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ABSTRACT

This study assessed the effects of providing learners with a graphic illustration of coordinate concept relationships to supplement learning from text-based instruction. Seventy-three undergraduate students were given a passage of approximately 1,200 words in length, describing Ausubel's Categories of Meaningful Learning. Half of the students also received a graphic concept tree which illustrated the relationship between concepts presented in the text. Findings from analysis of variance on instructional motivation as measured by the Instructional Materials Motivation Scale (IMMS) and the immediate posttest indicate that students who used the concept tree outperformed those learners who did not use the concept tree, and that students who used the concept tree reported significantly higher amounts of attention, confidence, and satisfaction with the instructional materials. No interactions were found between the use of the concept tree and vocabulary ability. (51 references) (Author/GL)

Title:

Enhancing Motivation and the Acquisition of Coordinate Concepts through the Use of Concept Trees

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ENHANCING MOTIVATION AND THE ACQUISITION OF COORDINATE CONCEPTS THROUGH THE USE OF CONCEPT TREES

ABSTRACT

This study assessed the effects of providing learners with a graphic illustration of coordinate concept relationships to supplement learning from text-based instruction. Seventy-three undergraduate students were given a passage of approximately 1200 words in length, describing Ausubel's Categories of Meaningful Learning. Half of the students also received a graphic concept tree which illustrated the relationship between the concepts presented in the text. Findings from analyses of variance on an instructional motivation measure and the immediate post test indicate that students who used the concept tree outperformed those learners who did not use the concept tree, and that students who used the concept tree reported significantly higher amounts of attention, confidence, and satisfaction with the instructional materials. No interactions were found between use of the concept tree and vocabulary ability.

ENHANCING MOTIVATION AND THE ACQUISITION OF COORDINATE CONCEPTS THROUGH THE USE OF CONCEPT TREES

The use of modern technologies (e.g., CAI, video, interactive videodisc, telecommunications, etc.) has seen a recent gain in popularity in public and higher education. However, significant amounts of "required" course information is still transmitted though printed text. University students spend much of their academic task-oriented time reading handouts, textbooks, and journal articles. To keep up with class assignments, students are frequently asked to read ten to fifty pages of printed text daily. Add to that the rigor of class projects and examinations and suddenly, the ability to efficiently identify and encode key concepts within printed text becomes crucial to the academic success of college students. Due to the complex nature of some print materials, instructors may spend significant amounts of class time reviewing reading assignments If the purpose of instruction, however, is to teach higher order thinking skills, it seems that an instructional tool which facilitates the acquisition of key concepts would give students and instructors more time to concentrate on analysis, synthesis, and problem solving.

Textbooks and journal articles are also often viewed by students as boring or irrelevant to their needs. In particular, low ability readers may not be confident in their aptitude to identify key concepts and complete reading assignments with sufficient meaning. In turn, students who fail to derive meaning from class assignments may find instruction unsatisfying. Considering the demands of student time and the seemingly low motivation to read print-based materials, it is not surprising to find that students frequently fall behind on their reading assignments.

Many instructional tools, study methods and strategies have been designed to promote reading comprehension. However, little has been done to implement these tools in college course. Less has been done to define the motivational impact of these tools and their relationship to cognition. The purpose of this study was to determine the effects of graphic advance organizers on reading comprehension and motivation. Three hypotheses were tested in this study:

H_1 The addition of a concept tree to supplement text-based materials will increase students' ability to acquire coordinate concepts compared to students receiving only text-based instruction.

H_2 The addition of a concept tree to supplement text-based materials will increase students' perceived level of motivation compared to students receiving only text-based instruction.

H_3 The addition of a concept tree to supplement text-based materials will increase students' perceived level of confidence in successfully completing the reading assignment compared to students receiving only text-based instruction.

An additional research question of interest was, "Do students with different reading abilities experience differential gains in achievement when presented with a concept tree as a graphic advance organizer?"

Review of Literature

Over the past two decades, significant amounts of research has been conducted on the effects of advance organizers (AOs), graphic organizers (GOs), graphic advance organizers (GAOs), and graphic post organizers (GPOs) on reading comprehension, and coordinate concept learning. Numerous studies have also examined various motivational constructs and their impact on the initiation, direction, and persistence of goal oriented behavior. However, cognition and motivation have traditionally been studied in separate context (Nenniger, 1988).

