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ABSTRACT

Formal educational environments often provide less support for learning than do the everyday environments available to young children. This paper considers the concept of idealized learning environments, defined as "Havens." Various components of Havens are discussed that may facilitate comprehension, especially in science instruction. These components include: (1) the opportunity to learn in semantically rich contexts; (2) the availability of "mediators" who can guide learning; and (3) the importance of understanding how new knowledge can function as conceptual tools that facilitate problem solving. Three experiments were presented that suggest some of the advantages of learning in "Haven-like" environments. Two experiments were done with college students and one with junior high school students. The experiments involve very simple uses of instructional technology, yet they showed positive results. The results suggest that more sophisticated use of technology, especially computer-controlled interactive videodiscs, should have even greater benefits on comprehension and other forms of learning. Some videodisc-based Havens that are being developed at Vanderbilt University are described. (Author/TW)

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The Development of Videodisc Based Environments

to Facilitate Science Instruction

Robert D. Sherwood



SE 047 477

Abstract

Formal educational environments often provide less support for learning than do the everyday environments available to young children. In this paper we consider the concept of idealized learning environments, defined as Havens, and discuss various components of Havens that can facilitate comprehension and learning, especially in science instruction. These components include the opportunity to learn in semantically rich contexts, the availability of mediators who can guide the learning, and the importance of understanding how new knowledge can function as conceptual tools that facilitate problem solving. Three experiments are presented that demonstrate some of the advantages of learning in Haven-like environments. The experiments involve very simple uses of technology, yet they show positive results. The results suggest that more sophisticated uses of technology, especially computer-controlled interactive videodiscs, should have even greater benefits on comprehension and learning. Some videodisc-based Havens that are currently being developed at Vanderbilt are described.

## Introduction

The major purpose of this paper is to explore the concept of idealized learning environments (we shall call them Havens) that facilitate learning. The ultimate goal of a theory of Havens is to permit evaluations of the degree to which particular types of instructional practices deviate from the ideal.

Our initial explorations of factors that contribute to Havens for learning will involve analyses of children's natural learning environments. Like Papert (1980), we are impressed with the speed and ease with which children acquire new skills and knowledge and would like to understand these processes in more detail. Nevertheless, our analyses of the conditions necessary for children's success often differ from Papert's. For example, Papert (1980) places heavy emphasis on the importance of Piagetian ideas such as active discovery learning, where the primary focus is on the individual child and his or her approaches to various problems. We agree that active attempts to learn are important, but we place equal emphasis on the social contexts for learning that are created by parents, siblings, teachers and peers (e.g., Brown, Bransford, Ferrara & Campione, 1984; Cole and Scribner, 1975; Feuerstein, 1979; Vygotsky, 1978).

In the discussion that follows we emphasize differences between everyday learning environments and the formal educational environments that are characteristic of schools. One of our goals is to ask whether some of the advantages of everyday learning can be incorporated into formal education. A second goal is to ask whether, given effective uses of technology, even everyday learning environments can be improved.

## Two Views About Children's Learning

Several investigators have argued that there are two conflicting views about children as learners (e.g., Bransford and Heldmeyer, 1983). One is that children are universal novices who consistently perform more poorly than adults. When tested in typical laboratory tasks, for example, children are less likely to remember information (e.g., Kail and Segal, 1977), to comprehend and communicate effectively (e.g., Chapman, 1978; Chomsky, 1969; Glucksberg, Krauss and Higgins, 1975); to solve problems (e.g., Inhelder and Piaget, 1958) and to accurately predict their own abilities to perform various tasks (e.g., Flavell and Wellman, 1977). There are several reasons why younger or less mature learners would be expected to perform more poorly than more mature learners. First, younger learners have acquired less knowledge than older learners (e.g. Chi, 1978; Gelman, 1978) and hence have fewer and less well organized knowledge structures for assimilating information. Second, younger learners are less likely to know and use sophisticated strategies (e.g. Brown, 1979; Flavell, Beach and Chinsky, 1966; Ornstein and Naus, 1978). Some investigators also argue that younger children's working memory is more limited, although the degree to which this is a limitation of "actual" versus "functional" memory is still a matter for debate (e.g., Case, 1974; Chi, 1976). Overall, younger children seem to have a number of disadvantages that can hurt their performances in a variety of domains.







In contrast to the proceeding position is one that views children as exceptionally effective learners. Adults often marvel at the ease with which children acquire concepts, language, motor skills, spatial skills, social skills and so forth. Adults often wish that they could learn as enthusiastically, effectively and seemingly effortlessly as they did when they were young. Bransford and Heldmeyer (1983) emphasize the following:

> ...if we hold this view of "children as exceptional learners" in conjunction with the "child as universal novice" view...we are forced to acknowledge that children are amazingly effective learners despite their lack of knowledge, despite their lack of sophisticated strategies and despite possible limitations on their working memory. How can children be such successful learners in the face of such disadvantages?

Note that assumptions about children's effectiveness as learners generally stem from their performance while learning in everyday contexts rather than from their performance in laboratory tasks. Children's abilities to learn therefore seem to be closely tied to the conditions under which their learning takes place. Important aspects of these conditions are discussed below.

### Learning in Context

One of the advantages of everyday learning is that it usually takes place in the context of meaningful, ongoing activities. Children are therefore likely to receive feedback from the consequences of their actions, and they are able to make use of contextual cues when attempting to understand what others mean. Excellent illustrations of the importance of contextual cues are provided in Chapman's (1978) discussion of children's comprehension strategies. She notes that parents of one-year-old children frequently report that their children understand everything that is said to them. Furthermore, observations of children's performance in natural language settings provide support for such beliefs. Nevertheless, there is a great deal of information that these children really do not understand.

One example discussed by Chapman involves Lewis and Freedle's (1973) analysis of the comprehension abilities of a 13 month old child. When handed an apple while she was in her high chair and told "Eat the apple", the child bit it. When handed an apple while playing in her playpen and told "Throw the apple", the child threw it. Lewis and Freedle performed an experiment in order to test whether the child really understood words such as "eat" and "throw". They handed the child an apple while she was in her high chair and asked her to "throw the apple". The child bit it. Later, when the child was in her playpen she was handed an apple and told "eat the apple". She threw it. As Chapman (1978) notes, the child's strategy was basically to assume that she should "do what you usually do in this situation". This is a very sound strategy that frequently is correct.

