THE EFFECTS OF CUEING LEARNERS TO A TRANSFER PROBLEM PRIOR TO INSTRUCTION

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(ABSTRACT)

Prior research indicates that cueing or priming an individual prior to exposing them to a basic stimulus, either visual or verbal, will direct their perception and attention toward specific aspects of that stimulus. Furthermore, it suggests that those aspects of the stimulus that are attended or perceived may be related by the extent to which they afford the resolution of a problem, need, or state invoked by the cued phenomenon.

The purpose of this study was to determine whether similar results would be found using content of a greater scale. In other words, the purpose was to determine whether the same cueing and priming results found using words and phrases would apply using entire instructional modules. Specifically, this study attempted to determine whether cuing individuals to an expected outcome performance prior to instruction would cause them to focus on those parts of the instruction needed to succeed on the outcome performance. It was hypothesized that prior cuing would result in superior performance on a transfer problem. Similarly, it was also hypothesized that, since the learner's attention would be directed toward specific parts of the instruction to the neglect of others, overall memory retention would be diminished for learners that were cued.

To test these hypotheses, an experimental design was used with two overall groups: one receiving prior exposure to a transfer problem and one not. In addition, in order to avoid the possibility that any results could be generalized only to the subject matter being taught, two different subject domains were used: statistics and biology. Therefore, 115 undergraduate students were randomly assigned to one of four groups: (a) a statistics group receiving prior exposure to a transfer problem; (c) a statistics group without prior exposure to a transfer problem; (b) a biology group receiving prior exposure to a transfer problem; (d) a biology group without prior exposure to a transfer problem. Following instruction, each group received the transfer problem and recall test appropriate for the subject area covered during their instruction (statistics or biology).

The resulting data was analyzed using two ANOVAs, one for retention and one for transfer. Neither ANOVA yielded significant results. Hence, the results reported in this study do not support either hypothesis.

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Chapter 1: Introduction & literature review

Introduction

As an introduction to the concepts explored in this paper, read the following passage taken from a study conducted by Bransford and Johnson (1972; 1973):

> *The procedure is actually quite simple. First you arrange the items into different groups. Of course one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities that is the next step; otherwise, you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run this may not seem important but complications can easily arise. A mistake can be expensive as well. At first, the whole procedure will seem complicated. Soon, however, it will become just another facet of life. It is difficult to foresee any end to the necessity for this task in the immediate future, but then, one never can tell. After the procedure is completed one arranges the materials into different groups again. Then they can be put into their appropriate places. Eventually they will be used once more and the whole cycle will then have to be repeated. However, that is part of life.*

Bransford and Johnson (1972; 1973) found that participants without prior knowledge of the topic ("washing clothes") had difficulty comprehending the passage and were unable to recall very much of the text. Participants made privy to the topic only after reading the passage had similar difficulties. On the other hand, participants with prior knowledge of the topic experienced little trouble comprehending and subsequently, recalling various details of the paragraph.

Now consider an entirely different study: Roth and Shoben (1984) presented participants with a series of sentences each of which included an ambiguous word. Participants were then asked to select the thing that they felt most typified the ambiguous word. For example, some participants were given the sentence “Stacy volunteered to milk the animal whenever she visited the farm.” They were then presented with a list of several animals and asked to select the one they felt was referenced in the original sentence. The animal selected most often was considered the exemplar for that sentence. When the sentence described the act of milking, participants felt that cows and goats were most typical of the term “animal”. When the sentence described the act of riding, horses and mules were considered most typical of the term.

Though simple and by no means comprehensive, together, these two seemingly disparate studies offer a number of important suggestions about the nature of learning and instruction that warrant further investigation. First, both studies suggest that there is a great deal of variance in the response generated by a single environmental stimulus. An individual’s responses will vary from stimulus to stimulus. But perhaps more significantly, the response that a particular stimulus generates will vary from person to person. In fact, one person will respond to the same stimulus in various ways from moment to moment. This inconsistency in response from person to person, and from time to time, is largely influenced by the environmental stimuli preceding the one in question (this statement might be restated as "response variance is influenced by the individual's currently activated cognitive structures" without changing its fundamental meaning). Furthermore, these studies suggest that this inconsistency is caused by the particular type of relationship that one stimulus has with another. For example, two stimuli when related by structure or shape may generate a reaction that is entirely distinct from the reaction generated when the two are related by function. This was the case when researchers found that participants grouped objects differently when they varied along different dimensions such as shape, size, or color (Landau, Smith, & Jones, 1988; Landau as cited in Smith & Samuelson, 1997).

What is the significance of these propositions if in fact they are found to be valid? Generally speaking, these findings suggest that learners will not react consistently to any given stimulus. Each time an individual encounters something in the environment, his or her reaction will vary from encounter to encounter, even if the something does not. This suggests that, if a student is presented with instruction in the classroom, and subsequently demonstrates mastery of the desired skill set, there is no guarantee that they will actually use this skill when appropriate. This may be suitable for certain types of learning environments designed to tolerate or even promote inconsistent, subjective reactions from the learner. However, in situations where the intended result is the consistent generation of a specific reaction on the part of the learner, then it will be critical to exert control over those factors that prevent the correct response from being consistently generated. Certainly, most if not all objectives-based instruction falls into this category. Therefore, it follows that objectives-based instruction can benefit from the systematic identification and investigation of those environmental factors that influence the nature and consistency of an individual's response.

Instability in individual responses to the environment

In a 1988 study, Landau, Smith, and Jones (1988) presented students with a drawing of an abstract shape that appeared to be an inverted "U". The drawing contained a label that read "is a dax." Participants were then presented with a series of other drawings that differed from the original "U" along one of several dimensions. For example, one object had the same shape as the original but differed in color. Another differed from the original in size but had the same shape and color, while another a differed only in the shape. When asked which of these subsequent objects were also "daxes," participants tended to select the drawings that were similar in shape. In a similar study (Landau as cited in Smith & Samuelson, 1997), participants were presented with an object that was made of sponge and told it was a dax after which an experimenter used it to wipe up water. Participants were then shown a number of objects of varying shapes and composed of various materials. When the outcome task involved labeling the objects with a particular name, participants tended to categorize the objects by their shapes. When the outcome task involved using the object for a given function, participants categorized the objects by the materials of which they were made. In other words, when given a single group of items the characteristics that participants used to determine group membership changed from situation to situation. In one case, the defining characteristic was the shape, while in another using the exact same objects it was the material. This evidence suggests that individuals spontaneously develop ad hoc categories to deal with specific situations both novel and familiar. The fact that the categories were fictional provides further weight to this conclusion because participants would not have been able to use existing knowledge of the concept to make the necessary distinctions.

This is directly counter to the belief held by many cognitive scientists that concepts are in fact static mental structures whose requisite properties are preserved in an individual's mind. The notion that concepts are static structures is commonly referred to as the classical view of concept formation (Ross, 1994). In the words of Ross, the classical view "assumes each concept has a set of properties that are singly necessary and jointly sufficient to categorize an instance" (p. 122). This means that, in the classical view, each concept has a list of properties required to determine whether something is an instance of the concept and this determination is made by simply ascertaining the existence or nonexistence of these properties.

Theoretically, there are a number of noteworthy problems with the classical view. One is that, for most concepts, it is nearly impossible to generate a list of properties that is all-inclusive. For example, most non-scientific property lists for birds will not exclude outliers such as penguins and ostriches. On the other hand adjusting the list to accommodate them inevitably leads to the inclusion of non-instances. While it may be possible to develop an adequate definition of birds based on biological concepts, most people do not need an awareness of these biological concepts in order to recognize an instance of a bird even if it is atypical. This suggests that people can make accurate categorizations even without knowledge of the required attribute lists.

Another problem with the classical view of concepts is that it does not account for instances that appear to be either more or less typical. Pioneering research by Rosch (1978) has demonstrated that individuals possess an awareness of the typicality of a concept instance regardless of whether it possesses defining properties (for example, people consider robins more typical examples of birds than other birds [Rips, 1973]). Rosch asserts that each concept has a number of prototypical examples. These examples contain certain features, or sets of features. Once exposed to the prototypical examples, people use these features to estimate the probability that something else either is or is not an instance of a particular category or concept. The fact that different prototypes share some features while not others allows people to identify those features that are the most critical to concept membership, while recognizing those that are less critical. Thus, some instances may lack some important features, as long as the more critical ones are present. The idea that people determine concept membership by ascertaining the probability of certain features being present is known as the probablistic view of concepts (Ross, 1994).

The probablistic view of concepts is supported by a good deal of empirical research (Labov, 1973; McCloskey & Glucksburg, 1978; Rosch & Mervis, 1975), including research commonly referred to as family resemblance research (Ross, 1994). Family resemblance research illustrates that when an intergenerational picture of a family is observed, some members appear to "belong" more than others despite the fact that no single feature occurs in all members.

For example, family resemblance studies conducted by Labov (1973) investigated whether participants would categorize certain images as being of the family “cups” (i.e. containers from which to drink). The images varied along a number of dimensions. For example, the height was varied, the diameter of the opening was varied, the shape of the opening was varied, and the shape and existence of a stem was varied. All of these variations occurred on a continuum. Thus, in the extreme case of one dimension, the diameter of the cup is far wider than the height of the cup, thereby giving the appearance of a bowl. The one feature all images had in common was the same lifting handle. Participants were presented with each image and asked whether or not it represented a cup. Based upon these classifications, it was possible to determine approximate or typical boundaries for the concept of cup along certain dimensions. For example, Labov found that the number of cup classifications decreased with the increasing diameter of the cup openings. It is interesting to note that when the example cups were filled with either food or flowers, the typicality selections changed. For example, when the vessels were filled with mashed potatoes, participants were less sensitive to smaller vessel diameters, thereby refusing to label many items a cup that they would have otherwise labeled a cup without mashed potatoes.

Labov's results not only support the probablistic view of concepts, they introduce another important aspect of concepts currently receiving great attention: the instability of graded structure. The instability of graded structure is a phrase coined by Barsalou (1987) to refer to the variance in typicality selection caused by various external environmental elements. The instability of graded structure postulates that for each concept there are numerous feature sets which individuals use to determine concept membership, but that only one is used at a time, and the feature set used depends upon the context. This is another way of saying that what people believe to be a typical instance of a concept varies depending upon the context. Thus, in Labov's experiment, the classification of an image as representative of a cup was variable for each object that was placed within that cup. Conceivably, such classifications could have also been influence by the placement of the cup within a room such as a kitchen, or any number of other variables.

In 1983 Roth and Shoben conducted another study showing support for the notion of unstable concept structure. Participants in their study considered cows and goats to be more typical instances of the concept animal than horse and mule when the term animal is considered within the context of milking. In contrast, the participants found horse and mule to be more typical instances of the term animal when presented in the context of riding. Thus, the term animal is a concept whose structure varies from context to context, and perhaps even from person to person. This typifies unstable graded concept structures.