AOs, GOs, GPOs, & GAOs & Concept trees

Early studies with advance organizers (AOs) yielded contradictory results (Luiten, Ames, & Ackerson, 1980). However, recent reviews utilizing a variety of analytic procedures (e.g., meta-analysis, t-statistics, voting technique, etc.) indicate that AOs do, in fact, and facilitate learning (Kozlow, 1978; Mayer, 1979; Luiten, Ames, & Ackerman, 1980; Stone, 1983). Although researchers agree that the presentation of AOs may enhance learning, studies of such variables as age, ability, and styles of presentation, have yielded mixed results.

Barron (1980) noted that graphic organizers (GOs) were developed as a variation of Ausubel's advance organizers. GOs are defined as visual representations which portray relationships among key terms derived from the learning task (Moore & Readence, 1984). Three studies reviewed the effects of GOs on learning and retention. Smith (1978) concluded that GOs did not facilitate learning. However, Smith analyzed only six studies which used GOs solely as teacher-directed pre-reading exercises. Applying meta-analytic techniques on 16 investigations, Moore & Readence (1980) computed a small positive overall effect of GOs on learning (average effect size = .30, standard error = .05). In a more recent review of research, Moore & Readence (1984) found similar results; the use of GOs increased learning regardless of subject matter and other variables under study (average effect size = .22, SD = .58). Moore & Readence (1984) also concluded that graphic post organizers (i.e., GOs constructed by either the teacher or the learner after the learning task) have a greater effect on learning than graphic advance organizers (GAOs). Graphic post organizers, however, require significantly greater investments by instructors and students compared to GAOs in terms of implementation and directed use.

One type of graphic organizer (i.e., concept trees), requires relatively little time in terms of development and implementation and has yielded consistent gains in student performance on immediate posttest measures (Tessmer & Driscoll, 1986). Developed by Tessmer & Driscoll, concept trees are defined as "...a diagrammatic display of the propositional relationships among concepts. It presents in a hierarchical fashion the superordinate and subordinate class relationships (genus and differentia) of a set of related, coordinate concepts" (p. 196). Unlike traditional GOs and AOs which related learning tasks to superordinate and subsuming concepts that have already been learned (Stone, 1983; Estes, Mills & Barron, 1969), concept trees do not necessarily depict prior knowledge. Concept trees also regularly include brief narrative examples of key ideas (see fig. 1). Although concept trees have been associated with increased achievement compared to expository methods of presenting information, the use of concept trees as graphic advance organizers and its resultant impact on student motivation has not been investigated.

Qualitatively, Moore & Readence (1984) indicated that the GOs may affect teachers' and students' motivation. By analyzing the results, discussions, and conclusions of 23 studies, Moore & Readence noted that "teachers believed that GOs prepared them to help students cope with particular pieces of content" (p. 15). However, "In pre-reading conditions, many students apparently failed to see how GOs were connected with the materials to be learned" (Moore & Readence, 1984, p. 15). Thus, the use of GOs appears to be motivationally appealing but the perceived relevance of GAOs may be low which, in turn, may cause students to pay little attention to the GAOs. Although Moore & Readence provides some insight concerning the affective impact of GAOs, empirical data describing the effects of GAOs on student motivation is limited.