Note that, in everyday settings, young children have rich opportunities for learning because they can use context to figure out what someone must mean by various sentence structures and words. Unless she was being tested by tricky experimenters, for example, the child discussed above could determine the general meanings of "apple", "eat" and "throw". Similarly, if a mother says "Get your shirt" while pointing to the only loose object (a shirt) on the rug, the child begins to understand the meaning of "get" and "shirt". Chapman (1978) emphasizes that language acquisition cannot take place in the absence of shared social and situational contexts because the latter provide information about the meanings of words and sentence structures. In MacNamara's (1972) terms, the child "...uses meaning as a clue to language rather than language as a clue to meaning". The child who is asked to learn out of context often has little basis for inferring the meanings that speakers intend.

The ability to use contextual information as a cue to language is important not only for young children. It is also important for older children who may not understand all the words used by adults. For example, a statement such as "They saved the bics to make a vac" provides very little information about the meaning of "bics" and "vac". As will be discussed later, however, in certain contexts this statement can produce new learning because there are many fewer degrees of freedom about what "bics" and "vac" might mean. In an analogous manner, students who have the advantage of a context for interpreting relatively novel (for them) words such as " variability", "maneuver" and so forth should have a chance to learn from the instruction that they receive.

## Context and Elaboration

Clearly, context can provide information beyond what is necessary to understand specific concepts or lexical items. For example, it can also provide information necessary to understand the significance of utterances even if they contain familiar words. The psychologist Karl Buhler (cf. Blumenthal, 1970) noted long ago that an utterance such as "five" can have very different meanings depending on the context in which it is uttered (e.g., it might mean "I need five more seconds, hours, days", "There are five of us here", "The show comes on at five" etc.). When "five" is uttered out of context it is extremely difficult to understand the significance of the message even though one knows what the word "five" means. Peoples' comprehension of the significance of messages is related to their abilities to use relevant knowledge to elaborate what they hear, see or read (e.g., Anderson, 1984; Anderson & Reder, 1979; Stein & Bransford, 1979).

Context also has powerful effects on one's interpretation of relations among statements. Imagine, for example, that one hears "The floor is dirty. Sally is using the mop". The interpretation of these statements differs greatly depending on whether the floor is getting dirtier or cleaner as the mopping continues. In one case the interpretation is synonymous with "The floor was dirty because Sally used the mop"; in the other case it is consistent with "The floor was dirty so Sally used the mop".



## The Role of Mediators

Implicit in our discussion of learning in context was the fact that parents, friends and peers play an extremely important role in cognitive development (e.g., Feuerstein, 1979; Vygotsky, 1978). Their role is not simply to act as stimuli who provide words, sentences and actions to be modeled by children. Instead, they act as mediators who provide structure to the experiences of the child. For example, mediators arrange the environment so that children will encounter certain experiences (e.g., toys, books); they help children separate relevant from irrelevant information ("you can eat on this plate even though it is blue rather than red"); they prompt children to anticipate events (e.g., "After we get up from our nap we will do what?") and they help children connect various parts of their experiences ("This story mentions a duck. Didn't we see a duck yesterday in the park?"). In addition, effective mediators monitor the performance of their children so that they can encourage as much independent performance as possible yet provide help (scaffolding) when it is necessary. In Vygotsky's (1978) terminology, effective mediators are sensitive to their child's "zone of proximal development"—the zone where children can perform with prompting in ways that they could not perform without prompting. This sensitivity to the zone of proximal development is assumed to be one of the major factors responsible for children's abilities to learn (e.g., Brown, Bransford, Ferrara and Campione, 1983; Vygotsky, 1978).

The roles played by mediators can be clarified by considering our earlier discussion of the girl who bit or threw apples depending on whether she was in her high chair or play pen. The major goal of the child's parents was not to test whether she really knew the meanings of "eat" and "throw"; instead, they wanted to communicate with their child. They therefore made statements that were appropriate to the context and, by doing so, gave the child the chance to figure out what various words mean.

Snow (1977) provides another example of how parents behave in ways that help young children learn important information. Parents of very young children often provide information about the nature of conversations by pausing in places were the child's responses should be and by accepting almost anything (e.g., a burp or a hand movement) as part of the infant's contribution to the conversation. As the infant become older and more competent as conversationalists, the parents narrow their criteria for what counts as an acceptable response. Additional examples of the role of mediators are provided by Greenfield (1984) and by Rogoff and Gardner (1984). In each of these examples, parents are helped in their ability to provide appropriate interventions or "scaffolds" because of the child's active participation; this behavior provides an important index of the degree to which the child has understood. For example, parents can frequently tell by children's actions whether they have understood a statement or request.

It is instructive to contrast the preceding situation to the plight of the school teacher who frequently has to work with a number of students. When providing a lesson, for example, the teacher must usually rely only on general actions such as nods and "looks of understanding" in order to gauge the appropriateness of the instruction. Under these conditions it is very difficult to assess each student's level of comprehension and to modify the instruction in order to meet various needs.

## Recreating Shared Contexts

In the preceding discussions we focused on in vivo learning in the sense that mediators helped children perform tasks that were relevant to their current environment. Another aspect of learning involves the recreation of contexts that one has shared with a child. For example, Rogoff and Gardner (1984) discuss an experiment where mothers were asked to help their 6 to 9 year old children perform a memory task involving objects that are usually found in the kitchen. Many of the mothers did not simply rely on the context of the experimental room (which was designed to look like an actual kitchen). Instead, they attempted to supplement this environment by helping the child recreate more familiar situations. One mother started by saying "Okay, now we just got home from the store, okay?" Another began with "Okay, now, this is going to be a very organized kitchen...just like ours, right?" Parents' instructions frequently followed the form of imagining a situation that the child presumably knew and using it as a context for performing various tasks.

It seems clear that there are many other instances where children are helped to learn because mediators prompt them to recreate familiar environments. The present authors frequently find themselves referring to well-known situations in order to explain the meaning and importance of new concepts to our children. For example, where one of our children took Logo programming, we found that it provided a useful context for discussion even when no computers were available. Similarly, we find that simple concepts of problem solving and the use of strategies can be readily understood by 4 year old children when the concepts are introduced with reference to movies such as The Wizard of Oz, Swiss Family Robinson and so forth.

In order to be effective, mediators need to be aware of various experiences that the child has had that can provide a context for new learning. This is relatively easy for parents who have shared a great number of experiences with their children. For a teacher, however, it can be very difficult to know which sets of experiences will provide support for each child's learning. The task becomes even more difficult when children come from cultural backgrounds that differ from those of the teacher. Under these conditions, children may have special difficulties in their attempts to learn because they lack contextual support.

## Knowledge as Tools

The availability of mediation in semantically rich context facilitates the acquisition of useful knowledge. A number of theorists argue that it is particularly important for people to understand how concepts and procedures can function as tools that enable them to solve a variety of problems (e.g., Bransford & Stein, 1984; Dewey, 1963; Hanson, 1970; Vygotsky, 1978). Bacon (1620) emphasized this idea long ago when he discussed the importance of mental "helps" or tools:



> The unassisted hand and the understanding left to itself possess but little power. Effects are produced by means of instruments and helps, which the understanding requires no less than the hand.

