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ABSTRACT

The effect of instructional analogy training on the level of immediate, as well as 14-day delay, comprehension of tangible and intangible physiological concepts was investigated. Ninety-four college-aged subjects were given training either with or without instructional analogies over five tangible and five intangible advanced physiological concepts. Results showed significantly higher scores of comprehension, both immediately and after the delayed period, for those subjects who had received the analogies. Moreover, subjects receiving analogies reported higher perceived levels of lesson enjoyment. Results are discussed in terms of the prescriptive use of analogies within instructional materials and future research possibilities. Two figures are appended. (52 references) (Author/BBM)

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Instructional Analogies and the Learning of Tangible and Intangible Concepts

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Abstract

The effect of instructional analogy training on the level of immediate, as well as 14-day delay, comprehension of tangible and intangible physiological concepts was investigated. Ninety four college-aged subjects were given training either with or without instructional analogies over five tangible and five intangible advanced physiological concepts. Results showed significantly higher scores of comprehension, both immediately and after the delayed period, for those subjects who had received the analogies. Moreover, subjects receiving analogies reported higher perceived levels of lesson enjoyment. Results are discussed in terms of the prescriptive use of analogies within instructional materials and on future research possibilities.

Instructional Analogies and the Learning of Tangible and Intangible Concepts

An instructional analogy has been defined as an explicit, nonliteral comparison between two objects, or sets of objects, that describes their structural, functional, and/or causal similarities (Stepich & Newby, 1988b). An example includes: A red blood cell is like a truck in that they both transport essential supplies from one place to another through a system of passageways.

Commonly utilized as instructional tools (e.g., Curtis & Reigeluth, 1984), analogies have been employed to teach a variety of subjects, including science (Cavese, 1976· Last, 1985; Scheintaub, 1987), computer programming (Rumelhart & Norman, 1981), composition (Ledger, 1977), and creative problem solving (Gordon, 1961). In a particularly innovative application, Nichter and Nichter (1986) taught rural villagers in India principles of health and nutrition by likening them to more familiar principles related to planting and tending crops. Their purpose is to allow relational information to be mapped from a source known to the learner to one that is unknown (Vosniadou & Schommer, 1988).

Instructional analogies have been shown to consist of four basic components: (a) the target domain (or subject); (b) the base domain (or analog); (c) the connector; and (d) the ground (ref.). The target domain refers to the new to-be-learned information. From the previous example, the target would be the red blood cell. The base domain (truck, from the example) consists of information familiar to the learner which will be used to make a comparison. The connector is a verb phrase, such as is like, which establishes the nature of the relationship between the base and target domains (Rumelhart & Norman, 1981). Finally, the ground is a detailed description of the similarities, and possible differences, indicated by the connector. It is represented by the phrase, transport essential supplies from one place to another through a system of passageways.

Theories of analogical transfer have been developed to explain how information from a base domain is used to facilitate the understanding or manipulation of information in another unrelated target area (Gentner, 1982; 1983; 1988; Gentner & Toupin, 1986; Holyoak, 1984; 1985) In most cases, analogical transfer has come to be viewed as a process of "second order modeiling" (Holyoak, 1985) in which a model of the base is used to progressively develop a model for the target. This process takes place through the mapping of a limited set of properties between the domains. Central to this conceptualization is that prior knowledge, which is organized and stored in the learner's memory, serves as a framework or "assimilative context" for the acquisition of new knowledge (Glass & Holyoak, 1986; Mayer, 1979).

Although analogies have been frequently utilized and have become integral parts of accepted theories of instructional design (e.g., Reigeluth & Stein, 1983), research to this point has been divided in terms of their effectiveness for the comprehension and retention of concepts. Drugge and Kass (1978), for example, found that verbal analogies did not significantly increase immediate comprehension. Gabel and Sherwood (1980) in a year-long study of analogies within a high school chemistry curriculum demonstrated no significant improvement on chemistry achievement. Likewise, Bean, Singer, and Cowen (1985) found analogies were not effective with above average students.