Motivation

Performance can be viewed as a function of motivation and ability. Indeed, psychologists have long studied the effects of personality and motivation on human behavior and performance. Constructs such as, the Need for Achievement (Atkinson, 1964; McClelland, 1976), Self-Efficacy (Bandura, 1977), Attribution (Weiner, 1980), Locus of Control (Rotter, 1954), Anxiety (Spielberger, 1972; Endler, 1975), Hygiene (Herzberg, 1966), Personal Causation (deCharms, 1976), etc., have all been correlated to behavior and performance. In the field of instruction, numerous authors have also cited the importance of learner motivation on performance (Mager & McCann, 1961; Mager & Clark, 1963; Gagne, 1965; Briggs, 1980; Wlodkowsky, 1981; Brophy, 1983; Keller, 1987a). Studies by Alderman & Mahler and Johnston (cited by Keller, 1983) indicate that instructional programs associated with superior learning may result in increased student attrition and procrastination relative to a comparison group. This suggests that instruction can affect learning and motivation as separate variables, which provides support for studying such effects separately. Recent investigations have also shown that student performance may be regulated by interactions between cognitive variables and the type of motivation stimulated by the learning environment (Pintrich, Cross, Kozma, & McKeachie, 1985; Pintrich, 1987; Nenniger, 1987). For example, students with contrasting conceptualizations of motivation (i.e., intrinsic, extrinsic, achievement, and fear of failure) identified differing approaches to learning (Entwistle and Kozeki, 1988).

Although the need to address motivational issues has been stressed (e.g., Martin & Driscoll, 1984), systematic efforts to integrate motivational requirements with instructional design have been lacking (Keller, 1987a: Reigeluth, 1979). Some theorist label "motivation" as an explicit element of their design model (e.g., Bloom, 1976; Cooley & Lohnes, 1976; Gagne, 1977; Reigeluth & Merrill, 1979). However, systematic procedures for manipulating motivation factors have not been elucidated with the rigor associated with concept acquisition (Keller, 1983). As Briggs (1980) observed, "our theories or models of design do not take enough account of motivation, even though we may acknowledge that motivation effects are stronger then treatment effects" (p. 49).

The need for improved methods for measuring motivation and the need for a better theory upon which to base these measures have been discussed by Cooley & Lohnes (1976) and Keller (1983). However, direct measures correlating motivation with performance have been rather elusive (Keller, Kelly, & Dodge, 1978). This has been due, in part, to the absence of a comprehensive, and systematic approach to studying motivation in relation to schools of learning (Keller, 1988). Current measures of motivation only take into account a limited number of constructs which have been associated with behavior and performance. Thus, in order to develop a holistic view of learner motivation, researchers would have to employ a battery of tests which is not practical in educational settings. Although multi-dimensional models of motivation have been developed, few provide educational practitioners with a practical method of addressing motivational requirements that takes into account the range of motivational constructs which have been correlated to performance.

Keller (1987a) has proposed an eclectic model of motivation which provides educational practitioners with: (1) a typology to organize knowledge of human motivation, (2) a pragmatic method of measuring the motivational impact of instruction, and (3) a systematic procedure for designing motivationally effective instruction. Based on a rigorous examination of current motivational theories, Keller (1987a) synthesized the ARCS model which identifies four basic motivational requirements. Keller (1987a) posits that in order to motivate students to learn, instruction must: (1) gain and sustain learner Attention, (2) be Relevant to learner needs, (3) foster learners' Confidence in their ability to successfully complete the task, and (4) be Satisfying to learners by meeting their expectations and providing equitable feedback (for a more complete review of the ARCS model, see Keller 1983, 1987a and 1987b). Keller (1988) and Keller & Subhiyah (1987) have developed two instruments to measure the motivational effectiveness of instruction based on the ARCS model--the Instructional Materials Motivation Scale (IMMS) & the Course Interest Survey (CIS). Although empirical evidence supporting the construct validity of the ARCS model is still rather limited, studies have reported statistical reliability for its measures (Cronbach's alpha ranging from .6 - .8) several different instructional settings. By systematically assessing both the cognitive and motivational impact of instruction, we should be able to gain a better understanding of the factors which contribute to learner performance in specific instructional situations.

Methods

Subjects & Design

Subjects were male and female undergraduate education students (n=125) enrolled in 3 sections of an educational psychology class at the Florida State University in Tallahassee, Florida. On the first day of class, the 36-item Advanced Vocabulary Test II from the Kit of Factor-Referenced Cognitive Tests (Ekstrom, French, Harman, & Dermen, 1987) was administered to all students as a pretest measure. The internal consistency of the pretest was calculated as a split-half reliability coefficient. As corrected with the Spearman-Brown prophecy formula, the reliability coefficient was .89.