The idea of powerful sets of "helps" or tools for enhancing general problem solving seems to be a very important component of a Haven for learning. Based on our experiences, few students view their courses from this perspective. For example, we have asked a number of college students majoring in education or arts and science to explain why logarithms are useful. In what ways do they make it easier to solve various problems? Despite remembering something about logarithms, the vast majority of the students were surprised when told that logarithms represent an important invention that greatly simplifies problem solving. They had never been helped to understand logarithms in the way illustrated by the following quotation from the English Mathematician Henry Briggs (1624):

> Logarithms are numbers invented for the more easy working of questions in arithmetic and geometry. By them all troublesome multiplications are avoided and performed only by addition....In a word, all questions not only in arithmetic and geometry but in astronomy also are thereby most plainly and easily answered.

We have encountered many additional examples of situations where students have memorized factual and procedural information with very little appreciation of how they simplify problem solving. For example, what would happen if we used only one standard of length measurement such as inches rather than use a number of them such as feet, yards and miles? What would happen if there were no concept of multiplication and division and we could only add and subtract? Some children assume that the elimination of a variety of standards and computational procedures would make life easier because less learning would be necessary, and to some extent they are correct. Nevertheless, they need to be helped to see that such inventions are extremely useful. For example, it would be very cumbersome to express all distances in inches and to have to add rather than to use multiplication as a short cut for computing answers. In Bacon's terminology, these inventions are important mental "helps" or tools.

In everyday learning, the tool function of information is generally apparent. For example, when a parent teaches a child about a physical tool, he or she provides information about function as well as structure. Implicitly, at least, the child understands how a tool makes it easier to solve various problems that one may face (e.g., a spoon helps us solve the problem of eating soup and other foods in liquid form). Similarly, a person who acquires conceptual tools understands at least some of the problems that the tools make it easier to solve.

One advantage of understanding the tool function of concepts and inventions is that people comprehend their value and therefore are more motivated to learn. This is especially true when people encounter naturally occurring problems that "create the need" for new information and inventions. Vygotsky (1878) illustrates how the creation of needs can the acquisition of new information. Similarly, one of Papert's ts for the advantage of Logo programming environments is that, the course of attempts to achieve self-initiated programming goals, s will encounter problems that enable them to understand the value concepts and procedures. For example, in Logo classes children ave difficulty drawing designs because they did not know how many to turn in order to draw a square corner, a triangle and so forth. ventions such as protractors are introduced, the students can see how these devices enable them to solve problems that they were ting. In contrast, when concepts and inventions are introduced out ext, they are frequently viewed as "something complicated to be " rather than as tools that simplify one's life (e.g., Bransford & 1984; Vygotsky, 1978).

ual Tools and Transfer

ple's abilities to understand the need for new tools seems to more than an increase in motivation to learn about them. People more likely to understand the conditions under which the tools are and hence should be more likely to access them when needed. Many ties to solve problems stem from failures to access relevant tion that was previously acquired (e.g., Bransford & Nitsch, 1978; Campione, 1978).

e striking examples of failures to access relevant information are ated in several recent studies involving college students (e.g., Holyoak, 1980; Perfetto, Bransford & Franks, 1983). In these , students were presented with information that was clearly relevant solution of various problems and were then presented with the s. Unless explicitly prompted to use the relevant information, s failed to solve the problems they received.

nider some examples from the Perfetto et. al study (1983). s were presented with a series of "insight" problems such as the ng:

ah Fuller, the famous Israeli superpsychic, can tell you the score baseball game before the game starts. What is his secret?

an living in a small town in the U.S. married twenty different n the same town. All are still living and he has never divorced one . Yet, he has broken no law. Can you explain?

college students have difficulty answering these question unless l with hints or clues. Prior to solving the problems, some students ven clue information that was obviously relevant to each problem's n. Thus, these students first received statements such as "Before ts the score of any game is 0 to 0"; "A minister marries several each week." The students were then presented with the problems and tly prompted to use the clue information (which is not stored in to solve them: Their problem solving performance was excellent. tudents were first presented with the clues and then given the s but they were not explicitly prompted to use the clues for problem



solution. Their problem solving performance was very poor; in fact, it wa no better than that of baseline students who never received any clues.

Failures to access relevant information are often assumed to be due to breakdowns in metacognitive processes. This concept is, however, ambiguou (see Brown et al., 1983). For example, it seems clear that general strategies such as "search for similar problems that you have encountered" are relatively weak (e.g., Newell, 1980). The success of one's ability to access relevant information seems to depend heavily on the way in which it was learned originally. As an illustration, assume that students are without a calculator or computer and must multiply a number of pairs of large numbers. Unless they had previously learned that logarithms enable one to substitute simple additions for difficult multiplications, it is highly unlikely that they would think of using them in this situation. Similarly, people who learn how the structural features of camels enable them to survive desert sandstorms are more likely to use camels as a model for thinking about the problem of helping people survive in deserts (Bransford, 1984). If only facts or properties of logarithims or camels are taught, exclusive of their applications, access of these concepts in order to apply them to new problems is not facilitated.

Summary of Children's Learning

To summarize, we have argued that it is important to explore the concept of Havens—of idealized learning environments. As an initial step in this direction we focused on young children's remarkable abilities to learn despite a number of disadvantages such as lack of knowledge, lack of sophisticated learning strategies and possible limitations on working memory. The efficiency of children's learning seems to stem, in part, fro the advantages of learning in context. Furthermore, children are helped considerably by the presence of mediators who arrange environmental conditions and provide feedback and instruction that is uniquely suited to the performance level of the child. Mediators also help children recreate mutually familiar contexts so that discussion and instruction can more readily take place. In addition, they help children transform facts and procedures into useful conceptual tools.

In contrast to the advantages of everyday learning in childhood, children in formal educational settings are often forced to learn out of context. Teachers may try to provide contexts through pictures and verbal descriptions, but they often have little knowledge of the types of experiences that each child could use in order to better understand the intended instruction. Furthermore, the contexts provided are frequently unrelated to one another rather than integrated into overall themes such a "What we do on Saturdays?" or "What happened during our last camping trip?". Through the use of technology to make instruction more similar to the Havens normally available to children, it should be possible to create integrated contexts that permit effective mediation.

Overview of the Experiments

The experiments discussed below are designed to (a) illustrate and (b) evaluate some procedures for creating Havens for learning. We use video tapes and computer-controlled video disks to create meaningful environments that can be shared by students and mediators, and we compare the effects of learning in these Haven-like environments with the effects of environments that are often found in schools. We then discuss how more sophisticated use of computer-controlled technology can be used to create Havens that are even more ideal.

