17 who had generated examples.

Tests of Equivalence Between Groups

Since this study involved self-selected participants in the treatment, we were concerned whether the differences that were found between groups was due to the selection factor. To test for equivalence of the two groups (example generators vs. non-generators), two-tailed t-tests related to the students' grade point averages at the beginning of the semester and also related to their average for the course were performed. No statistically significant difference on entry-level grade point average was found. The means for the example-generating group was 2.71; for the non-generating group, it was 2.57.

A t-test for average in the course, however, yielded a statistically significant difference favoring the example-generating group ($\bar{X}$ = 83.45) over the non-generating group ($\bar{X}$ = 76.38), t(df=53) = 3.06, $p < .01$. A follow-up analysis (oneway ANOVA) that split the example-generating group in the Social and Cognitive sub-groups revealed a statistically significant difference, $F(2,54) = 4.89$, $p < .05$. Post hoc comparisons (Scheffe) at the .05 confidence level showed that the Social sub-group ($\bar{X}$ = 84.25) had a significantly higher course average than the non-generating group ($\bar{X}$ = 76.38); the Cognitive sub-group's average ($\bar{X}$ = 82.00) was not significantly different from the non-generating group's average.

Correlations Among Items

To determine if the items for which subjects generated examples were significantly different in difficulty than items for which examples were not generated, a Pearson correlation was performed on the number of persons who generated examples for each concept and the number of persons who got the correct answer to that item on the examination. The correlation found was a non-significant -.03. Additionally, the correlation between the number of persons who generated examples related to a concept and number of persons who obtained the correct answer for that concept within each category of concepts was a non-significant -.02. There is no statistically significant correlation between the number of subjects who found examples for a particular concept and the total number of subjects (same category or different category) who got the item correct on an examination.

Discussion

Results confirm the hypothesis that individuals would recall concepts for which they generated their own examples better than for concepts they did not. The activity of finding relevant examples to fit defined concepts apparently increases the processing effectiveness associated with storing and retrieving the concepts. A close consideration of the conditions under which the subjects generated examples may clarify issues that are involved in interpreting results of this type of study.

Since laboratory controls were not available, the conditions under which subjects sought and generated examples was relatively fluid. They were given a list of available concepts and allowed to submit examples of up to ten of the concepts on the list. This meant that the subjects actually had to review all of the concepts on the lists. To determine which ones to submit they had to spend time thinking about each of the concepts, eventually selecting the ones that they found easiest to generate. Thus, concepts for which they generated examples are intermixed with the ones for which they did not generate examples.

One might argue that subjects performed better on generated examples simply because of the extra practice that would be associated with seeking examples. However, because of the necessity of reviewing and examining the concepts for inclusion in their lists, both sets of concepts were practiced to some extent. A procedure that mixes treatment and non-treatment conditions generally would mean that possible effects for generating examples would be washed out by the additional practice that is associated with reviewing all of the concepts on the list. To find significant results in the comparison of each list of examples, then, is even more notable.

A second argument may be that concepts for which examples were generated contain greater memorability in general. Possibly they are more interesting, more concrete, or more basic concepts. The nature of the concepts themselves were not investigated in this light. However, we would expect highly concrete and memorable concepts to be chosen much more frequently than others. In this study, there was much variability in the selection of the concepts the subjects submitted. No clear pattern of selection is evident. Thus, the influence of such factors appears to be limited.

The variability of concepts selected by the subjects offers the possibility that highly individual settings, experiences or orientations of the subjects were at play in the use of concepts. Inclusion of a particular concept on a subject's list would depend upon the availability of children of a certain age or of family members' ability to suggest examples from the family's past. The special nature of each subject's experiences may improve retention of certain concepts because it increases personal associations in their storage. Since we may assume that s _lar amounts of exposure and practice of the concepts was involved, the effects that are observed are likely to be due to self-generated examples acquiring more meaningful or salient associations for the learner than those non-generated concepts. In other words, the individual's personal experiences, along with the more immediate flavor of ideas that are generated by the learner, may contribute to short-term and long-term retention of particular concepts.

A further possibility is that particular concepts for which subjects generated examples may be easier to understand or to remember on examinations. The test for that possibility involved correlating the incidence of selection of each concept with the performance on tests of each concept of all subjects who took the examination. If the concepts used most frequently by subjects when generating examples were actually easier to learn, we would expect to find a positive correlation between their inclusion and the scores obtained on those items on the examination. Since correlations between these two variables for both generators and non-generators across and within the same category were virtually zero (-.03 and -.02, respectively), we can conclude that relative difficulty of concepts was not a factor in the difference in the scores obtained between the self-generated examples and the non-generated examples.

It is also important to note that the higher level of performance on generated examples is maintained during the intervening three months, even though performance on other sections of the examination deteriorates (see Figure 1). While lack of availability of a large number of subjects on the long-term retention examination may have distorted the results in that analysis, the fact that performance was compared within each subject does indicate robustness of findings for the subjects who were located. Greater personal associations with the relevant concepts could account for superior recall compared to the non-generated examples. In fact, one of the subjects commented following the second examination that she had explicitly relied upon her memory of the generated examples from four months earlier to inform her how to respond to the test items. Other subjects may have implicitly or explicitly adopted a similar strategy.

In addition to the differences found within each subject, between-group comparisons showed significantly higher retention of concepts on the short-term examination in comparison to non-generators. In particular, there was one set of concepts (Social) for which generating examples led to higher levels of performance than non-generators. In fact, the strength of the gain for those in the Social group accounts for the overall difference between the groups of generators and non-generators. The overall finding suggests that generating examples may increase performance on tests of the same and similar concepts. However, as with the within-groups analysis, there are some alternative explanations which need to be considered.