The instability of the graded structure has been studied by Murphy (1991), and Smith and Samuelson (1997) to name a few (Knowlton, 1977; Landau, Smith, & Jones, 1988; Reed, 1972; Smith, Jones, & Landau 1992). It's existence has been fairly well-established (Armstrong, Gleitman, & Gleitman, 1983; Lakoff, 1986) as has its importance for a variety of tasks like the ease of concept learning, speed of example identification, and decision-making (Barsalou, 1987). As a testament to the degree of instability from person to person, Barsalou (1987) notes that from person to person, agreement on the typicality of an instance will correlate about 0.45 on average (p. 108), and that individuals ranking of typicality from time to time only correlated about 0.80 on average (p.112). In addition, all kinds of concepts exhibit the properties of unstable graded structures, from goal-derived categories, to taxonomic categories.

This research led Barsalou and others to conclude the concepts are actually ad hoc categories created on-the-fly to deal with particular situations. The ability of people to almost instantly develop such ad hoc categories is aptly illustrated by a study that Reed conducted in 1972. Reed presented participants with ten drawings of faces slightly more complex than smiley faces. Several features were varied in each face like the space between the eyes, overall size of the forehead, space between the eyes and nose, etc. The ten drawings were divided into two categories of five faces each with the division being determined by a vague similarity in the members of each group. Each category was given a non-sensical label. Participants each went through twelve iterations of looking at all the drawings in random order attempting to associate each drawing with the correct label. Following this training period, participants were presented with 24 new faces, two of which were prototypes from each group (with size and spacing of features averaged out), and asked to determine to which group the face belonged. Participants were able to identify the prototypes 90 percent of the time, indicating that they had successfully developed ad hoc concepts in order to meaningfully categorize the faces. Other studies have demonstrated that such ad hoc categorization can occur after one exposure to a handful of items (Landau, Smith, & Jones, 1988; Smith, Jones, & Landau, 1992).

Because graded structure researchers were focused on identifying the basic psychological element, they spent the majority of their efforts validating the existence of concepts with graded structures and exploring its boundaries. They were not as concerned with discovering the precise mechanisms that cause the structure of any given concept to shift. Barsalou does suggest that graded structure is heavily influenced by context (p. 106), but he declines to fully define context.

While he does suggest the possibility that the nature of the task plays an important role (p. 116) he does not explore the issue in depth.

Smith (1995) offers one suggestion: graded structure is largely determined by the properties of the object and its surrounding context that are attended to during initial and repeated exposures. This proposition follows the logic that people have a limited number of attentional resources to dedicate to any particular stimulus, and that many stimuli contain properties that exceed this capacity. When an individual encounters something in the environment, they must select a limited set of features to attend. Thus, the extent to which the structure of any given concept shifts is dictated by those qualities of the stimulus to which an individual pays attention. While this may at first appear obvious, it is important because it suggests that the mechanism guiding the selecting of attention is an important instructional variable.

Summarizing the findings noted in this section, while symbols and objects themselves are static physical phenomena, they do not appear to be mentally represented as such. Concepts are not permanent mental structures. Instead, concepts are temporary constructs built ad hoc in order to deal with a particular situation. They possess loosely graded boundaries the importance of which shifts from context to context. This means that when an individual encounters environmental stimuli either new or familiar, his or her reaction will likely be inconsistent from encounter to encounter. Selective attention appears to be the primary cause of this variance. The research cited earlier does not directly address the issue of what precisely directs the selection of attention.

From an instructional standpoint, this suggests that when a learner encounters new phenomenon in a classroom, and subsequently learns to react to that phenomenon in a fashion deemed appropriate, he or she may not react in the intended fashion when the same phenomenon is encountered in a non-instructional setting (or even in another instructional setting). This is not sufficient for instructional situations that demand a conditioned reaction in an environment other than that used for initial instruction. Therefore, in order to consistently generate the appropriate reaction from encounter to encounter it is critical to identify and control those variables that cause differences in learner responses. In other words, it is necessary to identify and successfully manipulate those environmental elements that direct a learner's attention to specific property sets and not others.

Selective attention and perception

Briefly reconsider the study by Bransford and Johnson (1972; 1973) presented at the beginning of this investigation. Some participants were presented with a passage describing how to perform a certain function. When participants had been told that the passage pertained to the act of washing clothes, they were more successful at comprehending and remembering details of the passage than participants who had no prior knowledge of the topic. Contrast this study with others conducted by Jenkins and fellow researchers (Hyde & Jenkins, 1969; Johnston & Jenkins, 1971; Till & Jenkins, 1973; Walsh & Jenkins, 1973) in which participants were presented with a text passage and asked to focus attention on one of two things: the surface structure or the meaning. When participants were told to attend to the number of letters in the words, participants had difficulty recalling whether certain words were present. However, when participants were asked to determine whether the words were either pleasant or unpleasant, or whether they were important or unimportant, recall was much higher.

Notice that in the Bransford and Johnson study, the experimental cue was necessary in order to comprehend the passage. Because the stimulus materials were incomplete, comprehension was not possible, much like comprehension is not possible when certain letters are missing from a word. On the other hand, when the stimulus materials were complete (i.e. when they included cues about the contents of the passage) participants had little trouble with comprehension. This means that participants had already been conditioned to respond appropriately to the said stimulus. Participants had already learned what needed to be learned, but the stimulus presented in the experiment was incomplete. Thus, the deficiency in this experiment was with the passage, not the learner.

In contrast, the stimulus materials in the Jenkins and colleagues studies were completely sufficient to generate the intended response. Without additional cues, the stimulus materials were complete and meaningful. This is evidenced by the fact that participants did not experience difficulty comprehending the passage in isolation. It was comprehensible without any additional cues. However, when participants were cued to attend to the stimulus in a specific way, they could not successfully accomplish the outcome task. Whereas in the Bransford and Johnson study, the materials were insufficient (much like an incomplete sentence), in the Jenkins studies, the materials were sufficient, but the orientation of the learner was not. The problem was not with the passage but rather, with the learner. Without an additional cue to direct their attention, the learners did not know which aspects of the stimulus to attend in order to generate the correct response.

This suggests a very important lesson: even if stimulus materials are completely comprehensible, their comprehension may not lead to a successful outcome if the attention of the learner is not adequately directed. This notion is evident in a study conducted by Craik and Watson (1973). They postulated that the superficial processing of external stimuli would result in poorer learning than processing that is semantically deep. Jenkins and fellow researchers (Hyde & Jenkins, 1969; Johnston & Jenkins, 1971; Till & Jenkins, 1973; Walsh & Jenkins, 1973) explored this hypothesis using a series of studies that presented participants with stimulus material and required them to focus attention on one of two aspects: the surface structure or the meaning. For example, when participants were told to attend to the number of letters in the words, recall was low. However, when participants were asked to determine whether the words were either pleasant or unpleasant, or whether they were important or unimportant, recall was much higher. Nitsch, McCarrell, Franks, and Bransford (in Bransford, Nitsch, & Franks, 1977) found similar results for images as well. When participants were asked to focus on the physical features of the components within the image, they were not as capable of remembering the objects represented in the images as participants who were instructed to think about some aspect of the represented objects (for example, participants were asked to think of the various things that they could do with the objects shown). This led the researchers to conclude that information that is processed meaningfully will lead to greater retention.

However, Stein (1978) questioned this interpretation. Like the graded structure researchers (Barsalou, 1987), Stein believed that the meaning of a stimulus was relative and that the Jenkins outcomes were skewed by the fact that the outcome task favored one group of participants. For example, had the outcome task required participants to recall the number of letters in the words, the results would likely have been reversed. Stein (1978) conducted his own experiments to support this conclusion. He found that when participants were cued to focus on particular surface features of a word, they performed better than participants cued to focus on the meaning of the word when the criterion task was to remember surface features of the word.

The Stein study shows that even if a stimulus is completely sufficient to generate a response, it might not generate that response even if it has been previously conditioned. In fact, there may be any number of "correct" responses for any given stimulus. The correct response is determined by the outcome task and the generation of the correct response is determined by how the learner comprehends the stimulus. This comprehension is in turn determined by which particular aspects of the stimulus are attended to. In other words, in order to use information in a meaningful way, it must be clear to the learner what parts of the information to pay attention to. The correct parts to pay attention to depend upon how the information will be used in the outcome task.

In the Jenkins (Hyde & Jenkins, 1969; Johnston & Jenkins, 1971; Till & Jenkins, 1973; Walsh & Jenkins, 1973) and Stein studies (1978) as well as others (Nitsch, McCarrell, Franks, and Bransford in Bransford, Nitsch, & Franks, 1977) the successful learners were simply told which aspects of the stimulus to pay attention to. For example, when the outcome requires students to remember the number of words in a passage, participants are told to pay attention to the number of words. When the outcome requires students to remember the presence of words, meanings, or themes, participants are told to pay attention to the meanings of the words. In other words, if a learner is told to pay attention to specific parts of a stimulus that are needed to perform an outcome task, they will have much more success with that task.

However, there is evidence to suggest that it is not necessary to explicitly direct attention to the appropriate parts of a stimulus if the learner is aware of the outcome task prior to seeing the stimulus. In fact, this proposition is implicit in the findings of the concept researchers cited earlier in this document (Barsalou, 1987; Rosch, 1994). The very idea of graded structure indicates the relative nature of perception. A prime example of this relativity can be found in Labov's (1973) study finding that participants were more likely to classify a vessel as a cup when it denoted the act of eating (it was filled with food) than when it denoted the maintenance of plants (it was filled with flowers). Barsalou, who coined the phrase graded structure, expressed his belief that graded structure is heavily influenced by context (p. 106) and that task plays a central role in these classifications (p. 116). A Roth and Shoben (1983) study supports this conclusion. Roth and Shoben demonstrated that cow and goat were considered more typical examples of the concept animal than horse and mule when the term animal is considered within the activity of milking, while horse and mule were more typical examples of animal in the activity of riding. And finally, reconsider the study cited earlier by Landau (as cited in Smith & Samuelson, 1997) in which students were presented with a U-shaped object called a dax, and then asked to identify other objects as being either daxes or not daxes. When the exemplar was used to wipe up water, participants categorized according to the object's composition, while others were more apt to categorize according to shape.

In reviewing these findings, it appears that in order to accomplish a particular task, there are specific qualities of a stimulus that must be attended to, while others may be altogether ignored. It also appears that individuals will simply attend to whatever qualities of the stimulus they desire unless they are otherwise cued. This would account for either the incorrect responses to a stimulus or variability in the generation of the correct response. Cueing learners to attend to the critical aspects of a stimulus aids in generating the correct response consistently. However, the necessity for these cues is diminished if not eliminated when the learner possesses an awareness of the outcome task.

These phenomena are best explained by the theory of affordances postulated by J.J. Gibson (1977). Gibson has been called an ecological psychologist because he believed that cognition can best be studied in terms of the relationships between agents and the systems with which they interact rather than as a series of independent functions that work together to process, store, and retrieve information in the form of internal mental structures. When a single stimulus generates a number of responses from the same individual at different moments, Gibson would explain this by asserting that when the individual generates a response, it is not the stimulus in its entirety that is responsible. Rather, specific parts of it are. It may be necessary to have the entire stimulus present, but that stimulus possesses many elements that are irrelevant to the outcome. However, those elements that are irrelevant for the first task may be quite relevant in generating other responses that the stimulus provokes in different situations. Thus, the role of perception is critical in understanding such action. Based on these ideas, Gibson believed that the study of learning is in large part if not entirely the study of processes of differentiation. That is, psychologists should study how and why individuals perceive those aspects of the environment that contribute to meaningful action.