The video segments that we have used involve popular films such as Swiss Family Robinson, Raiders of the Lost Ark and Smokey and the Bandit. One reason for using existing films to create contexts for teaching is that this procedure eliminates the costs of producing high-quality video—costs which average approximately $1,000 a minute. In addition, the films are highly motivating to watch. Furthermore, since the films do not include instructional segments in them, there is much more opportunity to use them flexibly than is usually the case with typical educational films. The ability to utilize computer controlled access to any segment of a video disc makes the opportunities for instruction much richer than is possible in typical uses of films.

The purpose of the videos is to provide a context for mediation. Students who view the video segments in the absence of a mediator are entertained, but they miss most of the opportunities for learning that the video provides. For example, we have shown segments of Smokey and the Bandit to a number of college students. None of them spontaneously noticed the richness of problem solving that takes place in the film. Once students are provided with some background and direction, they begin to notice that the film is full of problems and strategies and that it includes a number of "natural word problems" such as the average speed the actors must drive in order to travel from Georgia to TexArkana and back to Georgia in 20 hours. The segment becomes especially rich when students are prompted to evaluate the accuracy of the film. For example, can a truck really hold as much cargo as the actors need? Is their estimate of the average speed needed for the trip accurate, especially since they would probably have to stop for fuel? Is it reasonable to use the actors' strategies for switching channels on their CB so that the police cannot track them and for keeping a running record of how much they are on schedule?

We have also worked with segments of Swiss Family Robinson. This film provides a rich problem-solving context since it involves a shipwreck, attempts to explore an island and so forth. For example, during the first 25 minutes of the film one sees the shipwreck, the construction of a raft and a journey to shore, the construction of a makeshift shelter, a trip back to the ship to get additional materials, a foray with pirates and a trip back to the shore.

The first 14 minutes of Raiders of the Lost Ark also provides an excellent context for learning. For example, at one point in the film Indiana Jones wants to fill a bag with sand so that it weighs the same as a golden idol. Assuming that the idol is solid gold, how reasonable is it to suppose that it weighs about the same as a small bag of sand?



This question can be addressed at a number of different levels of complexity. For example, students in a high school science class might be helped to calculate the mass of the idol based upon estimates that could be approximated from the movie and on information about the density of gold. Discussions could then involve questions about other metals (e.g., lead) and the mass they would have. The use of the bag of sand as an equal mass could then be investigated. An approximation of the volume of sand needed to equal the mass of the idol can be calculated based upon the density of silicon dioxide. Our calculations indicate that the idol would have to have a mass of 38 kilograms, and that the volume of sand would have to be over 15,000 cubic centimeters. If the idol were really this heavy, it is also instructive to observe other scenes in the movie where it is carried and thrown with almost no effort. A number of other aspects of just the first 14 minutes of the movie provide a context for a host of additional problems. For example, the explorers taste the poison on an arrow to see if it is fresh. Is this possible? And where did the natives get the poison and how does it affect the body?

At another point Indiana Jones jumps across a pit. What cues can be used to estimate the length of the pit? Given this information, could a human possibly jump across it (for example, what is the world record in the running long jump?). In addition, if the latter information is not available or needs to be calculated for a particular individual, how does one do so? This problem provides a context for discussing experimentation, averages, variability in performance and so forth.

Indiana Jones also has a number of spiders on his back after he enters a cave. Are these supposed to be dangerous from the perspective of the film? (yes). Would the film makers actually put dangerous spiders on their star actor? (probably no). What kinds of spiders are these (a form of tarantula). Do they live in South America? In caves? Did they spin the giant webs in the caves?

At another point in the adventure Indiana and his cohort use torches to light their way. Why did they not use flashlights? At the beginning of the film the date is given as 1936. Was there electricity at this time? (yes). Were there batteries at this time, and how portable were they? The concept of "portable electricity" and how it is made become salient here. In addition, one can ask about the variables that should be considered in order to determine the number of torches to take on a trip (e.g., how long do they last, how long is the trip, how many are needed at once, etc.). The preceding examples occur during the first 14 minutes of the Raiders film. There are many different situations that occur during these 14 minutes—so many that, after watching the segment as many as 50 times, we keep noticing new questions that are relevant for educational purposes. Furthermore, there are many more scenes in this film and there are many other films as well.

## Experiment 1

The purpose of Experiment 1 was to assess some of the claims made earlier about advantages of learning in semantically rich environments. For example, we argued that rich contexts enable people to infer the meanings of unfamiliar concepts, make elaborations, and interrelate ideas and concepts that otherwise might seem unrelated. We also argued that these advantages are important not only for children but for adults as well.

## Subjects

Subjects were twenty six undergraduate college students at Peabody College of Vanderbilt. Students received extra credit for their participation in the experiment.

## Materials

The video segment used to create a context for the experimental group was the first 25 minutes of Swiss Family Robinson. As mentioned previously, this segment of the film involves many scenes where the film characters are involved in problem solving situations.

Four sets of test items were utilized in the experiment. The first consisted of a set of 10 difficult-to-comprehend sentences such as The rocks were helpful because the cloth had ripped; The pig was safe because the barrels were tied. One has to make a number of inferences in order to comprehend such statements. For example, the first becomes more comprehensible if one assumes that it refers to a ship whose sails were torn and would capsize if it did not get wedged between some rocks (this happens in Swiss Family Robinson). The second statement makes sense if one relates it to the scene where barrels are tied to a pig in order to help it float while travelling from the ship to the shore.

Statements similar in form to those used in the present experiment have been used in other studies that explored various effects of previously acquired knowledge on comprehension and retention (e.g. Bransford & McCarrell, 1984; Auble & Franks, 1978; Franks, Bransford & Auble, 1982). However, in these other studies, specific contextual information was always presented for each individual sentence; for example, the cue "bagpipes" was presented for The notes were sour because the seam split. In the present study we did not supply specific cues for individual sentences. Instead we asked whether, given a 20 minute segment of film, students could generate the specific information necessary to make the statements make sense.

A second set of test items assessed students' abilities to fill in the blanks in texts and to infer the meaning of nonsense words. For example, students were asked to decipher statements such as The Lel was in trouble so they needed to reach the Geck. They therefore sawed some Becs to make a Zim. A number of authors have studied peoples' abilities to infer the meanings of new or unfamiliar words as a function of verbal context (e.g., Werner, 1950; Sternberg & Powell, 1983). We asked whether a verbal context in conjunction with video can facilitate the ability to predict and infer meanings. As noted earlier in this paper, children seem to use contextual information in order to learn the meaning of new statements and words (e.g., Chapman, 1978; MacNamara, 1972).