With these inconsistent findings the limitations of the analogies and their parameters for effective learning should be investigated in order to successfully predict when their use would be beneficial within a particular instructional setting. To date, a number of factors have been identified. The first, and most prominent, is the learners' comprehension of the analogy used to teach the new content. In the Gabel and Sherwood (1980) study, analogies were not helpful to all students. However, it was shown that as many as 48% of the subjects did not fully understand the analogies used to teach the content. Of those that did understand, scores on the semester achievement tests were significantly higher. Similar results were found in later studies designed to identify difficulties in chemistry problem solving (Gabel & Samuel, 1986; Gabel & Sherwood, 1984).

A second limitation of analogies is the tendency to overgeneralize. Overgeneralization refers to the tendency to include things in a category when they, in fact, don't belong. Schustack and Anderson (1979), for example, asked subjects to read and recall brief biographies of fictional characters. When asked to identify statements they had seen before, subjects showed a higher frequency of false recognitions when the fictional biography was closely analogous to the life of a famous real person. In a recent study by Halpern, Hanson, and Riefer (1990) subjects receiving analogies which were designed from base domains significantly different than the target domains proved to be more successful than those derived from similar or near base domain subject matter. Their conclusions indicated that those from the far domain required additional depth of processing to successfully complete the structural mapping and thus the extra effort increased their abilities and subsequent performances. Another interpretation, however, could include that those from the near domain may have had increased numbers of mistakes due to overgeneralization.

Another limiting factor appears to be the time required to make use of analogies. Analogies are effective, but may not always be efficient as instructional aids. In two sets of studies, Simons (1982; 1984) noted that including an analogy in printed instructional materials increased recall and comprehension of newly learned information, but only under conditions of unlimited study time. Restricting the amount of time the subjects were given to read the materials reduced the advantage of the analogy based instruction. According to Simons, analogy based materials require more time because the additional information in the analogy must be read and compared to the other information in the text. This additional effort pays off in subsequent reading of the same materials, however. Learners can often reread text with analogies more rapidly than text without analogies because of the deeper conceptual understanding they gained from the first reading (Simons, 1984).

A final limiting factor is the learner's need for cues indicating the relationship between the information to be learned and its analog. Cueing is particularly important because learners do not always see the relationship between an analog and its target. As a result, they do not always use the analog when performing the target task (Gick & Holyoak, 1980; 1983). Reed, Dempster, and Ettinger (1985) tried a variety of cueing techniques to increase the transfer of information between algebra word problems. These included describing the relevancy of the analog, making the analog solution available while solving the target problem explaining why a particular equation was used to solve an analog problem, and matching the complexity of analog and target problems. Their failure to produce consistent results demonstrates the difficulty learners have in applying analogous information, even when its usefulness is highlighted.

As indicated by the previous studies, the emphasis on the study of analogies and their impact on learning has been focused on the analogy itself (i.e., how they are constructed, cued, and placed within the instructional materials). A second area of research however, should also extend to the type of to-be-learned concept or material within the target domain which is to be taught. Are analogies more or less effective when the to-be-learned concepts vary in difficulty, ambiguity, complexity, or abstractness? Newby and Stepich (1987) for example, have argued that abstract concepts are qualitatively different than concrete concepts in ways that make them more difficult to learn. An analogy, in their view, can facilitate learning an abstract concept by generating a "prototype substitute" that can represent the abstract concept in memory in much the same way that a prototype comes to represent a concrete concept in a concept learning task. Davidson (1979) has also described analogies as a way of translating abstract information into a form that is more concrete and imaginable and, therefore, more easily understood. According to Simons (1982; 1984) this is the "concretizing" function of analogies.

The concretizing function was demonstrated in a lesson designed by Iona (1982) to teach college students about electricity. The more abstract components of an electrical system were likened to the more concrete and imaginable components of a hydraulic system in which water flows from a hilltop reservoir to a mill at the bottom of the hill. For example, in the analogy electrical voltage was likened to the distance between the reservoir and mill; amperage was likened to the rate of water flow; and electrical resistance was likened to narrow pipes or anything else that will obstruct the flow of water. Other concretizing applications can be found in subjects as diverse as biology (Cavese, 1976) and political science (Russell, 1980).