For Gibson, perception is governed by those aspects of the environment that either encourage or enable actions. When some aspect of the environment enables a particular action, it is said to afford that action. In accordance with the themes being discussed, any single object or set of objects may afford a large number of actions. For example, a beer stein affords drinking, personal defense, containing coinage, or even hammering a nail. Therefore, in order to complete any intended action, an individual must perceive those qualities that afford the action of their intention, and ignore those that do not. Gibson (1977) claims that individuals do this naturally when he said "we do not perceive stimuli or retinal images or sensations, or even just things; what we perceive are things we can eat, or write with, or sit down on, or talk to" (p. 60). Thus, in the words of Greeno (1994) "if a person is engaged in an activity of going to attend a class, then the action of moving into the classroom is a functional part of that activity. That will make a person attentive to aspects of the environment that could provide an affordance for moving into the classroom, such as the doorway from the hall into the classroom" (p. 340).

This theory and the language used to describe it is strikingly similar to that used by Rosch (1978) - considered responsible for the probabilistic view of concepts - in describing her theory of base level concepts. Recall that Rosch is one of the many concept researchers noted earlier that helped establish the idea that concepts are relative phenomena. During her many studies in which she required participants to decide whether or not some object belonged to a particular category, Rosch noticed that the degree of difficulty was largely determined by the extent to which the category term was either abstract or concrete. The term should not be too abstract, and yet it should not be too concrete. Thus, for any given category, there is a midpoint (Varela, Thompson, & Rosch, 1991). This is "the point at which cognition and environment become simultaneously enacted" (p. 177). This statement implies that the base level term for any concept varies depending upon a relationship between the agent and the systems with which they interact.

The theories and research of graded structure (Rosch, 1978) and its instability (Barsalou, 1987) support Gibson's position, and his ideas aptly explain their conclusions. Individuals do appear to respond differently to the same environmental stimuli (Barsalou, 1987) and this difference is dependent upon the nature of the outcome task (Roth & Shoben, 1983). In other words, the environmental stimuli provided affordances for a number of different tasks and those that were attended to were determined by the outcome task. This dependence on task did not go unnoticed by Barsalou.

Likewise, the theory of affordances explains and is supported by the cueing and primeing research (Hyde & Jenkins, 1969; Johnston & Jenkins, 1971; Nitsch, McCarrell, Franks, and Bransford in Bransford, Nitsch, & Franks, 1977; Stien, 1978; Till & Jenkins, 1973; Walsh & Jenkins, 1973) in which the stimulus participants experienced was sufficient for the desired response yet still generated inconsistent results. As Stein noted, these inconsistencies can be attributed to the differing nature of the outcome task, which is to say that the learners perceived affordances that were in accordance with their task.

Summarizing these findings, the accomplishment of a particular task requires attention to specific qualities of a stimulus while others may be altogether ignored. The studies cited in the body of this text indicate that individuals will simply attend to whatever qualities of the stimulus they desire unless they are otherwise cued. Incorrect responses and inconsistency therein can be attributed to this phenomenon. Cueing learners to attend to the critical aspects of a stimulus aids in generating the correct response consistently. However, the necessity for these cues is diminished if not eliminated when the learner possesses an awareness of the outcome task. The critical aspects of a stimulus can be thought of as affordances. Affordances exist in direct relation to the outcome task. In other words, the affordances that must be perceived in any situation is determined by the nature of the desired outcome.

Summary and implications for instruction

Research into the psychological nature of concepts indicates that they are actually fluid categories developed by an individual spontaneously to address a particular situation. Since every situation differs from others in varying degrees, individuals understanding of concepts and reactions to the environment tend to be unstable and inconsistent. In situations where a response is consistent, that is when an individual does generate the same category repeatedly; this is a factor of the environmental conditions rather than of stored mental representations of the concept or its defining attributes.

Cueing and priming research suggests that this instability is a result of selective attention. That is, any object in the environment has a large number of properties that can be attended to. But with limited attentional resources, only a select few may be attended to. This selectivity is what causes differences in an individual's response to a single object from one situation to the next. In other words, in one situation, an individual notices certain things about an object and ignores others, while in another situation, that same individual notices different things about the object and ignores others. Thus, when an individual is directed to attend to the appropriate properties of an object, the intended response occurs more consistently.

The theories of J.J. Gibson suggest that it is not necessarily attention that is responsible for these findings as much as it is perception (the primary distinction hinging upon the idea that the term "attention" assumes a deliberate direction of cognitive resources while perception assumes the process is more automatic). In his view, individuals not only process limited aspects of the phenomenon, they will be entirely ignorant of others despite their observable presence. Put another way, perception is directed automatically to those aspects of a phenomenon that serve the individual, and away from those that do not. Research conducted by the cueing and priming researchers confirms this hypothesis empirically (Barclay, Bransford, Franks, McCarrell, & Nitsch, 1974). Gibson (1977) hypothesized that selective perception is guided by affordances. In his words, affordances "relate the utility of things, events, and places to the needs of animals and their actions in fulfilling them" (p. 60). Thus, "we do not perceive stimuli or retinal images or sensations or even just things; what we perceive are things that we can eat, or write with, or sit down on, or talk to" (p. 60). Thus, when an individual possesses a need or goal, the specific aspects of specific objects that afford the satiation of those needs or goals are those that are perceived automatically.

Thus, as the cueing and priming research indicates, the appropriate aspects of a stimulus may be processed by directing attention to them. However, prior to this guided direction, an individual will perceive specific qualities automatically in accordance with their goals or needs. Given these conclusions, an instructional strategy of focusing attention on the appropriate aspects of a stimulus should result in superior performance than instruction that does not. However, when the same performance is desired in other situations (in other words, when the skills must be transferred to the application environment) where remediation and guidance are not present, the likelihood of an incorrect performance increases because of its absence. On the other hand, when students in instructional settings possess goals and needs that will be present in the transfer environment, the correct aspects of the stimulus should be perceived more readily and the likelihood of incorrect response in the transfer environment should decrease.

This is simply another way of stating that prior knowledge of the expected outcomes will positively influence the actual outcome of instruction because individuals will perceive and hence attend to those aspects of the instruction that afford the accomplishment of those outcomes. This statement may at first appear obvious since informing learners of the learning objectives has been central to many instructional design theories for quite some time. But instructional objectives are often framed in reference to the instructional environment. Thus, one would expect prior knowledge of the instructional objectives to have a positive influence on outcomes within an instructional environment. However, the same results would not be expected during performance in the transfer environment. In other words, as the research and theories cited in this study suggest, a prior awareness that one will be taking a test of a certain kind may aid in the performance on that test, but it cannot be expected to positively influence any performance other than test-taking performance.

It is worth noting that none of the popular instructional design models suggest that any reference to the transfer environment be made in the introductory materials or in any other aspect of the instruction. In the Dick and Carey (1990) model that exemplifies the systems approach to instructional design, a thorough analysis of the transfer environment is recommended (p. 16). However, when this analysis is completed the results are translated into performance objectives that follow the Mager (1972) format (p. 16). Such instructional goals address outcomes that are expected within the learning environment, but not outside of the learning environment. Dick and Carey site an example of a well-developed instructional objective (p. 115):

> Given several simple declarative, interrogative, and exclamatory sentences with correct and incorrect closing punctuation, select the declarative sentences with closing periods.

Notice that the objective refers to a performance that will occur within the classroom and not one that will occur outside of the classroom. Thus, if the research cited previously is valid, one would expect learners to experience fewer problems accomplishing this objective when informed prior to instruction (as Dick and Carey recommend). However, we would not expect such an objective to impact the use of the new skills in a transfer environment.

The Dick and Carey approach is based on the theories of Gagne (1974). In describing the events of learning Gagne indicates the importance of attention and perception (p. 45). Yet, when translating this theory into practice, he too espouses introducing learning objectives fashioned after Mager. For example:

> Given the question, “What are the provisions of the First Amendment to the U.S. Constitution?” state the provisions.

Gagne uses this objective as an exemplar of appropriate instructional objectives (p. 73). But, like Dick and Carey, this objective refers to an outcome that will take place within the classroom and not outside of the classroom. Thus, we would expect it to result in superior classroom performance, but have negligible effects on performance in a transfer environment.

The model proposed by Smith and Ragan (1993) suffers from the same problem, perhaps because it is so heavily influenced by Gagne's events of instruction. While Smith and Ragan do suggest analyzing the "learning context", it is clear that by learning context, they are referring to "a description of the learning environment in which the instructional product will be used" (p. 27) rather than a description of the environment in which the new skills or knowledge will be used. Smith and Ragan recommend "establishing purpose" prior to instruction, but the examples given (e.g. "you will learn to …") indicate that doing well within the instructional environment provides sufficient purpose for most learners. In a similar fashion, Dave Merrill (1994), who was also influenced by Gagne, emphasizes analyzing learning objectives in terms of the behavior that will be expected within the learning environment.

The theories and experiments cited earlier in this investigation suggest that learners who are familiar with the eventual performance environment before experiencing instruction will perform well. This appears to be implicitly recognized by many major instructional design theories (although the explanations vary). Yet none of the instructional theories mentioned here suggest referencing the transfer environment during any aspect of instruction.

This contradicts the research cited previously, which indicates that attention is dictated by perception and that perception is dictated by affordances (the relationship that the perceived phenomena has to the goals or needs of the individual). If these theories were valid, then it would be logical to expect that learners who are familiar with the eventual performance environment prior to experiencing instruction will exhibit superior performance than those who experience instruction alone. Conversely, learners who are not exposed to the expected performance outcome prior to instruction should experience greater difficulty completing the achieving the desired outcome. This is the same as saying that, when receiving instruction that will be applied in a transfer environment, learners will have greater success on that transfer task if they are made aware of the task prior to receiving the instruction.

More specifically, if a learner experiences a unit of instruction, followed by a transfer problem in which the instructional content is applied, that learner would be expected to experience greater difficulty solving the transfer problem than a learner who had been made aware of the problem prior to instruction. If this hypothesis were found to be true, it would support Gibson's theories of ecological psychology. That is, it would suggest that the learner's perceptions and attentions were directed by those aspects of the instruction that afforded the accomplishment of the transfer problem. It would also suggest that the transfer task should play an important role in the design and presentation of instructional materials. Therefore, the intention of this study is to explore whether or not learners experience superior performance on a transfer task if they are presented with the task prior to receiving instruction than learners who are not presented with the task prior to instruction.

Chapter 2: Methodology

Hypotheses

Research cited previously suggests that cueing or priming someone before presenting them with a stimulus will direct their attention to specific aspects of the stimulus, thereby altering their perception and memory of that stimulus (Bransford, Franks, McCarrell, & Nitsch, 1974; Bransford & Johnson, 1972; Bransford & Johnson, 1973; Craik and Watson, 1973; Hyde & Jenkins, 1969; Johnston & Jenkins, 1971; Nitsch, McCarrell, Franks, & Bransford in Bransford, Nitsch, & Franks, 1977; Roth & Shoben, 1984; Stein, 1978; Till & Jenkins, 1973; Walsh & Jenkins, 1973). Other theories suggest that when attention is focused in this way, it is guided by those aspects of the stimulus that afford the solution of a problem or need (Gibson, 1977).