A third set of test items assessed students' abilities to generate inferences that provide coherence to a message. For example, students were asked to interpret statements such as The shore was barely visible. He picked up the saw; The cannonballs were getting closer. He thought about the flag. The ability to generate sentence-connecting inferences is necessary in order to comprehend (e.g., Haviland & Clark, 1974; Kintsch, 1976; Trabasso, Stein & Johnson, in press).

The fourth set of test items consisted of a list of 30 topics such as telescopes, diseases, heroism vs. cowardice, why wood floats, sharks, brains over brawn, maritime law, etc. Students were asked to read each topic and rate the degree to which it might provide a useful lesson for fifth graders. Following the rating test they received a surprise free recall test for the 30 topics. The purpose of the recall test was to assess the effects of the film context which, because of its organizing properties, should facilitate retrieval (e.g., Mandler, 1967). As noted in the earlier discussion, the availability of an integrated context should facilitate students' abilities to remember and summarize what they learned in school.

## Procedure

The two groups in the experiment consisted of a film viewing group and a non-viewing group. The film viewing group saw the 20 minute segment of "Swiss Family Robinson" mentioned above before completing the assessment instruments; the non-viewing group saw no film before completing the instruments. Fourteen subjects were in the viewing group and 12 were in the non-viewing group.

## Results

Descriptive statistics and t-tests for the various instruments across the two groups are presented in Table 1.

TABLE 1 About Here

As can be seen from the table, there were substantial differences between the groups on all of the measures, with the film viewing group having higher scores in each case. All of the t-test results are significantly different at $p < .001$ except the number of concepts remembered task (fourth task), which had a probability level of $p < .05$ for a one-tailed test.

## Discussion

The results of Experiment 1 illustrate that video segments can provide a number of advantages that are similar to those available to young children. First, college students who had seen the video segment were better able to understand the meaning of difficult-to-comprehend sentences than were students who had not seen the video (see the first column in Table 1). These results suggest that the video context permitted inferences about the referents of various statements and about relations among these referents. For example, in order to comprehend a statement such as "The flag worked because the consequences were dire" one needs to understand the type of flag used (a signal flag) and its message (it signalled the presence of black plague). One also must understand "work" and "consequences" in the sense of "the use of the flag scared away the Pirates since they were frightened of the consequences; namely, catching the black plague."

Data illustrating the effects of context on language comprehension have usually involved very specific types of information that were supplied just prior to or just after individual statements (e.g., Bransford and McCarrell, 1974; Auble and Franks, 1980). In the present experiment, students were able to make use of contextual information that was distributed across 25 minutes of film.

A second feature of Experiment 1 is that college students who had seen the video segment were much better able to determine the intended meaning of nonsense words than were students who had not seen the video (see the second column of Table 1). For example, the video helped students interpret the meaning of "The Lel was in trouble so they needed to reach the Gek. They therefore saved some Bics to make a Zim". Of course, nonsense words are rarely used in educational contexts so one might argue that these results are irrelevant. We contend that similar processes are important when students are not familiar, or are only partially familiar, with concepts used by teachers in school.

A third pattern of results from Experiment 1 is that students who had seen the video segment were much more consistent in the inferences they made to fill in the gaps in messages than were students in the non-video group. All students received sets of sentences such as "The shore was barely visible. He picked up the saw" and were asked to explain the relationship between the sentences. Students who had seen the video were very consistent in their answers. For example, for the preceding sentences they stated that the saw was used to make a raft for getting to shore.

The data reported in the third column in Table 1 reflect the degree to which students made inferences that were consistent with information from the movie. Students in the no-video group were usually able to make some type of inference, but it was often hard to determine whether their inferences really made sense. Therefore, if their inferences did not reflect the theme of the movie we did not score them as correct. We decided to score the data in this manner because it is usually important to teachers that students' inferences conform to the intended theme of a lesson. An alternate measure would be to assess the time necessary to make various inferences. It is our impression that students without a video context would take more time regardless of whether their inferences were consistent with the survival theme illustrated in Swiss Family Robinson. Furthermore, we expect that, for younger children, video context will often be necessary in order for them to generate any inference.

The fourth set of results found in Experiment 1 illustrates how a common theme can facilitate remembering (see the fourth column in Table



1). Students who had seen the video were better able to recall a set of topics for potential lessons than were those in the no-video group. Since the video can provide a context for retrieval, we suspect that the recall differences between the video and no-video group would become larger as a function of greater time lags between acquisition and test.

Overall, the results of Experiment 1 provide strong support for advantages of using technology to create some of the Haven-like environments that are available during childhood. The data show clearly that video-based contexts can help college students understand difficult-to-comprehend statements, determine the meaning of nonsense words, fill in the gaps in messages and recall a number of seemingly-unrelated topics. Of course, the materials used in Experiment 1 were artificial. We used these materials because they are especially useful for revealing differences in inference processes. In the next experiment we explore how similar processes affect the comprehension of materials that are more similar to those normally found in schools.

## Experiment 2

### Purpose

Experiment two was designed to extend the initial information found in experiment 1 by applying some of the techniques of the first experiment to actual classroom situations. In addition, the material to be learned by the students was much more relevant to actual science content.

### Subjects

The subjects of the study were 7th and 8th grade students at a rural junior high school in the southeastern part of the United States. They participated in this experiment as part of a larger program in reading instruction being carried out at the school.

### Materials

Two types of instructional materials were prepared for the study. The basic science information to be learned was in the form of 11 short informational segments that covered topics such as the characteristics of tarantulas and the density of materials. The topics varied in length from as few as 28 words to as much as 258 words. All were modified from science textbooks and/or encyclopedia entries on the topics. Some segments included table material such as a table of densities.

### Procedure

Four classes were used in the study; two at the seventh grade level and two at the eighth grade level. The classes at the two levels were randomly assigned to either a video or control group. In the video group, the whole class saw a 12 minute segment of the film Raiders of the Lost Ark taken from the first of the film (slightly edited to remove on instance of graphic violence) via a laser videodisc player and large monitor. The science information material was then handed out. For each science segment the students (1) read an organizing paragraph containing a question or questions , (2) saw a very short (15-30 second) segment from the film that was related to the content of each particular science passage, and (3) read the science passage , and (4) were asked to answer to themselves the question(s) posed in the organizing paragraph.

For example, in the example of the tarantulas passage, the organizing paragraph was "In the movie, the spiders that crawl on Indiana and his sidekick are supposed to be viewed as very dangerous. They seem to be tarantulas. Are these types of spiders present in South America? Did they spin the webs in the cave? Are they dangerous to man?". The students read this first, then saw a short segment of the film where Indiana Jones and his helper go through some spider webs and have tarantulas appear on their bodies. The students then read the science passage about tarantulas and finally they were asked to answer to themselves the questions posed in the organizing paragraph. In the control group the student read the science passages only without viewing any video segments.