The present study was designed to compare the effectiveness of instructional analogies given different types of concepts within a single target domain. Specifically, five concepts rated as highly tangible and five rated as highly intangible, all from the same content area of physiology, were selected for this study. Two groups of subjects received training involving all concepts. Training for one group included instructional analogies for each of the concepts; whereas, the training for the other group omitted the analogies. The main purpose of the investigation was two-fold: (a) to investigate if subjects given instructions with analogies comprehend and recall concepts more effectively than subjects who receive instructions without the analogies; and (b) to study the differential effects of analogies given tangible and intangible physiological concepts.

The design of this study also allowed for the investigation of several additional questions involving the use of analogies. For example, "Would an intervening period of time between training and additional testing affect the group performances?"; moreover, "Would there be a reported change in the degree of comprehension and recall based on concept type?"; "Would using analogies result in greater confidence in learning?"; "Would using analogies result in greater lesson enjoyment?"; and "Would the times required for initial learning and/or testing of the materials differ between the groups?".

Method

Subjects

Ninety four subjects (72 female, 22 male) from an undergraduate introductory educational psychology course at a major midwestern university were solicited to participate in the study. All subjects volunteered in order to meet a course requirement for participation in research. The participants' declared major fields of study included education (64.9%), humanities (14.9%) science (11.7%), and physical education (3.2%). Eight subjects failed to return for the two-week follow-up testing. These included six who had been assigned to the analogy group and two from the no-analogy group.

Instructional materials

Concept selection. Physiology was selected as the content area for the study based on the premise that it is a concept-rich subject that includes a range of concepts from the very tangible to the very intangible. Additionally, this subject matter was predicted to be highly unfamiliar to the target group of subjects. A physiology instructor from the Purdue University School of Veterinary Science and Medicine and two of his graduate assistants served as content experts for the development of the materials.

The content experts used their course textbook, Physiology: A Regulatory Systems Approach (Strand, 1983), to identify 611 potential target concepts. This list was reduced to 32 using the following rules: (a) concepts that labeled structures were eliminated while concepts that labelled processes were kept; (b) two word concepts were eliminated while one word concepts were kept; (c) concepts common in everyday language (e.g. salivation, respiration) were eliminated.

In order to make the final selection of concepts from this list of candidates, the 32 concepts were rated by 10 experts (professors, instructors, and advanced graduate students) from Purdue University's School of Veterinary Science and Medicine and the School of Science. Using a seven-point semantic differential rating instrument, each expert rated each of the 32 concepts (Kerlinger, 1973). Five concepts rated as the most tangible (ossification, parturition, micturition, adaptation, and peristalsis) and five rated as the most intangible (disinhibition, pinocytosis, adsorption, summation, and catabolism) were selected for the study.

Instructional materials development. The purpose of the development phase was to create the lesson, in analogy and no-analogy versions, that would be used to teach the concepts selected in the preceding stage. In its final form, the lesson included the following written materials: (a) an introduction and instructions; (b) instructional materials for each concept, including a definition, a one-paragraph description of the physiological process, a verbal analogy (for the analogy condition only), a posttest, and a follow-up questionnaire. The development and validation of the materials followed accepted instructional design principles (e.g., Dick & Carey, 1985).

The first step in creating the lesson was to meet with the content experts and construct an analogy for each of the selected concepts. Construction of the analogies followed the steps outlined by Stepich and Newby (1988b). For each concept, the feature most important to comprehension was identified and one or more concrete items having the same or a similar feature were listed. One of these concrete items, likely to be familiar to the learners, was then chosen as an analog. The analogy was completed by describing the similarities between the chosen analog and the concept. As an illustrative example, the feature most important to understanding the process of peristalsis is the progressive wave of muscular contraction propelling food through the digestive tract. Potential analogs included extracting toothpaste from a tube or squeezing ketchup out of a single-serving packet. Both analogs were expected to be familiar to the learners and the ketchup squeezing analog was chosen as the more accurate of the two. Peristalsis was then described in terms of the analog:

> "Peristalsis is like squeezing ketchup out of a single-serving packet. You squeeze the packet near one corner and run your fingers along the length of the packet toward an opening at the other corner. When you do this, you push the ketchup through the packet, in one direction, ahead of your fingers until it comes out of the opening."

This process was repeated for each of the other nine concepts. Each of the analog or base domains were selected based on two criteria: (a) their high degree of familiarity for the learners (Gabel and Samuel, 1986) and (b) they were from a different or far domain than the to-be-learned concepts (Halpern, et al., 1990).