Based on pretest scores, the matched pair technique (Tuckman, 1988) was used to assign students to two groups. Following assignment, one group was randomly chosen to receive the materials with the concept tree; the other group comprised the control, and received the material without the concept tree.

Due to eventual scheduling difficulties, students in section 3 of the class were unable to participate in the experiment. A comparison of mean pretest scores and standard deviations on the experimental pretest measure revealed no difference between the three sections that might systematically affect subsequent results, so the loss of students in section 3 was not considered a threat to the internal validity. The exclusion of the students in section 3 and subsequent attrition due to students dropping the course or being absent on the day of the experiment reduced the final subject pool to 73.

Instructional Materials

A common set of instructional materials was developed for both treatment and control groups. This included a printed 1323 word passage describing different kinds of meaningful learning (Ausubel, 1980). The content was chosen for its appropriateness to the overall course content and for its presentation of coordinate concepts.

The materials for the treatment group also contained a graphic advance organizer in the form of a concept tree, preceding the text passage. The concept tree illustrated each of the key concepts presented in the text passage, the hierarchical relationship between the concepts, and an example of each concept. No information was added to the concept tree that did not appear in the text passage. Both the format and the content of the concept tree were validated through consultation with a subject matter expert in the areas of learning theory and instructional design. The presence or absence of the concept tree constituted the independent variable for this study.

Figure 1 about here

The materials also included a cover page, explaining that a new unit was being considered for inclusion in the course, and the attached material represented a 'try-out' of that unit. It further stated that students would have 20 minutes to read the material, after which a short questionnaire and quiz would be administered.

The cover page for the experimental group contained an additional paragraph describing the function of the concept tree and directions for use. The paragraph also informed students to study the concept tree prior to reading and encouraged students to refer to the concept tree during reading.

Dependent Measures

Two instruments were used to measure the effects of six dependent variables. The instruments included an immediate posttest and the Instructional Materials Motivation Scale (IMMS).

Immediate posttest - An 11 item posttest served as a dependent measure of immediate concept acquisition. The items consisted of six fill-in-the-blank and five multiple choice questions. The questions asked students to recall: (1) the definition of each concept, (2) the hierarchical relationship between concepts, and (3) the name of the concept associated with presented examples. A subject matter expert in educational psychology validated the format and content of the posttest. To gauge the internal consistency of the posttest, a split-half reliability coefficient was calculated for posttest scores. As corrected with the Spearman-Brown prophecy formula, the reliability coefficient was .71.

Instructional Materials Motivation Scale (IMMS) - A modified version of the IMMS, developed by Keller (1988), was used to measure the motivational impact of the instructional materials. Based on the ARCS model of motivational design, the original version of the IMMS contained 36 items related to the 4 primary dimensions of motivation proposed by Keller (1987)--Attention, Relevance, Confidence, and Satisfaction. Due to the time limitations of the course, 6 items from each of the 4 dimensions were selected for this study. Each item required subjects to indicate strength of agreement with statements regarding motivational aspects of the instructional materials on a 4 element Likert scale. The effect of the concept tree on overall motivation was calculated by summing the scores of each of the four subscales. The subscales were also examined independently to measure the effects of the concept tree on attention, relevance, confidence, and satisfaction. The standardized item alpha coefficient of reliability for the overall IMMS was calculated as .90. Subscale reliability coefficients were: (1) Attention = .74; (2) Relevance = .67; (3) Confidence = .68, and; (4) Satisfaction = .82.

Procedures

On the day of the experiment, each student was given a copy of the assigned learning material, based on that student's assignment to treatment or control. All students were then directed to read the cover page on the learning materials, as the instructor read it aloud The directions informed the students that the materials represented a trial of a new learning unit being considered for subsequent offerings of the course, and that students would be given 20 minutes to read the materials. The instructor then directed students to turn the page and begin.

Students were allowed 20 minutes to read the instructional text, after which they were asked to complete the motivation scale. Following the completion of the scale, the instructional materials were collected and a posttest was administered. Students were given 15 minutes to complete the test.

Statistical Analysis

A 2 x 3 factorial design was employed for this study, in which the variables were treatment (concept tree vs. no concept tree) and reading ability (low vs. average vs. high). All statistical analysis in this investigation were performed with the commercially available SPSS program (Hull & Nie, 1981).