The purpose of this study was to determine whether these findings could be reproduced using content of greater scale than simple words, sentences, paragraphs, or single images. Specifically, this study sought to determine whether cuing learners with a transfer problem prior to instruction would direct their attention to those aspects of the instruction that afford the resolution of the transfer problem. Thus, it was hypothesized that learners presented with a transfer problem prior to instruction would be better able to solve that problem after instruction than learners that received no prior cuing.

Similarly, since prior cueing was expected to limit the learners' attention to specific aspects of the instruction, it was hypothesized that they would not recall as much of the information presented during instruction. Thus, this study sought to validate the following hypotheses:

1. Learners that are exposed to a transfer problem prior to instruction (prior cueing) will have greater success solving that transfer problem after instruction than learners with no prior exposure (no prior cueing).
2. Learners that are not exposed to a transfer problem prior to instruction (no prior cueing) will recall more of the information presented during instruction than learners that are exposed to the transfer problem prior to instruction (prior cueing).

Research design and procedure

In order to study these hypotheses, it was necessary to compare the transfer and retention scores of two groups: one group that was cued to the transfer problem prior to instruction, and another that was not. However, such a simple design would not have allowed the results to be generalized to all subject domains. In order to generalize the results beyond a single topic of study, it was necessary to provide instruction and outcome measures in more than one subject. Because of this, two subject domains were used: statistics and biology.

In adhering to these constraints, a four group, post-test only randomized experimental design was employed (see Table 1). Two of those groups received statistics instruction, while the other two groups received biology instruction. Among the statistics groups, one received exposure to the transfer problem prior to instruction, while the other did not. Following instruction, both groups were required to take a retention test and solve a transfer problem in that order. The groups receiving biology instruction received the same basic treatment. One group received exposure to the transfer problem prior to instruction while the other did not, and both were required to take the same transfer problem and retention test following the instruction.

Table 1

Experimental Groups

	Prior cueing	No prior cueing
Statistics	1A	1B
Biology	2A	2B

Target population

A total of 115 undergraduate students attending Milligan College participated in the study. Milligan is a private Christian liberal arts college located in Northeast Tennessee. Milligan has a student body of more than 900, 60% of which come from outside of the state. The College offers more than 25 majors. Milligan is non-denominational, and "welcomes students from various religious backgrounds" (www.milligan.edu).

Participants for the study were selected by virtue of their enrollment in specific Milligan courses. Instructors at Milligan College were asked to volunteer class time for the administration of the experiment. The study sample is composed of students enrolled in classes whose instructors agreed to participate. All participating instructors allowed their students to take part in the study during a portion of their normally allotted class time. Participation in the experiment was not mandated, nor were any incentives to participate provided. Only one student declined to take part in the study.

In total, eight classes participated: two sections of Economics 201, one section of Computer Science 211, one section of Computer Science 275, one section of Computer Science 341, one section of Business Administration 315, one section of Business Administration 375, and one section of Geology (see Table 2).

Table 2

Number of Study Participants Enrolled in Each Class

Business Administration 315	17
Business Administration 375	10
Computer Science 211	8
Computer Science 275	15
Computer Science 341	10
Economics 201 (1)	17
Economics 201 (2)	18
Geology	20
Total	115

All academic years were represented within the sample as were a variety of GPAs. Of the 100 participants reporting GPA, the range went from 2.20 to 3.90 on a 4-point scale, with an average of 3.07.

Instrument development

The stimulus materials used in this study consisted of four self-paced instructional workbooks (see Appendix A through D). Each workbook included a consent form, explicit directions showing participants how to proceed through the instruction, a small unit of instruction covering a single concept, followed by a retention test, and then a transfer problem. The instruction and the transfer problem used in each workbook were adapted from existing college level textbooks (Hanke & Reitsch, 1994; Hildebrand & Ott, 1996; Meissner, 1988; Zuwaylif, 1974).

The self-paced workbooks differed along only two dimensions: subject matter and treatment. In terms of subject matter differences, two of the workbooks included instruction addressing a statistical concept, while the other two addressed a biological concept. In terms of the treatment differences, two of the workbooks let participants view the transfer problem prior to taking the instruction, while the other two did not.

The two statistics workbooks included instruction on a single statistical concept: confidence intervals. Confidence intervals represent a standard part of undergraduate statistics education, and were deemed sufficiently appropriate for individuals with little or no statistical background, and with only elementary mathematical skills (A. Kohler, personal communication, 1999; K. Singh, personal communication, 1999). The two statistics workbooks differed along a single dimension: treatment. One statistics workbook gave participants exposure to the transfer problem prior to instruction (see Appendix D), while the other did not (see Appendix C). Both workbooks shared the same instruction, and the same transfer and retention measures. The instruction on confidence intervals and the transfer problem were taken from standard undergraduate statistics textbooks (Hanke & Reitsch, 1994; Hildebrand & Ott, 1996; Zuwaylif, 1974). The retention measure included six multiple-choice questions each requiring participants to remember a single fact covered during instruction. The transfer measure required participants to use their new knowledge of confidence intervals to determine whether a hypothetical shoe company should open a new store in a particular location with particular attributes. The transfer measure had only one correct response. In other words, the transfer problem had a maximum value of 1 (indicating the answer was correct) and a minimum value of 0 (indicating that the answer was incorrect).

The two biology workbooks included instruction on a single biological concept: arboviruses. The biology workbooks differed along the same dimension as the statistics workbooks: treatment. One biology workbook gave participants exposure to the transfer problem prior to instruction (see Appendix B), while the other did not (see Appendix A). Both workbooks shared the same instruction, and the same transfer and retention measures. The instruction on arboviruses and the transfer problem were taken from a standard pre-med biology textbook (Meissner, 1988). The retention measure included six multiple-choice questions each requiring participants to remember a single fact covered during instruction. The transfer measure involved a single question requiring participants to diagnose the illness of a hypothetical patient based upon symptoms discussed during instruction. The transfer problem had a maximum value of 1 (indicating the answer was correct) and a minimum value of 0 (indicating that the answer was incorrect).

The treatment materials were piloted with a group of eight participants. Six of were graduate students in the instructional technology program at Virginia Tech, one was a graduate student in microbiology at Cornell, and another was an undergraduate general studies student at Virginia Tech. The pilot was conducted in four rounds, with each round including four participants. Some of the pilot participants were included in multiple rounds, although no pilot participant received the same treatment more than once.

During the first round, two participants were given the biology treatment materials with prior cueing and two were given the biology treatment without prior cueing. After each treatment was completed, the results were graded, and discussions were held with each participant to determine whether the materials were either too difficult, too simple, or in any way problematic. This was determined in part by the final scores of the participants, and in part by verbal feedback from the participants. As a result of this feedback, some additional content was added to the instruction included within each workbook. The adjusted books were then used in the second round with four different participants.

During the second round, two participants were given the adjusted biology treatment materials with prior cueing and two were given the adjusted biology treatment without prior cueing. After each treatment was completed, the results were graded, and discussions were held with each participant to determine whether the materials were either too difficult, too simple, or in any way problematic. This was determined in part by the final scores of the participants, and in part by verbal feedback from the participants. The results indicated that the biology treatment materials were neither too difficult nor too simple for the target audience.

The final two pilot rounds were similar to the first two, only they involved the statistics treatment materials. During the third round, two participants were given the statistics treatment materials with prior cueing and two were given the statistics treatment without prior cueing. After each treatment was completed, the results were graded, and discussions were held with each participant to determine whether the materials were either too difficult, too simple, or in any way problematic. This was determined in part by the final scores of the participants, and in part by verbal feedback from the participants. After minor adjustments were made both to the instruction and the transfer problem, the adjusted treatments were administered two four other participants in the fourth round. At this point, the materials were judged to be of adequate difficulty for the target audience.

<u>Data collection procedures</u>

After the study was approved (see Appendix E for the IRB approval letter), the treatments were administered to eight intact classes at Milligan College during regularly scheduled course hours. Each class received all four treatments via random distribution as described below. Because the eight courses met at different times and on different days, the data was collected over a period of three consecutive days. The procedures for data collection were as follows:

1. Study introduction.

After a brief introduction by the course instructor, the purpose and intent of the study were explained to participants. It was made clear that their participation was not mandatory and that they could remove themselves from the study at any time. In addition, participants were assured that once their signed consent forms (see Appendix F) were removed from the workbooks, their responses would remain irrevocably anonymous.

2. Random distribution of workbooks.

Participants were randomly given one of four possible workbooks and asked to leave them face down until instructed otherwise.

3. Section one: directions (5 minutes).

After all workbooks were distributed, participants were asked to sign their consent forms, and to begin reading the first section of their workbooks (which included directions for proceeding, and in some cases, prior exposure to the eventual transfer problem). Participants were asked not to proceed beyond the first section until directed to do so.

4. Section two: instruction (15-minutes).

All participants were told to proceed to the next section (which included a brief instructional module). Once again, participants were asked to stop at the end of the section.

5. Section three: outcome measures (15-minutes).

All participants were told to proceed to the final section, which included the two outcome measures.

6. Workbook collection.

All of the workbooks were collected and participants were dismissed from class.

These procedures were repeated for each of the eight classes participating in the study over the three-day period. After all participants had completed their workbooks, those without signed consent forms were discarded. The consent forms were then removed for all of the remaining workbooks. The outcome measures in these workbooks were graded and recorded in a statistical software package where they were aggregated and analyzed according to the procedures described in the next section.

Data analysis procedures

Before analyzing the outcome measures for mean differences, descriptives and frequencies were run to determine whether there were errors in data entry, and to identify items that had variances or means substantially different from other items. This was necessary to determine whether the dataset met all assumptions required to analyze possible differences in outcomes.

After descriptives and frequencies were run, two 2 x 2 ANOVAs were used to test whether there were any differences in mean scores between groups. One ANOVA analyzed mean differences between transfer scores (as illustrated in Table 4), and the other analyzed mean differences between retention scores (as illustrated in Table 5). Each ANOVA determined whether there were significant main effects for topic and treatment, and whether there was a significant interaction between topic and treatment. An alpha level of .05 was adopted for each ANOVA.

Table 4

ANOVA 1 - Transfer Scores

	Statistics	Biology
Prior cueing	Transfer scores	Transfer scores
No prior cueing	Transfer scores	Transfer scores

Table 5

ANOVA 2 - Retention Scores

	Statistics	Biology
Prior cueing	Retention scores	Retention scores
No prior cueing	Retention scores	Retention scores

Chapter 3: Results

Introduction

The research cited earlier suggests that students will perform better on a transfer problem if they are given the chance to see the transfer problem prior to instruction. It also suggests that students who do see the transfer problem prior to instruction will recall less information since their attention will be focused on those parts of instruction relevant to solving the transfer problem.

To test these hypotheses, an experimental design was used with two overall groups: one receiving prior exposure to a transfer problem and one not. In addition, in order to avoid the possibility that any results could be generalized only to the subject matter being taught, two different subject domains were used: statistics and biology.

Therefore, 115 undergraduate students were randomly assigned to one of four groups: (a) a statistics group receiving prior exposure to a transfer problem; (c) a statistics group without prior exposure to a transfer problem; (b) a biology group receiving prior exposure to a transfer problem; (d) a biology group without prior exposure to a transfer problem. Following instruction, each group received the transfer problem and recall test appropriate for the subject area covered during their instruction (statistics or biology).