Differences found between the two groups (generators and non-generators) could be due to initial differences in ability. While there are several measures that could be employed to determine the academic or intellectual equivalence of the two groups, grade point average for all subjects when they entered the course was the only one available. Analysis of grade point averages showed that there was no significant difference between the two groups (x = 2.71 and 2.57, respectively). Thus, general academic preparation and prior attainment tentatively may be ruled out as explanations for the differences between groups.

On the other hand, there may be motivational and performance differences between the two groups which could account for differential performance.

Those who chose to generate examples may have been more interested in the subject, more inclined toward concentration on reaching higher levels of understanding of relevant concepts, more comfortable with psychological vocabulary, or more studious. We had no opportunity to measure any of these potential factors related to performance. However, a calculation of the final average for the course and analysis of the groups on that basis did show that the example-generating group had significantly higher averages. It is not known how much this difference is due to motivational and background differences between the two groups.

Given the limited scope of the concepts of interest in this study, it is unlikely that participation in generating examples led to the differences in course averages. It is more likely that differences in levels of motivation accounts for the differences in performance in the course, and also in differences on the examination that tested for concepts in this study. Thus, the finding of significantly higher levels of performance for the example-generating group, while apparently not due to prior levels of academic achievement (as measured by gpa), may be due to higher levels of motivation or effort on this group's part.

Even if the between-group differences are accounted for by some consistent motivational differences, the finding of within-group differences in performance using generated examples justifies examination of the phenomenon in other settings and under more reliable conditions. Further studies that control for exact sets of concepts may be able to verify the advantages of generating examples over not generating them and explore the factors that contribute to such performances.

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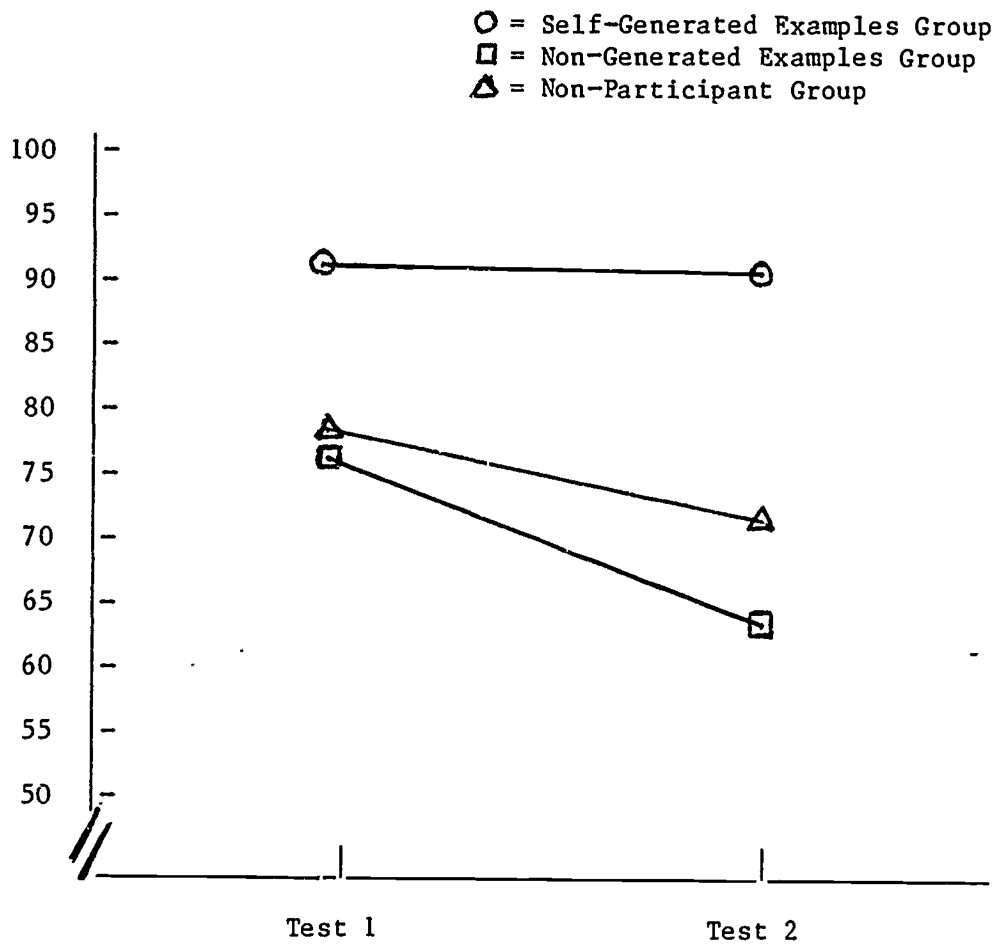
Figure 1. Means of Percent Correct on Retention Tests.



Note: Self-Generated Examples Group includes all concepts for which subjects generated examples; Non-Generated Examples Group includes all concepts for which the same subjects did not generate examples; Non-Participant Group includes concepts all for subjects who did not generate any examples at all.

Appendix: Lists of Concepts

Social/ Personality Development Concepts

Projection
Reaction Formation
Regression
Fixation
Behavior Shaping
Negative Reinforcement
Generalization
Learned Helplessness
Negative Identity
Desatellization
Id
Prosocial Behavior
External Locus of Control
Modeling
Reciprocal Socialization
School Phobia
Self-Fulfilling Prophecy

Cognitive/Linguistic Development Concepts

Animism
Artificialism
Accommodation
Assimilation
Centration
Class Inclusion
Conservation
Contrary-To-Fact Reasoning
Decentration
Deductive-Hypothesis Testing
Deep Structure
Egocentrism
Gestalt Principles
Holophrases
Inference-Drawing
Metacognition
Object Permanence
Optimal Mismatch
Role-Taking
Script
Transductive Reasoning
Transformations (linguistic)