For each dependent measure, a visual inspection of score distributions was performed. Each set of data appeared consistent with an assumption of normality. Following this, homogeneity of variance was tested for each of the measures, using the F_{max} test (.05 level). Because cell sizes differed, a conservative approach to determining degrees of freedom was taken (i.e., degrees of freedom for the smallest cell was used for purposes of comparison). In all cases, variance ratios were below the critical value at $p=.05$, $F_{max}(6,9) = 7.80$, and homogeneity was assumed. A two-factor analysis of variance (treatment x ability level) was conducted for each dependent measure.

Results

Data comparing the effects of the concept tree on coordinate concept acquisition and learner motivation is presented in table 1. Since no interactions were revealed in the analyses, a simply summary of mean scores for treatment and control groups on all dependent measures are presented.

Table 1 about here

Posttest Achievement

The two-factor (treatment x ability level) analysis of variance revealed a significant main effect of treatment, $F(1,67)=7.98$, $p<.05$. This indicates that the average post test achievement score of subjects receiving the concept tree was reliably higher than that of subjects who did not receive the concept tree. No significant main effect of ability level was found, $F(2,67)=1.46$, $p>.05$. The interaction was also non-significant, $F(2,67)=.85$, $p>.05$. The significant main effect of treatment supports the first research hypothesis. The lack of significance for the aptitude treatment interaction suggests that the answer is "no" to the research question, "Do students with different reading abilities experience differential gains in achievement when presented with a concept tree as a graphic advance organizer?"

IMMS Scores

A two-factor ANOVA similar to that conducted on posttest scores was conducted on overall scores for the IMMS. As with the posttest, a significant main effect of treatment was discovered, $F(1,67)=8.587$, $p<.05$. This supports hypothesis #2, indicating that the presentation of a concept tree may increase students' perceived level of overall motivation. Neither the main effect of ability level nor the interaction were found to be significant.

Virtually identical results were found in 3 of the 4 ANOVAS performed on the IMMS subscale scores. The main effect of treatment was found to be significant in the Attention subscale, $F(1,67)=7.59$, $p<.05$, the Confidence subscale, $F(1,67)=8.30$, $p<.05$, and the Satisfaction subscale, $F(1,67)=8.05$, $p<.05$. No statistically significant interactions between ability and treatment were found for any of the four subscales. No significant main effects or interactions were revealed on the Relevance subscale. The significance of the main effect of treatment in the Confidence subscale supports research hypothesis #3; students receiving the concept tree as a graphic advance organizer for the text passage reported significantly higher levels of perceived confidence than subjects not receiving the concept tree.

Discussion

The ability to efficiently identify and acquire coordinate concepts presented in text passages is believed to be crucial to the academic success of university students. Thus, in order to gain a better understanding of reading comprehension, it is important to determine both the cognitive and motivational effects of instructional tools designed to facilitate reading. This study examined the effects of providing a concept tree along with text information on coordinate concept acquisition and learner motivation.

The results indicate that the presentation of a concept tree may increase students' ability to recall: (1) the definition of coordinate concepts, (2) the hierarchical relationship between concepts, and (3) the name of the concept associated with presented examples. It seems apparent that the addition of a diagram illustrating the relationship of key concepts would help students identify and encode coordinate concepts. The focus of this study, however, is to demonstrate that a relatively simple procedure (i.e., developing a concept tree) facilitates students' ability to identify and acquire coordinate concepts, thereby giving both students and instructors more time to concentrate on higher order thinking skills. The results also lend additional evidence to the premise that the use of graphic advance organizers can improve learning from text (Moore and Readence, 1984).

The presentation of a concept tree is also associated with increased levels of perceived motivation. Students receiving the concept tree reported significantly higher levels of overall motivation, attention, confidence, and satisfaction. This suggests that college students receiving a concept tree may extend more effort to learn information delivered through text-based instruction. More specifically, it appears that a concept tree may increase perceptual arousal and enhance students' perceived ability to read difficult text passages with meaning. In turn, students who gain substantial amounts of knowledge from reading assignments while expending a reasonable amount of effort may experience higher levels of perceived satisfaction compared to students having difficulties in reading. The concept tree, however, did not appear to affect perceived levels of relevance. Students receiving the concept tree may have experienced equal levels of perceived relevance compared to students not receiving the concept tree because relevance may be more of a function of content then presentational style.