To determine whether the groups performed differently on the two outcome tests, two 2X2 analyses of variance (ANOVA) were run, one for each outcome measure (transfer and retention). Each ANOVA indicates whether there were main effects between the treatments (prior exposure versus no prior exposure) and the topics (biology versus statistics). Each ANOVA also indicates whether there was an interaction between the treatments and the topics. The following sections describe and discuss the results of these analyses, starting with the descriptive statistics. More detailed information about the study procedures can be found in the Procedures section.

Originally, the data were to be analyzed using ANCOVAs in order to determine whether the results were related to the GPAs of the participants. However, because few participants reported GPA, and many more participants receiving biology instruction reported GPA, the assumptions required to run an ANCOVA were not met. Since all participants were randomly assigned to treatments, participants of varying intelligence and achievement had an equal chance of being assigned to any of the four groups. This provided a natural control for the influence of varying degrees of intelligence or achievement. As a result, ANOVAs were used instead.

Descriptives

The overall means, standard deviations, and sample sizes for each group are reported in Table 6. While the sample sizes appear evenly distributed from group to group, none of the biology students without prior exposure to the transfer problem answered the transfer problem correctly (see Table 7). Therefore, they have a mean of zero and a standard deviation of zero. As a result, the overall sample lacks homogeneity of variance, which means that the variance within each group was not equal. Homogeneity of variance is a condition required in order to run an ANOVA. While this is problematic, as Howell states, ANOVAs are robust against violations of homogeneity of variance as long as the sample sizes are relatively even (p. 321). Therefore, the decision was made to continue with the ANOVA analyses despite a lack of homogeneity of variance.

Table 6

Means, Standard Deviations, and Sample Sizes

	No prior cueing		Prior cueing	
	Retention test	Transfer test	Retention test	Transfer test
Biology	N = *32*	N = 32	N = 27	N = 27
	M = .604	*M = 000*	*M = .594*	*M = .148*
	SD = .206	*SD = 000*	*SD = .156*	*SD = .362*
Statistics	N = 27	N = 27	N = 29	N = 29
	M = .603	*M = .556*	*M = .569*	*M = .414*
	SD = .306	*SD = .506*	*SD = .309*	*SD = .501*

Table 7

Correct Transfer Responses and Group Sample Sizes

	No prior cueing		Prior cueing	
Biology	0	N = 32	4	N = 27
Statistics	15	N = 27	12	N = 29

Finally, current GPA data was solicited from each participant in order to control for any possible influence that varying intelligence might have on the responses. However, as illustrated in Table 8, a sizable number of respondents did not report their current GPA. More critically, far more respondents receiving biology instruction reported GPA than respondents receiving statistics instruction. Because the sample already lacked homogeneity of variance, and ANCOVA analyses are not robust against both heterogeneity of variance and inequality of sample sizes (Howell, 1997), it was decided that GPA would not be used as a covariate, and that ANOVAs would be run rather than ANCOVAs as originally planned. In addition, since all participants were randomly assigned to treatments, participants of varying intelligence had an equal chance of being assigned to any of the groups. This provided a natural control for the influence of varying degrees of intelligence.

Table 8

GPA Scores Reported for Each Treatment Group

	No prior cueing		Prior cueing	
	All data	Data with GPA	All data	Data with GPA
Biology	32	31	27	27
Statistics	27	21	29	21

Analysis of mean differences

Introduction

A total of two 2 x 2 ANOVAs were used to test whether there were significant differences in means scores between groups (see Appendix G for ANOVA tables). One ANOVA analyzed possible differences between transfer score means, and the other analyzed possible differences between retention score means. Each ANOVA determined whether there were significant main effects for topic and treatment, and whether there was a significant interaction between topic and treatment.

Transfer differences

Before discussing the transfer ANOVA analyses, it should be mentioned that Levene's test for equality of variance was significant ($p < .001$) (see Table 9) indicating that the variance of the dependent variable is not equal across groups. This violates one of the assumptions required to run an ANOVA. However, as Howell states, ANOVAs are robust against heterogeneity of variance provided sample sizes are relatively even from group to group (Howell, 1997). The current study meets this criterion.

Table 9

Levene's Test of Equality of Variance

F	df1	df2	Sig
92.536	3	111	.000

The results of the ANOVA for transfer scores are reported in Appendix G. Table 10 displays the means and standard deviations of the transfer scores for biology prior cueing and no prior cueing groups, and for the statistics prior cueing and no prior cueing groups. The transfer scores had a maximum value of 1 (indicating 100% of the answers were correct) and a minimum value of 0 (indicating that 0% of the answers were correct). The summary ANOVA table for transfer scores is show in Appendix G.

The results of the ANOVA for transfer scores indicate that the main effect for topic is significant, $F(1, 115) = 31.295$, $p < .001$ (see Appendix G for ANOVA tables). In other words, there was a significant difference between the number of participants receiving the biology treatment that correctly solved the transfer problem and the number of participants receiving the statistics treatment that correctly solved the transfer problem. A significantly higher number of the participants solving the statistics problem answered the problem correctly ($M = .482$, $SD = .504$) than participants solving the biology problem (M = .068, SD = .254). As suggested earlier, this can probably be attributed to the confusion over the degree of specificity required for the correct response.

The results of the ANOVA for transfer scores also indicate that the main effect for treatment is not significant, $F, (1, 115) = .002$, $p = .965$ (see Appendix G for ANOVA tables). There was no significant difference between the scores of participants receiving prior exposure to the transfer problem ($M = .286$, $SD = .456$) and the participants that did not receive prior exposure to the transfer problem ($M = .254$, $SD = .439$). This contradicts the hypothesis that participants receiving exposure to a transfer problem prior to instruction will be more capable of solving that same transfer problem after instruction.

Finally, the transfer ANOVA suggests that the interaction between topic and treatment was not significant, $F(1, 115) = 3.900$, $p=.051$. The transfer scores for participants within the two treatment groups did not differ significantly across topics.

Table 10

Means and Standard Deviations of Transfer Scores for Treatment and Topic

	No prior cueing	Prior cueing	Total
Biology	*M = 000*	*M = .148*	*M = .068*
	SD = 000	*SD = .362*	*SD = .254*
Statistics	*M = .556*	*M = .413*	*M = .482*
	SD = .506	*SD = .501*	*SD = .504*
Total	*M = .254*	*M = .286*	
	SD = .439	*SD = .456*	

<u>Retention differences</u>

As with the transfer ANOVA, the retention ANOVA failed the Levene's test for equality of variance (*p* < .001). The significant of the Levene's test (see Table 11) means that the variance of the dependent variable is not equal across groups. This violates one of the assumptions required to run an ANOVA. However, to reiterate Howell's opinion, ANOVAs are robust against heterogeneity of variance as long as the sample sizes are relatively even from group to group (Howell, 1997). The samples in this study meet this criterion.

Table 11

Levene's Test of Equality of Variance

F	df1	df2	Sig
7.897	3	111	.000

The retention scores (see Table 12) had a maximum value of 1 (indicating 100% of the answers were correct) and a minimum value of 0 (indicating that 0% of the answers were correct). The results of ANOVA for retention indicates that the main effect for topic is not significant, *F* (1, 115) = .073, *p = .788.* Thus, the overall retention scores of the participants receiving the biology treatment (M=.599, SD=.183) did not differ significantly from the overall retention scores of the participants receiving the statistics treatment (M=.585, SD=.305).

The retention ANOVA also shows that the main effect for treatment is not significant, *F, (1, 115)* = .225, *p* = .636. In other words, the retention performance of the participants receiving prior exposure to the transfer problem (*M = .581, SD = .245*) was roughly the same as the retention performance of the participants without prior exposure (*M = .603, SD = .254*). Once again, this directly contradicts the hypothesis set forth in previous sections of this study that students receiving prior exposure to a transfer problem will have a more difficult time remembering information than students without prior exposure. The rationale behind this hypothesis, that prior exposure causes students to direct their attention only to those parts of instruction helpful in solving the transfer problem, was not supported by this data.

Finally, the retention ANOVA indicates that the interaction between topic and treatment was not significant, *F* (1, 115) = .065, *p=.799*. The retention scores for participants within the two treatment groups did not differ significantly across topics.

Table 12

Means and Standard Deviations of Retention Scores for Treatment and Topic

	No prior cueing	Prior cueing	Total
Biology	*M = .604* *SD = .206*	*M = .594* *SD = .156*	*M = .599* *SD=.183*
Statistics	*M = .603* *SD = .306*	*M = .569* *SD = .309*	*M=.585* *SD=.305*
Total	*M=.603* *SD=.254*	*M=.581* *SD=.245*	

Summary of findings

Earlier studies indicated that showing people cues prior to showing them a stimulus would direct their attention to specific parts of that stimulus thereby affecting the way they perceived and remembered it (Bransford, Franks, McCarrell, & Nitsch, 1974; Bransford & Johnson, 1972; Bransford & Johnson, 1973; Craik and Watson, 1973; Hyde & Jenkins, 1969; Johnston & Jenkins, 1971; Nitsch, McCarrell, Franks, and Bransford in Bransford, Nitsch, & Franks, 1977; Roth & Shoben, 1984; Stein, 1978; Till & Jenkins, 1973; Walsh & Jenkins, 1973). This same research also suggested that this direction of attention is guided by needs or goals already possessed by the individual, or invoked by the cue. Therefore, it was hypothesized that presenting learners with a transfer problem prior to instruction would better enable them to solve that problem after instruction because it would focus their attention on those parts of instruction relevant to the resolution of the problem. However, the results of this study do not support this conclusion (see Appendix G for ANOVA tables). Specifically, the mean transfer scores of the participants that were cued to the transfer problem prior to instruction were not significantly different than the mean transfer scores of participants without prior cueing. The same results were found when comparing the means of the participants receiving the biology treatment that were cued versus those that were not, as well as the participants receiving the statistics treatment that were cued versus those that were not.

Since the prior cueing was expected to focus participants' attention only on certain parts of the instruction, it was also expected that they would have more difficulty recalling information presented during instruction. In other words, it was expected that participants who were shown the transfer problem prior to instruction would score lower on a retention test than participants that were not. Once again, the results of this study do not support this hypothesis (see Appendix G for ANOVA tables). The mean retention scores of the participants cued to the problem were not significantly different from the retention scores of the participants that were not cued to the problem. The data show similar findings when comparing participants receiving the statistics treatment that were cued versus those that were not, and biology students that were cued versus those that were not.

Lessons learned

There were a number of issues with the outcome measures that may have conspired to confound the results of the study as well. For example, only one transfer problem was used for each instructional module thereby increasing the possibility that the correct answer could have been given purely as a matter of chance. For the biology transfer problem, the overall low scores suggest that this may not have been a problem, perhaps because there were an infinite number of response options (the low scores does suggest another issue that will be discussed next). But the statistics problem had only two response options, thereby increasing even further the possibility that the right answers were achieved as a result of chance. This may have been a problem given that the statistics transfer problem scores hovered around the 50% mark.

Another problem with the statistics transfer problem could have impacted the study results. The statistics instruction provided participants with a mathematical procedure that they could use to solve the transfer problem. However, using a far more a far more elementary mathematical procedure that was not covered during instruction would, using incorrect methods, yield the correct answer. Solving the problem using either procedure, while yielding different numerical answer, would yield the same situational response. Thus, it was possible for participants to use the wrong formula, but still get the answer correct. While this problem did not appear in the pilot study, efforts were made to anticipate the problem by asking participants to show their work. Had use of the correct formula been a requisite for a correct response, the results may have been different. However, since that was not proposed prior to conducting the study, the responses were not graded in such a fashion.