The next day students were asked to complete a quiz of eight items that covered the concepts presented by the science passages. For the tarantulas passage the question was "What are some important characteristics of tarantulas?".

## Results

Student responses on the posttest were graded on the basis of their congruence with the science passage information in a blind manner, e.g., the grader did not know the treatment group of the students. For the tarantulas question, students were given credit for every characteristic that they mentioned that was in the tarantula passage. Some items were of a knowledge level such as "The density of a substance can be found by taking it's weight and ______________ it's volume." Four alternatives were given; "A. Adding it to", "B. subtracting it from", C. multiplying it by", "D. dividing it by". Two items attempted to see if students had a more complete understanding of density by asking them to devise experiments to solve a problem that used density concepts, e.g., the Archimedes problem of determining if a crown was solid gold. A total of 14 points could be obtained on the quiz by the students.

Because of the non-random assignment to treatments of students (only classes were assigned) covariate data was collected on students from standardized reading achievement scores.

An analysis of covariance was undertaken with reading achievement test scores acting as the covariate and the two treatment groups, video or control as the one factor. Results of these analyses for each grade are found in Table 2. Adjusted means are also reported in the same table. At both grade levels the F values reached statistical significance at less than the 0.01 level.



Table 2 About Here

Strength of effect estimates were calculated as suggested by Good and Fletcher (1981) by the omega squared method and resulted in a value of .195 for the seventh grade data and .186 for the eighth grade data indicating slightly under 20 percent of the variance could be accounted for by the treatment factor. An examination of the individual items on the outcome measure indicated that for every item the video group had a higher mean value than the control group.

## Discussion

While the results of this experiment needed to be replicated with larger samples and with random assignment of students to treatments, it does show a rather strong effect for only a one day intervention in the classroom. The video sequences appeared to help students recall knowledge that that had read the previous day better than just reading the material. Our expectation is that a mediator, such as a teacher, could improve this method even more by actively calling attention to the relationships seen on the film sequences and the science concepts. Furthermore, the teacher could reshow a segment and ask students to generate questions about the scene. The ease which the teacher can return to the appropriate video sequence to refresh student's memories is very apparent when using videodiscs. This allows effective mediation in short time periods.

## Experiment 3

The purpose of Experiment 3 was to extend the information gained in the first two experiments by conducting a controlled study to determine if (1) a strong contextual basis could be used to integrate several seemingly disjointed sets of scientific information and improve student recall of the information and (2) whether the opportunity to use information to solve a problem in the video context (e.g. to use information about spiders to decide if Indiana Jones was in possible danger from poison) could increase the probability that that information would be spontaneously used later on a subsequent problem solving task.

The previous studies as well as others conducted by Bransford, Sherwood, Kinzer, and Hasselbring (1985), lead us to expect that a video context would improve recall of information . In this study, an overt video selection was not used; rather only a relating statement that connected the written materials to be learned to a film that all the subjects were familiar with, Raiders of the Lost Ark. In addition, the effect of making the information applicable to a problem solving task was investigated. As was discussed earlier, subjects frequently fail to use relevant information when they are uninformed about it's relevance to a new task even though, when they are explicitly informed, they can use the information (e.g. Perfetto et al., 1983). In the present study we investigated a similar issue. In particular, we explored the effects of acquisition condition on both an informed task (explicit instructions to recall) and an uninformed task (a problem solving task that was not explicitly related to the information that students had learned).

## Subjects

Subjects were 128 undergraduate college students in a general psychology course at Vanderbilt University. Students participate in a number of experiments during the semester as part of the course.

## Materials

A booklet of instructional materials was prepared in two different manners. Each version contained twelve science related passages each of which contained 100-200 words written in relatively non technical terms on separate sheets of paper. The passages covered a variety of topics including; The value of carbohydrates as foods, weights of liquids, characteristics of South American frogs, methods of purifying water, how to make a bronze age lamp, facts about tarantulas, how pottery is useful for dating civilizations, density of solids, finding the volume of an object by water displacement, the efficiency of recent bicycles, solar powered aircraft, densities of liquids, use of computers in personnel selection. The segment below was on the characteristics of South American frogs.

> "Many frogs survive in the wild because they blend in with nature and hence are not easily seen. However, some frogs in South America are very brilliantly colored. At first this was puzzling to scientists until it was discovered that these frogs were highly poisonous. Other animals therefore learned to avoid them.
>
> Indian tribesmen of Central and South America trapped these frogs for poison. They toasted the frogs in order to increase the virulence of the poison. One frog could provide enough poison to treat 30 to 50 individual hunting instruments such as arrows or darts."

For the non-contextual version, the passages were the only thing on the pages. For the contextual versions, each passage was preceded by a short paragraph (not over three sentences) that related the science information to the film Raiders of the Lost Ark and posed a question. For example, the frog segment given above was preceded in the contextual version by, "Indiana's men see an arrow in a tree, taste its tips and say "poison". It would be wise to bring an antidote for the native's poison if one were available. How did South American Indians get poison for their arrows?"

The directions for the non-contextual version of the materials were, "The information to be presented below involves relatively short passages about topics that scientists have researched. Please try to learn this information. The experimenter will tell you when to start." The directions in the contextual version of the materials were, "In order to be successful, any trip into the wilderness needs to be well planned in



advance. For example, in Raiders of the Lost Ark, Indiana Jones goes to South America in order to get a golden idol. He obviously planned his trip beforehand and was prepared for certain dangers. Some things that were important for explorers to know are discussed below. Please try to learn this information. The experimenter will tell you when to start."

## Procedure

The two types of written materials were randomly passed out to the subjects with equal numbers of each type represented. Students were told to read the directions and were allowed to read the 12 concept sheets at their own pace. After all subjects had read the passages two different forms of the assessment measure were used. Subjects were randomly assigned within their group to use either an "informed" or "uninformed" measure. Both versions were titled "A Problem to Solve" and contained the same first paragraph, "Assume that an adventurer plans to travel to a desert area in the Western United States in order to bring back some artifacts that were left by Pueblo cave dwellers. The adventurer would need to plan carefully in order to survive, and would often need backup plans in case anything went wrong.".

In the informed version the second paragraph stated "List each of the topics of information that you just read about, and briefly state how each could be important for the adventurer to know.".

In the uninformed version the second paragraph stated "List at least 10 topics of information that the adventurer should know in order to have a successful journey. List more than 10 if possible. Be brief but be specific. For example, don's simply say "she'll need supplies and something to carry them", but say something bout the kinds and amounts of supplies that she might need--both for everyday living and for emergencies.". After comple.ion of the assessment instrument, the experimenter confirmed that all of the students had previously seen Raiders of the Lost Ark. The assessment instrument was scored by counting the number of times subjects mentioned the information from the science passages as being important for the adventurer of the assessment question.