In light of studies that have demonstrated the differential effects of instruction on cognition and motivation (Alderman & Mahler, 1973; Johnston, 1975), the importance of examining both factors during the design and implementation of instruction is unequivocal. This study indicated that the use of concept trees as advance organizers may increase student motivation and their ability to acquire coordinate concepts. Thus, concept trees may facilitate learning and enhance students' desire to initiate, direct, and/or persist at text-based instruction.

One major caveat must be stated. Regardless of the presence of the concept tree, posttest performance scores were relatively low. Although significant, the difference in average posttest scores of subjects who had access to a GAO and those who did not represents slightly more than one additional question correct. In conjunction with large standard deviations representing somewhat flat distributions of student scores, the reader is cautioned that issues of effect size must be considered when interpreting the results of the achievement test.

Alternatively, a different explanation for low posttest performance can be offered. The instructional text used for this study, while relatively short, was difficult. When coupled with the short duration of reading time, low performance scores are not unexpected. Students are frequently required to deal with text that is difficult or potentially confusing, especially in an unfamiliar area of study. Viewed in this light, the improved posttest performance in this study of subjects who had access to a GAO must not be overlooked.

Perhaps the most significant new direction identified in this research is the effect of graphic organizers on subjects' motivational states. To date, few studies have examined the simultaneous impact of graphic organizers on motivation and cognition. Typically, prior studies which have dealt with motivational aspects of graphic organizers have examined the motivation of students to use the organizers during instruction (Moore and Readence, 1984). This has been viewed largely as a function of the perceived "fit" between the organizer and the material it was designed to support. As mentioned earlier, the congruence between GAO and instructional text in this research was validated through consultation with a subject matter expert; hence, a good match was presumed.

Given the correct "fit" described above, and the demonstrated increases in motivation associated with the graphic organizer, several questions remain to be investigated. First, what are the specific features of the organizer, separately and in conjunction with the text it is designed to support, that are related to increases in motivation? An analysis and quantification of such features may lead to a systematic and replicable method for producing graphic organizers which, in turn, would be related to consistent increases in student motivation over text which contains no such organizer. A second, and perhaps more important, question pertains to the relationship between motivation and performance. Presuming that a system could be devised for producing graphic organizers that consistently improve students' motivation toward instructional materials, what would be the subsequent effect on performance in terms of retention, transfer, and cognitive style? Will students presented regularly with a concept tree begin to use this strategy in other instructional situations such as reviewing for a test? This question can only be answered after a system for producing consistent, replicable, and high-quality organizers has been developed. Finally, this study examined gains associated with a single, isolated exposure to a GAO. Further research is required on the cumulative impact of such devices as an ongoing or regular instructional strategy. In addition, research that examines the effectiveness of GAOs on passages of varying difficulty levels and on passages that are aimed at different types of learning (e.g., verbal information, rules, or cognitive strategies) will provide a more balanced picture of the overall efficacy of these devices.

The results of this research appear to support the efficacy of graphic organizers in terms of both concept acquisition and motivation. Given the ease with which such organizers can be created, and the relatively low cost in terms of time and required materials, they represent a potentially valuable tool for facilitating the acquisition of coordinate concept information. In addition, this study presents a pragmatic method of examining both the cognitive and motivational effects of instruction. In order to gain a better understanding of the factors which affect human performance, we need to take into account the impact of instruction on cognition and motivation.