Next, several physiology textbooks (Holmes, 1979; Jacob & Francone, 1965; Luciano, Vanden, & Sherman, 1983; Parker, 1984; Schmidt & Thews, 1983; Strand, 1983; Vanden, Sherman, & Luciano, 1983) were used as information sources and an initial draft of the lesson was written. This draft included an introduction to the study, a definition. description, and analogy for each concept, and a follow-up questionnaire. This draft was then evaluated by the content experts and two experienced instructional designers to ensure its accuracy, clarity, and appropriateness for the intended subject group. Suggestions obtained were incorporated into a second draft of the materials. The concept materials were again evaluated by the content experts and their suggestions were incorporated into a third draft.

At this point the content experts wrote a set of 20 multiple-choice test items (two items per concept). Each item was developed to focus on concept application, as opposed to simple recall. All test items were then ordered randomly. The test directions and items were then reviewed by an instructional designer and experienced teacher who had not previously seen the materials and who was not a content expert. This helped to ensure that the tests were clear and comprehensible. Evaluative comments were incorporated into a revised version of the test.

The follow-up questionnaire was next constructed. This consisted of questions to obtain bibliographic information (e.g., sex, age, academic major), a question asking the participant to estimate how many questions on the 20-item test they answered correctly, and a Likert-type rating scale to indicate their degree of enjoyment with the lesson.

The development of the materials was followed by a field test involving 24 subjects. Each was given a complete set of materials which included an introduction and set of instructional materials, a posttest, and a follow-up questionnaire. The instructional materials differed based on the independent variable; however, tests and questionnaires were identical for all subjects. Reliability scores, using the Kuder-Richardson formula (Mehrens & Lehman, 1984) indicated a posttest reliability of .68. Following suggestions given by the participants, the wording of several questions in the questionnaire was revised and the verbal instructions given to introduce the study were incorporated within the written instructions.

Procedures

For the formal investigation, subjects were allowed to sign up for one of three scheduled 90-minute periods. Each session was scheduled in a university classroom that could facilitate up to 50 students. Investigators monitored each experimental session and were given a set of procedures to follow. A digital clock was placed at the front of the room to provide consistent time to be recorded. When the subjects were seated the investigator briefly introduced the study and distributed the handout containing the introduction and concept lesson. This handout had been stacked alternating between analogy and no-analogy versions. The copies were then distributed by rows, effectively randomizing assignment to the two experimental conditions.

The concept lesson asked the subjects to note the last four digits of their social security number (for identification purposes) and to record the time they began studying the materials. After they had studied the concept materials for as long as they wished, they were again asked to note the time. The first handout was then returned to the investigator whereupon a copy of the posttest was received. All subjects received the same posttest. Subjects were asked to record the 4 digit identification code, as well as the starting and completion times of the test. No limits were given on the amount of time to finish the exam.

After the test was completed, subjects returned it to the instructor and they were given a copy of the follow-up questionnaire. Upon completion and return of the questionnaire each subject was reminded to return in 14 days at the same time and location. No further instructions were given and they were free to leave.

When the subjects returned in 14 days they were each given a second posttest. This test consisted of a short set of directions and the same 20 questions (in a new random order) of the initial posttest. Subjects were also asked to record their four-digit social security code number and the beginning and ending time of the test. No time limit was given for the test and it was returned to the investigator upon completion. All subjects were then debriefed and thanked for their participation.

Results

This investigation examined four dependent variables: comprehension of the concepts (both immediate and longer term); enjoyment of the lesson; confidence in learning; and time required to study the concepts and complete the posttests. In each case separate analyses were completed.

To compare the comprehension of the concepts across conditions, the 20-question immediate posttest was graded for each subject and the results were grouped based on method of instruction and type of concept. A mixed-factorial analysis of variance (method of instruction by type of concept with repeated measures) was performed on the mean number of items answered correctly for each concept. As shown in Figure 1, those subjects receiving instructions with analogies significantly outperformed those who did not receive the analogies ($\underline{F}$ (1,92) = 10.53; $\underline{MS}$ = 67.92; $\underline{p}$ < .002). No significant difference was shown between the comprehension of the tangible and intangible concepts; however, a significant interaction ($\underline{F}$ (1,92) = 6.09; $\underline{MS}$ = 17.28; $\underline{p}$ < .02) between the two independent variables was recorded. Figure 1 illustrates that those subjects in the analogy group performed at a slightly higher level given tangible concepts than they did given intangible concepts; whereas, those in the no-analogy group achieved a higher score given intangible concepts when compared with their scores for the tangible concepts.