Finally, as mentioned earlier, the low scores on the biology transfer problem suggest that it was too difficult for learners to solve regardless of whether they received prior cueing. However, another explanation is more likely. The transfer problem required participants to diagnose the illness of a hypothetical patient based on certain known symptoms. The hypothetical patient was suffering from a particular illness. This illness belongs to a broader category of illnesses. Thus, if the participant selected the broader category of illness, while technically correct, their response was considered incorrect. Had the broader illness been considered a correct response, the result of the study may have been altered. Once again, the pilot study failed to uncover this problem.

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Appendix A – Biology No Prior Cueing

1.1 INTRODUCTION

Context-driven instructional design: the effect of prior exposure on transfer task
Nathan Pienkowski (540) 961-1487
Dr. Mike Moore (academic advisor)

Purpose of the study	This experiment looks at whether certain instructional approaches either hinder or help students to use their skills to solve "real-world" problems. The purpose of this study is to determine whether students are better at solving "real-world" problems when they are told about the problem before receiving instruction.
Procedures	If you choose to participate, you will be given an instructional booklet, asked to read through the contents (following instructions where applicable), and then given some questions. There will be between 5 and 10 multiple-choice questions along with a word problem. The time required to complete the booklet is not expected to exceed 30 minutes. You may refuse to answer any question you do not feel comfortable answering.
Risks	Participating in this study should not present you with any risk. Your professors will not have access to the materials that you complete, nor will any other individuals aside from the researcher. You may refuse to answer any questions that make you uncomfortable and you may choose not to participate in the experiment at any time.
Benefits	There are no direct benefits to you, but your participation in this research might help us better understand how to develop more effective instruction.
Extent of Anonymity and Confidentiality	When the questions are graded and recorded, your name will not be recorded with your scores. Once the data has been aggregated and analyzed, it will be destroyed or erased along with the surveys on which your answers were written. All reports or articles written using this data will discuss only the scores that have been totaled. No individual scores will be mentioned, nor will the names of any individuals participating in the study. Despite our every effort to preserve it, however, it is possible that anonymity may be compromised.
Freedom to Withdraw	You are free to withdraw from participation in this study at any time. Just inform the researcher during the experiment.

By signing below, you indicate that you have read and understood the informed consent and conditions of this project, that you have had all of your questions answered, and that you give your voluntary consent for participation in this project.

If you participate, you may withdraw at any time without penalty.

____
Signature Date

PLEASE TURN THE PAGE TO FINISH READING THE INTRODUCTION

1.2 DIRECTIONS

This booklet has been divided into three primary sections: an introduction, an essay, and some follow-up questions. When you are instructed to do so, please turn this page and begin reading the text in section two until you reach the end. While performing the activities in this booklet, do not take notes, and do not proceed to the next sections until you are instructed to do so. Do not look back at previous sections under any conditions. When you have finished the final section, please return this booklet to the instructor.

WHEN YOU ARE INSTRUCTED, PLEASE PROCEED TO THE NEXT SECTION

2.1 AN INTRODUCTION TO ARBOVIRUSES

Definition of arboviruses

The insect-borne viruses (arboviruses) are a varied group of agents that cause a wide range of illnesses, from mild influenza-like infections to encephalitis or hemorrhagic fevers. These diseases are more prevalent in the tropics than in the temperate regions of the world because they follow the distribution of mosquitoes and flies involved in their transmission. The principal diseases in this group are dengue, yellow fever, and a large number of encephalitides.

About arboviruses

More than 100 different arboviruses are known to infect humans. Many cause encephalitis, while others produce yellow fever, hemorrhagic fever, or denque fever, diseases characterized by internal hemorrhages, severe joint and muscle pain, and skin rashes. Arboviruses are often named after the disease they cause or the place where they have been found (e.g. LaCrosse, Semlike Forest, Rift Valley fever, Colorado tick fever, Venezuelan equine encephalitis, West Nile fever, etc.). They are diseases of wild and domesticated animals; humans are only accidentally infected.

Carriers include mosquitoes, ticks, and flies. There are viruses that are biologically similar to arboviruses and often cause similar diseases but are not transmitted by an insect. For example, the virus that causes German measles shares similarities with equine encephalitis virus but is transmitted from person to person.

The natural life cycle of the viruses that cause equine encephalitis virus and other encephalitides is from bird to bird, via the bite of mosquitoes. It is not known if the virus survives the winter in cold climates or if it is reintroduced each year by migrating birds. As its name implies, horses acquire EEE, but they seldom play a role in the development of human infection. The virus is present in the horses' blood for so short a time that it is unlikely the horse would be bitten by a mosquito during this time. Like humans, horses do not participate in the normal life cycle of the virus. When the horses become infected, they alert the human population that the virus has escaped its normal biological boundaries and is a threat to humans.

The following table lists a variety of arboviruses and their major characteristics:

Genus and sample	Main disease and manifestations	Primary carrier	Major geographic distribution
Togaviridae Family			
Alphavirus			
Eastern equine encephalitis	Encephalitis	Mosquito	Caribbean, Florida
Western equine encephalitis	Encephalitis	Mosquito	Western U.S., Canada, Mexico, Brazil
Venezuelan equine encephalitis	Encephalitis	Mosquito	Central and South America, Texas, Florida

Many others	Fevers, encephalitis	Mosquito	Africa, Asia, Central and South America
Flaviviridae Family			
Flavivirus			
St. Louis encephalitis	Encephalitis	Mosquito	Eastern U.S.
Japanese B. encephalitis	Encephalitis	Mosquito	Japan, East Asia
Dengue	Fevers, hemorrhages	Mosquito	All tropics
Yellow fever	Homorrhagic fever	Mosquito	Africa, Central and South America

END OF SECTION TWO – DO NOT PROCEED UNTIL INSTRUCTED TO DO SO

3.1 QUIZ: MULTIPLE CHOICE

Directions

This section contains several questions. Please answer each question to the best of your ability without referring to the previous sections of this booklet or to any other outside resource. Proceed to the next section as soon as you are finished.

Questions

1. How many arboviruses are known to infect humans?

   A. 1 – 50
   B. 50 – 100
   C. 100 – 150
   D. 150 – 200

2. The following diseases are all caused by arboviruses except:

   A. Influenza
   B. Dengue
   C. yellow fever
   D. encephalitis

3. Arboviruses are transmitted by all of the following agents except:

   A. ticks
   B. birds
   C. humans
   D. mosquitoes

4. Which of the following plays a major role in the arbovirus lifecycle:

   A. Horses
   B. Humans
   C. Birds
   D. Fleas

5. German measles are transmitted:

   A. From bird to bird
   B. From horse to human
   C. From mosquito to human
   D. From human to human

6. Which of the following diseases is not common to the United States:

   A. Eastern encephalitis
   B. Western encephalitis
   C. St. Louis encephalitis
   D. Dengue

3.2 QUIZ: WORD PROBLEM

Directions	This section contains a word problem. Please do your best to solve this word problem without using any resources other than this booklet, a pen or pencil, and a calculator. Write your answers and your work on this booklet. Please do not return to sections one or two at any point. You may take as much time as necessary. When you are finished, please return this booklet with your answers to the instructor.
Problem	In the summer before he was to enter medical school, Mr. R. spent the month of July sunning himself on the beaches of Maryland. The weather was particularly hot and wet. His favorite spot was a pond in a wooded area where he could watch horses from a nearby farm. One afternoon, he suddenly became lethargic and fatigued and went home to bed. That evening he was awakened for supper by his father but felt confused and was not hungry. By 10 PM, he had a fever of 40.7° C and refused to answer questions. Four hours later, his father had difficulty rousing him and brought him to the emergency room of a local hospital. Several hours after admission, Mr. R. was unable to respond to simple commands. His condition gradually deteriorated, and he experienced periods of increasing stupor and paralysis of the limbs, common indications of encephalitis. He lapsed into coma 2 weeks after admission and died 2 weeks after that.
Questions	Suppose that you are an investigator for the Center for Disease Control. In your final report, what will you say is the precise cause of Mr. R's death?

Please explain why you came to this conclusion.

What is your current grade point average (if you are not sure, please estimate)?

WHEN YOU HAVE ANSWERED ALL OF THE QUESTIONS, RETURN THIS BOOKLET TO THE INSTRUCTOR

Appendix B – Biology Prior Cueing

1.1 INTRODUCTION

Context-driven instructional design: the effect of prior exposure on transfer task
Nathan Pienkowski (540) 961-1487
Dr. Mike Moore (academic advisor)

Purpose of the study	This experiment looks at whether certain instructional approaches either hinder or help students to use their skills to solve “real-world” problems. The purpose of this study is to determine whether students are better at solving “real-world” problems when they are told about the problem before receiving instruction.
Procedures	If you choose to participate, you will be given an instructional booklet, asked to read through the contents (following instructions where applicable), and then given some questions. There will be between 5 and 10 multiple-choice questions along with a word problem. The time required to complete the booklet is not expected to exceed 30 minutes. You may refuse to answer any question you do not feel comfortable answering.
Risks	Participating in this study should not present you with any risk. Your professors will not have access to the materials that you complete, nor will any other individuals aside from the researcher. You may refuse to answer any questions that make you uncomfortable and you may choose not to participate in the experiment at any time.
Benefits	There are no direct benefits to you, but your participation in this research might help us better understand how to develop more effective instruction.
Extent of Anonymity and Confidentiality	When the questions are graded and recorded, your name will not be recorded with your scores. Once the data has been aggregated and analyzed, it will be destroyed or erased along with the surveys on which your answers were written. All reports or articles written using this data will discuss only the scores that have been totaled. No individual scores will be mentioned, nor will the names of any individuals participating in the study. Despite our every effort to preserve it, however, it is possible that anonymity may be compromised.
Freedom to Withdraw	You are free to withdraw from participation in this study at any time. Just inform the researcher during the experiment.

By signing below, you indicate that you have read and understood the informed consent and conditions of this project, that you have had all of your questions answered, and that you give your voluntary consent for participation in this project.

If you participate, you may withdraw at any time without penalty.

____

Signature Date

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1.2 DIRECTIONS

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PLEASE TURN THE PAGE TO FINISH READING THE DIRECTIONS

1.3 WORD PROBLEM

Directions	Please read through this word problem but do not make an attempt to answer the question. The next section contains a brief essay on the topic of "arboviruses". After reading the essay on arboviruses you will be asked to solve this problem. Please do not take notes.
Problem	In the summer before he was to enter medical school, Mr. R. spent the month of July sunning himself on the beaches of Maryland. The weather was particularly hot and wet. His favorite spot was a pond in a wooded area where he could watch horses from a nearby farm. One afternoon, he suddenly became lethargic and fatigued and went home to bed. That evening he was awakened for supper by his father but felt confused and was not hungry. By 10 PM, he had a fever of 40.7° C and refused to answer questions. Four hours later, his father had difficulty rousing him and brought him to the emergency room of a local hospital. Several hours after admission, Mr. R. was unable to respond to simple commands. His condition gradually deteriorated, and he experienced periods of increasing stupor and paralysis of the limbs, common indications of encephalitis. He lapsed into coma 2 weeks after admission and died 2 weeks after that.