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Table 1. Mean scores for dependent measures

	Concept tree		No concept tree	
Dependent measure	M	SD	M	SD
Posttest*	46.90	18.97	34.97	17.29
IMMS (24 items)**	49.55	12.18	41.71	10.29
Attention (6 items)**	11.68	3.91	9.49	2.74
Relevance (6 items)**	14.92	3.45	13.77	3.29
Confidence (6 items)**	12.32	3.74	9.94	3.40
Satisfaction (6 items)**	10.66	3.63	8.49	2.64

* Percentage score

** Sum of points for all items, each item with point range of 1-4

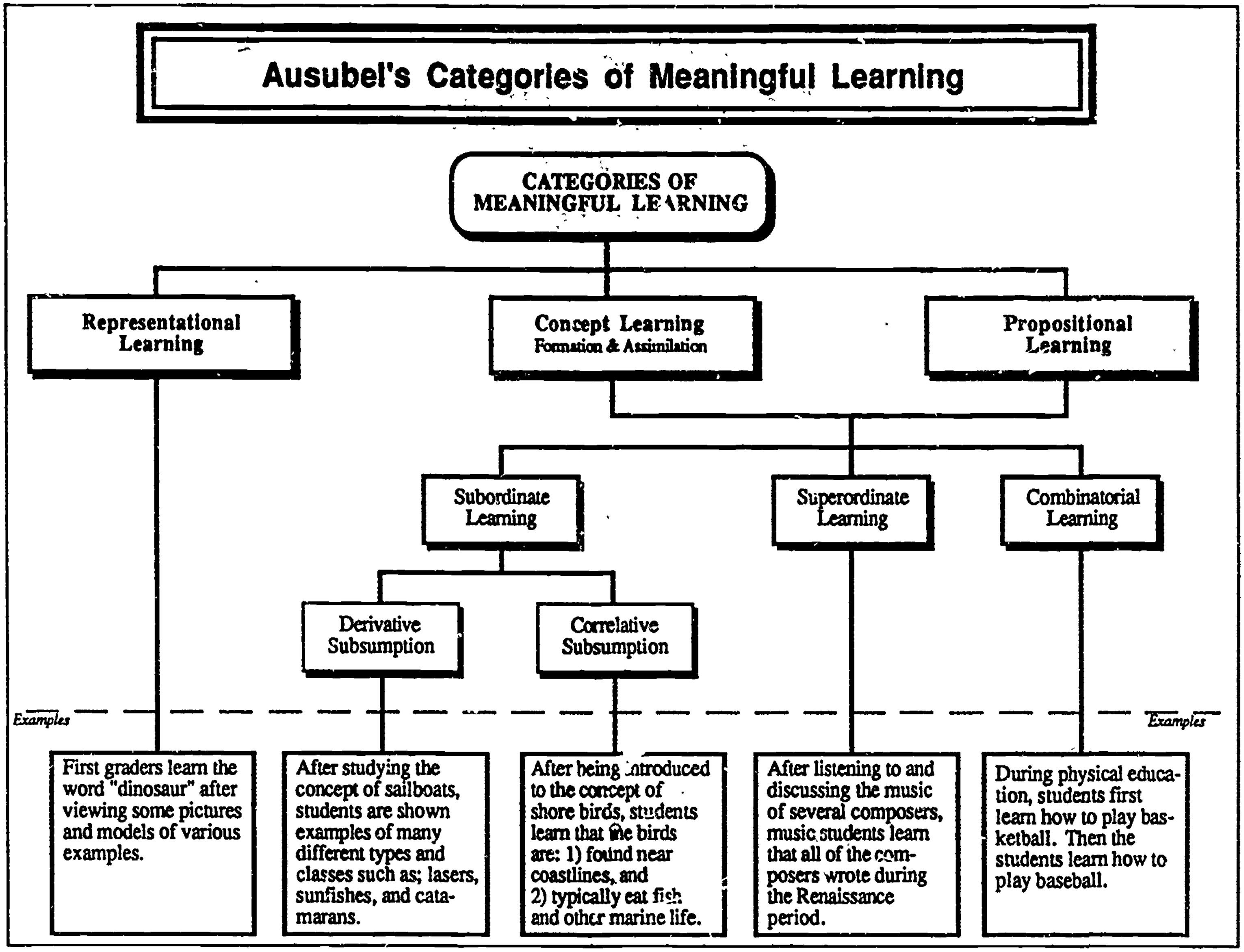

Figure 1. The concept tree illustrates the relationships between key concepts discussed by Ausubel.