Insert Figure 1 about here

The two-week posttest was examined in the same manner as that of the initial posttest. As shown in Figure 2, the two groups attained the same mean scores as reported for the initial posttest for the tangible concepts but decreased in their comprehension for the intangible concepts. A significant difference was again recorded based on the method of instruction as those receiving analogies significantly outperformed those not receiving such instructions (F (1,84) = 9.43; MS = 67.37; p < .003). In this case however, there was a significant difference between the tangible and intangible concepts (F (1,84) = 7.17; MS = 22.349; p < .009), but no significant interaction was reported.

Insert Figure 2 about here

Enjoyment of the lesson was measured by a single questionnaire item in which the subjects were asked to rate how much they had enjoyed the lesson on a scale from 1 (not at all) to 5 (a lot). A significant difference was found between the analogy (M = 3.02) and the no analogy (M = 2.59) conditions using a two-tailed t-test (t (92) = 1.869; p <.05).

Confidence in learning was measured by asking the subjects to predict how many items they felt they had answered correctly on the initial posttest. Means for the analogy and no-analogy conditions were 14.19 and 13.55 respectively. A two-tailed t-test indicated no significant difference between the analogy/no-analogy predictions.

In order to measure the final variable, time, all subjects were asked to record the time they started and finished both the lesson and the two posttests. The time spent, in minutes, was then tallied for the analogy and no-analogy conditions. Two-tailed t-tests were performed on the mean study times and the mean test times. A significant difference was found in the mean study times (t (92) = 1.953; p < .05) but not for either of the testing periods. The mean study times for the analogy and no-analogy conditions were 12.04 minutes and 10.55 minutes, respectively.

Discussion

From the measurement of the four dependent variables, comprehension, enjoyment, confidence, and time, several important findings should now be discussed. First, the results indicate that analogies had a beneficial effect on the comprehension of unfamiliar concepts. In other words, subjects who received instructions which included analogies scored significantly higher on the immediate posttest than those who did not receive training which included the analogies. Moreover, this difference in comprehension was sustained during the two-week posttest. Even though the learners were not prompted to recall or use the analogies in any way, comprehension scores indicate a difference between the two groups remained even after the 14-day interval. The use of analogies appears to be an effective instructional strategy which increases the immediate and long term comprehension of concepts.

Conclusions about the influence of analogies on the comprehension of different types of concepts in the present experiment are strengthened by the fact that the subjects in the analogy condition were neither trained in the use of analogies nor cued to use the analogies they were given. Gick and Holyoak (1980; 1983) and others (e.g., Reed, Dempster, & Ettinger, 1985; Schustack & Anderson, 1979) have shown that training and cueing are essential aspects of using analogies effectively in instruction. The subjects in the present experiment, however, were not given practice in using analogies or cues to use analogies in recalling the concepts for the test. In spite of this, subjects in the analogy condition outperformed subjects in the no-analogy condition on both posttests. This indicates that training and cueing may not be necessary and that analogies facilitate concept learning even when the subjects are neither trained nor cued. Additional research is needed to further explore the contribution training and cueing make to the effectiveness of analogical instruction as well as the best methods for providing such training and cueing.

A second relevant finding from this investigation was the degree of effectiveness of analogies based on the concepts being either tangible or intangible in nature. Although during the immediate posttest the analogy group significantly outperformed the no-analogy group given either type of concept, the analogy group showed no significant difference in the comprehension of the tangible versus that of the intangible concept types. This was not the case, however, after the 14-day interval had elapsed. In that instance, while the analogy group still significantly outperformed the no-analogy group for both types of concepts, the comprehension of the intangible-type concepts decreased significantly for both groups. Although the analogy instruction remained more effective, the concurrent decrease indicates the possibility of interference being greater for those concepts of a less tangible nature. Several authors have pointed out the differences between concept types and the increased difficulty of those of an intangible nature, however, further research focusing on the potential interference differences is needed (Newby & Stepich, 1987; Reed & Dick, 1968).