## Results

The design of the experiment was a simple 2 X 2 with type of material (contextual vs. non-contextual) being one factor and assessment prompt (informed vs. uninformed) the second factor. Table 3 summarizes the descriptive statistics.

Table 3 About Here

As is rather obvious from the table, subjects in the contextual treatment had a much higher mean score than those in the non-contextual treatment. Subjects who had the informed assessment prompt were also somewhat higher than the uninformed group. A classical ANOVA was performed on the data with the results reported in Table 4.

Table 4 About Here

The ANOVA confirms the expectation that the a significant main effect exists for both the contextual variable and the informed variable at a low level of probability. The interaction effect is also statistically significant. As an indication of the strength of the effect, omega squared values were calculated as in experiment 2. For the contextual main effect, the value was .13 indicating a reasonable percentage of variance in the outcome variable being explained by that main effect. The informed main effect was substantially higher at .36 and the interaction substantially lower at .02. Both the main effect strength of relationships are much larger than in many reported science related studies (Good and Fletcher, 1981)

## Discussion

The main effects of the study point toward (1) the positive effects of using a contextual basis to assist students in remembering science related topics in a recall situation and (2) the effects of acquisition on students' tendency to spontaneously use information in a new problem solving situation.

In order to examine the interaction more closely, a graphical presentation of the interaction effect is presented in Figure 1. As can be seen the contextual treatment means are both substantially higher than the non-contextual means across the second factor. What the interaction appears to show is that when dealing with an uninformed assessment prompt, which may be closer to actual class instruction, the need for a contextual basis is especially important. The slope of the uninformed treatment from non-contextual to contextual is much more (4.34) than that of the slope of the informed treatment (2.62).

Figure 1 About Here

The variety of topics covered by the science passages, some of which involved numerical values e.g., "Density of Solids" while others were purely qualitative leads to the conclusion that the use of an underlying contextual basis to help students organize information may produce major increases in student retention of information in classroom settings. While this study was in the controlled situation of the university as have been most of the previous related research (e.g., Bransford, McCarrell, 1984; Auble & Franks, 1978; Franks, Bransford & Auble, 1982), it gives empirical basis to conduct field studies of a similar nature using video segments (either presented in the class or ones that student's are familiar with already) as a contextual basis for instruction in science and is consistent with the earlier Perfetto, et al. (1983) research that students many times do not spontaneously use previously acquired information in later problem solving situations.



## Overall Discussion

The results of the three experiments provide evidence that Haven-like environments can produce increases in comprehension and learning. Data from Experiment 1 illustrate that college students can be helped to (a) make inferences necessary to fill in the gaps in messages, (b) understand the meaning of unfamiliar words, and (c) interrelate various topics or lessons (e.g., maritime law, barrel making, etc.) that otherwise seem unrelated.

In Experiment 2, with actual classroom students and science based textual material, a short intervention of video segments and organizing questions yielded positive results as compared to simple reading of materials. Students recalled more science content and were, to some extent, better able to use science concepts to solve problems.

In Experiment 3, the use of organizing questions that related science information to video that the subjects were already familiar with increased the use of the science information in a problem solving situation. In addition, the need to specifically prompt students to use previously acquired information was demonstrated.

In each of the experiments we were able to facilitate comprehension and learning by using video segments (or prompts to video segments) to provide a rich context for learning, and by creating spoken or written materials that helped students elaborate on the contexts. In general, we tried to create learning environments that included some of the advantages available to humans during the initial years of their lives. Nevertheless, none of our experiments used environments that we consider to be ideal Havens. The concept of a Haven is more complex than the learning environments used in our studies. Nevertheless, even these simple environments resulted in increases in comprehension and learning. Ideally, Havens involve an environment that is (a) highly motivating, (b) provides mediated guidance within a context-rich microworld, and (c) keeps detailed records of student interactions with the computerized microworld.

At present, we have several prototype Havens that are currently under development. These are based on the present findings plus a number of design principles derived from the motivation and instructional effectiveness literature (e.g., Lepper, 1985). To begin, the Havens are designed to maximize student attention as they engage in learning. One way in which this can be done is through the use of fantasy. In the prototype Havens we do this by building a fantasy environment around popular films such as Raiders of the Lost Ark, Swiss Family Robinson, Star Wars, and King Kong. In these Havens, learner's are placed in more active roles than they were in the present experiments; their goal is to assist characters in the film to solve problems as they go through an adventure together. For example, in using the movie Raiders of the Lost Ark, the learner has to assist Indiana Jones in solving numerous math and science problems that are encountered in his quest to retrieve a golden idol. In contrast, in the movie Swiss Family Robinson, the learner must help the family solve the problems associated with survival following the shipwreck. In both cases the films provide a motivating environment in which problems can be solved in a context rich microworld.

Motivation can be further enhanced in a Haven by placing the adventure within a game context, where the student scores points for successfully solving problems and loses points or even has to start the adventure from the beginning if he or she fails to solve the problems successfully. In this respect, Havens resemble some of the common computer-based adventure games. One important difference, however, is that in a Haven, problem solving is more academically oriented than in most other adventure-type games.

An additional characteristic found in all Havens is "mediated guidance." Mediation is provided in terms of guidance about what to notice and feedback about one's performance. For example, in his quest for the golden idol, one of the problems that Indiana Jones is faced with is the removal of the idol from a weight-sensitive pedestal that will set in motion a catastrophic set of events if a change in weight is detected. Thus, Indiana must remove the idol while simultaneously replacing it with a item of equal weight. At this point, the problem presented to the student working through the Haven is to determine if a bag of sand that Indiana is going to put in place of the golden idol weighs the same as the idol. Without this type of prompting, many students fail to ask themselves whether it is reasonable to assume that a solid gold idol would weigh the same as a small bag of sand.

In order to solve the preceding problem, the student must use knowledge and principles from math and science. The student must determine the mass of the idol by estimating the idol's volume and then multiply this by the specific gravity of gold. Next, the student must calculate the mass of the sand in the leather bag by the same procedure. If the student does the calculations correctly, he or she will know that the weight sensitive pedestal will detect a change in weight since the mass of the idol is far greater than the mass of the sand. In this case the student receives points for correctly solving the problem and is able to continue through the adventure.

If students fail to solve the problem correctly they lose points and then receive mediation in order to solve the problem correctly. Using text, audio, and graphic feedback, the students are questioned and prompted until they are able to solve the problem. At this point, if the students' scores have not fallen to zero they are allowed to continue through the adventure. If no points remain they must return to the beginning of the adventure and start again. This time they and Indiana will encounter a new set of adventures and problems.