END OF SECTION ONE – DO NOT PROCEED UNTIL INSTRUCTED TO DO SO

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Definition of arboviruses

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Carriers include mosquitoes, ticks, and flies. There are viruses that are biologically similar to arboviruses and often cause similar diseases but are not transmitted by an insect. For example, the virus that causes German measles shares similarities with equine encephalitis virus but is transmitted from person to person.

The natural life cycle of the viruses that cause equine encephalitis virus and other encephalitides is from bird to bird, via the bite of mosquitoes. It is not known if the virus survives the winter in cold climates or if it is reintroduced each year by migrating birds. As its name implies, horses acquire EEE, but they seldom play a role in the development of human infection. The virus is present in the horses' blood for so short a time that it is unlikely the horse would be bitten by a mosquito during this time. Like humans, horses do not participate in the normal life cycle of the virus. When the horses become infected, they alert the human population that the virus has escaped its normal biological boundaries and is a threat to humans.

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Alphavirus			
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Venezuelan equine encephalitis	Encephalitis	Mosquito	Central and South America, Texas, Florida

Many others	Fevers, encephalitis	Mosquito	Africa, Asia, Central and South America
Flaviviridae Family			
Flavivirus			
St. Louis encephalitis	Encephalitis	Mosquito	Eastern U.S.
Japanese B. encephalitis	Encephalitis	Mosquito	Japan, East Asia
Dengue	Fevers, hemorrhages	Mosquito	All tropics
Yellow fever	Homorrhagic fever	Mosquito	Africa, Central and South America

END OF SECTION TWO – DO NOT PROCEED UNTIL INSTRUCTED TO DO SO

3.1 QUIZ: MULTIPLE CHOICE

Directions

This section contains several questions. Please answer each question to the best of your ability without referring to the previous sections of this booklet or to any other outside resource. Proceed to the next section as soon as you are finished.

Questions

1. How many arboviruses are known to infect humans?

   A. 1 – 50
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   C. 100 – 150
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   B. birds
   C. humans
   D. mosquitoes

4. Which of the following plays a major role in the arbovirus lifecycle:

   A. Horses
   B. Humans
   C. Birds
   D. Fleas

5. German measles are transmitted:

   A. From bird to bird
   B. From horse to human
   C. From mosquito to human
   D. From human to human

6. Which of the following diseases is not common to the United States:

   A. Eastern encephalitis
   B. Western encephalitis
   C. St. Louis encephalitis
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3.2 QUIZ: WORD PROBLEM

Directions

This section contains a word problem. Please do your best to solve this word problem without using any resources other than this booklet, a pen or pencil, and a calculator. Write your answers and your work on this booklet. Please do not return to sections one or two at any point. You may take as much time as necessary. When you are finished, please return this booklet with your answers to the instructor.

Problem

In the summer before he was to enter medical school, Mr. R. spent the month of July sunning himself on the beaches of Maryland. The weather was particularly hot and wet. His favorite spot was a pond in a wooded area where he could watch horses from a nearby farm. One afternoon, he suddenly became lethargic and fatigued and went home to bed. That evening he was awakened for supper by his father but felt confused and was not hungry. By 10 PM, he had a fever of 40.7° C and refused to answer questions. Four hours later, his father had difficulty rousing him and brought him to the emergency room of a local hospital. Several hours after admission, Mr. R. was unable to respond to simple commands. His condition gradually deteriorated, and he experienced periods of increasing stupor and paralysis of the limbs, common indications of encephalitis. He lapsed into coma 2 weeks after admission and died 2 weeks after that.

Questions

Suppose that you are an investigator for the Center for Disease Control. In your final report, what will you say is the precise cause of Mr. R's death?

Please explain why you came to this conclusion.

What is your current grade point average (if you do not know, please estimate)?

WHEN YOU HAVE ANSWERED ALL OF THE QUESTIONS, RETURN THIS BOOKLET TO THE INSTRUCTOR

Appendix C – Statistics No Prior Cueing

1.1 INTRODUCTION

Context-driven instructional design: the effect of prior exposure on transfer task
Nathan Pienkowski (540) 961-1487
Dr. Mike Moore (academic advisor)

Purpose of the study	This experiment looks at whether certain instructional approaches either hinder or help students to use their skills to solve "real-world" problems. The purpose of this study is to determine whether students are better at solving "real-world" problems when they are told about the problem before receiving instruction.
Procedures	If you choose to participate, you will be given an instructional booklet, asked to read through the contents (following instructions where applicable), and then given some questions. There will be between 5 and 10 multiple-choice questions along with a word problem. The time required to complete the booklet is not expected to exceed 30 minutes. You may refuse to answer any question you do not feel comfortable answering.
Risks	Participating in this study should not present you with any risk. Your professors will not have access to the materials that you complete, nor will any other individuals aside from the researcher. You may refuse to answer any questions that make you uncomfortable and you may choose not to participate in the experiment at any time.
Benefits	There are no direct benefits to you, but your participation in this research might help us better understand how to develop more effective instruction.
Extent of Anonymity and Confidentiality	When the questions are graded and recorded, your name will not be recorded with your scores. Once the data has been aggregated and analyzed, it will be destroyed or erased along with the surveys on which your answers were written. All reports or articles written using this data will discuss only the scores that have been totaled. No individual scores will be mentioned, nor will the names of any individuals participating in the study. Despite our every effort to preserve it, however, it is possible that anonymity may be compromised.
Freedom to Withdraw	You are free to withdraw from participation in this study at any time. Just inform the researcher during the experiment.

By signing below, you indicate that you have read and understood the informed consent and conditions of this project, that you have had all of your questions answered, and that you give your voluntary consent for participation in this project.

If you participate, you may withdraw at any time without penalty.

____
Signature Date

PLEASE TURN THE PAGE TO FINISH READING THE INTRODUCTION

1.2 INSTRUCTIONS

This booklet has been divided into three primary sections: an introduction, an essay, and some follow-up questions. When you are instructed to do so, please turn this page and begin reading the text in section two until you reach the end. While performing the activities in this booklet, do not take notes, and do not proceed to the next sections until you are instructed to do so. Do not look back at previous sections under any conditions. When you have finished the final section, please return this booklet to the instructor.

WHEN YOU ARE INSTRUCTED, PLEASE PROCEED TO THE NEXT SECTION

2.1 AN INTRODUCTION TO CONFIDENCE INTERVALS

Definition

Confidence intervals are used to estimate the probability of a score falling between a specific range of numbers. For example, the statement "it is 95% likely that Joe's test score will fall between 75 and 85" is an expression of a confidence interval. More specifically, it is a .95 confidence interval estimate. A confidence interval is a range of values that has a specified probability of containing the parameter being estimated. The 95% and 99% confidence intervals which have .95 and .99 probabilities of containing the parameter respectively are most commonly used. Thus, in the previous example, the interval between 75 and 85 has a .95 probability of containing Joe's test score.

Computing a confidence formula

To compute a .95 confidence interval, use the following formula:

$$\overline{X} \pm 1.96 \left(s/\sqrt{N}\right)$$

Where:

$\overline{X}$ = the average score of your sample
s = the standard deviation of your sample
N = the number of subjects or scores in your sample

Using words to describe this formula, to compute a .95 confidence interval, you divide the standard deviation by the square root of the total number of scores recorded. You then multiply that by 1.96. Then, simply add and subtract this result from the average score to get your confidence interval.

For example, if you want to find the .95 confidence interval for IQ scores of 100 college students with an average of 112 and a standard deviation of 10, you would use the following formula:

$$\overline{X} \pm 1.96 \left(s/\sqrt{N}\right)$$
$$112 \pm 1.96 \left(10/\sqrt{100}\right) =$$
$$112 \pm 1.96 \left(10/10\right) =$$
$$112 \pm 1.96 \left(1\right) =$$
$$112 - 1.96 \left(1\right) = 110.04$$
$$112 + 1.96 \left(1\right) = 113.96$$

What this means is that if we selected any one of these students at random and gave him or her an IQ test, there is a 95% chance that their score will fall between 110.04 and 113.96.

Confidence interval limitations

In the example stated previously, the confidence interval that we computed is only applicable to the 100 college students that we sampled. Thus, we can say that there is a 95% chance that a n IQ score selected randomly from those 100 college students will fall between 110.04 and 113.96. But to say the same thing about college students in general based only on this data would be inaccurate. If the information about your sample is all that you have to work with, then for practical reasons, it will be the basis for your decisions. However, if one truly wishes to generalize to a larger population, then he or she will need to replace the standard deviation of the sample with either the standard deviation of the larger population, or an estimate of the standard deviation of the larger population.

END OF SECTION TWO – DO NOT PROCEED UNTIL INSTRUCTED TO DO SO

3.1 QUIZ: MULTIPLE CHOICE

Directions

This section contains several questions. Please answer each question to the best of your ability without referring to the previous sections of this booklet or to any other outside resource. Proceed to the next section as soon as you are finished.

Questions

1. A confidence interval is:

   A. An estimation of the confidence that one set of numbers is significantly different than another set of numbers.
   B. An estimation of the amount of variance expected when scores are tabulated.
   C. An estimation of the probability that a value will fall within a specific range of numbers.
   D. The total range of values in a particular set of data.

2. If you were computing a .95 confidence interval, what would be the value of L in the following equation:

   $$134 \pm L\left(24/\sqrt{38}\right)$$

   A. 0.99
   B. 1.99
   C. 0.96
   D. 1.96

3. If you had a sample size of 56, a mean score of 121, and a standard deviation of 49, what would be the value of $\sqrt{N}$?

   A. 11
   B. 8
   C. 7
   D. 9

4. In the formula listed below, what is the average score of your sample?

   $$134 \pm L\left(24/\sqrt{38}\right)$$

   A. 134
   B. L
   C. 24
   D. 38

5. In the formula listed below, what is the standard deviation of your sample?

   $$134 \pm L\left(24/\sqrt{38}\right)$$

   A. 134
   B. L
   C. 24
   D. 38

6. In the formula listed below, what is the number of subjects in your sample?

$$134 \pm L\left(24/\sqrt{38}\right)$$

A. 134
B. L
C. 24
D. 38

3.2 WORD PROBLEM

Directions

This section contains a word problem. Please do your best to solve this word problem without using any resources other than this booklet, a pen or pencil, and a calculator. Write your answers and your work on this booklet. Please do not return to sections one or two at any point. You may take as much time as necessary. When you are finished, please return this booklet with your answers to the instructor.

Problem

You have just been promoted to the position of regional executive at the ABC Shoe Company. The ABC Shoe Company operates a chain of retail stores around the country. Since the ABC Shoe Company judges its executives by the amount of sales generated within their respective regions, your primary goal is to improve your region's sales. You decide that the best strategy toward this goal is to open new stores. But building a new store is expensive. From your research, you know that you should only build new stores in areas where you can be 95% sure that total expenditures on shoes in the area is at least $1 million dollars. Springdale is the first community you consider. They have a population of 20,000 families. You select a random sample of 49 families and administer a survey. It turns out that there is an average expenditure of $60 per family with a standard deviation of $21. Based on this sample information, should the ABC Company establish a branch in Springdale? Please explain how you came to your conclusion.