A final point that should be considered in the discussion of the concept-type differences is that of the interaction effect shown to occur during the initial posttest. As indicated in Figure 1, the no-analogy group initially scored higher for intangible concepts than they reported for the tangible concepts while the opposite was true for the analogy group. Such results by the no-analogy group contradict previous investigations as well as their own 14-day interval posttest results, and thus may be an indication of spurious results (Royer & Cable, 1976; Reed & Dick, 1968). However, this result may also be an indication of the overall effectiveness of the training. For each individual concept the learner received a definition and a description. It may be that those different training lessons for the intangible concepts were initially clearer or more readily understood. These conclusions are questionable however, because of similar effects not being revealed within the data from the analogy group and because of no interaction seen aftger the two-week interval.

A second factor measured during this investigation was enjoyment for the lesson as perceived by the learners. Following training and the initial posttest, all subjects were asked to rate the degree to which they enjoyed the lesson. The results indicate the use of analogies positively influenced the subjects' rated enjoyment of the lesson. That is, analogies may be valuable in instruction because they increase the learners' enjoyment of learning. Keller and Kopp (1987) and Newby (in press) have pointed out that familiarity helps learners see the relevance of what they are learning which increases their motivation to learn. Analogies connect new concepts to familiar objects and events and, thus, may increase the learners' motivation by increasing the relevance of the instruction. The strength of this conclusion is limited, however, because it is based on a single subjective measure. Additional research is needed to explore the effects of using analogies on more objective measures of enjoyment.

The third variable measured the perceived confidence subjects had in their comprehension of the concepts. The results show that using analogies did not affect the subjects' confidence in their learning. This is contrary to what might be expected, especially in light of the observed differences in comprehension between subjects in the analogy and no-analogy conditions. One possible explanation for this result is that the subjects perceived the concepts as so difficult that they saw little chance of success, even with analogies to help them, and so predicted a lower score than they actually obtained. Another possibility is that confidence is not closely related to actual performance. The relationship between analogy and confidence is an important issue because confidence is an important aspect of motivation (Keller, 1983). Additional research is needed to explore the relationship and to determine how analogies might be used to increase the confidence of the learners.

The final measured variable included the amount of time they used to both study the concepts and complete the posttest. The results show that subjects in the analogy condition used significantly more time studying than subjects in the no-analogy condition, but did not require significantly more time to complete the posttest. These results are consistent with the findings of Simons (1982; 1984) in which analogies may be more time-consuming, as well as more effective, than other instructional strategies. It is the efficiency of the instruction rather than its effectiveness that is at issue here. Even when they are equal in length, lessons with analogies require more time than lessons without analogies because the analogies require the learners to process the connection between the target and analog in addition to reading the content. Simons notes that there is a trade-off between the increased time needed to use analogies and their benefits in performance. The results of the present experiment support Simons' conclusion. However, the strength of this support is limited by the fact that the lessons used in the present experiment were unequal in length. For the analogy condition the analogies were simply added to the descriptive paragraphs for each concept, which means that the subjects in the analogy condition had more content to read. Subjects in the analogy condition took more time to study the concepts, but their comprehension was improved. The exact location of the balance point is unclear, however, and may be a purely subjective decision to be made by the individual teacher or learner. Additional research is needed to further investigate the relationship between study time and comprehension in concept learning through analogical instruction.

In conclusion, several lines of reasoning converge to suggest that analogies are potentially powerful instructional tools: (a) their pervasiveness in both everyday and instructional communication; (b) anecdotal evidence of their influence in scientific discoveries throughout history; and (c) empirical evidence of their effectiveness in a variety of learning tasks. However, what has been written about analogies is almost entirely descriptive in nature. There is little prescriptive information and, as a result, few guidelines for using analogies in instructional practice. Newby and Stepich (1987) have taken a step toward filling this gap by suggesting a set of procedural guidelines for both creating and utilizing analogies within instruction. The present investigation was undertaken as an empirical test of one of their prescriptions: that analogies are effective given intangible, as well as tangible concepts. The primary finding confirmed this assumption. Secondarily, the study found that using analogies affects the enjoyment of the learners but not their perceived confidence.