We are especially interested in helping students develop the ability to identify new problems on their own, and to create their own problem solving adventures that others can attempt to solve. This emphasis on problem identification and problem generation seems to be an especially important aspect of problem solving that is often absent in instructional



settings (e.g., Bransford and Stein, 1984). The use of commercial video segments is especially good for problem identification because these contain many instances where events do not fit reality either because of mistakes or because of "artistic intent". Part of our work is therefore aimed at creating software that permits students to design their own adventures. In addition, we are attempting to create data bases that students can access in order to find information (e.g., about spiders, density, etc.) that helps them design adventures of their own.

The final characteristic of all Havens is their ability to keep detailed records of students' interactions as they go through the Haven. These records are integral to the successful Haven since a single Haven may have multiple adventures of varying levels of difficulty. By keeping track of students' responses, a tailored adventure can be constructed for the learner, making sure that the appropriate mix of problem difficulty is presented to the student in order to maximize motivation and learning. A second reason for storing student responses and interactions is for diagnostic purposes. By reviewing a students' record of responses, one is often able to diagnose specific problems a student is exhibiting in the problem solving process, thus enhancing the quality of remediation. If these response data are not captured there is little hope of assessing a student's specific problems.

The Havens currently under development are heavily reliant upon video disc and computer technology. At present, the student interacts with the Haven through an IBM PC that is interfaced with a Pioneer 1000 video disc player. The PC controls the video disc through a proprietary authoring system developed by IBM, and the PC and disc player use a common video monitor. Using the authoring system, the setting for an adventure is created for the student using text, graphics, and audio. The student is then taken through the adventure by viewing selected segments of the film that the adventure is based upon. As described above, the student must solve problems successfully in order to continue through the adventure. By combining video disc technology with the text and graphics capabilities of the authoring system, we are able to create extremely flexible and powerful Havens around adventures portrayed in some of the favorite movies of children. The Havens can be used by groups of students or by individuals working alone.

In sum, the data from both experiments suggest that Haven-like learning environments are successful in enhancing comprehension and learning. We refer to these environments as "Haven-like" because they involved relatively simple uses of technology and of teacher support. They therefore fall short of the ideal. Nevertheless, it seems important to attempt to understand and document how even simple uses of technology can improve student learning--especially given the skepticism among many educators concerning claims about the "panacea" offered by computers in the schools. By showing how even simple uses of technology can facilitate comprehension, learning and problem solving, the stage is set for exploring how more sophisticated uses of technology can enhance learning to even greater degrees.

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Table 1

Descriptive Statistics and $t$ Values for Groups and Measures

| | | Measure | | | |
|---|---|---|---|---|---|
| Group | $n$ | Difficult Sentences | Nonsense Words | Inferences | Memory |
| Film | 14 | $\bar{X}$ = 39.79 | 4.79 | 4.93 | 12.54 |
| | | $SD$ = 10.35 | 0.58 | 0.27 | 3.23 |
| Control | 12 | 26.83 | 2.00 | 0.42 | 10.33 |
| | | 6.31 | 1.58 | 0.52 | 2.18 |
| | $t$ value[a] | 3.77 | 6.05 | 28.65 | 1.78 |

a $p < .001$ for first 3 measures, $p < .05$ final measure, one tailed test

Table 2: Analysis of Covariance and Adjusted Means

7th Grade Subjects

| Source of Variation | Sum of Squares | df | Mean Square | F | Sig. of F |
|---|---|---|---|---|---|
| Reading (Covariate) | 5.55 | 1 | 5.55 | 1.93 | 0.17 |
| Group | 32.69 | 1 | 32.69 | 11.38 | 0.002 |
| Explained | 38.24 | 2 | 19.12 | 6.55 | 0.003 |
| Residual | 112.05 | 39 | 2.87 | | |
| Total | 150.29 | 41 | 3.67 | | |

Adjusted Means: Video Group = 4.55 (n=16), Control Group = 2.74 (n=26)

8th Grade Subjects

| Source of Variation | Sum of Squares | df | Mean Square | F | Sig. of F |
|---|---|---|---|---|---|
| Reading (Covariate) | 31.46 | 1 | 31.46 | 7.47 | 0.010 |
| Group | 42.11 | 1 | 42.11 | 10.00 | 0.004 |
| Explained | 73.57 | 2 | 36.79 | 8.74 | 0.001 |
| Residual | 126.31 | 30 | 4.21 | | |
| Total | 199.88 | 32 | 6.25 | | |

Adjusted Means: Video Group = 5.78 (n=16) Control Group = 3.51 (n=17)

Table 3: Descriptive Statistics for Groups

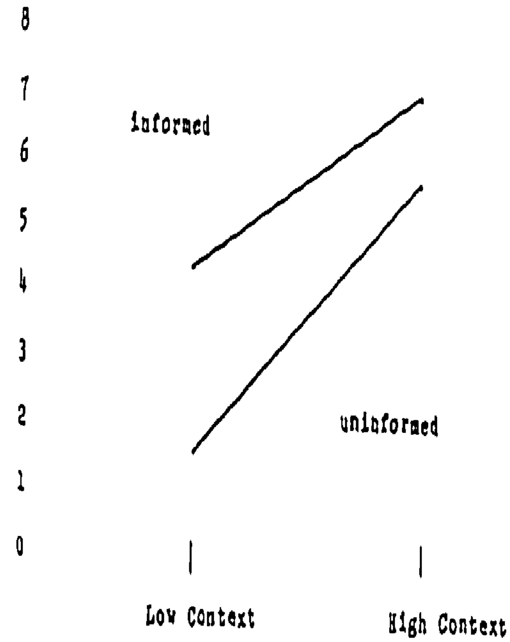
| | | Context | No Context |
|---|---|---|---|
| Informed | X = | 7.00 | 4.38 |
| | S.D. = | 1.48 | 2.77 |
| | n = | 32 | 32 |
| Uninformed | | 5.75 | 1.41 |
| | | 1.83 | 1.78 |
| | | 32 | 32 |

Table 4: Analysis of Variance

| Source of Variation | Sum of Squares | df | Mean Square | F | Sig. of F |
|---|---|---|---|---|---|
| Context | 142.38 | 1 | 142.38 | 64.89 | <.001 |
| Informed | 388.51 | 1 | 388.51 | 94.98 | <.001 |
| C X I | 23.63 | 1 | 23.63 | 5.78 | .018 |
| Explained | 554.52 | 3 | 184.84 | 45.19 | <.001 |
| Residual | 507.22 | 124 | 4.09 | | |
| Total | 1061.74 | 127 | 8.36 | | |



Figure 1



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