Questions

Based on this sample information, should the ABC Company establish a branch in Springdale?

Please explain how you came to your conclusion (please show your work if applicable).

What formula did you use?

What is your current grade point average?

WHEN YOU HAVE ANSWERED ALL OF THE QUESTIONS, RETURN THIS BOOKLET TO THE INSTRUCTOR

Appendix D – Statistics Prior Cueing

1.1 INTRODUCTION

Context-driven instructional design: the effect of prior exposure on transfer task
Nathan Pienkowski (540) 961-1487
Dr. Mike Moore (academic advisor)

Purpose of the study	This experiment looks at whether certain instructional approaches either hinder or help students to use their skills to solve "real-world" problems. The purpose of this study is to determine whether students are better at solving "real-world" problems when they are told about the problem before receiving instruction.
Procedures	If you choose to participate, you will be given an instructional booklet, asked to read through the contents (following instructions where applicable), and then given some questions. There will be between 5 and 10 multiple-choice questions along with a word problem. The time required to complete the booklet is not expected to exceed 30 minutes. You may refuse to answer any question you do not feel comfortable answering.
Risks	Participating in this study should not present you with any risk. Your professors will not have access to the materials that you complete, nor will any other individuals aside from the researcher. You may refuse to answer any questions that make you uncomfortable and you may choose not to participate in the experiment at any time.
Benefits	There are no direct benefits to you, but your participation in this research might help us better understand how to develop more effective instruction.
Extent of Anonymity and Confidentiality	When the questions are graded and recorded, your name will not be recorded with your scores. Once the data has been aggregated and analyzed, it will be destroyed or erased along with the surveys on which your answers were written. All reports or articles written using this data will discuss only the scores that have been totaled. No individual scores will be mentioned, nor will the names of any individuals participating in the study. Despite our every effort to preserve it, however, it is possible that anonymity may be compromised.
Freedom to Withdraw	You are free to withdraw from participation in this study at any time. Just inform the researcher during the experiment.

By signing below, you indicate that you have read and understood the informed consent and conditions of this project, that you have had all of your questions answered, and that you give your voluntary consent for participation in this project.

If you participate, you may withdraw at any time without penalty.

____
Signature Date

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1.2 DIRECTIONS

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TURN THE PAGE TO FINISH READING THE DIRECTIONS

1.3 WORD PROBLEM

Directions	Please read through this word problem but do not make an attempt to answer the question. The next section contains a brief essay on the topic of "confidence intervals". After reading the essay on confidence intervals you will be asked to solve this problem. Please do not take notes.
Problem	You have just been promoted to the position of regional executive at the ABC Shoe Company. The ABC Shoe Company operates a chain of retail stores around the country. Since the ABC Shoe Company judges its executives by the amount of sales generated within their respective regions, your primary goal is to improve your region's sales. You decide that the best strategy toward this goal is to open new stores. But building a new store is expensive. From your research, you know that you should only build new stores in areas where you can be 95% sure that total expenditures on shoes in the area is at least $1 million dollars. Springdale is the first community you consider. They have a population of 20,000 families. You select a random sample of 49 families and administer a survey. It turns out that there is an average expenditure of $60 per family with a standard deviation of $21. Based on this sample information, should the ABC Company establish a branch in Springdale? Please explain how you came to your conclusion. Based on this sample information, should the ABC Company establish a branch in Springdale? Please explain how you came to your conclusion (please show your work if applicable).

END OF SECTION ONE – DO NOT PROCEED UNTIL INSTRUCTED TO DO SO

2.1 AN INTRODUCTION TO CONFIDENCE INTERVALS

Definition

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END OF SECTION TWO – DO NOT PROCEED UNTIL INSTRUCTED TO DO SO

3.1 QUIZ: MULTIPLE CHOICE

Directions

This section contains several questions. Please answer each question to the best of your ability without referring to the previous sections of this booklet or to any other outside resource. Proceed to the next section as soon as you are finished.

Questions

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   A. An estimation of the confidence that one set of numbers is significantly different than another set of numbers.
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   $$134 \pm L\left(24/\sqrt{38}\right)$$

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   B. 8
   C. 7
   D. 9

4. In the formula listed below, what is the average score of your sample?

   $$134 \pm L\left(24/\sqrt{38}\right)$$

   A. 134
   B. L
   C. 24
   D. 38

5. In the formula listed below, what is the standard deviation of your sample?

   $$134 \pm L\left(24/\sqrt{38}\right)$$

   A. 134
   B. L
   C. 24
   D. 38

6. In the formula listed below, what is the number of subjects in your sample?

$$134 \pm L\left(24/\sqrt{38}\right)$$

A. 134
B. L
C. 24
D. 38

3.1 QUIZ: WORD PROBLEM

Directions

This section contains a word problem. Please do your best to solve this word problem without using any resources other than this booklet, a pen or pencil, and a calculator. Write your answers and your work on this booklet. Please do not return to sections one or two at any point. You may take as much time as necessary. When you are finished, please return this booklet with your answers to the instructor.

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Questions

Based on this sample information, should the ABC Company establish a branch in Springdale?

Please explain how you came to your conclusion (please show your work if applicable).

What formula did you use?

What is your current grade point average?

WHEN YOU HAVE ANSWERED ALL OF THE QUESTIONS, RETURN THIS BOOKLET TO THE INSTRUCTOR

Appendix E – IRB Approval Letter

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

Office of Sponsored Programs

301 Burruss Hall
Blacksburg, VA, 24061-0249
(540)231-5281 Fax: (540)231-4384

MEMORANDUM

TO: Nathan Pienkowski
Teaching and Learning

FROM: H. T. Hurd
Director

DATE: November 11, 1999

SUBJECT: IRB EXEMPTION APPROVAL/"Context-Drive Instuctional Design: The Effect of Prior Exposure to the Transfer Task" – IRB #99-294

I have reviewed your request to the IRB for exemption for the above referenced projects. I concur that the research falls within the exempt status.

Best wishes.

HTH/baj

cc: Jan Nespor

A Land-Grant University—125th Anniversary
An Equal Opportunity / Affirmative Action Institution

Appendix F – Consent Form

Context-driven instructional design: the effect of prior exposure on transfer task

Nathan Pienkowski (540) 961-1487
Dr. Mike Moore (academic advisor)

Purpose of the study	This experiment looks at whether certain instructional approaches either hinder or help students to use their skills to solve "real-world" problems. The purpose of this study is to determine whether students are better at solving "real-world" problems when they are told about the problem before receiving instruction.
Procedures	If you choose to participate, you will be given an instructional booklet, asked to read through the contents (following instructions where applicable), and then given some questions. There will be between 5 and 10 multiple-choice questions along with a word problem. The time required to complete the booklet is not expected to exceed 30 minutes. You may refuse to answer any question you do not feel comfortable answering.
Risks	Participating in this study should not present you with any risk. Your professors will not have access to the materials that you complete, nor will any other individuals aside from the researcher. You may refuse to answer any questions that make you uncomfortable and you may choose not to participate in the experiment at any time.
Benefits	There are no direct benefits to you, but your participation in this research might help us better understand how to develop more effective instruction.
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Freedom to Withdraw	You are free to withdraw from participation in this study at any time. Just inform the researcher during the experiment.

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If you participate, you may withdraw at any time without penalty.

____

Signature Date

Appendix G – Summary ANOVA tables

Summary ANOVA table of transfer scores

Source	*df*	SS	MS	F	P
Topic	1	4.824	4.824	31.295	.000
Treatment	1	0.0003	0.0003	.002	.965
Topic x treatment	1	.601	.601	3.900	.051
Error	111	17.109	.154		

Summary ANOVA table of retention scores

Source	*df*	SS	MS	F	P
Topic	1	.005	.005	.073	.788
Treatment	1	.014	.014	.225	.636
Topic x treatment	1	.004	.004	.065	.799
Error	111	7.060	.063		

VITA

Nathan Pienkowski

2008 Englewood Avenue   Durham, NC 27705   (314) 378-5132   nathan@newsagelearning.com

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SUMMARY

Instructional technologist with more than six years of experience designing, developing, and managing technology-mediated instructional products and services of varying type and scale.

PROFESSIONAL EXPERIENCE

8/2000 – PRESENT

New Sage Learning Systems (www.newsagelearning.com)

Founder and president
Established and currently operate a successful e-learning consultancy serving a variety of Fortune 1000 enterprises in various industries.

Wyeth-Ayerst Pharmaceuticals
Led the distance learning initiative that enabled the Global Medical Affairs Division to deliver compliance training to field and corporate employees within an FDA-mandated time frame.

IBM
Designed a variety of online courses to train support staff and channel partners to sell, service, and support PC and Server products.

Blue Cross & Blue Shield of Missouri
Led the design and development of a 12-hour online writing course allowing Blue Cross & Blue Shield of Missouri to reduce travel and classroom hours by as much as 50%.

Ethicon Inc./Johnson & Johnson
Led the design and development of an online course enabling Ethicon to deliver compliance training to over 500 sales representatives spread across the globe.

A.G. Edwards & Sons Inc.
Designed and developed an online orientation course that helped A.G. Edwards to standardize the way that new hires are oriented at over 400 branch offices.

10/1998 – 6/2000

CourseQuest

Founder and president
Founded the first online e-learning portal providing corporate trainers with a single point of access to online courseware from over 30 content providers including DigitalThink (DHTK), UCLA Extension, and Headlight.com.

9/1998 – 6/1999 The Smithsonian Museum of Natural History
Instructional technologist
Assisted in the development of a research prototype designed to enable K-12 students and teachers to engage in scientific inquiry using online virtual museum specimens.

6/1998 - 6/1999 The National Science Foundation
Instructional technology evaluator
Led the evaluation of grant-funded educational technology software developed by the Aerospace engineering department at Virginia Tech.

6/1997 – 6/1998 The Appalachian College Association
Instructional technologist
Assisted the faculty employed at 33 liberal arts colleges in the design and execution of instructional technology initiatives.

1/1996 - 6/1997 Odyssey Research Associates
Instructional systems developer
Led the development of Netbook, an educational groupware system created for the Department of Defense School District (the largest school district in the world) in collaboration with Cornell's Interactive Media Group.

8/1995 – 1/1996 Concept Systems
Performance support systems designer
Developed a performance support system to assist Concept System users in effectively deploying a group planning process.

1/1995 – 6/1995 Hollingsworth & Vose
Instructional technology intern
Established overall instructional technology strategy for Virginia-based manufacturing facility.

8/1994 – 1/1995 Anderson & Associates Engineering
Instructional technology intern
Designed and developed a multimedia new-hire orientation course.

8/1993 – 1/1994 Pulaski Community Hospital
Instructional technology intern
Streamlined the administration and delivery of aseptic technique training to nursing staff.

EDUCATION

2/2002 Virginia Tech
Doctorate, Instructional Systems Technology
Studied distance learning theory and practice. Research focused on problem-based learning. Produced e-learning products for various clients both inside of and outside of the University.

6/1995 Virginia Tech
Masters, Instructional Systems Technology
Studied distance learning theory and practice. Produced e-learning products for various clients both inside of and outside of the University.

12/1991 Virginia Tech
Bachelors, Communications
Studied and practiced formal theories of communication focusing on cinema and television studies, public relations, and journalism.