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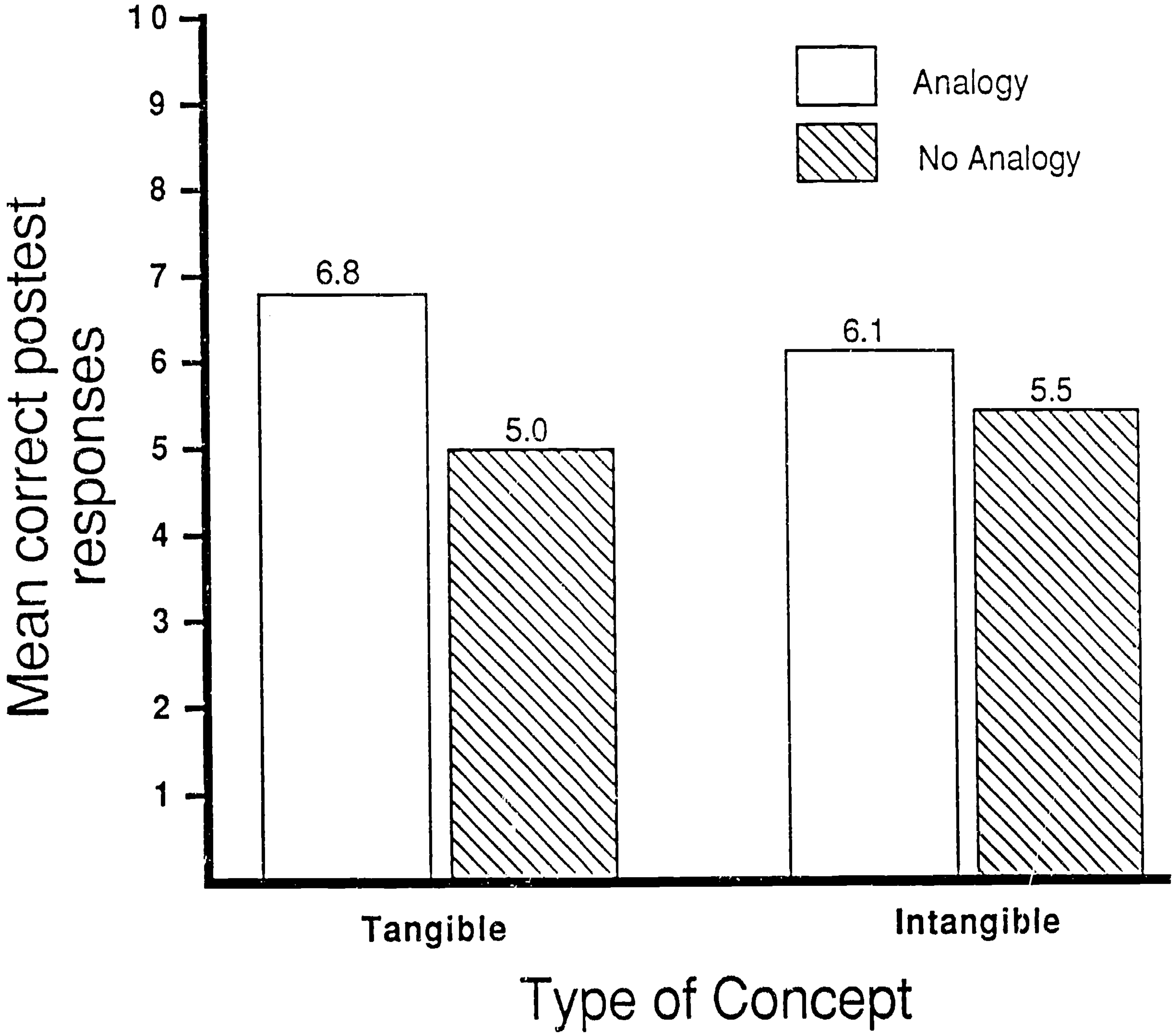
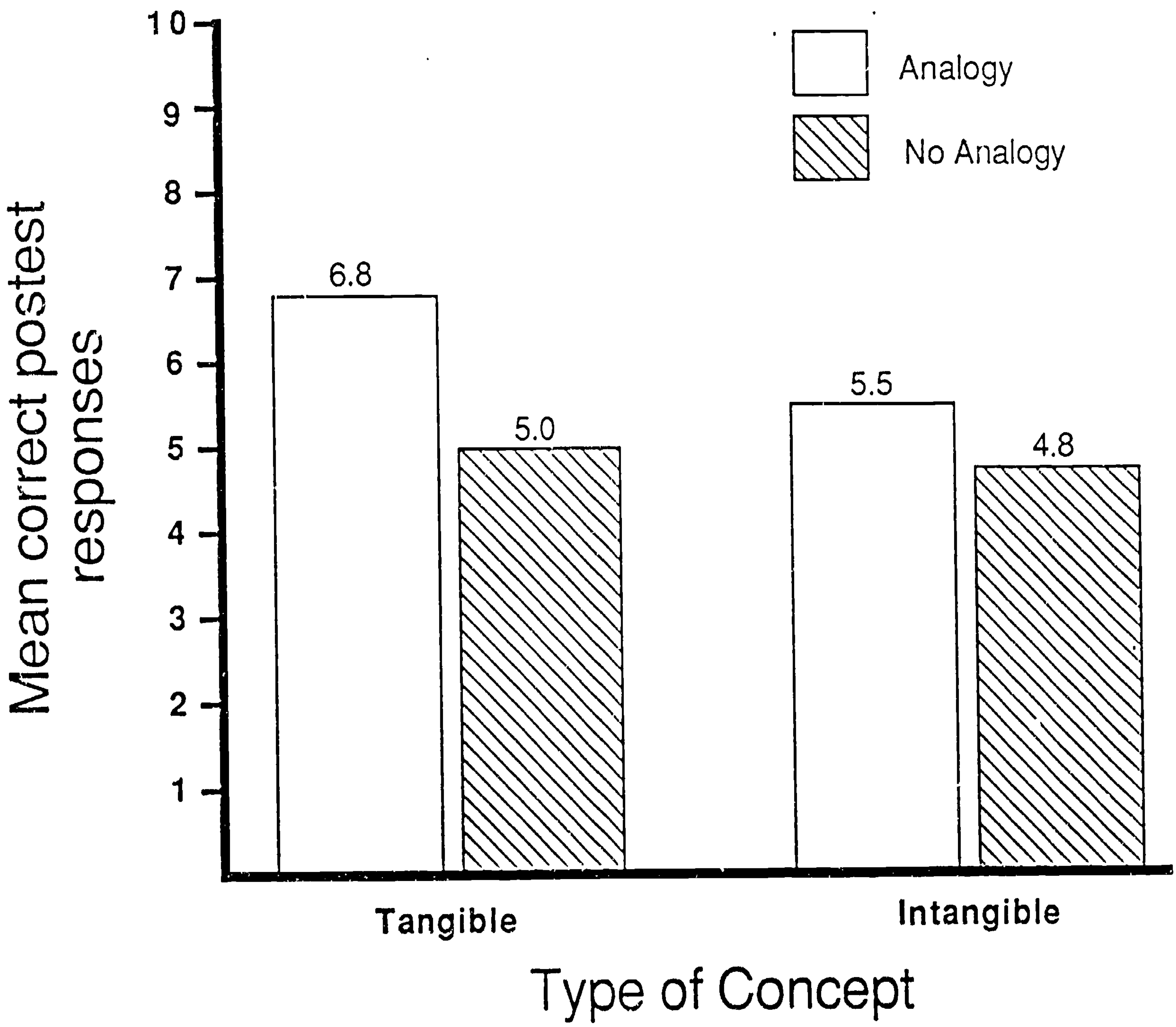
Figure Captions

Figure 1. Immediate posttest comprehension mean scores comparing analogy versus no-analogy trained subjects across tangible and intangible concepts.

Figure 2. Fourteen-day posttest comprehension mean scores comparing analogy versus no-analogy trained subjects across tangible and intangible concepts.



Analogy
No Analogy
Mean correct postest responses
10
9
8
7
6
5
4
3
2
1
6.8
5.0
6.1
5.5
Tangible
Intangible
Type of Concept


Mean correct postest responses
10
9
8
7
6
5
4
3
2
1
Analogy
No Analogy
6.8
5.0
5.5
4.8
Tangible
Intangible
Type of Concept

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